

River Itchen Steering Group

Sustainable Management of the River Itchen
Special Area of Conservation

Scoping Report – Volume 1

October 2000

Halcrow Group Limited

River Itchen Steering Group

Sustainable Management of the River Itchen
Special Area of Conservation

Scoping Report – Volume 1

October 2000

Halcrow Group Limited

Halcrow Group Limited

Burderop Park Swindon Wiltshire SN4 0QD
Tel +44 (0)1793 812479 Fax +44 (0)1793 812089
www.halcrow.com

Halcrow Group Limited has prepared this report in accordance with the instructions of their client, River Itchen Steering Group, for their sole and specific use. Any other persons who use any information contained herein do so at their own risk.

© Halcrow Group Limited 2000

Halcrow Group Limited
Burderop Park Swindon Wiltshire SN4 0QD
Tel +44 (0)1793 812479 Fax +44 (0)1793 812089
www.halcrow.com

River Itchen Steering Group

Sustainable Management of the River Itchen
Special Area of Conservation

Scoping Report – Volume 1

Contents Amendment Record

This report has been issued and amended as follows:

Issue	Revision	Description	Date	Signed
1	0	Final	31/10/00	

Contents

Executive Summary

1	Introduction	1
	1.1 <i>Terms of Reference</i>	1
	1.2 <i>Content of Report</i>	2
	1.3 <i>Approach to Scoping Study</i>	3
2	Issues and Questions for Sustainable Management	5
	2.1 <i>Introduction</i>	5
	2.2 <i>Assessment of Target Flows</i>	6
	2.3 <i>Sustainability Issues</i>	7
3	Methods, Models and Monitoring for Evaluation of Impacts	14
	3.1 <i>Recommendations</i>	14
	3.2 <i>Framework for Catchment Modelling</i>	21
4	Proposed Work Programme	23
	4.1 <i>Introduction</i>	23
	4.2 <i>Development of Work Programme</i>	24
	4.3 <i>Summary Activities and Duration of Work Programme</i>	32
	4.4 <i>Phase I – Reviews, Analyses, Monitoring & Development of Modelling Database</i>	38
	4.5 <i>Phase II – Modelling & Interpretation of Model Outputs</i>	46
	4.6 <i>Phase III – Investigation of Alternative Management Strategies</i>	48
	4.7 <i>Project Specific Research</i>	50
	4.8 <i>Reporting and Documentation</i>	50
5	Budget Costs of Work Programme	51
6	Conclusion and Next Steps	53
	6.1 <i>Conclusion</i>	53
	6.2 <i>Next Steps</i>	54

Figures

Figure E1 Sketch Map of the River Itchen Catchment

Figure 2.1	Features of the Proposed Sustainability Studies
Figure 3.1	Interaction Between Groundwater Modelling, River Modelling and Environmental Modelling
Figure 4.1	Proposed Strategy for River Itchen Sustainable Management Investigations

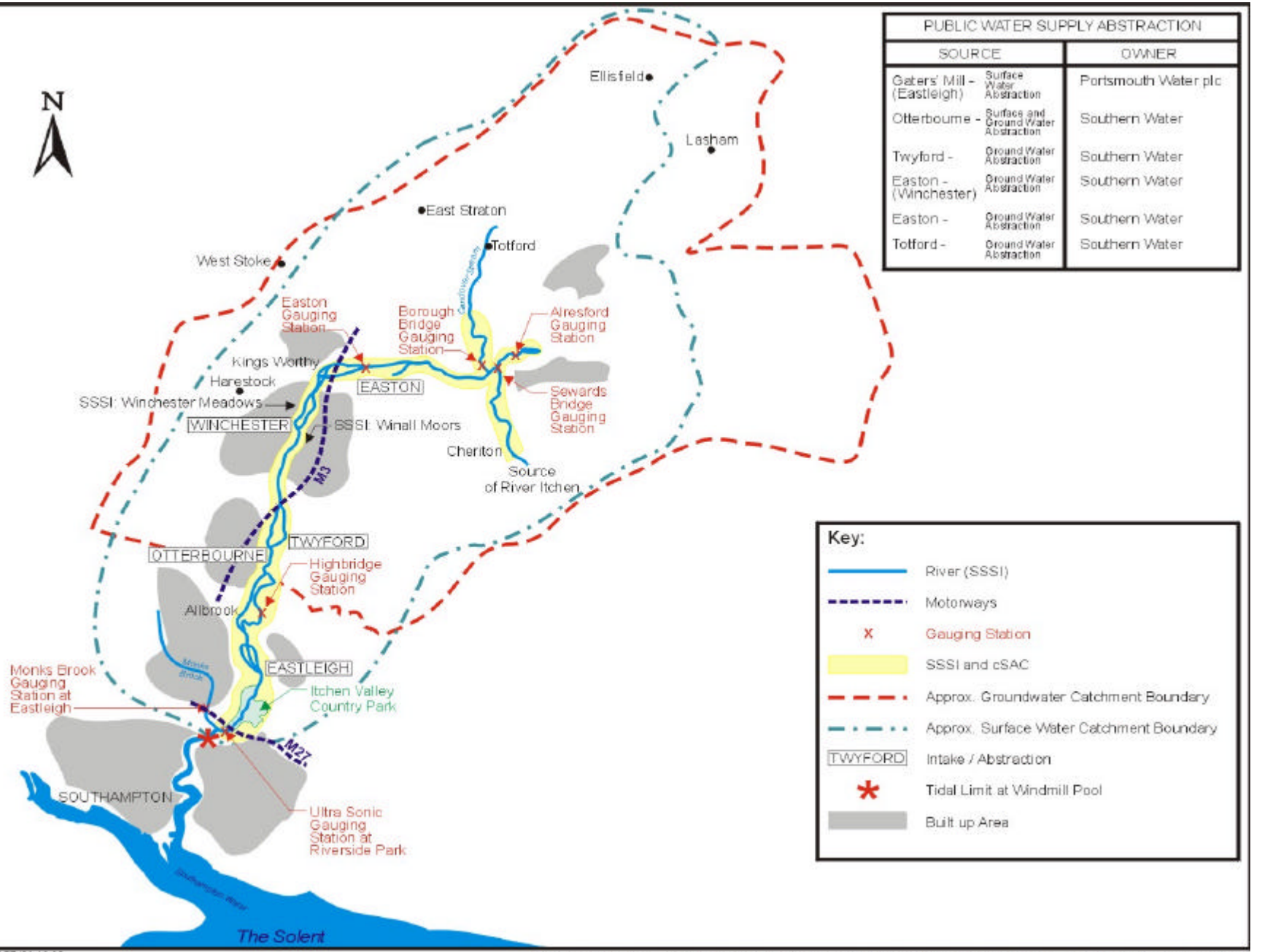
Tables

Table 2.1	Key Issues that will allow Decisions to be made by the competent Authorities
Table 2.2	Key Questions to be Addressed as part of the Investigation of Impacts
Table 4.1:	Summary Justification(s) for Component Projects, Budget Costs, Priorities and Responsibilities
Table 4.2	Tentative Work Programme for Proposed Investigations
Table 5.1	Summary Breakdown of Budget Costs
Table 5.2	Indicative Expenditure Profile (£k)

Annexes – Volume 2

Annex A	Invitation and Terms of Reference
Annex B	Information Reviewed
Annex C	Notes of Consultation Meetings
Annex D	Ecological Review
Annex E	Fisheries Review
Annex F	Hydrogeological Review

Annex G	Hydrological Review
Annex H	Water Quality Review
Annex I	Review of River Modelling, Land Drainage and Morphology
Annex J	Land Use Issues
Annex K	Range of Methods and Models Considered



PUBLIC WATER SUPPLY ABSTRACTION		
SOURCE		OWNER
Gaters' Mill - (Eastleigh)	Surface Water Abstraction	Portsmouth Water plc
Otterbourne -	Surface and Ground Water Abstraction	Southern Water
Twyford -	Ground Water Abstraction	Southern Water
Easton - (Winchester)	Ground Water Abstraction	Southern Water
Easton -	Ground Water Abstraction	Southern Water
Totford -	Ground Water Abstraction	Southern Water

Key:	
	River (SSSI)
	Motoways
	Gauging Station
	SSSI and cSAC
	Approx. Groundwater Catchment Boundary
	Approx. Surface Water Catchment Boundary
	Intake / Abstraction
	Tidal Limit at Windmill Pool
	Built up Area

SKETCH MAP OF THE RIVER ITCHEN CATCHMENT

Executive Summary

Background

In September 2000, the River Itchen Steering Group, consisting of the relevant competent authorities (Environment Agency, Hampshire County Council, Eastleigh Borough Council, Winchester City Council), together with English Nature and the two water companies, Southern Water and Portsmouth Water, commissioned Halcrow Group Ltd (Halcrow) to undertake a scoping study of the River Itchen.

The River Itchen was listed in 'A Price Worth Paying' (the National Environment Programme 2000 – 2005) as a Habitat Directive Site requiring further investigation of the impact of water company operations. The river will also come under increasing pressure from aspects of further planned development including two Major Development Areas in the catchment. The scoping study is therefore concerned with the sustainable management of the River Itchen Special Area of Conservation (SAC), with the overall aim of recommending a suite of methodologies to investigate the impact of water company activities on the critical species and habitats of the SAC. The outcome of the scoping study will therefore guide the approach and methodology for the actual investigation of water company operations on the River Itchen.

Approach

The approach adopted for the scoping study placed more emphasis on a review of information made available in the short timescale of this study, and the generation of ideas based on Halcrow's (and our external advisers) collective experience and background in assessing and modelling environmental impacts on groundwater-fed rivers, and less on a data gathering exercise.

Conclusions

Within the timescale of the proposed investigations, a number of specific studies have been recommended, linking the effects of flow changes with the behaviour of the critical species and habitats of the SAC. In addition, some more general investigations are justified to strengthen these studies and to set them into the context of a highly managed ecosystem that has undergone radical changes and is changing still.

While the River is considered by many people to be one of the most attractive English natural landscapes, the typical Chalkstream such as the Itchen is in fact a highly modified and managed ecosystem. The river has been manipulated, engineered and exploited for many hundreds of years for milling, water meadow operation, agriculture, land drainage, navigation, fishing, water supply and landscaping. As these different interests have dominated and declined so the ecosystem of the river and surrounding methods has

changed considerably. Any management of the river must take account of the historic, current and likely future activities that affect it. It is therefore recommended that an examination of past and present river and riparian management is incorporated into any future study. This must include a consideration of changes in land use and the management of water levels.

On the basis of the information made available and reviewed, we consider that the most suitable approach for the investigations is the one that builds upon the available data, the wealth of experience and knowledge of river management developed by riparian owners over the years, and the water resources groundwater model of the River Itchen catchment. In the recommended approach, we propose that a river model and a suite of environmental models within a catchment-modelling framework should complement the groundwater model. The environmental modelling will involve both ecological models, and habitat models.

We propose a staged approach to the investigations, with the following phases each of which are noted as follows:

- Phase I – Reviews, Analyses, Monitoring and Development of Modelling Database
- Phase II – Modelling and Interpretation of Model Outputs
- Phase III – Investigation of Alternative Management Strategies

A tentative work programme (to be refined on completion of the initial stages of the proposed Phase I activities) has been developed and this is underpinned by the proposed decision process framework which is given as Figure E1. The decision process framework will ensure that the investigations remain '**issue focussed**'.

Next Steps

The River Itchen Steering Group needs to:

1. Commission quickly, the initial stages of the proposed Phase I activities which would be made up of reviews, analyses, monitoring and the development of a modelling database.
2. Review, refine, finalise and agree the tentative work programme proposed for the evaluation of impacts based on insights from the initial stages of the proposed Phase I activities.
3. Once the work programme for the investigations has been agreed, appoint a programme co-ordinator to oversee the timely delivery of the different aspects of the proposed three-phase investigation. The programme co-ordinator will be expected to provide the link between the modelling group and the River Itchen Steering Group.

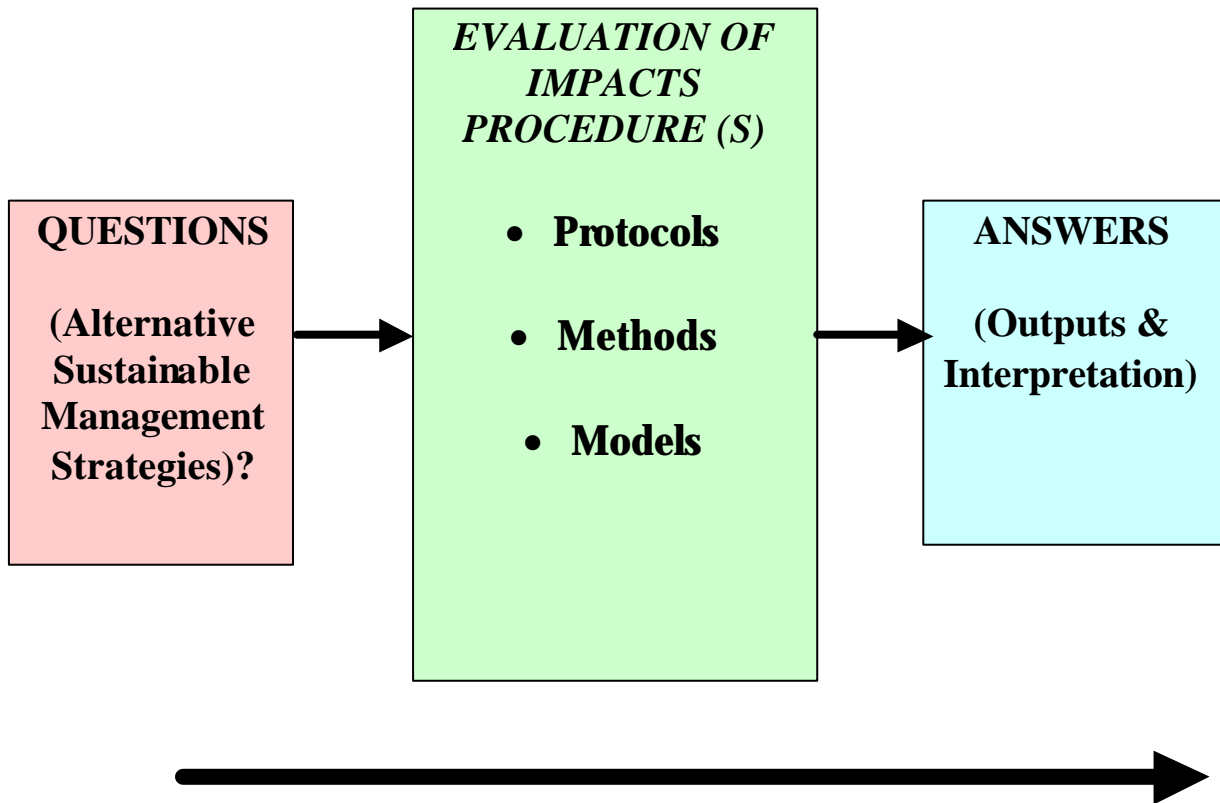


Figure E1 SUSTAINABLE MANAGEMENT: Proposed Decision Process Framework

1 Introduction

1.1 *Terms of Reference*

The scoping study, which is the subject of this report, is concerned with the sustainable management of the River Itchen Special Area of Conservation (SAC). The Client is the River Itchen Steering Group ('The Group') and the project is managed by the Environment Agency. The invitation and terms of reference are given in Annex A, Volume 2 of this report.

The overall aim of the scoping study is to recommend a suite of methodologies and/or models to investigate the impacts of water company activities on the critical species and habitats of the SAC. The Group must in due course be in a position to make soundly based decisions on new and existing developments so that the conservation objectives of the SAC can be met. The scoping study therefore has the following key objectives:

- To identify key issues that will require decisions to be made by the competent authorities;
- To list the significant water management impacts on the ecology of the SAC that will include abstraction, discharges of effluent, runoff from developed areas as well as diffuse sources of pollution;
- To review the available models that may be used to investigate relationships between flow, water quality, ecology and morphology of the river;
- To recommend the most suitable modelling approach and identify studies needed to collect information for the modelling work. This objective to include collation of the types of data available and to identify and cost the collection of data not currently collected or held;
- To ensure that there is integration of the wider river modelling with the groundwater modelling;
- To consider how the importance of water meadows and side carriers can be included in the assessment;

- To develop a timed programme for the investigations and model development;
- To take into account the importance to public health of a reliable supply of drinking water in the context of planned development in Hampshire;
- To consider strategic relocations of public water supply intakes and sewage treatment works outfalls along the river; and
- To provide indicative costings for the work programme.

In essence, the scoping study aims to answer the following questions:

1. What are the state of the art methods and models that can be used to set target flows for the different reaches of the Itchen on a monthly or seasonal basis considering all relevant issues – fisheries, land use, hydrogeology, diffuse pollution, abstractions etc?
2. What data or information or monitoring do these methods and models need? Is available information sufficient - if not what additional investigations need to be carried out for additional data gathering?
3. What is the likely timescale (in view of the constraints of the Habitat Directive programme) and how much will the investigations cost to deal with all of the issues?

The outcome of the scoping study is the subject of this report.

1.2

Content of Report

This document presents the outcome of the scoping study into the sustainable management of the River Itchen SAC. The structure of the document is described as follows.

- Section 1, Introduction – describes the terms of reference for the study, the outline contents of this report, and approach to scoping study.
- Section 2, Issues and Questions for Sustainable Management – a discussion of the main issues of sustainable management and the associated questions. This section also discusses criteria for assessing target flows and includes a wider discussion of the key issues.

- Section 3, Methods, Models and Monitoring for Evaluation of Impacts – this section presents the scoping study recommendations and the proposed framework for catchment modelling.
- Section 4, Proposed Work Programme – an outline of a three-phase work programme for the investigations.
- Section 5, Budget Costs of Work Programme – this section presents indicative costs and the complementary expenditure profile associated with the work programme identified in Section 4.
- Section 6, Conclusion and Next Steps – this section presents the conclusions and identifies the way forward for consideration by the River Itchen Steering Group.

Volume 2 of the Scoping Report contains all annexes to this Volume 1 summary report. Invitation to undertake the scoping study and terms of reference are given in Annex A. The list of information reviewed as part of the scoping study is given as Annex B. Summary notes of Consultation Meetings held between Halcrow and the scoping study consultees are given in Annex C. Notes of the ecological and fisheries reviews are given in Annexes D and E respectively. Summaries of the Hydrological & Hydrogeological Review are given in Annexes F and G. Water Quality Review notes are given in Annex H.

A summary of our brief review of River Modelling, Land Drainage and Morphological aspects are given in Annex I, and review of Land Use Issues is summarised in Annex J. Range of methods and models considered as part of the scoping study is summarised in Annex K.

1.3

Approach to Scoping Study

The approach adopted for the scoping study has placed more emphasis on a review of information made available in the short timescale of this study. The approach involved the:

- generation of ideas based on Halcrow's (and our external advisers) collective experience and background in assessing and modelling environmental impacts on groundwater-fed rivers and less on a data gathering exercise.

A draft scoping report in two volumes was presented and discussed with the River Itchen Steering Group and the relevant Environment Agency regional and area

staff at a meeting at Colvedene Court, Hampshire on 17 October 2000. Feedback from the presentations and discussions has been incorporated into this document.

2 Issues and Questions for Sustainable Management

2.1 *Introduction*

We believe that the goal of sustainable management of the River Itchen SAC must be to achieve reliable, environmentally sustainable and socially acceptable water resource management. Recent public attention on water resources has served to illustrate the often fragile balance, which exists between the demands for a safe, reliable system of public water supply and those of the environment.

In general, it can be said that almost all abstractions of water within the Itchen catchment, from the river or the underlying Chalk aquifer, affect river flows. However, there are questions over the degree of influence of water company activities on the ecology of the River Itchen conservation sites.

The outcome of the investigation of the water company activities by the River Itchen Steering Group in the period 2000 to 2002 may result in the identification of individual and collective constraints for use in future abstraction licensing regulatory framework.

2.1.1 *Issues and Constraints*

In order to develop an environmentally sustainable management plan for the River Itchen it is first important to identify the main issues that management regimes would be likely to affect. These have been identified on a global scale by the Local Environment Agency Plan (LEAP) document for the Itchen but details are summarised in Tables 2.1 and 2.2.

In summary, the River Itchen is an important water source but is also used for land drainage, a recreational resource, and conservation area. All these uses have different management requirements and thus to provide an environmentally sustainable management strategy of the River Itchen, all of these factors must be considered. Summary of the main issues concerning the management of the River Itchen river channel-riparian zone system is:

- Maintenance of a healthy and sustainable river ecosystem;
- Maintenance of the conservation value of the River Itchen;

- Maintenance of a continuous and reliable water supply;
- Maintenance of an adequate land drainage system;
- Maintenance of a flood defence facility; and
- Maintenance of a recreational resource and fisheries.

The water level and flow regime should ideally be tailored to meet as many of the requirements of the various management issues as possible. These requirements vary throughout the year and the requirement of one issue may conflict with the requirements of another. A management strategy must be determined which will allow as many as possible of these objectives to be met.

These requirements may vary spatially throughout the system and thus ideally high water levels may be required at one point in the system whilst low water levels may be required at another location at the same time. The adoption of the proposed catchment-modelling framework (see Section 3.2) would facilitate this process. Implementation of the framework would allow the determination of the magnitude of river levels/flows that are reasonable to conform with specified management aims and how these levels/flows may best be controlled to produce the optimum management regime.

2.2

Assessment of Target Flows

We consider that target flows should be derived on a seasonal basis, and for the different reaches of the River Itchen with a consideration of two basic criteria:

- (a) Environmental criteria i.e. identification of flows, levels and velocities which will support diverse habitats for both flora and fauna and;
- (b) A reflection of natural conditions and sustainable management requirements. The range of annual variation is important, and it is difficult to know what an optimum flow is in any one season. The annual, as well as seasonal, flow variations are important as rivers are dynamic systems.

The two main criteria must be combined to evolve a target flow regime with the historical and natural flow regime compared. Once the questions relating to the degree of influence of water company activities on the ecology of the conservation sites are resolved, then target flows for sustainable management can be assessed,

and the assessment must address all the issues and questions relating to the sustainable management of the River Itchen SAC.

2.3

Sustainability Issues

The main issues relating to the River Itchen and important questions that require addressing as part of the investigation of impacts were developed through:

- a review of the project terms of reference;
- discussions with the Project Steering Group organisations; and
- a review of existing literature and management action plans/ strategies for the River Itchen catchment.

Details of our consultations and reviews are provided as Annex C to this report.

Following this initial consultation /review exercise, a list of issues and a list of questions were produced (see Tables 2.1 and 2.2). These tables represent the Halcrow project team's main focus for identifying relevant methods and methodologies and an appropriate work programme for the investigations as described in the following sections of this report.

The list of issues identified as part of the scoping study is given in Table 2.1.

Table 2.1 Key Issues That Will Allow Decisions To Be Made by The Competent Authorities

No.	Issue
Overall Goal	
G1	Determination of appropriate and sustainable seasonal target flows, levels and velocities for the different reaches of the River Itchen.
Ecology Issues	
E1	Impacts of water company, and other users' activities on ecology of conservation sites.
E2	Range of SAC/SSSI conservation objectives and target species.
E3	Relationship between macrophyte (<i>Ranunculus</i>) and flow .
E4	Management of flood meadows and water meadows.
E5	River engineering and loss of habitat/species.

No.	Issue
E6	Macrophyte growth and management (Identification of an optimum weed cutting regime).
Fisheries Issues	
F1	Factors affecting salmonid incubation success.
F2	Effects of flow on salmonid performance (recruitment, survival and migration).
F3	Effect of flow on performance of other fish species (e.g. brook lamprey and bullhead).
F4	Factors affecting angling success.
Water Quality and River Morphology Issues	
WQ1	Water quality management (Cryptosporidium, endocrine disruptors, and algal blooms in bankside storage at Itchen Valley Countryside Park).
WQ2	Influence of diffuse pollution (including sedimentation and morphological changes) on hydro ecological functioning of the River Itchen.
WQ3	Influence of cress-bed management on water quality.
WQ4	Influence of freshwater flow requirement to Southampton Water and sea level rise on the water quality of the lower reaches of the River Itchen.
Land Use Issues and Land Drainage	
LU1	Influence of changes in land use or land drainage (for example new development or stewardship schemes).
LU2	Management of land use change and development (polarisation into brown field or green field sites).
LU3	Influence of urbanisation (run-off/drainage) on river quality and quantity.
LU4	Value of Sites of cultural heritage.
Water Resource Issues	
WR1	Apportionment of responsibilities for hydrogeological monitoring and investigations.
WR2	Influence of water level management (cress bed operations) and operation of control structures on levels and velocities in the different reaches of the River Itchen.
WR3	Impact of climate change on sustainable management of the River Itchen's Special Area of Conservation.
WR4	Water company periodic Asset Management Planning (Information requirements).
Miscellaneous Issues	
M1	Influence of environmental legislation on sustainable management.
M2	Role of environmental economics in sustainable management of the River Itchen catchment.

The list of issues identified as part of the scoping study is given in Table 2.2.

Table 2.2 Key Questions To Be Addressed As Part of the Investigation of Impacts

No.	Question
Fundamental Questions	
FQ1	What are the key habitat/species to target, protect and manage in a sustainable manner? - is it SAC species? - is it all protected species/habitats? - is it all elements within the River Itchen ecosystem? What is favourable or good status for the target species?
FQ2	What are the effects of different uses, and different use categories on natural variations in flow in the various stretches of the Itchen?
Ecology Questions	
E1	What are the key habitats/species to protect and how should they best be managed?
E2	What defines 'favourable status' within the SAC, and how much seasonal/annual variation should there be?
E3	What target flows, levels and velocities are required to protect the river ecosystem?
E4	Once the key habitats, communities and species (and favourable status) of the river have been clearly defined, what proportion of the river should support them and what types of degradations might affect them?
E5	How can conservation objectives for the Itchen SAC (identified in the Chalk Stream Habitat Action Plan) and other designated sites be achieved and the status of the target species monitored adequately?
E6	What actions (listed in the Chalk Stream, and appropriate Species Action Plan) can be carried out on the Itchen to benefit the habitat and species locally and nationally?
E7	What is the extent and magnitude of impacts by alien species? Are the impacts local or catchment wide in their effects and their sources? Can they be addressed locally or is a holistic strategy necessary?
E8	What is the latest understanding of climate change effects on the flow of the Itchen following the recent two to three years of healthy flow following good recharge between 1998 and 2000?
E9	Can existing ecological models be improved (e.g. improved data for Loughborough model), or new ones developed (e.g. convert LIFE to model macrophytes), to assist in better understanding of the relationship of aquatic species and communities, and flow?
E10	Does existing macrophyte survey data enable rigorous modelling of the effects of flow on macrophytes, and what surveys should be recommended in the future (i.e. continue existing strategies or embark on new ones)?

No.	Question
E11	Since weed cutting is undertaken primarily on <i>Ranunculus</i> , what can be learnt about the generic effects of cutting from the ongoing <i>Ranunculus</i> R&D (reporting due March 2001)? What additional work, if any, is required to develop further, or apply, the R&D outputs to the River Itchen?
E12	How much does the Countryside Stewardship scheme target the floodplains and in particular ditch management for the southern damselfly and other target species?
E13	Where are the locations of river rehabilitation works and have the benefits been investigated and quantified?
E14	What is the extent of over-engineered river reaches in terms of sustaining 'desirable status' for the whole river?
E15	Are the effects of over-engineering exacerbated by changes in flow due to climate or increased abstraction?
E16	What contribution might (practicality) or should (necessity) rehabilitation play?
E17	What are the costs and benefits of past river rehabilitation projects?
Fisheries Questions	
F1	For the purposes of assessing salmonid incubation success, how much information on salmonid incubation success is available from CEFAS?
F2	Can a model to link flow and sediment behaviour in gravels be developed?
F3	Are detailed angling catch records and statistics available?
F4	Can salmon smolt migration data from River Test be compared/extrapolated to the River Itchen?
F5	Are major water intakes impacting smolts?
F6	Can the existing fish migration model for the River Itchen be developed further?
F7	Are water head-retaining structures causing a problem to fisheries?
F8	Are sufficient survey data for other fish species (e.g. brook lamprey and bullhead) available?
Water Quality and River Morphology Questions	
WQ1	What are the main diffuse pollution sources and what are their impacts?
WQ2	What are the implications of future environmental legislation (Water Framework Directive etc), and continuing groundwater recharge with effluent for water quality in the River Itchen catchment?
WQ3	What is the optimum freshwater flow into Southampton Water? And how would this affect water quality?

No.	Question
WQ4	What are the water quality implications of existing and planned water company activities/urbanisation in the Itchen catchment?
Land Use and Land Drainage Questions	
LU1	What is the impact of current and future planned and unplanned land use changes?
LU2	What are the short, medium and long-term development proposals for the Itchen catchment and how can this be accommodated in a sustainable manner?
LU3	What are the existing and planned polarisation of brown field and green field development within the catchment?
LU4	What is the polarisation of brownfield to greenfield sites within the River Itchen catchment, and is there enough brownfield to meet the needs of Major Development Areas?
LU5	How has the land use within the River Itchen catchment changed historically and can change be linked to changes in the River habitats/species?
LU6	What are the existing and projected future numbers, locations and coverage of Countryside Stewardship schemes within the Itchen catchment?
LU7	Are there any measurable benefits to the river, and species using the habitats, developing from existing Countryside Stewardship schemes?
LU8	What can be learnt from the Avon Land Care Project (an encompassing land management scheme on the Hampshire Avon) in terms of the relative effects of land use changes on the river?
LU9	Is a Land Care Project a priority for the River Itchen and how does this relate to the existing Countryside Stewardship scheme?
Water Resources, Hydrology and Hydrogeological Questions	
WR1	What is the existing and planned water companies resource management activities in the Itchen catchment now and in the future?
WR2	What is the degree of influence of current levels of abstractions and discharges on natural river flows, levels and velocities?
WR3	What are the uncertainty ranges to target flows due to water level changes associated with individual and collective local operation of sluices and mills?
WR4	What is the impact of water level and river management (cress beds, sluices, weed cutting) on the Special Areas of Conservation?
WR5	Will a high target flow be acceptable given the need for sustainability of water company operations and planned developments in the south east?
WR6	How much water does the river uses/users need (as a proportion of flows monitored at each gauging station), e.g. at Highbridge for the Itchen Valley Countryside Park?

No.	Question
WR7	How much water is available for use in different parts of the catchment at different times of the year in a wet, dry and average years?
WR8	What is the importance of water meadows and side carriers in the overall flow distribution within the Itchen catchment?
Catchment Modelling	
CM1	What are the limitations and constraints of the catchment modelling database and modelling tools employed in the sustainability investigations?

In the discussion of the issues and questions for sustainable management of the Itchen, we consider that it is important to recognise the relationship between the scoping study and the process leading to the proposed sustainability investigations and implementation of solutions.

This relationship is illustrated in Figure 2.1.

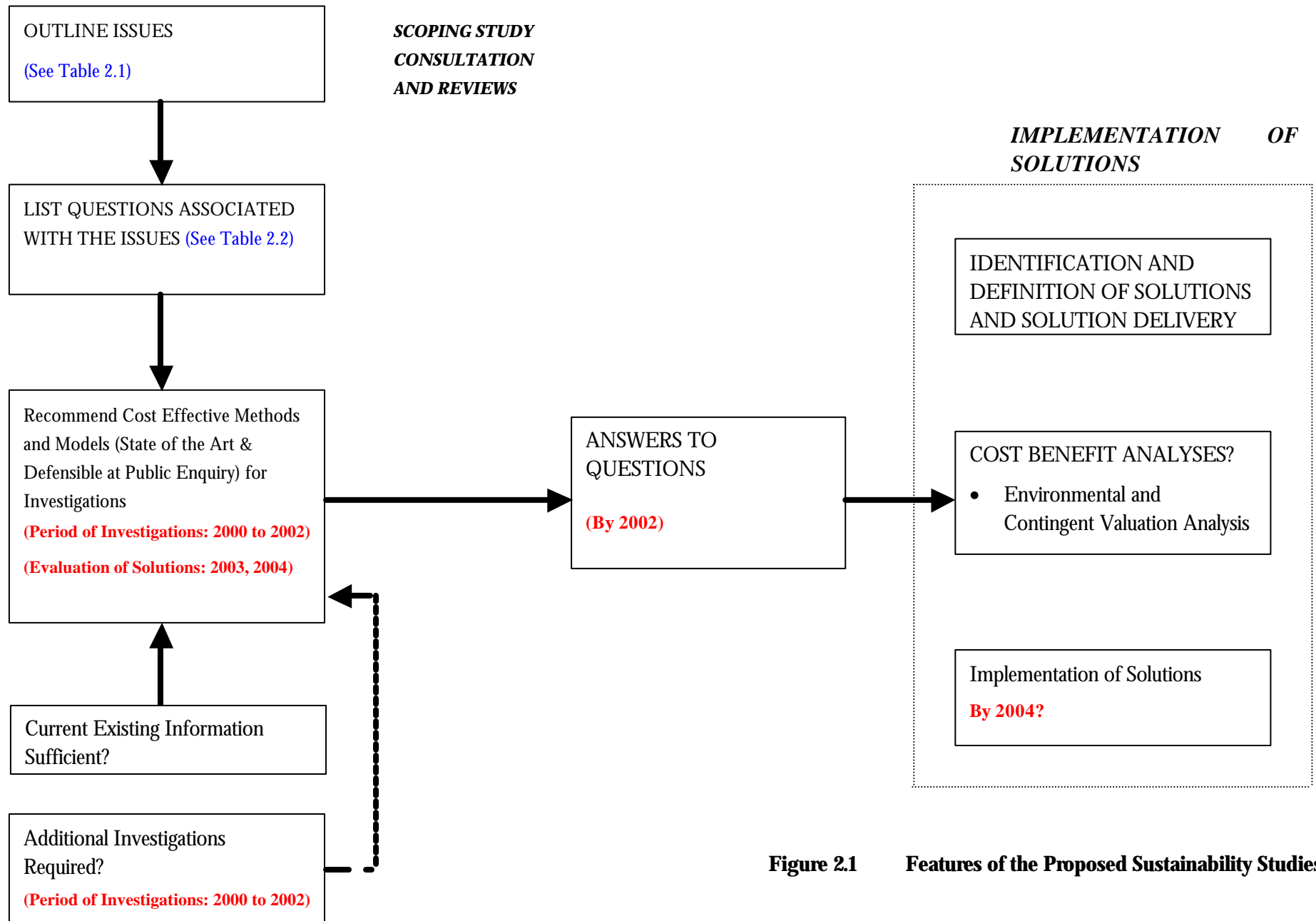


Figure 2.1 Features of the Proposed Sustainability Studies

3 **Methods, Models and Monitoring for Evaluation of Impacts**

3.1 **Recommendations**

The following recommendations are made for the purposes of developing a work programme for River Itchen sustainable studies investigations. The recommendations are grouped under the same key headings used for grouping issues and questions in Tables 2.1 and 2.2.

Fundamental Question:

1. It is important to define what are the target species for the River Itchen and what constitute favourable or good status for these species and how much natural variation this situation should embrace.

Overall Goal:

2. The River Itchen should be considered and managed in an integrated manner taking account of all the critical elements of the river ecosystem. Specific elements of that ecosystem (e.g. SAC species) should not be dealt with in isolation. Interdependencies, which exist between the behaviour of these species and hydrological/hydrogeological conditions) should be recognised in the development of a sustainable management strategy.

Ecology:

3. There is a need for ecological inputs to the development of hydrological, river modelling and groundwater modelling protocols. It is equally important to provide hydrological, river modelling and groundwater modelling inputs into the ecological modelling aspects.
4. Review ecological models – Multi Variate Regression models, Loughborough Ecologist macrophyte model, LIFE, PHABSIM and fish migration model and make final recommendation on models and protocols to be adopted.

The review should include Newcastle University's wetland model (see Volume 2, Annex K) which has previously been applied in South East England for

Southern Water to address the issue of the potential impacts of groundwater abstraction at Hardham on wetland ecology.

5. Macrophyte surveys based on an annual survey of the twenty four 1997 sites using the standard Environment Agency MTR method should be carried out (if required following review of need for surveys).
6. Carry out further analysis and investigation on relationship between *Ranunculus* and flow in the River Itchen.
7. Develop understanding of the natural flow regime throughout the year and the relative effects of abstractions and discharges in poor, average, and good recharge years. This will enable information to be collated on a transparent rationale for setting target flows.
8. Continuous monitoring of other species (in addition to the macrophyte/ecological modelling work) should include crayfish, otter and water vole on the river; southern damselfly on the flood plain (flood meadows, ditches and side carriers) overwintering and breeding survey of wader birds on the floodplain. In addition; the monitoring should include invertebrate monitoring of the river, not just for assessing water quality, but also species-level survey of aquatic, marginal and bankside taxa and alien species such as signal crayfish, mink, Japanese knotweed and Indian balsam.

Monitoring should utilise or supplement work already undertaken or being carried out through the Itchen valley. For example, water vole has been the subject of an intensive monitoring, research and rehabilitation project and results and recommendations should feed into future investigations on the River Itchen. Similarly, a bid for EU Life funding may provide resources for a four year research project investigating the precise ecological needs of the southern damselfly in the Itchen valley and results may influence future studies.

9. It is recommended that methods of survey and model of macrophytes need revisiting. We note that previous data collection exercise by Loughborough Ecologists was not targeted for model use. No more survey should be undertaken until there is discussion and agreement between modellers and surveyors to identify how correlations between macrophytes and environmental variables can be improved.

Fisheries:

10. Much of the management of the river is the responsibility of the riparian owners, especially in respect of day to day fisheries management. The keepers employed to run these fisheries have a wealth of experience and knowledge, albeit largely anecdotal and semi-quantitative at best. Any future study should include accessing the experience of these individuals, by interview or questionnaire.

Information they could contribute includes long-term catch statistics, observations of the impact of flows on fish and fishing, results of electric fishing exercises to remove unwanted fish, and recent history of water level and wetland management.

11. It is recommended that the relative importance of inputs of suspended solids for all potential sources should be assessed in relation to the location of salmon spawning gravels. The pattern of suspended solids concentrations and siltation of salmon gravels at different flow rates should then be modelled using all sources of suspended solids.
12. Investigate feasibility of the further development of the existing fish model of the Candover Brook using all available data to cover a wide range of stream sites. It is also recommended that PHABSIM be explored to establish whether data available for the Itchen is adequate for deployment of this approach. This may lead to a recommendation for more fieldwork. Relevant work from appropriate studies elsewhere e.g. Environment Agency/CEH Wallingford studies on the Rivers Allen, Wylde and Kennet should also be reviewed.
13. Explore development of a simple model based on catch records by reference to insights from a recent investigation on a fishery in upper Wylde.
14. Analyse River Test data for salmon smolt migration to establish whether a relationship between timing of migration and river flows can be derived, and if possible to link this to marine survival.
15. Salmon smolts may be delayed, damaged or killed at large water intakes. It is recommended that Otterbourne and Gaters Mill intakes and their operating regime be examined to establish whether a potential problem exists at these

sites. Initially a site inspection would be all that is proposed but if this gives rise to concern then some field observations at the site may be proposed.

We were advised by Southern Water that installation of screens at their major intake sites are in hand as part of the on-going AMP3 company's investment programme.

16. It is recommended that all available data are analysed using the latest migration modelling approaches to further refine the relationship between river flow and fish migration.
17. Consideration should be given to fish species other than salmonids, including brook lamprey and bullhead.
18. It is recommended that a thorough review is undertaken of the work conducted on siltation of gravels in the Itchen and other Chalkstreams, and of relevant work elsewhere. This may result in a recommendation for further field observations.

Water Resources, Hydrology and Hydrogeology:

19. Definition of Aquifer Base for Groundwater Modelling – Collate new BGS work, existing logging information and any new relevant information forthcoming from study, drilling etc
20. Definition of Aquifer Boundaries for Groundwater Modelling – Examine significance of aquifer boundary definition through model interrogation. Drilling, logging and testing of boreholes close to boundaries, if lack of boundary resolution significant. Analyse borehole hydrograph data.
21. Groundwater modelling – verification of aquifer hydraulic parameters. Carry out quality assessment of existing pumping test data and re-interpretation, as appropriate, using layered radial flow models. Refinement of hydraulic parameters using local layered distributed models for critical valley locations.
22. Hydrogeological verification of the Role of the Tertiaries. Specific hydrogeological study of the tertiaries in the southern enclave is recommended.

23. Delimitation of Superficial Deposits and Aquifer Hydraulic Parameters.
Review significance of the 'clay with flints' in terms of recharge.

Field examination of the clay with flint if found to be problematical, to include some lithological examination and field capacity testing. Delineation of gravel deposits, which are subject to saturation, outside of wetland areas and monitoring of groundwater head variations.

24. Explicit Wetland Studies. Resistivity profiling of wetlands that are thought to be hydraulically important. Augering to determine lithologies and set nested piezometers. Monitoring of transient heads. Measurement of local surface flows and drains in the wetlands.
25. Hydrochemical-Aquifer Hydraulic Constraint Interpretation. Review of existing hydrochemical data and interpretation of chemical water type significance with respect to distribution and possible flow zones. Inclusion of data from new drilling and testing could be directed towards an assessment of nitrate distributions related to future land use.
26. Low and migrational flow records should be analysed in relation to hydrogeological controls.
27. Given that a recharge model development exercise is in hand as part of the Environment Agency's water resources groundwater modelling of the River Itchen catchment, it is recommended that this model be tested in a range of sensitivity analyses to ensure that the different aspects of the catchment rainfall-runoff processes are adequately represented.

This may result in further development of the recharge model.

28. Development of the recharge model database should be co-ordinated with the requirements of the river modelling and environmental modelling aspects of the sustainability investigations.
29. The model parameters used to describe the physical processes encapsulated within the hydrological (recharge) model should be recognisable and must be capable of being related to soil type, geology and land use on the basis of available data.

Water Quality and River Morphology and Sediments:

30. It is recommended that the existing information on nutrient should be collated and diffuse inputs identified by a programme of monitoring and modelling. The impact of any potential changes in flow on nutrient concentrations and algal growth should be modelled.
31. There is a need to investigate relationship between river flow and sediment dynamics with due regard to factors such as sources of sediment and channel morphology.
32. It is recommended that the principal compounds responsible for endocrine disruptors in the Itchen catchment should be identified and the effects of applying proposed Environmental Quality Standards assessed. In the absence of sufficient existing information, a programme of monitoring should be implemented.
33. It is recommended that when examining the effects of changes in flow on water quality, it would be prudent to model the sensitivity of changes in flow to the concentration of all potential contaminants from watercress farms.
34. It is recommended that to identify most of the diffuse inputs to the river, a programme of sampling and modelling should be initiated (if this is proved to be necessary following review of need for sampling and monitoring).
35. It is recommended that further investigations into the quality of the existing information with regards to intermittent discharges should be undertaken.
36. It is recommended that the source of *Cryptosporidium* in Portsmouth Water source at Gaters Mill should be identified and the impact of appropriate treatment methods assessed.
37. With respect to the influence of domestic wastewater on groundwater quality, it is likely that the existing level of monitoring will be sufficient for interpretive use and that no further monitoring work will be required. A review of future legislation (e.g. Water Framework Directive) should be undertaken.
38. Since a river model will need to be developed for the investigation of the distribution of flows, levels and velocities in the River Itchen catchment, a

dynamic water quality simulation model should also be developed based on the river model to investigate impacts of existing and proposed discharges and to provide information for ecological assessment.

39. Since an ISIS model already exists for the middle reaches of the River Itchen catchment, it is recommended that this model be extended to cover the whole catchment and integrated with the water resources groundwater model, the Reading University's Integrated Nitrogen in Catchment (INCA) model of the Itchen valley (see Volume 2, Annex K), and the environmental (ecological models and habitat) models.
40. On going and planned supporting investigations for the water resources groundwater model such as bed level surveys should be co-ordinated with the river modelling work and the environmental modelling work.

Land Use Issues and Land Drainage:

41. The influence of increased Countryside Stewardship schemes in the Itchen valley on the physical and chemical attributes of the river and the distribution and quality of species and habitats should be assessed.
42. It is important to establish the benefits (or dis-benefits) to the River Itchen, and the species of the Itchen habitat, of the existing and proposed countryside stewardship schemes.
43. The availability and suitability of brownfield and greenfield sites for the proposed Major Development Areas on the River Itchen and associated floodplain should be assessed.
44. It would be useful to make use of lessons from the Avon Land Care project (an encompassing scheme on the Hampshire Avon) in terms of the relative effects of land use changes on the River Itchen.

Programme Co-ordination and Management:

45. A programme co-ordinator should be appointed to oversee the delivery of the different aspects of the three-phase investigation and the component studies, monitoring and development and application of recommended methods and

models. The programme co-ordinator will be expected to provide the link between the modelling group and the River Itchen Steering Group.

46. The programme co-ordinator should produce progress reports, working papers etc, and undertake revisions to the work programme throughout the life of the project.

Consultations:

47. It is important to carry out consultations with stakeholders throughout the life of the project, and the consultees should be fully informed of the study findings. To this end a consultation strategy should be developed.

Research:

48. It is likely that research needs will evolve throughout the life of the investigations. To this end, we recommend that allowance should be made for a research budget as part of the development of costs for the work programme.

The above recommendations underpin our proposed framework for catchment modelling, the associated work programme and the budget costs for the investigations.

3.2

Framework for Catchment Modelling

The framework for catchment modelling we propose builds upon the available data, the wealth of experience and knowledge of river management developed over the years, and the water resources groundwater model of the River Itchen catchment.

In the recommended approach, we propose that a river model and a suite of environmental models within a catchment-modelling framework should complement the groundwater modelling work. The environmental modelling will involve both ecological and habitat models. The interaction between groundwater modelling, river modelling and environmental modelling within the proposed catchment modelling framework is shown in Figure 3.1.

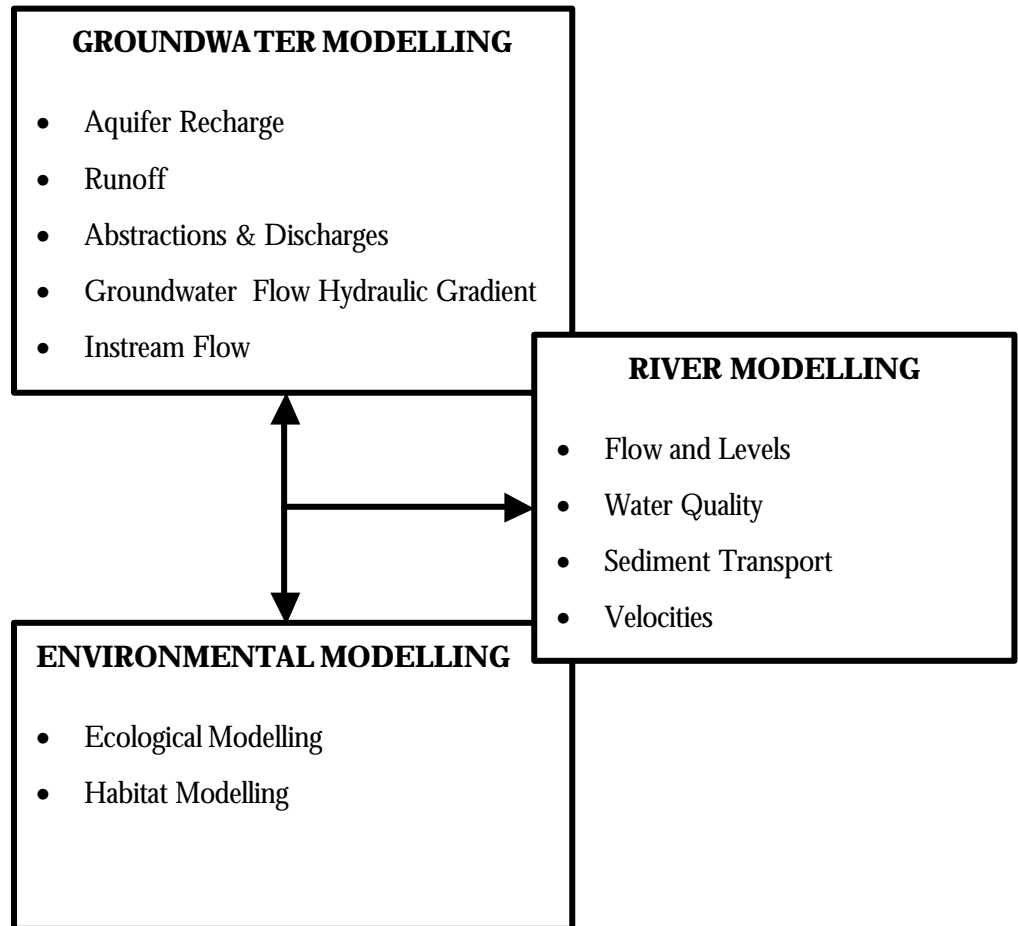


Figure 3.1: Interaction Between Groundwater Modelling, River Modelling and Environmental Modelling

The modelling would be complemented by ecological monitoring (assessing trends and relevant changes) and reviews of past/existing data and management strategies.

4 Proposed Work Programme

4.1 **Introduction**

On the basis of the information made available and reviewed, we consider that the most suitable approach for the investigations is one that involves a groundwater model, a river model and a suite of environmental models within a catchment-modelling framework.

We propose a staged approach to the investigations, with the following phases each of which are noted as follows:

- Phase I – Reviews, Analyses, Monitoring and Development of Modelling Database
- Phase II – Modelling and Interpretation of Model Outputs
- Phase III – Investigation of Alternative Management Strategies

We note that the fundamental constraint for the timescale of the sustainability investigations is the Habitats Directive programme. The period of investigations is 2000 to 2002 and the evaluation of solutions is expected to take place in the period 2003, 2004. By 2002, it is expected that answers should have been provided for the issues and questions highlighted in Tables 2.1 and 2.2 of Section 2.

We also note that work is at an advanced stage by the Environment Agency and the National Groundwater and Contaminated land centre on the development of a water resources groundwater model of the River Itchen catchment. Although this represents a major boost for the sustainability investigations, the limitation of the model in addressing some of the issues of sustainable management is recognised. For example, the model cannot be used to assess the influence of hydraulic or water level control structures explicitly. These constraints have been taken into account in the development of a strategy for the River Itchen sustainability investigation strategy.

The proposed strategy for the River Itchen sustainable management investigations is illustrated in Figure 4.1. A tentative work programme (to be refined on completion of the initial stages of the proposed Phase I activities) has also been

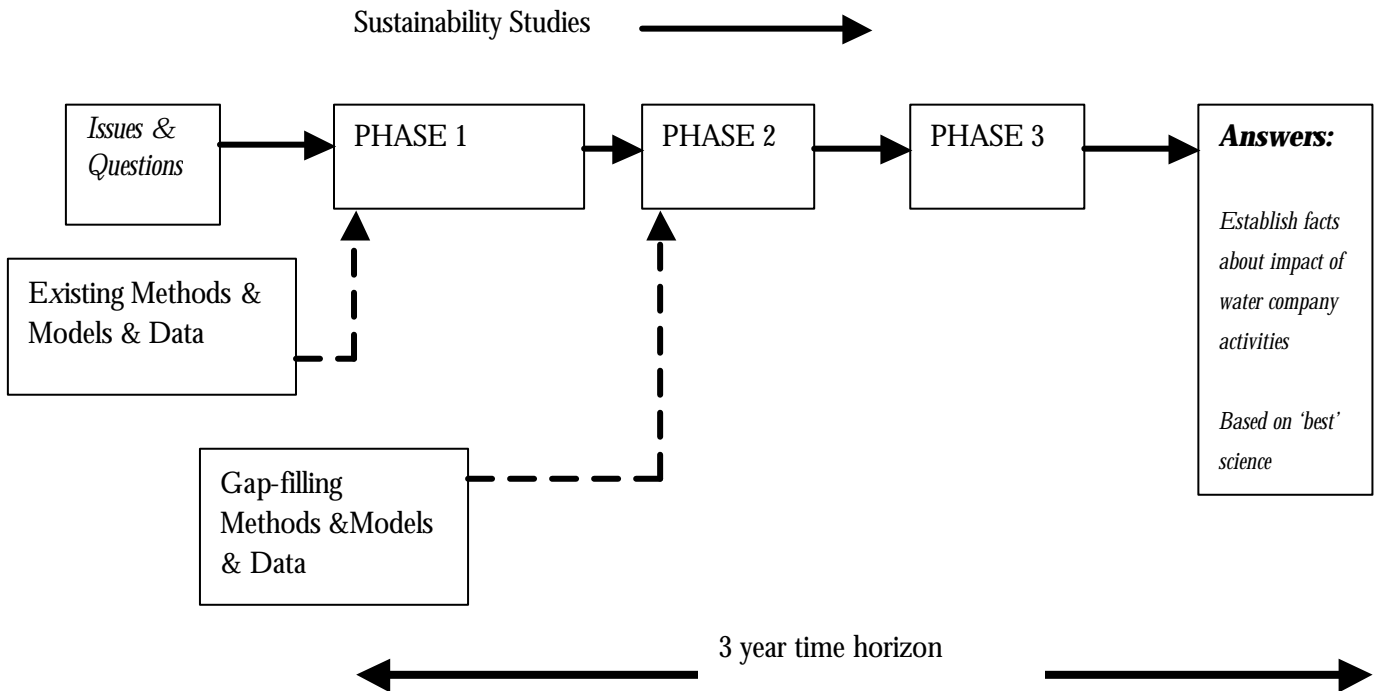


Figure 4.1 Proposed Strategy for River Itchen Sustainability Investigations

developed and this is underpinned by the proposed decision process framework which shown as Figure E1.

Our proposed decision process framework will ensure that the investigations remain ***'issue focussed'***.

4.2

Development of Work Programme

We have considered the issues and questions highlighted in Tables 2.1 and 2.2, and the recommendations outlined in Section 3.1 in the development of the component projects of the sustainability investigations. We have also used the most up to date information in developing budget cost estimates for the individual component projects.

To differentiate between the relative importance of the component projects in achieving the aim of the sustainability investigations, we have assessed project priorities and these have been classified into three broad categories. These categories are:

- Priority 1 - projects that are absolutely necessary
- Priority 2 - projects that are necessary, and will add value to the outcome of the investigations
- Priority 3 - projects that are ideal to have within a catchment modelling framework, but not absolutely necessary

Summary justification (s) for component projects, budget costs, priorities and responsibilities are given in Table 4.1. It is probable that some of the identified key issues identified will not be able to be adequately addressed without the initial stage of review incorporated into Phase I. This has been taken into account in the development of the proposed work programme.

Table 4.1: Summary Justification(s) for Component Projects, Budget Costs, Priorities and Responsibilities

ITEM	ACTIVITY	JUSTIFICATION			BUDGET COST (£K)			RESP' BLE	PRIORITY
		ISSUES (Table 2.1)	QUESTIONS (Table 2.2)	RECOMMENDATIONS ID (Section 3.1)	Co-ordination & Reporting	Agency	Projects		
PHASE I – Reviews, Analyses & Development of Modelling Database					40	228.5	166.5 - 211		
1.1	Define target species and favourable status		FQ1, E2, E5, E6	1	1.5		5	Steering Group	1
1.2	Hydrogeological Investigation and Conceptual Model Refinement	WR1		19, 20, 21, 22, 23, 25	1.5	50		Agency	1
1.3	Verification of the Role of the Tertiaries			22	1.5		8	Steering Group	3
1.4	Hydrochemical – Aquifer Hydraulic Model Interpretation			25	1.5	6		Steering Group	2
1.5	Groundwater Model and Recharge Model Development			27, 28, 29	1.5	169		Agency	1
1.6	Interview/Questionnaire Survey of Riparian Owners – Phase I Consultation			10, 47	1.5		6	Steering Group	1
1.7	Review Potential Ecological Models		E9, E10, F6	4, 9, 12	1.5		10	Steering Group	1
1.8	Review Water Quality Models	WQ1, WQ2, WQ3, WQ4	WQ1, WQ2, WQ3, WQ4	30, 31, 32, 33, 34, 36	1.5		10	Steering Group	1
1.9	Review monitoring data and programmes	E2	E1, E4, E5, E6	8, 9	1.5		5	Steering Group	1
1.10	Review Salmonid Incubation Data and Input to Sediment Studies		E4, F1, F2	11, 18, 31	1.5		5	Steering Group	1

ITEM	ACTIVITY	JUSTIFICATION			BUDGET COST (£K)			RESP' BLE	PRIORITY
		ISSUES (Table 2.1)	QUESTIONS (Table 2.2)	RECOMMENDATIONS ID (Section 3.1)	Co-ordination & Reporting	Agency	Projects		
1.11	Review Itchen Fisheries Survey Data and Relationships	F1, F2, F3	E4, F1, F8	10, 16, 17	1.5		7.5	Steering Group	1
1.12	Review Migration Data and Angling Catch Statistics	F4	E4, F1, F2, F3, F4, F6, F8	11, 13, 14, 16, 17, 18	1.5	2.5	5	Steering Group & Agency	1
1.13	Environmental Inputs into Groundwater/River/Water Quality Modelling Protocols		E11, WQ3, WQ4	3, 21, 22, 30, 32, 33, 36	1.5	1	5	Steering Group & Agency	2
1.14	Review Land Use and Land Care Information	LU1, LU2, LU3, LU4	E4, E12, E13, E14, E16, E17, LU1, LU2, LU3, LU4, LU5, LU6, LU7, LU8	10, 41, 42, 43, 44	1.5		10	Steering Group	1
1.15	Review Ranunculus R & D Output for application to the Itchen		E11	9	1.5		2.5	Steering Group	2
1.16	Review past/present River Management Operations	WR2, WR8, E4, E5, E6	E4, E12, E13, E14, E16, E17, F7	10	1.5		5	Steering Group	1
1.17	Review of Gravel Siltation in Itchen and Elsewhere		E4	11	1.5		5	Steering Group	1
1.18	Investigate Salmon Entrainment on Water Intakes		F5	15	1.5		2.5	Steering Group	1
1.19	If Required, Initiate PHABSIM Fieldwork		F6	12	1.5		15 – 25	Steering Group	3
1.20	If Required, Collect Macrophyte Data		E10		1.5		10	Steering Group	2

ITEM	ACTIVITY	JUSTIFICATION			BUDGET COST (£K)			RESP' BLE	PRIORITY
		ISSUES (Table 2.1)	QUESTIONS (Table 2.2)	RECOMMENDATIONS ID (Section 3.1)	Co-ordination & Reporting	Agency	Projects		
1.21	Undertake ecological monitoring		F6	5, 9, 13	1.5		20	Steering Group	Review after Project No 1.11
1.22	Review existing water quality monitoring data	WQ1, WQ2, WQ3, WQ4	WQ1, WQ2, WQ3, WQ4	30, 32, 33, 34, 35, 36	1.5		5 – 30	Steering Group	1
1.23	Review and Analyse Hydrological Data		WR7	7, 26	1.5		2.5 – 12	Steering Group	1
1.24	Develop Modelling Protocols, QA and Review Procedures	E1, WQ1, WQ2, WQ3, WQ4	WQ3, WQ4	7, 21, 22, 25, 26, 30, 32, 33, 35	2.5		5	Steering Group	1
1.25	Resistivity Profiling of Important Wetlands			24	1.5		7.5	Steering Group	2
1.26	Develop Modelling Database & Revise Work Programme			45, 46	1.5		10	Steering Group	1
PHASE II – Modelling & Interpretation of Model Outputs					56	28	173 – 183		
2.1	Recharge Modelling & Groundwater Modelling	M1, WR3, G1, E1	FQ2, E3, E4, E7, E8, WQ2, LU5, E12, E15, WR2, WR4, WR5, WR6, WR7, LU6, LU7	2, 7, 10, 21, 22, 23, 25, 26, 27, 28, 29, 37, 40, 42	6	25		Steering Group	1
2.2	River Modelling	M1, WR2, WR3, G1, E1	FQ2, E3, E4, E7, E8, F7, E12, E15, LU5, LU7, WR7, WR2, WR5, WR4, WR6, WR3, LU6	2, 7, 10, 26, 40, 42	6		50	Steering Group	1
2.3	Water Quality Modelling	M1, WQ4, WQ3, WQ2, WR3, WR2, WR6	FQ2, E3, E4, E7, E8, LU5, E12, WQ4, WQ2, E15, F7, WQ3	2, 10, 18, 30, 31, 32, 33, 36, 37, 38, 39, 40	6		50	Steering Group	1

ITEM	ACTIVITY	JUSTIFICATION			BUDGET COST (£K)			RESP' BLE	PRIORITY
		ISSUES (Table 2.1)	QUESTIONS (Table 2.2)	RECOMMENDATIONS ID (Section 3.1)	Co-ordination & Reporting	Agency	Projects		
2.4	Hydro-Ecological Modelling	M1, WR3, G1, E1, E3	FQ2, E3, E4, E7, E8, E12, WQ2, E15, F7, LU5, WR7, WR2, LU6, LU7, WR5, WR4, WR6, WR3, LU6, LU7, WR6, WR3, WR4, WR7	2, 6, 9, 10, 37, 39, 42	6		20 – 30	Steering Group	1
2.5	Fish Migration Modelling	G1, E1, M1, WR3	FQ2, E3, E4, E7, E8, E12, WR2, F8, E15, F4, F6, F7, LU5, WR7, LU6, LU7, WR5, WR4, WR6, WR3	2, 10, 12, 13, 14, 16, 17, 37, 40, 42	4	3	12	Steering Group & Agency	1
2.6	Catchment Modelling Outputs & Interpretation	WQ1, WQ2, WQ3, WQ4, WR3	E4, E8, E12, WQ3, WQ4, WR5, WR4, LU6, LU7, WR6	2, 7, 10, 30, 32, 33, 36, 38, 39, 40, 42	6		30	Steering Group	1
2.7	If Required, interpretation of ecological/environmental monitoring results	WR3	E4, E8, E12, WR5, WR4, LU6, LU7, WR6	9, 10, 40, 42	6		5	Steering Group	1
2.8	Prepare Phase II Report			45, 46	12			Steering Group	
2.9	Phase II Consultation				4		6	Steering Group	1
PHASE III – Investigation of Alternative Management Strategies					40	10	140		
3.1	Simulate Alternative Management Strategies	LU1, LU2, LU3, LU4, G1, WQ1, WQ2, WQ3, WQ4, M1, M2	FQ2, E3, E5, E6, E15, WQ2, WQ3, WQ4, LU4, WR2, WR3, WR5, WR6, WR7, CM1	2, 21, 30, 32, 33, 36, 37, 38, 39	8	5	40	Steering Group	1

ITEM	ACTIVITY	JUSTIFICATION			BUDGET COST (£K)			RESP' BLE	PRIORITY
		ISSUES (Table 2.1)	QUESTIONS (Table 2.2)	RECOMMENDATIONS ID (Section 3.1)	Co-ordination & Reporting	Agency	Projects		
3.2	Develop Sustainable Management Strategy	G1, LU2, LU3, LU1, WQ3, WQ2, WQ4, M1, M2, WQ1, WQ2, LU4	FQ2, E3, E5, E6, E15, WQ3, WQ4, LU1, LU2, LU4, WR2, WR3, WR5, WR6, CM1	2, 21, 30, 32, 33, 36, 37, 38, 39	8	5	30	Steering Group	1
3.3	Phase III Consultations			47	8		15	Steering Group	1
REPORTING AND DOCUMENTATION				45, 46	8		15	Steering Group	1
PROJECT SPECIFIC RESEARCH				48	8		40	Steering Group	1

Notes To Table 4.1:

1. For details of activities see Sections 4.2, 4.3, 4.4, 4.5 and 4.6.
2. Priority 1: Absolutely necessary.
3. Priority 2: Necessary and will add value.
4. Priority 3: Ideal, but not absolutely necessary

4.3

Summary Activities and Duration of Work Programme

Component projects of the work programme and the associated budget costs to enable the most cost-effective implementation of the proposed strategy for the investigations are summarised in Table 4.2. The tasks outlined would be carried out within the timescale of the Habitats Directive programme.

Table 4.2: Tentative Work Programme for Proposed Investigations

Item	Activity	Integrate existing model(s)	Timetable in years					Approx. Cost £ K
			2000	2001	2002	2003	2004	
PHASE I – Reviews, Analyses, Monitoring & Development of Modelling Database								
1.1	Define target species and favourable status			—				5
1.2	Hydrogeological Investigations & Conceptual Model Refinement			—				50
1.3	Hydrogeological Verification of the Role of the Tertiaries			—				8
1.4	Hydrochemical – Aquifer Hydraulic Model Interpretation			—				6
1.5	Groundwater model and recharge model development	4	—	—	—			169
1.6	Phase I Consultation – Interview/Questionnaire Survey of Experience and Knowledge of Riparian Owners			—				6
1.7	Review and compare potential ecological models (make final selection)	4		—				10
1.8	Review water quality models (make final selection)	4		—				10
1.9	Review existing ecological/environmental monitoring and management data/programmes	4		—				5
1.10	Review salmonid incubation data and input into sediment studies	4		—				5

Item	Activity	Integrate existing model(s)	Timetable in years					Approx. Cost £ K
			2000	2001	2002	2003	2004	
1.11	Review Itchen fisheries survey data to establish relationships between flow regime and salmonid recruitment success	4		—				7.5
1.12	Review migration data & angling catch statistics to assess relationship among flow regime, fish migration and angling success (updating fish migration model)	4		—				7.5
1.13	Environmental Input to Groundwater/River/Water Quality Protocols	4		—————				6
1.14	Review land use and land care information (make recommendations)			—				10
1.15	Review <i>Ranunculus</i> R&D outputs and propose a management strategy (make recommendations)	4		—				2.5
1.16	Review past/present river management operations (make recommendations for future)	4		—				5
1.17	Review of gravel siltation in the Itchen and elsewhere			—				5
1.18	Investigation into the impact of salmon entrainment at water intakes			—				2.5
1.19	If required initiate PHABSIM and collect field data	4		-----				15-25
1.20	If Required, collect macrophyte data (for Loughborough model)			—————	—————			10

Item	Activity	Integrate existing model(s)	Timetable in years					Approx. Cost £ K
			2000	2001	2002	2003	2004	
1.21	Undertake ecological/environmental monitoring to assess change and sensitivity to changes in flow	4		—————	—————			20
1.22	Review existing water quality monitoring data (collect additional data if required)			-----	-----			5 - 30
1.23	Review and analyse existing hydrological data (collect additional data if required)			-----	-----			2.5-12
1.24	Develop River and Environmental Modelling Protocol & QA Procedures.			—				5
1.25	Resistivity Profiling of Important Wetlands			—				7.5
1.26	Develop Modelling Database & Revise Work Programme – Phase I Report			—				10
PHASE II – Modelling & Interpretation of Model Outputs								
2.1	Calibrate, validate and run water resources groundwater model (including catchment recharge model)	4		—————				25
2.2	Set up, Calibrate, validate and run river model	4			—————			50
2.3	Set up, Calibrate, validate and run water quality model	4			—————			50
2.4	Set up, Calibrate and run ecological models	4			—————			20-30
2.5	Set up, Calibrate and run fish migration model			—————				15
2.6	Interpretation of Catchment Modelling Outputs	4			—————	—————		30

Item	Activity	Integrate existing model(s)	Timetable in years					Approx. Cost £ K
			2000	2001	2002	2003	2004	
2.7	Interpretation of ecological/environmental monitoring results					—		5
2.8	Phase II Report				—	—		Included in co-ordination costs
2.9	Phase II Consultations					—		6
PHASE III – Investigation of Alternative Management Strategies								
3.1	Simulate alternative sustainable management strategies	4			—	—		45
3.2	Develop a sustainable management strategy					—		35
3.3	Phase III Consultations						—	15
REPORTING AND DOCUMENTATION								15
PROJECT SPECIFIC RESEARCH		4		-----				40
CONSULTATION				—————				Included in 1.6, 2.9, 3.3
PROGRAMME CO-ORDINATION								136
Progress meetings, Reporting and Documentation				★ ★	★ ★	★ ★		

Notes to Table 4.2:

1. Key to Work Programme: Required: _____

May Be Required: -----

2. Estimated Total cost of Sustainability Investigations: £888k to £942.5k (covering Phases I, II, and III; Consultations, Programme management & Research Into Gap Filling Methods and Models).
3. The cost estimates given here are budget estimates, which by definition are tentative. These estimates should be revised and refined on completion of the reviews recommended as part of the Phase I activities.
4. A significant proportion of the estimated costs represents staff time costs and expenses by Environment Agency staff involved with the water resources groundwater model development and fish migration studies.

Each of the component studies, which constitute the proposed river Itchen sustainability investigation, are described in the following sections.

4.4

Phase I – Reviews, Analyses, Monitoring & Development of Modelling Database

Project 1.1: Define Target Species and Favourable Status

The purpose of this project will be to identify the key habitat and species to target, protect and manage in a sustainable manner. The project will be carried out in concert with English Nature and staffed with experienced ecological and fisheries advisers. As the outcome of the project is on the critical path for the subsequent stages of the sustainability investigations, it is suggested that the project should be managed by the programme co-ordinator. The project must address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

The project should identify wetlands that are thought to be hydraulically important for input into Project 1.25.

Project 1.2: Hydrogeological Investigations & Conceptual Model Refinement

This project represents the hydrogeological investigations and conceptual model refinement part of the water resources groundwater model currently being undertaken by the Environment Agency modelling group. Activities under the project would include:

1. Geological Mapping.
2. Seismic Investigations.
3. Bed Level Survey.
4. Additional borehole drilling.
5. Additional development of modelling software tool to accommodate variable K_v and variable S_y factors.

Other activities within the project should include the delimitation of superficial deposits and aquifer hydraulic parameters as well as hydrochemical- aquifer hydraulic constraint interpretation. The project must address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

Project 1.3: Hydrogeological Verification of the Role of the Tertiaries

The deliverable for this project essentially represents implementation of recommendation 22, which deals with the hydrogeological verification of the role of the Tertiaries. It will involve a specific hydrogeological study of the tertiaries in the southern enclave of the River Itchen Catchment.

Project 1.4: Hydrochemical – Hydraulic Model Interpretation

The deliverable for this project essentially represents the implementation of recommendation 25, which deals with hydrochemical- aquifer hydraulic constraint interpretation. It will involve reviews of existing hydrochemical data and interpretation of chemical water type significance with respect to distribution and probable flow zones. Inclusion of data from new drilling and testing could be directed toward an assessment of nitrate distributions related to future land use. The project must address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

Project 1.5: Groundwater Model and Recharge Model Development

This project represents a substantial part of the work currently being undertaken by the Environment Agency's modelling group on the development of a water resources groundwater model of the Itchen catchment. It is important for the project to liaise fully with the Steering Group and the project co-ordinator.

The project must address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

Project 1.6: Phase I Consultation - Interview / Questionnaire survey of experience and knowledge of riparian owners

This project represents the main input to Phase I consultations. It will involve the development of a consultation strategy to be adopted through the life of the investigations. The Phase I consultation will be achieved via interviews and/or

questionnaire survey of experience and knowledge of riparian owners. Questionnaires and procedures for consultation will be approved by the River Itchen Steering Group prior to circulation. Information collected will be analysed and results fed into the subsequent stages of the investigations. The project must address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

Project 1.7: Review Potential Ecological Models

This project will concentrate on reviewing and directly comparing the costs and benefits of four ecological models:

- Physical Habitat Simulation (PHABSIM) system
- Loughborough Macrophyte Model
- Lotic-Invertebrate Index for Flow Evaluation (LIFE)
- Site Specific Multi Variate Regression Models

The reviews will concentrate on assessing suitability and performance of models, examining data and current survey methods, identifying future development or data needs, and assessing the potential use of the models for other key species. The project must address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

Project 1.8: Review Water Quality Models

The project will concentrate on reviewing and assessing three water quality models:

- ISIS Quality to be based on the existing ISIS river model of the middle reaches of the Itchen.
- Quality Assessment Along Rivers (QUASAR)
- Integrated Nitrogen Catchment Model (INCA)

The reviews will concentrate on assessing the suitability and performance of the models against the key objectives of the study. Important consideration will be given to the integration of the models within the proposed catchment-modelling framework. The project must address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

Project 1.9: Review Monitoring Data and Programmes

Existing monitoring data, habitat and species management strategies, and proposed monitoring programmes will be reviewed as part of this project, to enable the development of a monitoring strategy for target species/habitats in the River Itchen Valley. This will encompass macrophytes, southern damselfly, water vole, otter, white-clawed crayfish and other target invertebrates. Monitoring will incorporate standard methodologies.

This project will help to define what compromises `good status` for species, communities and habitats. In addition the project will identify the range of SAC/SSSI constraint objectives and target species (see Issue E2). The project must also address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

Project 1.10: Review Salmonid Incubation Data & Input to Sediment Studies

This project will review and assess results from investigations into salmonid spawning/incubation success carried out on the River Itchen and elsewhere. Results and recommendations will be incorporated into sediment dynamic and modelling studies. The project must address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

Project 1.11: Review Itchen Fisheries Survey Data and Relationships

This project will review and assess results from standard Environment Agency electrofishing surveys to establish relationships between flow and salmonid recruitment/success. In addition, surveys results will be used to assess other fish species such as brook lamprey and bullhead. The project must address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

Project 1.12: Review Migration Data and Angling Catch Statistics.

This project will review and assess results from salmon/ smolt migration studies (tracking/tagging/fish counter) and angling catch statistics from the various fishing estates. The data will be analysed for relationships between fisheries migration, angling and the hydrological regime. Information will be input to the fish migration model to facilitate the assessment of relationships. The project must

address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

Project 1.13: Environmental Input to Groundwater/ River/ Water Quality Modelling Protocol

The project will allow freshwater ecologists and salmonid fisheries experts to provide an input in the development of groundwater/ river/ water quality modelling protocols and influence and define the output requirements (e.g. water flow, depth, velocity etc). The project must address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

Project 1.14: Review Land Use and Land Care Information

This project will review and assess past, present and projected future land use and land management practices in the River Itchen Catchment. In particular, the effects on the river habitats and ecology will be assessed. The review will encompass the River Avon Land Care project to evaluate the benefits and potential value for the River Itchen. A land use strategy will be proposed for the catchment as a deliverable, and this will identify and discuss availability and suitability of Brownfield and Greenfield sites. The project must address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

Project 1.15: Review *Ranunculus* R&D Outputs & Propose Management Strategy

Review *Ranunculus* R&D Outputs & Propose Management Strategy. This project will use on-going R&D project outputs to develop a vegetation management strategy for the River Itchen, as well as helping to define 'good status' for the River Itchen Chalk stream community. As part of the review any new research or additional studies specific to the River Itchen will be recommended. A *ranunculus* management strategy will be proposed as a deliverable. The project must address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

Project 1.16: Review Past/Present River Management Operations

This project will review past and present river management operations, river restoration, management guidelines and strategies. The review will encompass Water Level Management Plans, weed cutting, flood defence engineering and rehabilitation works, and will identify the associated constraints, opportunities, impacts and benefits of such actions. A strategy will be recommended that meets the legislative and practical needs of the river uses and users. The project must address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

Project 1.17: Review Gravel Siltation in Itchen and Elsewhere

This project will undertake a thorough review of the research conducted in understanding siltation of the gravels in the River Itchen and other Chalkstreams. This project may result in the recommendation for further field observations. The project must address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

Project 1.18: Investigate Salmon Entrainment on Water Intakes

This project will assess the potential for large water abstraction intakes on the River Itchen system (e.g. Gaters Mill) to delay, damage or kill salmon and smolts. The study would involve an initial site inspection, which may lead to further field observations. The project must address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

Project 1.19: If Required, Initiate PHABSIM Fieldwork

If deemed appropriate, this project would define the objectives of a PHABSIM study, initiate its implementation and undertake field data collection required to set-up and calibrate the hydraulic models. In summary, this would include:

- River inspection, study-site selection and transect selection;
- Transect placement and morphology measurements (should be combined with other channel surveys);
- Depth and velocity measurements for a range of discharges; and
- Substrate and cover measurements for a range of discharges;

The project must address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

Project 1.20: If Required, Collect Macrophyte Data for Loughborough Model

This project will supply additional data for the Loughborough Ecologists model if required. No surveys should be undertaken until there is discussion and agreement between ecologists and modellers to identify how the correlation between macrophytes and environmental variables can be improved. In addition, the macrophyte surveys will provide data to establish relationships between flow and status and monitor favourable status. The project must address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

Project 1.21: Undertake Ecological Monitoring

This project may be required following the review of the existing and future ecological monitoring data and programmes. If additional data is required, best practice and standard methodologies will be employed and a monitoring strategy proposed to establish relationships between flow and status. The project must address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

Project 1.22: Review existing Water Quality Monitoring Data

This project will comprehensively review water quality monitoring data and existing water quality monitoring programmes for the River Itchen catchment to identify whether additional sampling is required. The review will concentrate on:

- Suspended solids;
- Diffuse pollution sources;
- Nutrients (nitrogen and phosphorus);
- Endocrine disruptors; and
- Contaminants from watercress farms.

If required, a water quality sampling and modelling strategy will be proposed. The project must address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

Project 1.23: Review and Analyse Hydrological Data

This project will concentrate on reviewing the existing hydrological and hydrometric data needed to develop the river/water quality models. Following the review it may be necessary to collect additional site-specific data, which will include:

- Streamflow observations
- Streamflow accretion profiles
- Water levels and velocities
- Review of stage-discharge relationships (if necessary)

The project must address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

Project 1.24: Develop Modelling Protocols, QA and Review Procedures

This project will provide the guidance framework for undertaking river, water quality and ecological modelling. Statements on objectives, inputs, methodologies and outputs would be provided, as would the procedures for quality assurance of all modelling work.

It is intended that this project will develop a matrix of Factors (Issues) and Drivers (Causes) to help define modelling/monitoring requirements and establish the major causes of impact. The project must address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

Project 1.25: Resistivity Profiling of Important Wetlands

This project will take output of Project 1.1 and implement recommendation 24 (Section 3.1). It will involve use of techniques of applied geophysics for wetlands, which are thought to be hydraulically important. The project must also address the other relevant issues and questions in Tables 2.1 and 2.2 and implement other relevant recommendations in Section 3.1.

Project 1.26: Development of Modelling Database & Revise Work Programme

This project will assemble, collate and integrate output of Phase I activities and produce a report with details of the modelling database for the water resources groundwater model, river modelling, water quality modelling; ecological, habitat and fish migration models. The proposed sustainability investigation work programme should be refined and revised as part of this project. The deliverable for this project shall be the Phase I report. The project must address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

4.5

Phase II – Modelling & Interpretation of Model Outputs

Project 2.1: Set up, Calibrate, Validate & Run Groundwater Model (including catchment recharge model)

This project essentially represents the ‘modelling part’ of the on going Environment Agency activity related to the development of a water resources groundwater model of the River Itchen catchment. The project will provide outputs in the appropriate format to feed both the river model and the environmental models. The project must address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

Project 2.2: Set up, Calibrate, Validate & Run River Model

This project would extend the existing ISIS river model of the middle reaches of the Itchen for catchment wide coverage. The project will provide outputs in the appropriate format to feed into the water quality model and the environmental models. The project must address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

Project 2.3: Set up, Calibrate, Validate & Run Water Quality Model

This project would establish the water quality model(s), based on the outputs from both the water resources groundwater model and the river model and undertake all work required to provide outputs in the desired format to meet the objectives of the study. The water quality model must be validated with ‘time of travel’ information. The project must address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

Project 2.4: Set up, Calibrate & Run Ecological Models

This project would establish the ecological model(s) and undertake all work required to provide outputs in the desired format to meet the project objectives. The project must address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

Project 2.5: Fish Migration Modelling

This project would up-date and establish the fish migration model for the River Itchen by incorporating new fisheries data and best practice guidelines, and undertake all work required to provide outputs in the appropriate formats to meet the project objectives. The project must address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

Project 2.6: Catchment Modelling Outputs and Interpretation

This project would allow all experts involved in the groundwater, river, water quality and ecological modelling to interpret the results and make recommendations for sustainable management of the River Itchen based on the model outputs. The interpretation phase would be an integrated procedure allowing all functions, users and uses of the River Itchen catchment to be fully integrated within the sustainable management strategy. The project will also include consultations for model validation and a summary matrix of factors and drivers for key aspects of a sustainable management strategy. The project must address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

Project 2.7: Interpretation of Ecological/Environmental Monitoring Results (if required)

This project will only be required if additional ecological monitoring was deemed to be necessary on completion of Project 1.26. It will involve analysis and assessment of the full suite of ecological data to examine and identify ecological change and sensitivity of species/communities to changes in flow, thereby allowing management recommendations to be made. This project would also improve the understanding of 'good status' and facilitate better understanding of natural flow variations. The project must address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

Project 2.8: Phase II Consultation

This project will build upon Project 1.6 – Phase I consultations and will involve consultation with various groups and organisations that may have information and views relevant to the investigations. Some face to face meetings might be necessary and it is envisaged that these will be arranged by the Environment Agency in conjunction with the Steering Group and the programme co-ordinator.

Local conservation groups such as the Test and Itchen valley association will be consulted and informed of study findings. The consultations will be targeted at specific points throughout the duration of the programme to obtain information, comments and input on issues such as:

- historic and current baseline conditions;
- model development and verification; and
- river management regimes.

The project must address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

Project 2.9: Phase II Report

This project will assemble, collate and integrate output of Phase II activities and produce a report with details of the modelling and interpretation of model outputs for the water resources groundwater model, river modelling, and water quality modelling, ecological, habitat and fish migration models.

The deliverable for this project shall be the Phase II report. The project must address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

4.6

Phase III – Investigation of Alternative Management Strategies

Project 3.1: Simulate Alternative Management Strategies

This project would examine alternative sustainable management strategies based on output from numerical simulation modelling of different management/flow regimes. It would be an iterative process involving the input of all experts and the

Steering Group. The project must address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

Project 3.2: Develop Sustainable Management Strategy

Based on the findings from Project 3.1, an acceptable and sustainable management strategy would be identified and formulated. The final strategy would be agreed with the Steering Group and described in detail with identified management structures and clear assignment of responsibilities. The project must address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

Project 3.3: Phase III Consultations

This project will build upon Project 2.8 and will encompass organisations such as the riparian landowners, mill/slucice operators, fishery estates/representatives, cress-bed owners/representative, and local wildlife and user groups. Statutory service authorities concerning services, which may be affected by the implementation of options, considered for a sustainable management strategy shall also be consulted. The consultation at this stage will involve production of a maximum of three draft newsletters for approval by the Steering group prior to circulation to local and interested parties.

To inform the public of the work undertaken, and the sustainability management proposals, it may be necessary for the Steering Group to hold a maximum of three public meetings. This project will provide the following inputs to such a meeting.

1. Display material showing a plan of the River Itchen catchment and river system.
2. Display material detailing the key features of sustainable management proposals.
3. Presentation slides of key features for illustrative purposes.
4. A brochure outlining the background to the investigations, work undertaken, findings and future courses of action. Close liaison with the Steering Group will be needed in the production of the brochure.

The project must address the relevant issues and questions in Tables 2.1 and 2.2 and implement relevant recommendations in Section 3.1.

4.7

Project Specific Research

It is likely that research needs will evolve throughout the life of the investigations. To this end, we have allowed a budget sum for all research activities over the life of the project. Details of research needs will become clearer as the investigation progresses.

4.8

Reporting and Documentation

We consider that it is important to record and report on the process of developing a sustainable management strategy for the River Itchen. The documentation will identify the main issues, objectives, methodologies employed, conclusions and recommendations. It is envisaged that the following documents would be produced:

1. The River Itchen Catchment Sustainable Management Strategy
2. The Project Record (providing detail to the sustainable management strategy)
3. Individual Project Reports (documentation of individual component projects)

5 Budget Costs of Work Programme

Indicative costs for the proposed work programme are given in Tables 4.1 and 4.2. Details of the proposed work programme are also given in Table 4.2. A summary breakdown of budget costs associated with the work programme is given in Table 5.1 below.

Table 5.1 Summary Breakdown of Budget Costs

	Costs (£k)					
	Programme co-ordination, reporting and documentation	Agency (Groundwater model and fish migration studies)	Component Projects	Consultations	Research, Reporting and Documentation	Total
Phase I	40	228.5	160.5 – 205	6	0	435 – 479.5
Phase II	56	28	173 – 183	6	0	263 – 273
Phase III	24	10	70	15	0	119
Research, Reporting & Documentation	16	0	0	0	55	71
Total (£k)	136	266.5	403.5 - 458	27	55	888 – 942.5

An indicative expenditure profile over the period of the sustainability investigations is given in Table 5.2.

Table 5.2 Indicative Expenditure Profile (£k)

Phase		2000		2001				2002				2003				Total
		Q1 - Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
Phase 1	pm	12	7.5 - 8	26 - 28	10 - 13	10 - 12	8 - 9	4 - 5								77.5 - 87
	£ k	60	90.5 - 94.5	130 - 141	48 - 63.5	47.5 - 53.5	38 - 42	21 - 25								435 - 479.5
Phase 2	pm						5	6 - 7	8 - 10	11	9	10	3			52 - 55
	£ k						25.5	30.5 - 35.5	43 - 48	54.5	44.5	49.5	15.5			263 - 273
Phase 3	pm									5	3	7	4	3	2	24
	£ k									24	14	34	19	16.5	11.5	119
Research, Report. & Doc.	pm							4	4	3	3					14
	£ k							21.5	21.5	14	14					71
TOTAL	pm	12	7.5 - 8	26 - 28	10 - 13	10 - 12	13 - 14	14 - 16	12 - 14	19	15	17	7	3	2	167.5 - 180
	£ k	60	90.5 - 94.5	130 - 141	48 - 63.5	47.5 - 53.5	63.5 - 67.5	73 - 82	64.5 - 69.5	92.5	72.5	83.5	34.5	16.5	11.5	888 - 942.5

Notes to Table 5.2:

1. pm – person months
2. Research, Reporting & Doc. - indicates activities related to reporting and documentation, as well as research into gap filling methods.

6

Conclusion and Next Steps

6.1

Conclusion

Within the timescale of the proposed investigations, a number of specific studies have been recommended, linking the effects of flow changes with the behaviour of the critical species and habitats of the River Itchen SAC. In addition, some more general investigations are justified to strengthen these studies and to set them into the context of a highly managed ecosystem that has undergone radical changes and is changing still.

While the River is considered by many people to be one of the most attractive English natural landscapes, the typical Chalkstream such as the Itchen is in fact a highly modified and managed ecosystem. The river has been manipulated, engineered and exploited for many hundreds of years for milling, water meadow operation, agriculture, land drainage, navigation, fishing, water supply and landscaping. As these different interests have dominated and declined so the ecosystem of the river and surrounding methods has changed considerably. Any management of the river must take account of the historic, current and likely future activities that affect it. It is therefore recommended that an examination of past and present river and riparian management is incorporated into any future study. This must include a consideration of changes in land use and the management of water levels.

On the basis of the information made available and reviewed, we consider that the most suitable approach for the investigations is the one that builds upon the available data, the wealth of experience and knowledge of river management developed by riparian owners over the years, and the water resources groundwater model of the River Itchen catchment. In the recommended approach, we propose that a river model and a suite of environmental models within a catchment-modelling framework should complement the groundwater model. The environmental modelling will involve both ecological models, and habitat models.

We propose a staged approach to the investigations, with the following phases each of which are noted as follows:

- Phase I – Reviews, Analyses, Monitoring and Development of Modelling Database

- Phase II – Modelling and Interpretation of Model Outputs
- Phase III – Investigation of Alternative Management Strategies

A tentative work programme (to be refined on completion of the initial stages of the proposed Phase I activities) has been developed and this is underpinned by the proposed decision process framework which is given as Figure E1. The decision process framework will ensure that the investigations remain '**issue focussed**'.

6.2

Next Steps

The River Itchen Steering Group needs to:

1. Commission quickly, the initial stages of the proposed Phase I activities which would be made up of reviews, analyses, monitoring and the development of a modelling database.
2. Review, refine, finalise and agree the tentative work programme proposed for the evaluation of impacts based on insights from the initial stages of the proposed Phase I activities.
3. Once the work programme for the investigations has been agreed, appoint a programme co-ordinator to oversee the timely delivery of the different aspects of the proposed three-phase investigation.

References

Note: For Full List of Information Reviewed (Annex B, Volume 2)

Beard (1990). Effects of discharging sewage effluents to the chalk aquifer in Hampshire. In Chalk, Thomas Telford, London.

Boon et al (1996). SERCON: System for Evaluating Rivers for Conservation. Version 1 Manual, Scottish Natural Heritage Research Survey and Monitoring Report, No. 61, Scottish Natural Heritage, Edinburgh.

Cranston et al (1996). Modelling Macrophyte Status in Hampshire Chalkstreams (Rivers Test and Itchen). Report to the Environment Agency, Southern Region.

Dunbar et al (1996). Guide to Conducting a PHABSIM study in the UK. Institute of Hydrology, Wallingford.

Environment Agency (1999). Test and Itchen Local Environment Agency Plan. Environmental Overview

Environment Agency (1999). Test and Itchen Local Environment Agency Plan. Consultation Draft.

Environment Agency (1997). River Habitat Survey, Field Survey Guidance Manual. Environment Agency.

Environment Agency (1997). Consent Manual Vol. 024B, Version 1.1 (11/97). Environment Agency.

Environment Agency (1996). Design and Use of Fish Counters. Environment Agency.

Environment Agency North East (1996). Guidelines for Monitoring Methodologies for Water Resource Projects – Volume 2. Environment Agency.

Extence et al (2000). River Flow Indexing Using British Benthic Macroinvertebrates: A Framework for Setting Hydroecological Objectives. Environment Agency.

Gowing et al (1994). The Water Requirements of Lowland Wet Grassland Plants. Report to MAFF. Silsoe College.

Holmes et al (1999). Mean Trophic Rank: A User's Manual 134pp. Environment Agency R & D Technical Report E38.

National Rivers Authority (1995). Surface Water Abstraction Licensing Policy Development, Core Report, R&D Note 438. NRA.

National Rivers Authority (1995). Electrofishing in Deep Rivers, R&D Note 303.

National Rivers Authority (1994). National Sampling Procedures Manual – Volume 25 – Quality Management Systems for Environmental Sampling. NRA.

National Rivers Authority (1992). River Corridor Surveys: Methods and Procedures, Conservation Technical Handbook No. 1. NRA.

Pollock et al (1994). Angler Survey Methods and Their Application in Fisheries Management. American Fisheries Society Special Publication 25.

RSPB, NRA & RSNC (1994). The New Rivers and Wildlife Handbook. RSPB.

Solomon et al (1999). Salmon Migration and River Flow – Results of Tracking Radio Tagged Salmon in Six Rivers in South West England. Environment Agency and South West Water.

Standing Committee of Analysts (1988). Methods of sampling Fish Populations in Shallow Rivers and Streams. HMSO.

Standing Committee of Analysts (1985-6). Methods for the Use of Aquatic Macrophytes for Assessing Water Quality. HMSO.

Whitehead (1992). Examples of Recent Models in Environmental Impact Assessment. J. IWEM, 1992, 6, p475-484.

Wright et al (1989). Prediction of Invertebrate Communities Using Stream Measurements. Regulated Rivers: Research & Management 4, 147-155.