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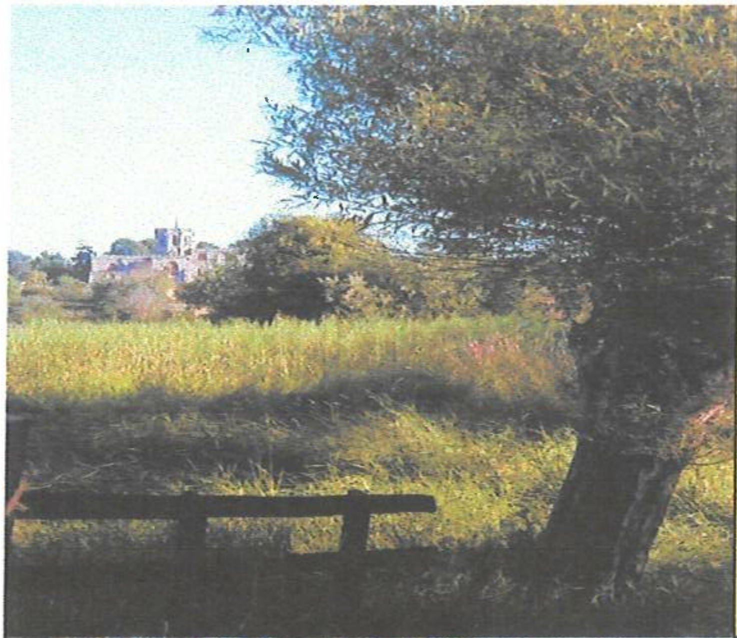
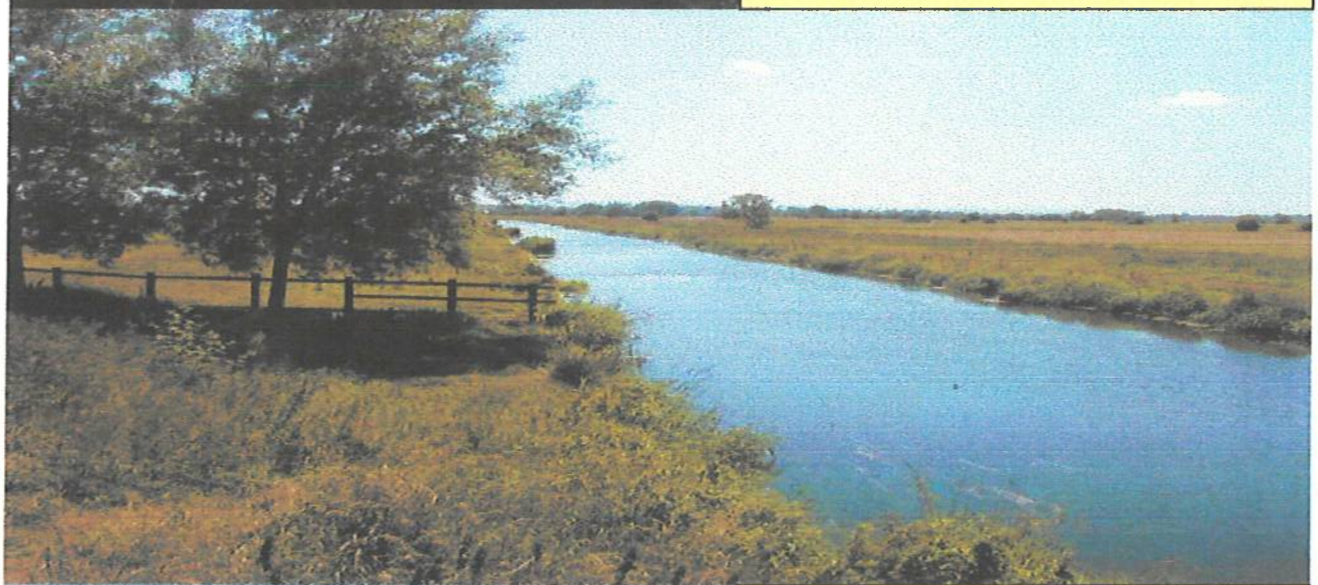


Economic Basis and Practicalities of Washland Creation on the Somerset Levels and Moors



<u>January 2002</u>

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ECONOMIC BASIS AND PRACTICALITIES OF WASHLAND CREATION ON THE SOMERSET LEVELS AND MOORS

Report to:

EU Wise Use of Floodplains Project
River Parrett Catchment

January 2002

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Executive Summary

Context, Aim and Approach

In Somerset, the Wise Use of Floodplains (WUF) Project has developed new ways of helping stakeholders in the River Parrett Catchment to find sustainable solutions for the management of water, both in flood events and throughout the year.

The Project is a partnership formed by the Environment Agency, Somerset County Council, The Levels & Moors Partnership (LAMP), RSPB and English Nature. It is an EU-LIFE Environment funded project, which is pioneering an integrated approach to sustainable flood and water management, by involving stakeholders fully in decision-making on the future management of the water resource. This work has been driven forward by a coalition of initiatives, which also include the Parrett Catchment Project (PCP) and the Environment Agency's local Review of Flood Management Practices (RFMP).

This report has been commissioned by the WUF Project, on behalf of all the local flood and water management initiatives, to consider the opportunities for redistribution of winter and summer flood water in the Parrett catchment in a way which will reduce the adverse effects of unwanted flooding and simultaneously exploit the beneficial opportunities that the managed storage of floodwaters would bring to the local economy, the environment and the community.

In this context, this study explored how public funds might be used most effectively to achieve better flood moderation through appropriate use of agricultural land in the mid and lower Parrett catchment on the Somerset Levels and Moors. It set out to determine the technical feasibility of flood storage and washland creation, the likely economic impacts of this type of development, and the financial and institutional mechanisms required to achieve implementation.

For this purpose the consultants carried out site review and visits, discussions with key informants and a participatory workshop with key stakeholders which captured responses to the broad options for the delivery of washland creation. The enquiry used a number of 'indicative' case study sites which provided a basis for analysis.

Technical Feasibility

The identification process classified five broad categories of flood storage initiatives or 'project types', which could be pursued in different parts of the Parrett Levels and Moors. These project types constitute the means by which a modified flood management strategy might be delivered. The projects variously involve more effective discharge of excess water to sea, temporary storage and managed evacuation of water in the lower levels, and holding back potential flood waters in the middle catchment.

Criteria for screening site selection for storage were developed and applied across the Parrett Catchment. These were hydraulic suitability (ease of filling, evacuation and containment), existing flooding regimes, opportunity for environmental enhancement, suitability of land use, and site constraints such as that imposed by settlements and infrastructure.

Following a reconnaissance level enquiry, four possible sites were identified out of a larger number. These sites were used to progress the study objectives with respect to environmental and economic assessment. Detailed proposals for and appraisal of development on these sites were not carried out, nor was this intended. The cases have been used to progress the concept of managed flood storage and washland creation.

Range of Benefits

The Parrett hydraulic system reflects a long history of flood defence and land drainage activities and there are wide ranging benefits and costs associated with managed flood storage. There are important links between flood defence, water regime management, land use and farming practice. Commercial agriculture is dependent on managed water regimes. In recent years, flooding in some areas of the Levels and Moors has been excessive, to the point where farming futures are threatened.

There is scope, through a managed approach to flood storage, to provide relief to those farmed areas worst affected by long duration flooding at the present time, and simultaneously provide new opportunities for washland creation in other areas. There is scope to develop, through the use of appropriate promotional mechanisms, washland areas which will simultaneously accommodate winter inundation, support extensive farming methods, deliver environmental benefits, and do this in a way which can underpin the rural economy.

Tourism and recreational activities would also benefit from a flood regime that served to enhance the wetland characteristics of the area, provided that access and mobility were maintained. The same could be said for the preservation of archaeological remains. However, the traditional production of withy would suffer from long duration flooding or permanently high water levels, although this could be relocated beyond the washland areas.

Managed washlands would, as previously stated, alleviate flood damage and disruption borne by those areas currently at risk, as well as incidental flood damage in other areas in all but the most extreme events. Given that the washlands offer a managed facility, they could take pressure off flood defences which protect urban property and infrastructure. They could also reduce the impact of uncontrolled flooding of communications infrastructure and the disruption this causes to economic and social activity, both locally and regionally.

The flood storage options could re-orient capital and revenue expenditure in the Levels and Moors more towards flood 'management' than flood 'defence' per se. This would serve to reduce the uncertainty of the impacts of flood events and provide responsible agencies with greater flexibility for flood management. The flood storage options would contribute to sustainable flood management in so much as they could provide a cost-effective basis for reconciling social, economic and environmental objectives in the Parrett flood plain.

Conservation Interests

The main conservation objectives in the Somerset Levels and Moors concern:

Wintering wildfowl;
Breeding waders;
Rare aquatic invertebrates and diverse aquatic plant communities;
Species rich lowland wet grassland features; and,
The wider wetland.

These objectives are pursued through the designation of SPA, Ramsar and SSSI sites, and the Natural Area Biodiversity Action Plan (English Nature, 2001). In that these objectives require management of water regimes, with respect to both flooding and groundwater levels, they can be met through judicious management of flood storage areas and washlands.

There are however potential conflicts of interests between environmental components which will require careful management of flooding regimes, especially in the spring period. This applies particularly to flood sensitive species rich plant communities. Agricultural interests can best be served by establishing inundation grassland (MG13/OV28), but there is scope for productive use of species rich pastures under careful management (MG4/5/8/7C/M22/24).

Financial and Economic Impacts

Two broad scenarios are identified for the assessment of changes in flood regimes which are distinguished in terms of their severity and impacts, namely:

- Damage and recovery scenario: relatively small changes in annual flood risk, which may include infrequent long duration events, but not to the degree that results in changes in agricultural land use. Examples include damage to the yield of grass or cereals, in some cases requiring reseeding of grass or winter cereals.

- Land use change scenario: significant change in flood risk which results in a shift in land use and farming practice, for example a shift from arable to grassland, or from intensive to extensive grassland.

Figure S.1 contains estimated flood damage costs on improved grassland according to the duration (in weeks) and depth (75mm to over 750mm) of flooding during the winter (October to March). Short duration flooding of about 1 to 2 weeks in mid winter has little impact, with costs of around £15/ha, including clean-up costs. Long duration floods of 2 months or so are likely to kill 'improved' ryegrass varieties and require reseeding at a cost of about £200/ha. Persistent long duration flooding of more than 2 months would encourage a stitch to a lower intensity land use with an estimated cost of about £170/ha to £220/ha

The tolerance to flooding depends on the timing of the flood and whether the period of inundation is continuous or made up of discrete events which might allow some intervening recovery. A month's flooding in March, however, on the onset of grass growth, could severely damage improved grasses. Thus, on improved grasses, the damage curve is likely to rise more steeply than indicated in Figure S.1 for continuous flooding of 5 to 8 weeks which occurs in late winter/early spring, after which it would plateau quickly at the maximum damage costs.

Figure S.2 shows the impact of flooding on ESA Tier 1 type grassland which is subject to limits on fertiliser use and hence livestock carrying capacity. Flood costs are proportionately lower than for improved grass, but the same principles apply.

For arable crops, it is assumed that winter flooding of more than a few days would destroy the crop and require reseeding with a lower yielding spring cereal, if feasible. Damage costs could be about £450 to £500/ha.

Figures S.1 and S.2 also indicate the value of flood alleviation relief that might be obtained where there are reductions in flood risk due to controlled washland flooding elsewhere. This could be the case, for example, in parts of the Tone catchment currently experiencing extensive flooding.

Standards of flood defence have a major influence on land use options and agricultural practices, not only as a consequence of surface flooding but also, and often more critically, as a consequence of waterlogging of soils. In many respects the land use in the Parrett catchment reflects these drainage circumstances, modified by ESA prescriptions where these apply. A change in flood risk associated with the adoption of flood storage options could involve a change in land use, for example from intensive to extensive grassland

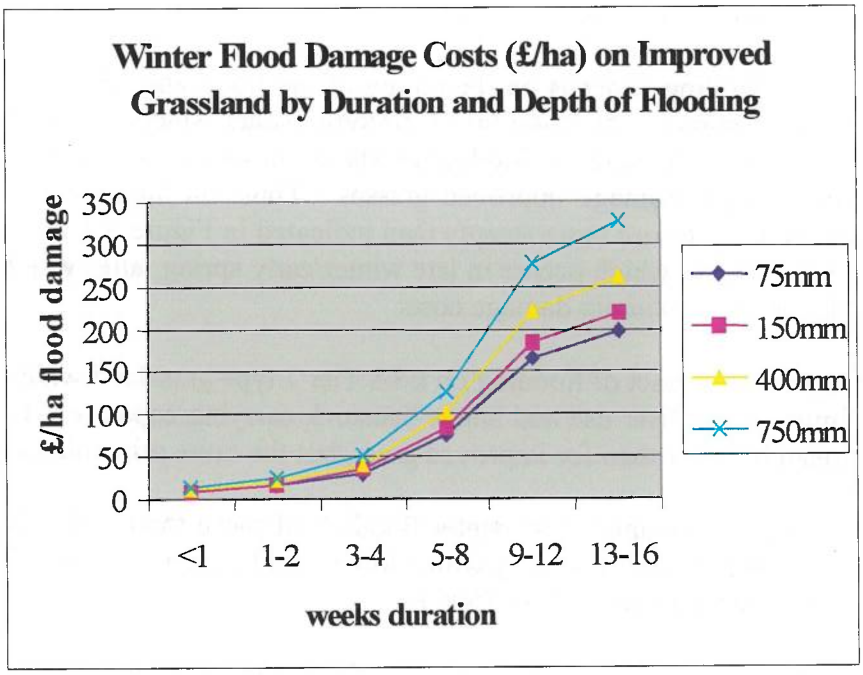


Figure S.1

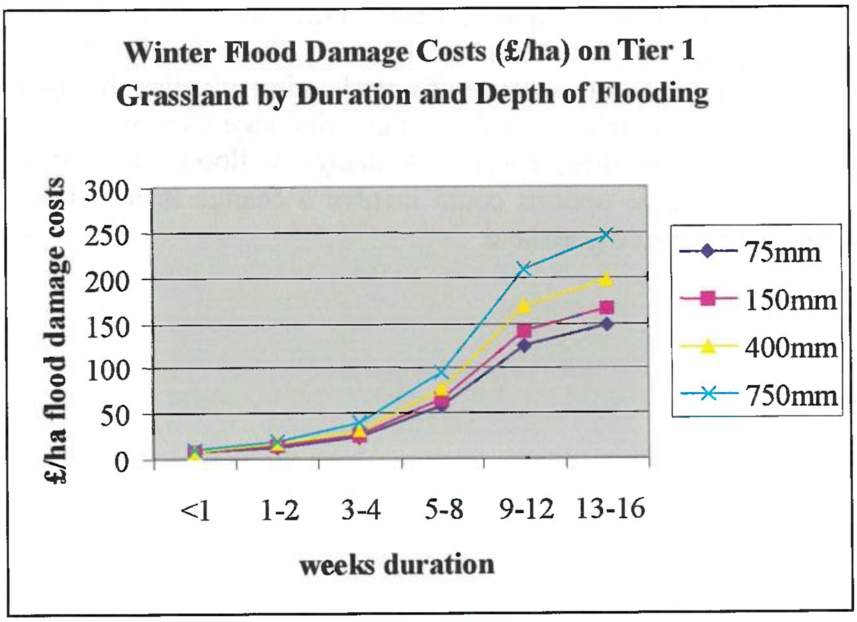


Figure S.2

Table S.1 shows estimated financial returns for the major grassland and livestock management systems in the Parrett floodplain (Returns for cattle and sheep systems only are significantly lower than those shown in Table S.1). Grassland is classified into improved grass and ESA Tiers 1 through to 3, each of which has its own management prescription.

Table S.1 Financial Returns by Grassland Management System: Parrett Catchment Dairy, Beef and Sheep combined systems

£/ha	Improved	Tier 1	Tier 1A	Tier 2	Tier 3 sedge	Tier 3 species rich	Tier '4' wash-land
Stocking rate Lu/ha	1.60	1.39	1.00	0.68	0.37	0.41	0.70
GM	**791**	**701**	**503**	**343**	**185**	**208**	**353**
Forage	255	168	97	130	140	66	82
GM after forage	**536**	**533**	**407**	**213**	**46**	**142**	**270**
Fixed Costs							
semi fixed*	217	188	135	92	50	56	94
full fixed**	403	350	251	171	92	104	176
Net Margin after:							
semi fixed costs	320	345	272	121	-4	86	176
full fixed costs	133	183	153	42	-47	38	94
ESA payments		**125**	**200**	**225**	**430**	**430**	**300?**

Fixed costs: * direct labour and machinery operating costs only, ** including labour costs, machinery operating and depreciation, and housing/building costs for stock.

A Tier '4' Washland package has been identified which comprises flood tolerant grass species and related grassland management, and offers potential advantage over the current Tier 3 arrangements. The financial indicators include gross margins (output less direct costs such as fertiliser and feed), and different definitions of net margins according to whether semi-fixed costs are charged (such as some direct labour and machinery operating costs) or full fixed costs (including full labour costs and depreciation on machinery and buildings).

A switch from improved grass to Tier 4 would, for example, result in an estimated annual reduction of about £260/ha (£536 less £270 in Table S.1) in gross margin (after forage costs) for the assumptions made. However, over the longer term, if farmers achieve savings in labour, machinery and buildings costs as they switch from relatively intensive dairy-based on improved grass to an extensive Tier 4 system, the loss in net margin (after full fixed costs) is much less, at about £40/ha (£133 less £94 in Table S.1) It is apparent from Table S.1 that farmers can draw benefit from signing up to Tier 1, with an ESA payment of £125/ha, compared to improved grass. Indeed, this is what has happened in practice.

By way of example, Table S.2 shows the income losses (excluding ESA payments) associated with a switch from Tier 1 Grassland (the dominant grassland system) and arable systems to an extensive so-called Tier '4' washland system. For the overall dairy and livestock mix in the Parrett catchment, the reduction in gross margins is about £260/ha, and in net margin (after full fixed costs) about £90/ha. The impact of a switch from cereal-based arable cropping to washland is also shown.

Table S.2 Reduction in the value of financial indicators associated with a switch from Tier 1 grassland or arable to extensive grazing on washland (before ESA payments, but including area payments on arable)

£/ha/yr reductions 2001 values	Dairy	Beef	Beef and Sheep	'Average' Catchment Dairy and Livestock	Arable
Gross Margin (before forage costs)	410	280	260	350	300
Gross Margin (after forage costs)	330	190	170	260	300
Net Margin after semi fixed costs*	215	140	100	170	150
Net Margins after full fixed costs**	150	80	0	90	90

* direct labour and machinery operating costs only ** including labour costs, machinery operating and depreciation. and housing/building costs for stock.

On the basis of the estimates in Table S.2, and given that the existing payment for Tier 1 is £125/ha/yr, Table S.3 shows the payment that might be required to 'compensate' for income lost (ie income loss from a switch to washland plus Tier 1 payment forgone)

At present ESA rates, annual payments would probably need to be about £300/ha/yr (in 2001 values) to attract farmer interest. Where whole farms are involved, and there is opportunity to save fixed costs such as labour and machinery due to extensification, such a payment would provide additional incentive to adopt the Washland option. An analysis of whole farm budgets for dairy farms and beef farms in the catchment showed that a payment of about £300/ha/yr would maintain the viability of these farms in a washland environment. Site specific environmental enhancements would need to be identified and built into the washland prescriptions. It envisaged that the washland option would specify grassland management requirements such as grass sward composition, grazing/cutting regimes, and zero chemical nitrogen. Scheme administration costs would be additional.

Table S.3 Payments to compensate for loss of income compared to Tier 1 inclusive of Tier 1 ESA payments.

£/ha/yr Washland Payments	**Dairy**	**Beef**	**Beef and Sheep**	**'Average' Catchment Dairy and Livestock**	**Arable**
GM after forage	455	315	295	385	300
NM after semi fixed costs	350	265	225	295	150
Net Margin after full fixed costs	275	205	125	215	90

These are derived by adding the ESA payment of £125/ha/yr to the estimates in Table S1

An economic analysis of washland creation, using DEFRA guidance for the analysis of flood defence projects, showed that, at current levels of government support to agriculture, there appears to be economic advantage of moving to extensive washland farming systems. This is because, after stripping out the costs of subsidies to the livestock sector, the majority of dairy, cattle and sheep show negative returns after full costs. That is, there would be a net benefit to the national economy of reducing the intensity of farm production in the Moors and Levels. Such a process would simultaneously reduce the negative environmental effects of intensive farming practices. Given the opportunity to achieve economic and environmental benefits through washland creation, and through targeted support to help sustain incomes to the farming community, it would appear in the public interest to redirect funding, both from agricultural support and flood defence for agriculture, into flood storage and washland creation.

As discussed below, one approach to the introduction of flood storage on washlands is to purchase land from current owners for the purpose. At present land prices, purchase would cost of between £2000/ha and £3750/ha, according to land characteristics. A premium over agricultural land prices may be needed to encourage sales. A land bank to support land swaps would improve the acceptability of this option. The costs of land transactions would be additional. Another option, that of an easement paid to land owners to accept flooding (see below), would probably need to approach 80% to 100% of the market value of the land.

Administrative Options for Flood Storage

Alternative forms of management and administration for washland creation and operation include land purchase, easements on flooding, management agreements supported by annual payments and leaseback partnership arrangements. These were screened against the criteria of effectiveness, efficiency, fairness, risks and whether they had a good chance of meeting the overall objective of wise use of flood plains.

The suitability of these options varies according to the purposes to be achieved, the need to provide long term robust solutions, and, linked to these, the preferred link between the farming community and the management of the land.

All of the aforementioned approaches are potentially feasible. Land purchase, annual payments and leaseback have their particular advantages, disadvantages and risks, and suit the interest of different groups (Table S.4). Easements may be appropriate to accommodate modest increases in flood risk, but probably not for regular deep flooding and where there is a wish to achieve environment enhancement.

The most common view expressed by owner-occupier farmers was a preference for land sale 'at a realistic price' with help to acquire land elsewhere, or rent back the land under a secure tenancy arrangement. Annual payment regimes were considered vulnerable to the availability of funds and policy priority, and would need to be secured for the long term. They also can create a culture of dependency.

The diversity of circumstance and practice in the Levels and Moors suggests that a diversity of approaches to washland administrative arrangements will be needed. A mosaic of land tenure arrangements may be acceptable provided this can deliver the scale, integration and reliability of service required.

Costs of Acquiring Flood Storage Capacity on Farm Land

Assuming depths of flooding between 75mm and 750mm, analysis showed that the capital costs associated with purchase of land or easement could vary between £5/m3 and £1.5/m3 of storage respectively. Clearly, there are economies in depth if the main purpose is storage capacity. The annual equivalent costs associated with either purchase or annual payments range between £0.04/m3 capacity/yr and £0.12/m3 capacity/yr, depending on site conditions. These are land acquisition costs only. They exclude design, supervision, engineering works and operation and maintenance costs. A meaningful estimate of costs needs to include the latter.

The costs of providing flood storage facilities are very site specific, varying according to flood characteristics and impacts. Recently estimated design and build costs for floodwater retention schemes in the upper-middle catchment of the Parrett were £2.2/m3 of storage capacity for a 24 ha scheme and £4.7/m3 for a 7 ha scheme. This is equivalent to between £0.16/m3 capacity/yr and £0.34/m3 capacity/yr respectively. Land costs would push total capital costs up to £3.1/m3 and £6.5/m3 respectively, and equivalent annual costs to £0.23/m3 capacity/yr and £0.47/m3 capacity/yr, excluding any flood management operating costs. Costs per m3 actually stored in a given season would be less than this according to the throughput of flood waters.

It is likely that the capital and operating costs of 'engineering' washland projects will replace some costs currently committed to conventional flood defence. The incremental costs of washland development may, therefore, be relatively low. But again these aspects will be site specific.

Mechanisms to Achieve New Washlands

Institutional and administrative arrangements for flood storage and washland creation will reflect land management and funding mechanisms. Given the multiple objectives to be served, a Washland Programme organisation with membership drawn from key stakeholders, could provide strategic direction and management, delegating responsibility for administration of the programme and its constituent projects to member organisations as appropriate. The flood storage facility would be managed by the Environment Agency in collaboration with DEFRA and the Internal Drainage Boards. Statutory and voluntary conservation organisations could variously manage operations at project area level. If it was decided to progress washland creation through an annual payment regime, it would make sense to administer this through existing mechanisms such as those operated by DEFRA or English Nature.

Table S.5 Administrative Options for Washlands

Option	*Strengths*	*Weaknesses*
Land Purchase and transfer of ownership to authority or trust	*Good chance of delivering flood storage and environmental objectives* *Efficient up-front funding* *Funded under capital budgets* *Provide exit route for some farmers*	*Risk of reduced ties to farming community* *Problems of attracting and negotiating tenants* *Difficult to arrange purchases in large blocks* *Relies on voluntary participation, unless made compulsory*
Easement: one-off payment to compensate future flood risk	*Focus on flood defence aspects* *Suited to compensating risk of infrequent flood events* *Attractive to flood defence agency: one-off payment funded out of capital*	*Less suited to significant changes in flood risk* *Less suited to delivering environmental enhancement*
Annual Payments to compensate for income loss and /or environmental enhancement	*Potential to deliver range of objectives: social, economic and environmental* *Maintain farmer and community links with land* *Farmer familiarity with payment mechanism* *Integrate with ESA scheme* *Can be adjusted over time according to objectives/circumstances*	*Inflate land prices, encourage subletting* *Mixed success of ESA schemes* *Participation dependent on 'incentives'* *Expensive, dependent on 'revenue' budgets* *Create dependency*
Lease-back: transfer of ownership or control to authority or trust with tenancies to previous owners	*Ability to focus on scheme objectives* *Partnership approach* *Farmers/community engaged in implementation* *Diverse 'partner' funding sources*	*Administratively and legally complicated to establish* *Reluctance to transfer assets, until scheme proven* *Requires clear community of interest amongst participants*

Follow-up action

A number of actions are recommended to progress the concept of flood storage and its implementation. These include filling gaps in knowledge regarding hydraulic processes in the Parrett catchment in order to (a) produce preliminary designs for a floodwater management and (b) confirm practical ways of reconciling flood storage, environmental and farming objectives.

This reconnaissance study confirms the potential feasibility and advantage of integrated approach to flood water storage and washland creation in the Parrett catchment. The processes of participatory working promoted by the WUF Project/LAMP/PCP coalition in the Parrett Catchment are now well established and there is a call for 'projects' on the ground. However, earmarking particular sites for flood storage in the lower catchment is a sensitive issue, given that it affects particular landowners and managers. This needs to be done sensitively, drawing on the trust that has been developed through the coalition's inclusive approach.

1. INTRODUCTION

1.1 Background and Context

In Somerset, the Wise Use of Floodplains (WUF) Project has developed new ways of helping stakeholders in the River Parrett Catchment to find sustainable solutions for the management of water, both in flood events and throughout the year.

The Project is a partnership formed by the Environment Agency, Somerset County Council, The Levels & Moors Partnership (LAMP), RSPB and English Nature. It is an EU-LIFE Environment funded project, which is pioneering an integrated approach to sustainable flood and water management, by involving stakeholders fully in decision-making on the future management of the water resource. This work has been driven forward by a coalition of initiatives, which, in addition to the WUF Project, also includes the Parrett Catchment Project (PCP) and the EA's local Review of Flood Management Practices (RFMP).

These three initiatives have identified the need to explore options for flood defence management which can reconcile the various environmental, social and economic dimensions of sustainable development in the Levels and Moors (Table 1.1). In particular, there is a need to determine whether agricultural and rural land can offer flood defence 'services' in the catchment through the retention of flood waters, and whether this could be done in a way which simultaneously meets environmental, social and economic criteria.

Table 1.1 Parrett Catchment Project Action Strategy and Floodwater Storage

The Strategy includes the following components: ***Creating temporary flood storage areas on farmland*** in designated storage areas in the upper- and mid-catchment until the peak flow has passed in the floodplain watercourses ***Creating new wetland habitats*** throughout the catchment to intercept and store floodwater during flood events ***Spreading floodwater across the Moors*** to lessen the average depth and period of flooding without affecting adversely settlements, properties or roads

1.2 Aims and Objectives

In accordance with the terms of reference, the principal aim of the study is to explore how public funds can be used most effectively to achieve better flood moderation through appropriate use of agricultural land in the mid and lower Parrett catchment on the Somerset Levels and Moors.

The specific objectives of the study are:

a. Identify and confirm the range of sustainable benefits accruing to different sectors that could be achieved by floodwater storage (referred to as 'water farming' from a farmer perspective in the terms of reference). These benefits will relate to urban flood defence, farming and related industry, conservation, tourism, recreation, historical interest, and other water users.

b. Determine the feasibility of approaches to floodwater storage in the lower and middle parts of the catchment, in terms of alternative storage capacity, design and location.

c. Determine the suitability of alternative organisational and funding mechanisms, particularly incentives to land managers to deliver floodwater storage while simultaneously meeting other sustainability objectives, notably those relating to rural livelihoods and nature conservation.

d. Determine factors which influence the uptake of alternative water retention options by land managers, including the practicality of the options, responsiveness to incentive schemes, and the management of risk inherent in any proposed change.

e. Determine the effectiveness, efficiency and administrative feasibility of the development options.

1.3 Approach

The consultants carried out site review and visits, discussions with key informants and a participatory workshop with key stakeholders which captured responses to the broad options for the delivery of washland creation.

An initial inception meeting was held with the client, and the approach was agreed. This simultaneously considered the technical feasibility of flood storage/washland creation and the likely benefits to be obtained. It was agreed to pursue the study objectives through the analysis of selected case study sites that varied in terms of their hydraulic characteristics and potential contribution to the objectives of washland creation.

The technical feasibility of washland creation was undertaken by drawing on the considerable and long standing knowledge of the study area by the consultants, combined with site visits. The sites selected for study were then simultaneously visited by the team as a whole with a view to integrating hydraulic, agricultural, environmental, economic and other related issues. Economic analysis of the impact of changes in water management regime was supported by a small, informal survey of representative farmers. The review of institutional arrangements drew on experiences elsewhere in Britain and Europe. A stakeholder workshop was held to identify factors likely to determine the acceptability of proposals for a washland programme.

The case study sites are used for indicative purposes only in order to prosecute the analysis of technical and economic feasibility of floodwater storage. It must be stressed that, at this stage of enquiry and in the context of this report, they are not being promoted as actual sites for development.

In the report the terms flood storage and washland are used interchangeably, the latter implying a particular type of land use and habitat which is compatible with a winter flood storage facility.

1.4 Report Structure

Following this introduction, Chapter 2 reviews the technical feasibility of floodwater storage in the Parrett Catchment through the classification and identification and screening of possible sites for development. Chapter 3 presents a broad overview of the potential benefits and impacts of floodwater storage, beyond that of agriculture and environment. The ecological impacts of washland creation are dealt with in Chapter 4, followed by the economic analysis of agricultural impacts in Chapter 5. Chapter 6 explores the alternative institutional arrangements to implement the development of flood storage, followed by conclusions and recommendations in Chapter 7. The report is supported by Appendices.

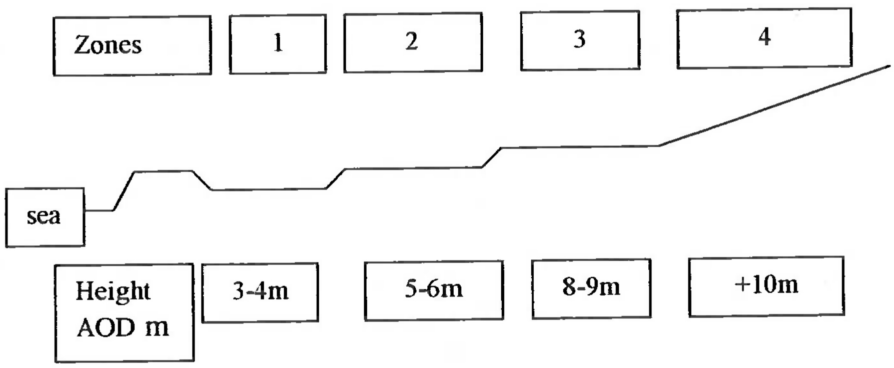
2. Feasibility and Location of Technical Options

This chapter reviews the selection of potential flood storage and washland sites for analysis.

2.1 Classification of Hydraulic Zones

Drawing on their knowledge of the study area, the consultants classified the Parrett catchment into zones (Figure 2.1) which vary in terms of topography, hydraulic characteristics and potential contribution to flood storage management. It was proposed to select sites within each of these zones and use these to develop typical case studies of potential water storage options.

Figure 2.1 Graphic Representation of Parrett Zones for Water Storage Options



Examples of hydraulic units within the zones include:

- Zone 1: North Moor, King's Sedge Moor
- Zone 2: Curry Moor, Aller Moor
- Zone 3: Langport Moors
- Zone 4: Parrett Valley, Upstream of A303

2.2 Identification of Possible Sites for Case Studies

2.2.1 Approach

The consultants identified possible sites for development of flood storage options by reviewing the overall characteristics and performance of the hydraulic system in the low and middle levels of the Parrett catchment. This drew on the consultant's local knowledge and involved consultation with agencies with particular responsibility for flood defence and land drainage management, namely the Environment Agency and the Internal Drainage Boards.

In this respect site identification drew on informed judgements about existing water management conditions and processes in the Levels and Moors. It also identified possible future changes in flood management facilities which could enable excess floodwaters to be distributed and contained more efficiently than at present and in ways which meet the objectives of the PCP Action Strategy.

The findings of the site identification process are summarised in the attached three plans (Plans1, 2 and 3) which cover various parts of the lower and middle Parrett catchment. The plans recognise the variation in topographical and hydraulic characteristics referred to in Figure 2.1 above. Each plan describes the nature of future flood distribution which could apply under a managed washland regime in different parts of the Parrett catchment. The plans contain notes on the rationale that underpins the suggested modifications to water management regimes. Locations where new works may be able to support enhanced flood management are highlighted on each plan. Appraisal sites can be selected from within the areas that have been shown as suitable for containment of greater quantities of excess floodwater than at present.

It is stressed that the suggestions contained within the plans are necessarily judgmental since full technical appraisal of the system is part of ongoing work by others, although a degree of liaison has been undertaken. The identification process has also been undertaken within the limits of resources available for the study. For this reason, cautious interpretation in required pending further investigation or confirmation from appropriate sources, as required.

2.2.2 Strategy for Future Flood Management

The identification process classified five broad categories of flood storage initiatives or 'project types', which could be pursued in different parts of the Parrett Levels and Moors. These simultaneously reflect the different hydraulic and other purposes which might be served by changes in flood water management in these areas. These project types constitute the means by which a modified flood management strategy might be delivered.

The projects variously involve more effective discharge of excess water to sea, temporary storage and managed evacuation of water in the lower levels, and holding back potential flood waters in the middle catchment. These are identified below, supported by notes on Plans 1, 2 and 3 accordingly.

(i) Optimise direct discharge of floodwaters to the sea (Plan sheets 1 and 2)

- Improve the Sowey River to carry the maximum feasible flows of Parrett floodwater direct to Dunball sluice, reducing the need for storage (note 1, plan 1).
- Utilise the Parrett outfall via Bridgwater to evacuate River Tone floodwaters on a priority basis, with or without a new tidal barrier (note 3, plan 2).

(ii) Create additional storage at the head of the Sowey (Plan sheet 2)

- This is potentially achievable by enhanced storage on Aller Moor and West Sedge Moor.
- There is sufficient elevation of floodwaters to support direct discharge to sea via Sowey River (note 1, plan 2).

- This would provide control over the volume and rate of floodwaters spilling out onto King's Sedge Moor (note 2, plan 2).

(iii) Overspill excess floodwater onto King's Sedge Moor (Plan 1)

- This storage facility would be used when Sowey flow capacity and/or additional storage at the head of the Sowey is fully taken up (note 2, plan 1).
- King's Sedge Moor offers a very large area of flood storage which can be taken up incrementally in sub-hydraulic units as required. If used, the area would be last to drain away in any flood event due to low elevation.
- It may be necessary to reduce Sowey flows intermittently to alleviate prolonged flooding at critical times.

(iv) No substantial change on Moors above Langport (Plan Sheet 3)

- It is understood that the maximum safe capacity for flood storage above Langport is fully utilised at present. Further investigation is needed to verify this but it is unlikely that further capacity exists (notes 1 and 2, plan 3).
- The function of two existing barrier banks (South Bank and Perry Moor Bank) may not be as indicated on plans (note 2, plan 3). Subsequent enquiry suggests South Bank is breached and Perry Moor Bank is related to the discharge of the Perry Moor Drain.
- There may be opportunity to contain floodwaters behind the natural topographic throttle on the River Yeo at Kings Moor. Further investigation could be justified (note 3, plan 3).

(v) Alleviate rate at which inflowing rivers discharge to the Levels and Moors (Plan 3)

- There is scope to increase the depth of flooding at selected floodplain locations in the middle catchment to increase storage.
- This can be achieved by throttling flood flows using a rated section in the channel and raising a floodwall across the adjoining floodplain (note 4, plan 3).
- There is an option to incorporate a sluice in the rated section to hold floodwater for longer periods, but this would increase the operational complexity.
- The scale of works required together with appropriate landscaping and environmental enhancement of affected reach of river will be important factors influencing feasibility. There has been no known precedent for such measures in the catchment, therefore an effective demonstration site is essential for this type of development.
- A site upstream of A303 is the only site which has been investigated. This was the subject of a preliminary appraisal undertaken on behalf of the Parrett Catchment Project in March 2001. There is another possible site at bottom of the River Isle shown on plan 3.

2.3 Criteria for Selection of Washland Sites

The suitability of potential sites for washland creation depends on a large number of factors: technical, economic, environmental and social. A key element of suitability, and a starting point for site selection, is whether a given site offers an effective solution to the flood storage objectives referred to in Table 1.1 earlier. In the first instance, it is required that the site must work from a hydraulic point of view. Basically storage sites must not only offer the potential of containing worthwhile quantities of flood water, but both the filling and the evacuation must be controllable for worthwhile benefit to be achieved. Thus hydraulic potential has been the initial selection criterion followed by other criteria which reflect opportunity for environmental enhancement, and likely social and economic impacts.

Seven main assessment criteria have been used, as explained below.

Ease of filling

It must be possible to fill the storage zone at the right time and quickly in order to optimise the flood protection benefits. Accordingly the storage site should:

- Be close to an arterial river (i.e. Parrett, Tone, Yeo or Isle);
- Have internal ground levels well below normal flood level in the river so that it could be filled quickly by gravity;
- Should require the minimum of engineering works to convey and control the floodwater into the storage zone.

Ease of evacuation

It must be possible to time the evacuation of the storage zone and to do so expeditiously in order to optimise flood protection benefits. Accordingly the site should:

- Be close to a suitable outlet path with spare capacity even under flood conditions. This point can be illustrated by considering the contrast between Curry Moor and King's Sedge Moor. Both areas become filled with large volumes of flood water from time to time. However in Curry Moor this water becomes trapped because the outlet is into the River Tone, which is likely to remain at flood stage for a prolonged period following filling of the moor, thus precluding operation of the evacuation pumps. By contrast, King's Sedge Moor has an outlet to the Parrett at Dunball which is virtually unaffected by the presence of flood water. Because the river here is so large, the presence of upland flood water raises its level by no more than a few centimetres. Notwithstanding the fact that the existing outlet is currently limited by other factors (namely tide-lock and a restricted outlet channel), the potential for evacuation from King's Sedge Moor is not limited by the receiving watercourse.
- Have internal ground levels well above normal flood level in the receiving watercourse so that water can be evacuated quickly by gravity;
- Require the minimum of engineering works to convey and control the floodwater out of the storage zone.

Ease of containment

Flood water in the storage zone must be effectively contained in order to retain control and also to ensure the safety of adjacent areas. To facilitate this the area should:

- Have convenient natural or man-made features already present to delineate the zone (if necessary with improvements). Suitable features could include rising

ground, raised floodbanks, highway causeways, railway embankments or any of the numerous existing medieval boundary banks (e.g. those around South Lake);
- If new embankments are needed, have suitable geology and soil types to facilitate this.

Current susceptibility to flooding
Areas which are currently flooded less frequently offer the greatest potential for providing flood relief benefits, although areas such as Curry Moor, which currently suffer frequent and prolonged flooding, might offer scope for managed flood storage if the evacuation arrangements could be significantly improved.

Potential for habitat improvement
Environmental enhancement is a key objective in the study area. This involves improvement of existing wetland sites and the creation of new ones. The availability of funding for the development of new flood storage areas is certain to be linked to the achievement of environmental enhancements. Accordingly the following features would assist:
- The area falls within the SPA, an SSSI or the ESA;
- Physically easy to enhance the habitat;
- Scope for reconciling flood storage objectives with environmental objectives, through managed flood and water level regimes.
- Offers the possibility of up-rating the sites official status for instance by re-designation.

It is also recognised that adoption of flood storage options on some species rich sites could potentially damage valued habitats due to untimely or prolonged flooding.

Appropriate current land use
Land use in the Levels and Moors is predominantly grassland, and relatively extensively managed for grazing or grass cutting. Much of the area is farmed under ESA grassland prescriptions. In some areas, especially those served by private pumping schemes, there is arable production. It is likely that only lightly stocked grassland could tolerate the regular inundation associated with the storage of flood water. In some areas, existing enterprises such as willow growing, intensive grass or arable might have to be abandoned and could increase compensation costs.

Freedom from existing infrastructure, or acceptable cost of providing protection or relocation
Roads, railways, buildings, buried pipelines, underground and overhead electricity lines, the landward face of raised floodbanks and any land drainage pumping stations would be susceptible to increases in flood frequency and duration. The effect of the stored water on routine access is also important. Inundation of these assets, services and utilities could involve substantial damage costs. The presence of these infrastructural assets reduces the attractiveness of a potential storage site.

It might be feasible to abandon a limited amount of infrastructure, or in other cases protection might be provided at reasonable cost. In many cases, however, the protection or relocation of assets would significantly add to the cost of developing a given flood storage site.

2.4 Sites Considered

Of the sites identified in section 2.2 above, six were considered against the aforementioned selection criteria for the purpose of analysis. These were identified following discussions with interested parties and the application of local knowledge and experience. Only sites with a sufficient chance of meeting an acceptable level of the selection criteria are presented. Those sites which were perceived to involve a high degree of risk of not satisfying a given criteria to an acceptable level were also excluded from further analysis. This does not mean that such schemes, once further information is known, are infeasible.

Table 2.1 shows the results of scoring the selected sites against the aforementioned criteria. The six sites all exhibit a wide range of scores illustrating that there is no 'perfect' site. Assuming that criteria are afforded equal weight, there is little to choose between the sites in terms of total score. Development of any of the identified sites would involve overcoming significant problems in at least one respect. In some cases, potential ease of flood facilities management (filling, evacuation and containment) is compromised by infrastructure impacts and in other cases by land use considerations. Potential for habitat improvement reflects the likely impact on farming practices. Furthermore, some sites, such as West Sedgemoor, which already have achieved considerable environmental protection and enhancement through raised water levels could find that this is placed at risk by long duration, deep flooding in early spring. Each site would require different management solutions to reduce site specific problems or exploit site specific opportunities.

The possible approach to site development are illustrated in the Plans 1, 2 and 3 . It should be emphasized that the number of ways any particular area could be developed is almost limitless, with wide variations in cost and effectiveness.

In all cases we have assumed that it is likely that there will be a concurrent improvement in the capacity of the Sowy system – probably by a combination of channel widening, bank raising and outfall improvements, thus affording the opportunity of using this route for evacuating certain of the storage areas we propose.

On the basis of the above, four sites have been progressed for the purpose of analysis. These are:

- Parrett Valley U/S of A303
- Aller Moor
- West Sedgemoor
- King's Sedge Moor

These sites are used for illustrative purposes only. They are indicative of the type of flood storage areas and related projects which could be progressed. This is not to say they will be, or that other sites are excluded.

Table 2.1 Screening of Possible Flood Storage Sites against Assessment Criteria

5 = BEST 1 = WORST

	U/S OF A303	ALLER MOOR	CURRY MOOR	KINGS SEDGE MOOR	LANG-PORT MOORS	NORTH MOOR	WEST SEDGE MOOR
EASE OF FILLING	5	5	5	5	5	3	2
EASE OF EVACUATION	4	4	1	3	1	2	2
EASE OF CONTAINMENT	3	2	5	5	4	4	5
POTENTIAL FOR HABITAT IMPROVEMENT	5	5	3	3	3	3	3
SUITABILITY OF CURRENT LAND USE	2	2	3	3	4	4	5
INFRASTRUCTURE CONSTRAINTS	4	4	3	3	2	3	4
TOTALS UNWEIGHTED	**23**	**22**	20	**22**	19	19	**21**

2.5 Assessment of Flood Scenarios for Study Sites

It is necessary to assess the expected changes in flood regime for each of the selected case study areas in order that the economic and environmental consequences can be evaluated. This has been undertaken only for those areas where redistribution measures could result in an increase in the depth/duration/frequency of flooding. The redistribution proposals (in conjunction with probable concurrent arterial improvements) provide considerable potential for reducing the severity of flooding in those areas currently perceived as suffering more than their fair share, such as Curry Moor, Hay Moor and to a lesser extent, most of the Langport Moors. Indeed the realisation of the benefits of flood alleviation is one of the main reasons for undertaking flood water redistribution. Nevertheless, this particular study does not require the evaluation of the consequential changes in areas that will experience reduced flooding, so 'with' and 'without' flood storage scenarios are not presented for these sites.

Owing to the complexity of the systems and limitations on both data availability and time resources, the assessments are necessarily subjective. They are, however, based on existing flooding information (Wessex Water Authority, 1979, Lewin Fryer & Partners, 2001), anecdotal evidence from local land managers and extensive practical experience of flooding in the Parrett catchment. The scenarios presented are indicative and presented for the purpose of analysis.

2.5.1 Redistribution Schemes

It should be noted that under the current systems the maximum flood water depths achieved when the various moors flood vary very considerably, from little more than 'splash' flooding in areas like Salt Moor and Earlake, to the 2.5 metres which Curry Moor experiences from time to time. These differences are generally, but not exclusively, a result of the configuration of the man-made flood defences rather than any basic differences in topography. Hence, there is considerable potential to juggle with the systems and redistribute flood waters along the lines suggested, or indeed in many other combinations.

The envisaged schemes comprise arrangements to provide controlled increases in the amount of flood water entering and accommodated in King's Sedge Moor, Aller Moor and West Sedge Moor. It is evident that positive management of appropriate river control structures would be needed to ensure this, and that the associated major operational decisions would fall to the Environment Agency, acting in close co-operation with the respective Internal Drainage Boards and organisations representing wildlife interests.

The proposed redistribution zones would be engineered and managed to provide strictly regulated water level regimes (depth, duration and seasonality) during typical flood situations, in order to ensure that environmental conservation objectives could be met (English Nature, 2001). In summary, these aim to provide by 2010 raised winter water levels on some 4,000 ha of the moors. To date about one third of this total has been achieved via ESA Tier 2S & Tier 3 schemes. However the aim is to provide deeper water on a significant proportion of the 4,000 ha – up to 750mm in places.

It is envisaged that Aller Moor could serve the purpose of a redistribution zone to accommodate relatively deep water flooding, and thereby contribute to this conservation objective. Freeboard would be available to cope with further influxes of floodwater once West Sedge Moor had been taken up. On the latter, the redistributed water would be used to provide shallower splash flooding of larger areas. This may allow withy growing to be continued as at present, but not if the whole area is regularly inundated.

The King's Sedge Moor zone would be retained as a last resort to provide capacity for rarer, more severe, events, although again splash flooding of all or part of the area could be maintained throughout the winter if this was required to meet conservation objectives.

It should be recognised that owing to basic system limitations, extreme weather conditions would overwhelm the capacities of any new systems from time to time, resulting in more severe flooding than that desired. Nevertheless as long as these deviations were to occur sufficiently infrequently, the agricultural and ecological viability of the areas should not be compromised.

2.5.2 Associated Improvements

It has been assumed that, in parallel with washland development, concurrent improvements would be made to the Sowy (Parrett Relief Channel) system, the lower end of the River Tone and the Parrett below Burrowbridge. It is outside the scope of this study to suggest how these improvements could best be achieved, and to what extent extra discharge capacity could be provided at economic cost. Other studies are planned by the Environment Agency to investigate these matters.

It is known, however, that under existing conditions, in a major flood event when most of the existing floodplain is under water, about half the total catchment runoff discharges directly to sea via the Parrett and Sowy, leaving the remaining half dispersed in the various washland areas (Lewin Fryer & Partners, 2001). This suggests that even modest improvement in these 'arterial' channels could significantly reduce the total amount of water requiring storage in any given flood event.

Taken in combination with an increase in storage in the areas identified, and bearing in mind the extra flexibility which would result from the associated improvements in control arrangements, it is evident that there is potential for significantly reducing the severity of flooding in the areas currently worst affected.

It will be noted that the West Sedge Moor and King's Sedge Moor redistribution zones are expected to experience a reduction in the severity of certain types of flooding after the envisaged changes have been implemented. However the frequency of splash flooding is not expected to change significantly, as this is more a function of rainfall and field configuration than of the effectiveness of the main drainage system.

2.5.3 Flooding Scenarios

Table 2.2 contains flooding scenarios which are used for the purpose of analysis, reflecting likely future 'with' and 'without' flood storage options on the case study sites. In the table, and from the viewpoint of flood facilities management Summer is taken to mean April to September inclusive. Winter is taken to mean October to March inclusive.

While there would be significant increase in flooding in the winter period, there would be some degree of alleviation of infrequent summer flood events attributable to the improvements in the main river system associated with the development of winter flood storage capacity.

Table 2.2 Flood Scenarios on Study Sites for 'With' and 'Without' Flood Storage Options

ZONE	WITHOUT FLOOD STORAGE - SCENARIO	WITH FLOOD STORAGE SCENARIO
ALLER MOOR / MIDDLE MOOR (area between Church drove and Head wall only)	**WINTER** 10% splashed for 2 separate 1 week periods every year 25% up to 150mm for a single 1 week period 1 year in 5 90% up to 300mm for a single 2 week period 1 year in 10 **SUMMER** 50% splashed for a single 1 week period 1 year in 50	**WINTER** 100% up to 750mm Dec/Jan/Feb/Mar every year Splashed Apr every year Deeper flooding single 2 week period in Oct/Nov or April 1 year in 10 **SUMMER** 50% splashed for a single 1 week period 1 year in 50
KINGS SEDGE MOOR	**WINTER** 50% splashed for two separate 1 week periods every year 100% up to 150mm for a single 1 week period every other year 100% up to 400mm for a single 2 week period 1 year in 5 **SUMMER** 50% splashed for a single 1 week period 1 year in 10	**WINTER** 50% splashed for two separate 1 week periods every year 100% up to 400mm for a single 2 week period 1 year in 10 **SUMMER** 50% splashed for a single 1 week period 1 year in 25
WEST SEDGE MOOR	**NOTE** 33% currently maintained as T2S or T3 raised winter water level areas by RSPB **WINTER** 67% splashed for two separate 3 week periods every year 50% up to 300mm for a single 3 week period every other year 90% up to 600mm for a single 4 week period 1 year in 5 **SUMMER** 50% splashed for a single 1 week period 1 year in 5 50% up to 300mm for a single 2 week period 1 year in 10 90% up to 600mm for a single 3 week period 1 year in 25	**WINTER** 90% splash flooded Dec/Jan/Feb/Mar every year Deeper flooding up to 600mm deep single 2 week period any time between Oct and Mar 1 year in 5 **SUMMER** 50% splashed for a single 1 week period 1 year in 5 90% up to 150mm for a single 2 week period 1 year in 10

ZONE	WITHOUT FLOOD STORAGE - SCENARIO	WITH FLOOD STORAGE SCENARIO
PARRETT VALLEY U/S A303	**WINTER** 100% up to 150mm for 3 separate 3 day periods every year 100% up to 450mm for a single 5 day period 1 year in 5 **SUMMER** 50% splashed for a single 1 week period 1 year in 5 100% up to 150mm for a single 3 day period 1 year in 20	**WINTER** 100% up to 1500mm for 3 separate 4 week periods every year **SUMMER** 50% splashed for a single 1 week period 1 year in 5 100% up to 1500mm for a single 2 week period 1 year in 20

2.6 Summary

This section has reviewed the approach to the identification and selection of study sites. Four 'indicative' sites have been identified which appear practically feasible and capable of delivering against the objectives of washland creation. Flood scenarios for with and without storage options have been defined. The next chapter considers the economic framework for the assessment of washland options

3. BENEFIT: COST ASSESSMENT

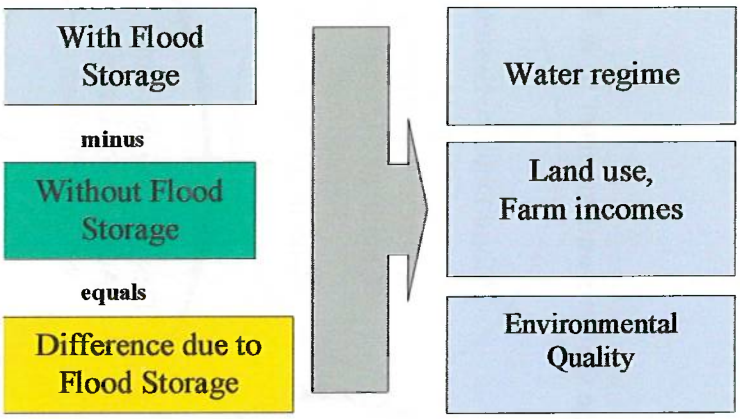
This chapter reviews the benefit cost framework for the assessment of flood storage options in the Parrett Catchment.

3.1 Assessment Framework

Figure 3.1 summarises the framework for benefit cost analysis of flood storage options. The analytical approach involves a comparison of benefits and costs relating to the future 'with' flood storage options and the future 'without' flood storage options. The impacts of washland and flood storage creation extend beyond those areas on which these facilities are established. There will be obvious impacts on sites which presently enjoy relatively high standards of protection but, for a variety of reasons, lend themselves to washland creation. Areas which are presently liable to extensive and frequent flooding may obtain relief due to increased storage elsewhere, unless of course they themselves become managed flood storage sites.

As shown in Figure 3.1, the range of benefit and cost impacts are substantial, and reflect a complex of social, economic and environmental issues. Particular attention is made here, however, to agricultural and environmental impacts. The study focuses on the consequences of the adoption of flood storage options on water regimes, land use, farming practices and incomes, and environmental quality. The approach compares these latter characteristics under the 'with' and 'without' flood storage conditions (Figure 3.2). Impacts to other interests and sectors are referred to in broad terms.

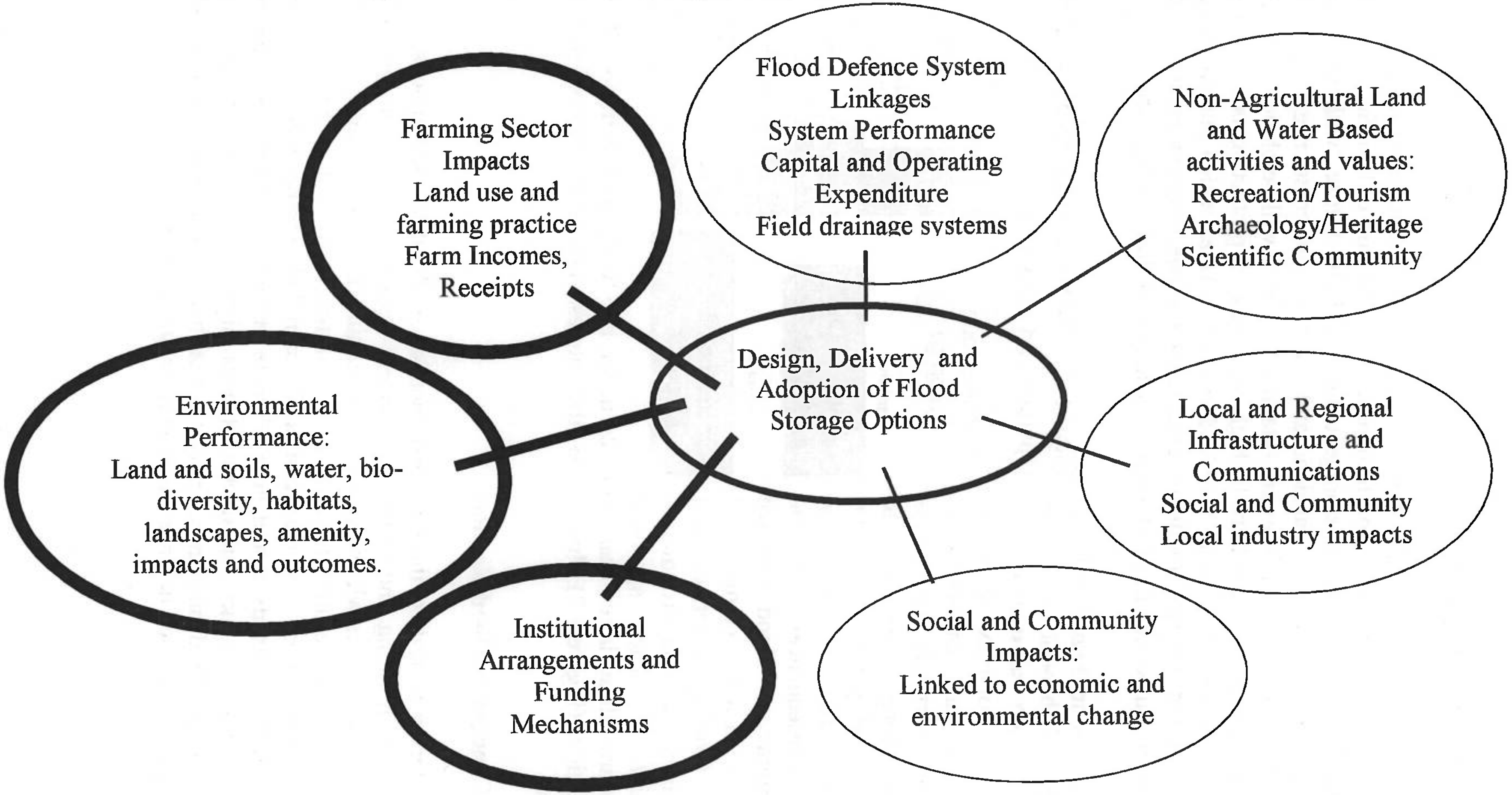
Figure 3.2: With and Without Flood Storage Options and Impacts



3.2 Changes in Flood Regime

As referred to earlier, the proposed adoption of flood storage options will lead to a change in flooding and water management regimes. The broad aim is to provide relief to those areas which experience uncertain but often prolonged inundation which results in negative impacts on land use, infrastructure, and in some cases protected conservation sites. A managed and controlled approach to flood storage on designated washlands would help alleviate undesirable flood risks, and exploit the opportunities that such managed washlands might offer to various stakeholders. The latter include land managers, environmental bodies and those organisations charged with providing flood defence and land drainage services.

Figure 3.1
Framework for Economic Appraisal of Flood Storage Options on Somerset L & M: Heavy eclipses denote study focus.



The extent of change will vary according to particular site characteristics and the design and operation of the flood facility. The change in regime is likely to include:

- A change in flooding frequency, duration and depth of winter flooding. In most cases the options will involve increased incidence of flooding in the flood storage areas. In some areas, existing high levels of flood risk would be alleviated under the new flood management regime. It is not proposed to make any significant change to summer flood regimes.

- Changes in winter groundwater levels associated with increased winter flooding, and in some cases the retention of high field water levels at other times if appropriate. In some areas, there would be opportunity to relieve excessive waterlogging.

3.3 The Distribution of Impacts

Figure 3.1 confirms the diversity of impacts associated with flood storage. The focus of the current enquiry is on the interface between flood storage options, farm economics, and environmental performance, and, given feasibility and potential value, on the institutional arrangements to deliver potential benefits. Washland creation and managed flood storage have diverse impacts across a range of sectors and stakeholder groups. These are summarised in Table 3.1 and briefly reviewed below.

3.3.1 Agricultural Impacts

Agricultural land use, farming practice and performance are critically dependent on flood defence and land drainage. This is particularly the case in the Levels and Moors of the Parrett catchment were flood risk and field water management largely define what is possible. Other factors, such as economic incentives, land tenure arrangements, and the motivations of land managers determine what is actually practised on the ground and the actual impacts of changes in flood regime. For example, a large proportion of the Somerset Levels and Moors (possibly as much as 40% in some areas) is sub-let for grass keep, often to graziers from out of the catchment.

The flood defence and land drainage standards to support commercial agriculture are well known and discussed in detail in Chapter 5 below. Flooding above and waterlogging below the surface of the land has major implications for land use, farming practices, productivity, value-added, and farm incomes. Generally, the lower the standards of flood defence and drainage, the lower is the intensity and commercial viability of farming.

The alleviation of flooding in some areas is likely to reduce damage costs and increase output and profitability, other things being equal. This will increase the sustainability of those farm business presently threatened by extensive flooding. An increase in winter flooding in the newly created washlands would impose restrictions on farming, which, in the absence of incentive payments, would reduce the income and profitability for farmers. The extent to which this occurs depends on the degree of change in flooding and waterlogging, and the extent to which existing land use is sensitive to this. It is envisaged that land managers will be offered financial inducements to voluntarily adopt flood storage options. This may take various forms (as discussed in Chapter 6) which to varying degrees would inject additional revenue into the farming sector and rural economy. In respect, washland creation, could help to contribute to sustainable rural livelihoods.

Much of the Parrett Levels and Moors are farmed under extensive systems supported by agri-environmental management agreements, including wetland management prescriptions. In such cases, the incremental impact of managed winter flood storage could be small. The detailed analysis of agricultural economic impacts are presented in Chapter 5

3.3.2 Environmental Impacts

Changes in flood regimes will have impacts on environmental quality, and especially bio-diversity. The extent of the impacts will vary according to the degree of change in the water regime, existing or potential environmental features and their sensitivity to changes. The various dimensions of the environment include field and ditch plant communities, birds especially migrant wildfowl and breeding waders, invertebrates, fish and small mammals. Plant communities and wetland birds are deemed to be the main environmental qualities to be protected and enhanced. These have different water regime requirements as discussed in Chapter 4. Species rich plant communities associated with valued and protected habitats are sensitive to prolonged winter flooding and have relatively low tolerance to spring flooding. Migrant wildfowl enjoy deep winter water, but breeding waders require shallow surface flooding during the spring.

The proposals to replace uncontrolled flooding with managed washlands has considerable potential for environmental enhancement in accordance with the Biodiversity Action Plan. Although, there are conflicts of interest amongst environmental components, there is scope to resolve these with careful management. These issues are discussed in Chapter 4.

3.3.3 Flood Defence Systems

The Parrett hydraulic system reflects a long history of flood defence and land drainage activities. The consultants recently undertook a strategic review of flood defence in the Somerset Levels and Moors for the Environment Agency. It was concluded that there is scope to redefine flood defence standards which can protect and enhance the critical and unique natural assets of the area, whilst simultaneously meeting social and economic objectives (Morris et al, 1999).

Managed washlands would, as previously stated, alleviate flood damage and disruption borne by those areas currently at risk, as well as incidental flood damage in other areas in all but the most extreme events. Given that the washlands offer a managed facility, they could take pressure off the defences which protect urban property and infrastructure.

The flood storage options would re-orient capital and revenue expenditure in the Levels and Moors more towards flood 'management' than flood 'defence' per se. This would serve to reduce the uncertainty of the impacts of flood events and provide responsible agencies with greater flexibility for flood management. The flood storage options would contribute to sustainable flood management in so much as they could provide a cost-effective basis for reconciling social, economic and environmental objectives in the Parrett flood plain.

3.3.4 Tourism

Tourism is a significant sector, both in terms of contribution to income, employment and the local economy as a whole. Most tourist activities focus on the seaside and coastal districts of Sedgemoor and West Somerset, with a seasonal, predominantly summer, trade. Reasons for visiting the area include the 'scenery', 'peace and quiet' and 'history and heritage'. The link between flooding and tourism is complex. The redistribution of winter flood waters would favour tourist participation if this serves to reduce the risk of personal damage, disruption, reduced mobility and reduced access to tourist attractions. Washland creation could enhance the quality of the environmental attributes which attract tourists to the area, such as the wildlife, nature conservation, landscape and amenity values associated with wetlands, benefiting the tourist experience and trade.

3.3.5 Recreation

In terms of recreation, there is a range of land and water based recreation pursuits in the Levels and Moors primarily related to public access for walking, horse riding, cycling and bird watching. A change in flood regimes would impact on both land and water based recreation in and around the Levels and Moors. Those outdoor recreation and amenity pursuits whose value is associated with the appreciation of wildlife, natural habitats and landscape would, for the most part, be enhanced by controlled winter flooding on washlands, and the switch to less intensive wet grassland. The same would generally apply to water based recreation activities such as angling, canoeing and selected water sports whose quality could be enhanced by increased bodies of open water. In all cases, however, direct user benefits depend on access and rights to use.

3.3.6 Fisheries

In the Levels and Moors section of the Parrett catchment, most of the major water courses are important coarse fisheries with roach, bream, pike, tench, ruff and eels as the dominant species. The variety and quality of fisheries habitat and resource is for the most part reduced as a consequence of flood defence activities such as river training, desilting and vegetation control Simultaneously, however, the managed water regime delivers benefits in the form of managed fisheries habitats, related to weirs, artificial channels and discrete water bodies. A change in flood defence, for example increasing the extent of stored winter water, could enhance the size and diversity of fish habitats and population, both in the river and water courses, and in shallow floodwaters which would provide spawning and recruitment areas into the breeding season. Care would be needed with the routing and rapid filling and evacuation of flood waters.

3.3.7 Archaeology

The archaeological interest of the Levels and Moors relate to both its pre- and post-drainage history, the area containing some of the oldest sites, remnants and relics of human settlement and activity in the British Isles. Many of these are Scheduled Ancient Monuments (SAMs), but a far greater number are thought to lie hidden and preserved in the waterlogged peat soils.

A return to traditional landscapes and water bodies associated with washland creation would further compliment the man-made cultural and historic aspects of the area. Increases in soil wetness tending to favour the preservation of many historic remains. Archaeological interests would also be served by a reduction in peat abstraction and the intensity of farming. However, protective measures may be needed to avoid flood damage to some historic remains, especially those associated with drainage and water transport history.

3.3.8 The Peat Industry

There is limited peat abstraction in the Parrett catchment. The peat industry relies on a controlled water environment both in terms of flood protection and reduced water table levels in the vicinity of the workings. Extensive winter flooding is therefore incompatible with peat production, although old peat workings could provide suitable flood storage sites

3.3.9 The Withy Industry

Withies are willows used for the production of hurdles, conical plant support, basket making and so forth. The Somerset Moors are well suited for willow production and the area is the centre of withy growing in Britain. Withies are currently concentrated around the Parrett and Tone catchments with areas of production on Curry Moor, Whitmoor, Stanmoor, Northmoor, Haymoor, Aller Moor, Saltmoor and West Sedge Moor. Overall, a total area of 160 hectares.

Flooding leads to a number of problems for withy production, primarily related to planting, harvesting and withy quality. Short duration flooding tends to have little effect on withies. Long duration flooding in excess of two months can depress yield and quality. Spring and/or summer flooding can restrict establishment and maintenance of the crop, part of which is often used by grazing livestock to control growth and weeds. It is particularly important, however, that flooding and waterlogging do not prevent the 'trafficability' of soils from December to April for harvesting machinery.

It is thus likely that withy production would not be compatible with the washland option, and would need to be relocated to areas with suitable standards of flood risk. This is feasible. Areas of withy are grown under contract to withy processors and product manufacturers: indeed the growing and the processing of withy material for manufacture are not necessarily dependent. The alleviation of flooding on some parts of the Levels and Moors as a consequence of washland creation could create a more secure environment for withy production.

3.3.2 Communications and Infrastructure

Extensive, long duration winter flooding in the Parrett catchment has caused disruption, inconvenience and nuisance to local residents and those that service their needs. The inundation of roads in particular increases the time and cost of travel, with associated risks for the provision of and access to vital and emergency services. These have severe consequences for the quality of life of Parrett residents, and the local business and service sectors. A managed approach to flood storage, which built infrastructural risk into its design criteria, would significantly reduce the social and economic costs associated with the present regime.

3.4 Summary

There are important links between flood defence and sectors such as tourism, recreation, fisheries (including angling), archaeology, and the peat and withy industries. Dependency on standards of flood defence vary. Tourism and recreational activities would probably benefit from a flood regime that served to enhance the wetland characteristics of the area, provided that access and mobility were maintained. The same could be said for the preservation of archaeological remains. However, the traditional rural industries of peat abstraction (generally outside of the study area) and withy production rely on protection from long duration flooding or permanently high water levels. Managed winter storage would, therefore, be mainly beneficial for tourism, recreation, fisheries and archaeological interests, but perhaps detrimental for the peat and withy industries.

Table 3.1 Impacts of Development of Flood Storage and Washland Facilities by Major Sectoral Interest

Aspect	Characteristics	User criteria	Impact of reduced flooding	Impact in flood storage areas
Agriculture	Predominantly grassland, with some arable in non flood areas.	Controlled flooding and drainage, field access for critical operations. Some ESA options specify 'wet' conditions.	Reduced flood damage, reduced costs, extra income, retention of farm land.	Switch to less intensive washland farming, reconciliation of farming and wildlife objectives. Take-up of washland management options, and related income and employment.
Environment	Predominantly wet grassland environment, range of field and ditch plant communities and wildlife, including birds.	Seasonal flooding and water levels to suit different environmental components.	Loss of some deep water winter flooding for wildfowl. Reduced damage to species rich plant communities.	Opportunity to create stable managed washland habitats to suit different environmental components.
Flood defence	Capital works including main and arterial channels and pump stations, and operations including vegetation control and pumping.	Avoidance of urban flooding. Evacuation of excess water by gravity and pumping with incidental temporary storage on farm land if necessary. Now seeking environmental enhancement.	Reduced flood damage due to incidental flooding. Reduced damage to flood defence infrastructure. Reduced requirement for emergency response and local dissatisfaction.	Managed facility offering flexibility for flood water management. Increased effectiveness and efficiency of flood management resources. Opportunity for sustainable, multi-purpose flood management.
Water resources	Water quantities (m3 by season) and quality (physical, chemical and biological).	User quantities required. user quality requirements: drinking water, industry, agriculture, tourism/recreation, environment.	Avoidance of pollution risks associated with unmanaged long duration flood waters, and eventual evacuation. Uncontrolled use of water bodies.	Opportunities to contribute to strategic water resource objectives through managed storage and treatment. Multi-purpose use of water bodies.
Tourism	Mostly coastal based, accessing inland for scenery and day excursions. Residential farm and village based accommodation in Levels and Moors. Eco-tourism.	Accommodation Facilities Attractions (especially country and wildlife based features) Mobility	Limited impacts on coastal belt summer holiday resorts. Reduced disruption to winter trade.	Possible enhancement of summer scenery values. Potential enhancement of wetland experience, for both winter and summer visitors. Increased eco-tourism potential.

Aspect	Characteristics	User criteria	Impact of reduced flooding	Impact in flood storage areas
Recreation and Amenity: Land	Land based informal and formal outdoor recreations: walking, bird watching, cycling, horse riding	Access, mobility and quality of recreation experience: infrastructure, scenery, landscape, habitats, wildlife, heritage, water quality aspects.	Reduce negative impact on mobility and access.	Enhancement of winter wetland habitat landscape and amenity values. Possible increase in public access in washland areas.
Recreation and Amenity: Water	Water based activities: canoeing, angling, water sports.	Access and mobility, facilities, water quality and water levels, land and landscape quality aspects	Loss of informal, casual use.	Increased area and predictability of water bodies and water space amenity for potential use.
Archaeology	Pre-historic remains and artefacts. Early flood defence infrastructure	Existence and bequest values, importance of artefacts in local cultural heritage, integration with recreation, amenity, tourism and education	Reduced damage to because of uncontrolled rapid filling or evacuation of flood water.	Increased preservation of artefacts in wetland environment. Enhanced value of Levels and Moors Heritage Site

4. Ecological Assessment

The chapter considers the existing ecological value of the study area and evaluates the effect of changes in the potential distribution of flood waters across the catchment.

4.1 Purpose

A key design aspect of the development of flood storage facilities in the Parrett catchment is to enhance environmental and ecological value where possible, to minimise negative effects of flooding on existing flood-sensitive species and habitats, and to exploit potential synergy between farming and environmental objectives.

The main conservation objectives in the Somerset Levels and Moors concern:

- Wintering wildfowl;
- Breeding waders;
- Rare invertebrates and diverse plant communities;
- Species rich lowland wet grassland features; and,
- The wider wetland.

These objectives are pursued through the designation of SPA, Ramsar and SSSI sites, and the Natural Area Biodiversity Action Plan (English Nature, 2001). All of these objectives require management of water regimes, with respect to both flooding and groundwater levels.

4.2 Approach

Just as commercial agriculture requires suitable water regimes, so do environmental and ecological characteristics and processes. The water regime requirements of features of the natural environment can be defined in terms of inundation and groundwater levels and these vary amongst species and habitats during the course of a year.

Figure 4.1 illustrates the variation in water regime requirements, measured in terms of depth of the water table level from the surface, for selected environmental characteristics during the calendar year. The gap in the diagram which runs through the year shows the minimum and maximum heights of water table levels which would satisfy the water regime needs of specific characteristics.

In Figure 4.1, characteristics lying below the gap have minimum water table levels as shown. For example, breeding waders require water table levels which are at least within 35cm of the surface during the period March to mid June inclusive. Species rich flood meadows, however, require water tables that are at least 20 cm below the surface during the mid March to end June period. The diagram also shows that there is general tolerance to flooding during the winter months. Indeed, wintering wildfowl are attracted by this facility. Of course, other fauna, such as small mammals, would need to be able to take refuge on higher ground during flood periods.

Figure 4.1 illustrates two main points. First, water regime requirements and tolerances vary between species and habitats through the year. For example, although flooding and water logging in winter suit visiting wildfowl, excessive flooding in spring is detrimental to breeding waders, invertebrates, small mammals and some plant species. Second , it is possible to manage water tables during the year (for example along the ranges shown by the gap in the diagram) in order to deliver multiple environmental and farming objectives. This is the essence of water level management.

4.3 Ecological Designations in the Parrett Catchment

The Lower Parrett catchment area has been identified as an area of high conservation value at both international and national level in terms of its wetland habitats and species. Within the Lower Parrett catchment nine sites are notified as Sites of Special Scientific Interest (SSSI). Of these nine sites, seven have been designated under the EC Wild Birds Directive (SPA) and as Ramsar sites. Parts of the study area are also designated within the Somerset Levels National Nature Reserve (NNR) (Table 4.1). In addition the study area is within the Somerset Levels and Moors Environmentally Sensitive Area (ESA).

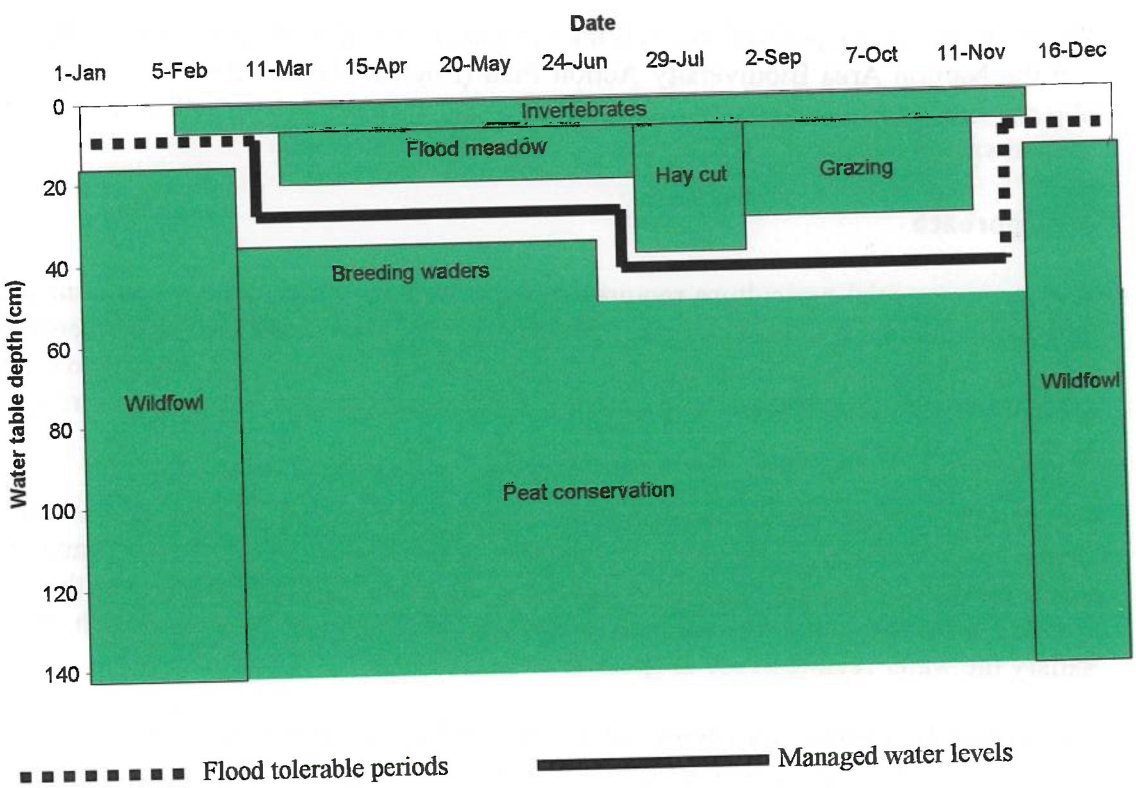


Figure 4.1: Water regime requirements for environmental characteristics

Table 4.1. Designations within the lower Parrett catchment

Site	SPA/Ramsar	SSSI	NNR
Curry and Hay Moor	✓	✓	
King's Sedge Moor*	✓	✓	✓
Langmead and Weston Level		✓	
Moorlinch	✓	✓	✓
North Moor		✓	
Southlake	✓	✓	✓
West Moor	✓	✓	
West Sedgemoor*	✓	✓	
Wet Moor	✓	✓	

* Case Study Sites

4.4 Flooding and Water Level Requirements of Wildfowl and Breeding Waders

Wintering Wildfowl require controlled water levels over critical minimum areas during the winter period (December to February inclusive), and a mix of splash (up to 10cm deep), shallow (10-30 cm deep) and deep (30-75cm) flooding. It is recommended that each of these areas should be at least 20ha, ideally in proximity of each other, and as groups located in at least 3 or 4 different locations in the Moors and Levels to facilitate flight (EN, 2001).

Breeding waders require areas which are flood free after mid March, except for some surface pools and water tables at around 20cm of the surface in the early spring. It is recommended that managed units should be about 50ha in size, with a mix of field water level conditions.

4.5 Plant Communities in the Flood Plain

There is a wide range of different plant communities found within the flood-plain areas which vary greatly in their response to water-regime. They can be divided into three broad groups according to their species characteristics. They are species-rich communities, washland communities and agriculturally improved communities.

4.5.1 Species-Rich Communities

These include:

- Great burnet hay-meadow (*Alopecurus pratensis – Sanguisorba officinalis*, MG4)
- Knapweed hay-meadow (*Cynosurus cristatus – Centaurea nigra*, MG5)
- Species-rich Foxtail flood-pasture (*Lolium perenne – Alopecurus pratensis – Festuca pratensis*, MG7C)
- Marsh-marigold flood-pasture (*Cynosurus cristatus – Caltha palusrtris*, MG8),
- Marsh Thistle fen meadow (*Juncus subnodulosus – Cirsium palustre*, M22)
- Meadow Thistle fen meadow (*Molinia caerulea – Cirsium dissectum*, M24).

None of these communities can tolerate inundation by surface water for more than a few days during the spring and summer (March – September). Prolonged spring flooding could drive vegetation succession towards inundation or swamp communities. Knapweed hay-meadow is rarely inundated throughout the year whilst the other plant communities can tolerate periodic inundation throughout the winter (October – February).

Several of the communities have specific water-regime requirements. For example, Marsh-marigold and species-rich Foxtail flood-pasture require a constant water-table throughout the summer usually within the top 50 cm of the ground surface. Great burnet hay-meadow can tolerate a deeper water-table (over a metre in depth) in the summer. These plant communities are of high conservation value, which have developed under traditional low-input agricultural management. It is very important to continue the agricultural management either by hay cropping and/or grazing. Therefore, a degree of water-table control is required in order for these practices to continue.

4.5.2 Washland Communities

These include the following:

- Creeping Bent inundation grassland (*Agrostis stolonifera – Alopecurus geniculatus*, MG13)
- Creeping Bent – Buttercup community (*Agrostis stolonifera – Ranunculus repens*, OV28)
- Reed Sweet-grass swamp (*Glyceria maxima*, S5)
- Greater Pond-Sedge swamp (Carex riparia, S6)
- Lesser Pond-Sedge swamp (Carex acutiformis, S7)
- Floating Sweet-grass water margin vegetation (*Glyceria fluitans*, S22)

These plant communities are tolerant of extended periods of flooding with regular inundation of surface water. They provide a valuable grazing resource for wildfowl and summer grazing for stock. *Glyceria maxima*, *Carex acuitiformis* and *Carex riparia* can tolerate surface water at ground level for much of the year.

4.5.3 Agriculturally Improved Communities

These include the following:

- Crested dogs's-tail grassland (*Lolium perenne – Cynosurus cristatus*, MG6)
- Perennial Rye-grass grasslands (*Lolium perenne*, MG7)
- Yorkshire Fog grassland (*Holcus lanatus – Deschampsia cespitosa*, MG9)
- Soft rush rush-pasture (*Holcus lanatus – Juncus effusus*, MG10)

These plant communities are related to various degrees of agricultural improvement. They tend to be species-poor and dominated by grasses. Perennial Rye grass and Crested dog's tail grasslands are rarely flooded and support intensive grazing and/or mowing regimes (silage). Yorkshire Fog grassland and Soft rush rush-pastures are found on permanently moist soils which can be periodically inundated by surface water. As a result of their permanently moist soil these communities are considered unproductive agricultural land, however they can provide valuable habitat for breeding waders such as Snipe, Redshank and Curlew which require tussocky grasslands and rushes as well as soft soil for feeding.

4.6 Impact of Changes in Flood Water Distribution on Plant Communities

Within the Lower Parrett catchment several areas have been identified as potential flood storage areas. These include West Sedgemoor, King's Sedge Moor and Aller Moor. Curry and Hay Moors currently serve as water storage areas.

The composition of plant communities is very sensitive to changes in the water-regime and the timing, frequency, magnitude and duration of flood events. Any change in the distribution of flood water across the lower Parrett catchment will potentially have a significant impact on vegetation.

Where possible priority must be given to safeguard the integrity of existing sites of high ecological value. King's Sedge Moor and West Sedgemoor both contain areas of species-rich plant communities that have very specific water-regime requirements. Summer flooding (March – September) of these sites, even for short periods, would be detrimental to the conservation value of these areas. Increasing the extent of flooding, particularly in the spring, on agriculturally productive grassland would result in the development of flood tolerant vegetation such as rush-pasture, inundation grassland or swamps depending on the degree of flooding. Although these communities can provide summer grazing, changes in agricultural practices will be necessary as a result of the change in flood water distribution. Possible environmental benefits from these changes include suitable habitat for breeding waders and wildfowl.

The post-scheme flood scenarios will have greatest impact on the vegetation and plant communities during the months of March and April. The deeper flooding scenarios at this time every year at Aller Moor / Middle Moor and the Parrett Valley will provide the conditions for the establishment of swamp communities. However, these communities also require waterlogged soils or standing water throughout most of the summer. Inundation grassland communities will tolerate the winter splash flooding scenarios at West Sedgemoor and King's Sedge Moor, but require a supply of water throughout the summer (the water-table within 20-50 cm of the soil surface). Although primarily identified as flood storage areas the habitats, which could be created in such areas, could provide valuable conservation benefit in terms of habitat for birds, particularly wintering wildfowl. However, frequent flooding of more than a few days beyond the October to February period on areas supporting species-rich grassland communities would be detrimental to the conservation value of these plant communities. Many of these communities are identified as priority habitats in the Biodiversity Action Plan.

Table 4.2 summarises the tolerance of the main types of grassland communities to flood regimes during winter and summer periods, and thereby the water management criteria that must be satisfied to secure these communities. The table also shows the equivalent values for dry matter (DM) and utilisable metabolisable energy (UME) production from the various grassland types. These values indicate the relative capacity of the grassland types to support livestock production, whether by forage conservation or grazing. These estimates are used in the economic analysis of grassland systems under different flood storage options.

4.7 Impacts of Flooding on Soils

The issues relating to land use are really ones that impact on post flood land capability. Temporary storage of flood water may impact on land use in a number of ways.

- Flooding depth and duration has obvious impacts for the timing of critical field operations and access. These apply to arable operations such as crop establishment and the grassland management operations such as forage harvesting and turnout dates of grazing animals. Disruption and delay will have an impact on revenues and costs.

- Materials deposited on the flooded area as a result of flooding may have an adverse effect on vegetation although some materials such as nutrients may enhance soil fertility. Sediments dropping out in flooded areas may hinder the rate of recovery of vegetation as it interferes with photosynthesis. Other contaminants may deposit on flooded areas but are unlikely to be a major problem in these areas. Soil enrichment through deposition of nutrients may adversely affect diverse species rich grassland.

- Flooding can cause chemical changes to the soil as a result of the release of unwanted materials due to anaerobic conditions. The greatest danger here may be iron which can be high in these areas although pH is likely to at or higher than neutrality as the flood waters are predominantly derived from base rich catchments.

- There is evidence that there may be an important impact on soil micro and macro fauna, arising from concern that Raised Water Level Areas on the Levels & Moors may cause significant loss of fauna due to long duration anaerobic conditions in the soil profile. Although temporary washlands may not suffer in this way, it is a topic worthy of further research.

Recovery of the soils, soil fauna and vegetation post-flooding will depend on the establishment of good water level management. This means that field drainage and ditch water level control will be important for the rapid re-establishment of ground conditions suitable for mechanised operations such as ground preparation for arable or for grass cutting.

4.8 Summary

The Levels and Moors of the Parrett catchment currently contain sites of local and national ecological value, distinguished by their plant communities. These are sensitive to water regimes. The proposed adoption of flood storage options provides an opportunity for enhancing existing environmental quality. At the same time however, increased flooding in some areas could, unless purposely controlled, cause damage to existing valued habitats, and frustrate the potential creation of new ones.

In this respect, the design parameters for flood schemes must incorporate environmental criteria.

Table 4.2 Class of Plant Community, Flood Regime Requirements and Grassland Productivity

	CLASS (and Tier reference)	WINTER FLOODING REGIME OCTOBER – FEBRUARY	SUMMER FLOODING REGIME MARCH – SEPTEMBER †	RELATIVE DM YIELD	RELATIVE UME
1	Species-rich communities MG4/5/8/7C/M22/24 (Tier 3 target)	Periodic flooding 1-2 weeks duration	MG4 rarely inundated in summer MG5 rarely inundated throughout the year MG7C/8 constant water table between 20 and 50 cm depth M22/24 soils wet/moist throughout year	0.25-0.61	0.19-0.4
2	Inundation grassland MG13/OV28 (Tier'4' washland)	Tolerant to extended periods of flooding	Will tolerate splash flooding in March and April	0.47	0.45
3	Swamps dominated by grasses/sedges S5/6/7/22 (Tier 3 tendency)	Tolerant to extended periods of flooding	Tolerant to water table to the soil surface	0.95	0.3 but limited information for these communities
4	Agriculturally improved MG7/6	Periodic flooding 1-2 weeks duration	Rarely flooded	1.0	1.0
5	(Previously) Agriculturally improved wet grassland MG9/10 (As per Tier 2)	Periodic flooding 1-2 weeks duration	Occasionally flooded always moist soils Main species that develop are dominated by *Deschampsia Caespitosa* (Tufted hair grass) *and Juncus Effusus* (Rushes) which are unpalatable	0.63	0.37

* Dry matter yields are unknown for these communities. Some species such as *Glyceria maxima*, Reed swamp grass, (which is unlikely to develop on the peat soils of the Somerset level) can provide very productive grazing. Relative Dry Matter Yield 0.94-1.71. Based on figures from Westlake (1966).

† Difference in summer flooding period between flood scenarios and vegetation requirements.

DM and UME data based on figures from Tallowin and Jefferson (1999)

5. Economics of Floodwater Storage on Farm Land

This chapter reviews the main characteristics of agriculture in the study area and considers the financial and economic impacts of the introduction of flood storage facilities and washland creation.

5.1 Farming Systems and Land Use in the Parrett (and Tone) Catchment

The agricultural economy in the Parrett catchment as a whole is primarily based on dairy, cattle and sheep production (MAFF, now DEFRA,1999). Overall about 70% of land use is grassland. Of the 30% arable, most of this is down to cereals and forage maize.

Land use within the flood risk areas of the catchment is predominantly down to grass (Tables 5.1 and 5.2). Where flood risk is low, cereals and maize for fodder are sometimes grown, in some cases assisted by private pump schemes.

Table 5.1 - Flood Plain Areas (100 year event) (ha) and Land Use in the Parrett and Tone Catchments, 1999

	Parrett (ha)	(%)	Tone (ha)	(%)	Total (ha)	(%)
Total Flood Plain Area	13,276		2,505		15,781	
Arable	1,726	13	251	10	1,894	12
Improved grass	5,974	45	1,002	40	6,944	44
Grass Tier 1 ESA	3,452	26	1,127	45	4,579	29
Grass Tier 1A ESA	266	2	75	3	341	2
Grass Tier 2 ESA	398	3	50	2	448	3
Grass Tier 3 ESA	1,195	9	0	0	1,195	8
Total ESA	5,311	40	1,252	50	6,563	42
Other (withy, peat, …)	398	2	..	..	398	2

Source: FRCA, personal communication.

Table 5.2 - Flood Plain Areas (annual event) (ha) and Land Use in the Parrett and Tone Catchments, 1999

	Parrett (ha)	(%)	Tone (ha)	(%)	Total (ha)	(%)
Total Flood Plain Area	2,100		200		2,300	
Arable	231	11	0	0	231	10
Grass [a]	1,869	89	200	100	2,069	90

[a] In the Parrett the grassland is divided equally between Tier 1, 1A, 2 and 3; and in the Tone the grassland area is either in Tier 2 with the raised water level supplement or Tier 3.

Traditionally, individual farms combine land on the higher ground with separate summer grazing parcels on the Levels and Moors. The majority of farm holdings in the study area are owned. There is a high and increasing proportion of small and part time holdings.

MAFF parish statistics were used to derive estimates of land use and livestock for the selected case study sites. This is difficult because of parish boundary problems and the confidentiality of data from 'small areas'. The observations mirror the patterns evident at catchment level, although in reality there is likely to be a greater proportion of land down to grass than shown by parish based statistics.

Regional Farm Business Management Survey results (University of Exeter, 1999. 2000, 2001) suggest that farms in the Parrett catchment tend to be smaller and less intensive, and therefore generally have lower average farm incomes than the regional average. Although very good performance is possible, many farms operate at lower levels of intensity than either their potential or the regional average (personal communication, M Turner, Centre for Rural Research, University of Exeter). On livestock farms, stocking rates are typically 1.4 – 1.5 livestock units/ha (including non grass forage crops), and about 1.6 lu/ha for dairy. Milk yields are between 5,300 to 5,600litres/cow/year. These are typically 10%-20% lower than the regional average.

Fertiliser application rates on grass are relatively low, at 150 kgN/ha on improved grass for dairy, and 75kgN/ha or less for cattle and sheep. The relatively extensive system of grassland management suits compliance with ESA Tier 1 requirements. Farmers are encouraged to keep their overall farm stocking rates (lu/forage ha) below threshold levels in order to qualify for the Beef and Sheep Premium Scheme extensification payments.

Although farming systems are dominated by dairy production, few milking cows are kept on the Moors themselves unless these are in easy walking distance of the farmstead. Most of the Moor is used for grass conservation and/or stock grazing. The latter mainly involves dry cows, beef suckler cows and their progeny, 24-30 month beef, store cattle of various ages, and sheep. In the drier areas, over-wintering of sheep (either purchased or temporarily 'agistered' from upland farms) has provided a useful income source for local farmers. Summer grazing by out-of catchment graziers is common, although the recent Foot and Mouth Disease (FMD) has restricted this and also the overwintering of sheep. The traditional finishing of heavy store cattle on the Moors has been curtailed by the 30 month age limit on beef cattle (required under BSE regulation), such that cattle are often sold off before finishing. There has been a continuing decline in the number of dairy farms, with dairy often replaced by beef cows producing fattening stock.

The average cereal yields on farms located in the Somerset Levels and Moors were 6.6 tonnes/ha in the period 1998 to 2000, although on well drained land these can approach 8 t/ha. Much lower yields at around 4.5 t/ha are not uncommon (M Turner, as above).

Sub-letting on short term seasonal and annual terms is common on the Moors, both for grazing and grass cutting. In some areas this can account for up to 40% of the total land area. The purchase of land by conservation organisations and award of seasonal lets has further encouraged this practice. Access to ESA payments (see below) has also encouraged owners to sublet fields as grass keep. Seasonal rents are variable, from £5 through to £40 per acre (£13 to £100/ha) according to the quality of grass, access and number of days let. In ESA areas on land held by conservation organisations and re-let to previous occupants rents are commonly between £25 to £50/ha/season, but restrictions on use apply.

Farm incomes in the study area have declined in line with declining fortunes in the farming sector as a whole. Particular factors affecting farm incomes in the study area include:

- Continued general deterioration in the ratio of output to input prices which reduce the terms of trade for farming;
- Real and significant decline in cereal prices;
- Reduced real prices for beef and sheep prices due to reduced subsidies, exacerbated by the effects of BSE and foot and mouth disease (FMD);
- Quota restriction and depressed prices (until very recently) for milk;
- Impositions, compliance requirements and disruption caused by BSE (e.g. 30 month age regulations) and FMD (especially stock movements for seasonal grazing).

In this context, opportunities to qualify for extensification (under Beef and Sheep Premia) and ESA receipts have allowed farmers in the Parrett catchment to cope relatively well with the general downturn in farming fortunes. But this has created a culture of dependency on these support mechanisms. They are particularly high in the grassland sector, such that livestock farmers are probably fairing better at present than their arable colleagues.

5.2 Participation in Environmentally Sensitive Area Schemes

The flood plain areas correspond closely to the eligible area of the Somerset Levels and Moors Environmentally Sensitive Area. The voluntary scheme pays farmers annual amounts in return for the adoption of agreed prescribed practices which are classified in 'tiers' of compliance (Tables 5.3 and 5.4).

Designated in 1987, it now covers over 29,000 hectares, of which almost 18,000 ha (60% of the total eligible area) are subject to a total of over 1000 agreements (Table 5.1). Uptake of Tier 1 covers 12,766 hectares, Tier 1A 870 hectares, Tier 2 2,990 hectares, and Tier 3 1,226 hectares: a total of 17,852 hectares. (S. Richardson, personal communication, 2001).

Overall, 42% of agricultural land in the study area receives payments under the ESA scheme. Farming systems within the ESA are primarily livestock based (95%). Although dairy production dominates in relation to land use (at 50%) it is on the decline. Beef and sheep systems constitute equal parts of the remaining land use area.

The overall aim of the Somerset Levels and Moors ESA is to protect and locally enhance the wet permanent grassland character of the area, with its landscape, wildlife and historic interest, through the maintenance and adoption of extensive pastoral farming systems.

An evaluation of the ESA scheme over the period 1991to 1996 showed that there had been some change from improved to traditionally managed grassland, but no significant change in cropping or livestock systems or stocking rates. The scheme had failed to arrest the decline in the number of breeding waders and general species diversity. It had, however, protected sites of historic and archaeological interest. As a result, raised water level buffer strip supplements, minimum water levels and a further restraint on fertiliser inputs were introduced in 1997.

The specific objectives of the Somerset ESA are:

- To maintain and enhance the nature conservation interest of extensive permanent grassland (Tier 1A).
- To maintain and enhance the nature conservation interest of the wet grassland by sustaining and extending the area under extensive management, by managing ditch water levels, and by increasing the area of land attractive to waders and wildfowl.
- To maintain and locally enhance the wet grassland landscape by sustaining and extending the area of permanent grassland, and through the management of elements such as pollarded willows and ditches.
- To protect archaeological and historical features.
- To make ESA land available for quiet informal recreation and thereby increase public enjoyment of the countryside.

These objectives are compatible with and would be served by the creation of flood storage, washland areas.

Table 5.3 - ESA Payments: Somerset Levels and Moors

Tiers and Supplements	**Annual payment rate (2001) £/ha**
Tier 1 Permanent Grassland	£125
Tier 1A Extensive Permanent Grassland	£200
Tier 2 Wet Permanent Grassland	£225
Tier 3 Permanent Grass Raised Water Level Areas	£430
Buffer Strip Supplement	£110 per ha equivalent
All Year Penning Supplement on Peat Soils	£18
Raised Water Level Area Supplement	£80
Public Access Tier	£170

5.3 Impact of Changes in Drainage Conditions on Agriculture

Agricultural land use, farming practice and performance are critically dependent on flood defence and land drainage. Flood defence for agriculture, as for most land-engaging activities, refers to acceptable levels of flooding above <u>and</u> below the surface of the ground.

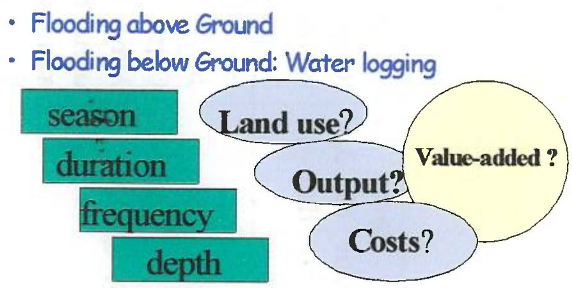
Table 5.4 - ESA Prescriptions for the Somerset Moors and Levels

Tier prescription	Tier 1	Tier 1A	Tier 2	Tier 3
Drainage	Where present maintained, no new schemes installed			
Ditch management	Actively managed	Actively managed	Maintain water level in ditches, 1st April to 31st October, not more than 45 cm below field level	Ditch levels at mean field level December to April, and within 30 cm May to November
Mowing	Can continue if aftermath grazed	After 1st July	After 1st July	Hay making only after 8th July
Grazing	Can continue if no problems	Topping after 31st August and winter sheep grazing to be avoided	Topping after 31st August and winter sheep grazing to be avoided	Cattle grazing only after 20 May, limited stocking rate until 8 July, summer and autumn stocking rates may be quite high to prevent rushes & sedges taking over
Fertiliser	Can continue Max 75kg N / ha. Max 37.5kg P / ha. Max 37.5kg K / ha. 60:30:30 / acre FYM & slurry	Can continue Max 25kg N / ha. Max 12.5kg P / ha. Max 12.5kg K / ha. 20:10:10 / acre FYM & slurry	Can continue Max 25kg N / ha. Max 12.5kg P / ha. Max 12.5kg K / ha. 20:10:10 / acre FYM & slurry	No artificial fertiliser

Buffer strip supplement	Tier 1, 1A, 2	Where no inorganic fertiliser applied within 6 metres of field boundaries
All year penning supplement	Tier 1, 1A, 2	On peat soils where water levels are maintained at the summer penning level throughout the year
Raised water level area supplement	Tier 1, 2	Where land is included within a Raised Water Level Area and more stringent water levels are met

Flooding above ground causes crop damage, reduces yield and quality, increases costs, and reduces cropping options. Flooding below ground level in the form of water logging similarly reduces yields, reduces cropping options, increases costs, and reduces overall financial performance of farming activities (Box 1).

Box 1 Key Elements in Flood Defence for Agriculture



Commercial crops are sensitive to waterlogged soils and anaerobic soil conditions during critical growth periods, with consequences for crop yield, quality and value. Wet soils have reduced strength and this reduces their bearing capacity which, in turn, restricts field access by machinery or grazing livestock. This leads to delays in critical field operations such as cultivations and fertiliser application, and to restrictions on grazing seasons. In the case of grassland, wet soils will not provide suitable growing conditions for commercially 'improved' grass species, restrict field access for the early application of fertiliser, and are liable to damage by grazing animals. For these reasons, and other requirements of more intensive livestock husbandry systems such as quality silage-making, persistently wet field conditions tend to be associated with extensive grassland, whether grazing or hay cutting.

For this reason, flood defence for agriculture involves measures to reduce inundation and waterlogging. The impact of flooding and waterlogging on farming varies much according to tolerance of the particular crop or land use activity, and the frequency, duration, depth and seasonality of the event. The latter factor is particularly important: the impact of a flood or water logging event varies a lot according to the time of year. Evidence suggests that relatively short duration flooding in winter has limited impact on grassland, but even a brief flood event in summer can completely destroy a standing crop of grass or cereals.

It is possible to prescribe the water regime standards required to deliver given types of farming activities and practices, from intensive horticulture, through arable systems involving root crops and cereals, to grassland whether managed for intensive livestock production or extensively grazed or cut for hay. The more intensive is the system, the greater is the degree of flood defence service required.

Based on observed landuse, Table 5.5 shows the common standards of flood defence associated with, and therefore implicitly required to support, given types of agricultural land use and productivity.

With respect to flooding (Table 5.5(a)), over the year as a whole, for example, cropping systems such as cereals would probably not be financially viable if flood risk was on average more frequent than once in 5 years; once in 10 years in the case of potatoes. The tolerable risk of summer flooding on cereals and potatoes is about

10 years and 25 years for cereals and potatoes respectively, reflecting the significantly greater damage associated with summer floods on these crops.

Grassland, as evidence bears out, has a much greater tolerance to flooding. Intensive grassland systems will tolerate relatively frequent flooding (once every 2 or 3 years) providing this is not long duration and does not occur in summer when tolerance is lower (once every 5 years or so). Extensive grassland is commonly associated with multiple winter flooding, but summer flooding is less acceptable because of the impact on grassland use.

With respect to water logging (Table 5.5 (b)), experimental and empirical research in Britain and the Netherlands (Hess and Morris, 1987, Dunderdale and Morris, 1997a,b) has shown that the productivity of agriculture is critically dependent on water table levels as they determine crop growth conditions and field access, as referred to above. This is especially the case during the spring and early summer periods, and to a lesser extent during the autumn. In the spring, water tables at or below 0.5m of the surface are indicative of 'good' agricultural drainage conditions and will support 'normal' agricultural productivity. Conversely, high water tables, within 0.3m of the surface are likely, if they persist, to indicate 'very bad' agricultural drainage resulting in 'very low' levels of agricultural productivity. The latter case would result in constraints on land use, limited field access, low yields and low financial performance. In many cases such conditions would not support arable cropping and mainly be confined to extensive grassland. Water tables between these two extremes would be associated with moderate impediment to drainage and productivity.

On grassland, productivity is a function of the production and use by animals of energy from grass. Drainage and flooding can affect the quality of the grass sward, grass growth conditions, ability to apply nitrogen, and access to fields for grazing livestock or machinery (to apply nitrogen and cut grass).

On arable crops, flooding reduces yields through depressed growth, direct damage, or delays operation the timing of which has a critical influence on yield. A deterioration of drainage and an increased risk of flooding reduce crop options: for example forcing a switch from arable to grassland, or from intensive to extensive grass

Of course, very low water table conditions during the summer period can cause water stress in crops (especially if they have poorly developed root systems because of water flooding earlier in the year) and there may be benefit of raised water tables to provide sub-irrigation. Indeed, traditional meadows draw benefit from high groundwater levels in summer, as indeed can arable crops. But, for the most part, spring/early summer water table levels are the defining influence on the feasibility of agricultural land use in Britain.

The method adopted here to assess the impact of a change in flooding regime associated with the adoption of flood storage options in selected case study areas involves:

For the Future 'Without' Flood Storage Case:

a) Identification of existing 'without' flood storage water regime (defined in terms of flooding and field water levels);
b) Identification of existing 'without' flood storage land use and farming practice, whether grassland or arable, and related productivity as determined by prevailing water regimes

For the Future 'With' Flood Storage Case

c) Proposed 'with' flood storage water regimes
d) Likely land use and farming practice and related productivity as determined by the proposed flood storage water regimes

Comparison of the 'With' and 'Without' Cases

e) Differences in land use, farming practice and productivity, and related performance attributable to the change in water regime (d-b above).

The approach recognises that for a given land use, whether arable or grass, a change in flood defence standards can have two main types of impact:

- A change in crop damage associated with surface flooding
- A change in the productivity of a crop (whether arable or grass) due to water logging

In situations where there is a significant change in flood defence standards, there may also be a switch in land use, for example from arable to grassland.

Table 5.5 - Flood and Drainage Standards for Agriculture

(a)
Common minimum acceptable flood risk by land use (return period in years)

	Whole Year	**Summer April-October**
Land use		
Horticulture	20	100
Roots crops	10	25
Cereals	5	10
Intensive Grass	2	5
Extensive Grass	<1	3

(b)
Field water table levels, drainage conditions and freeboard in watercourses

Water table height from surface	Agricultural drainage condition	Agricultural productivity	Spring time Freeboards in watercourses (no field drains)	Spring time Freeboards in watercourse (field drains)
0.5m or more	Good,	Normal, no impediment	1m (sands) to 2.1m (clays)	1.2m (clays) to 1.6m sands
0.3m to 0.49m	Bad,	Low reduced yields, reduced field access	0.7m (sands) to 1.9m (clays)	Temporarily submerged pipe outfalls
Less than 0.3m	Very Bad,	Very Low, severe constraints on land use, reduced yields, reduced field access, mainly wet grassland	0.4m (sands) to 1m (clays)	Permanently submerged pipe outfalls

Freeboard here is the height difference between water in ditch and adjacent field surface level. Required field water tables relate to conditions for crop growth and field travel. Very low water tables can result in crop water stress. Naturally drained peat soils usually require freeboard requirements that approach those of sands: about 1.3m, 1m, and 0.6m respectively for the 3 categories above, but conditions can vary.

The benefits of improved drainage for agriculture are readily apparent in the Parrett Catchment: improvement in grassland management and productivity, and where conditions permit, the introduction of arable cropping. A reduction in standards of drainage service, associated for example with the adoption of a washland scheme, could involve a reversion of land use to the pre-drained state, and the loss of associated potential benefits. There is scope, however, for a managed washland regime which, through purposeful land drainage management, reconciles the multiple interests of flood storage, extensive farming and environment.

5.4 Impact of Changes in Drainage Conditions on Farm Incomes

From a farmer perspective, increased flood risk could reduce farm revenues, increase some operating costs and therefore reduce profitability. In some cases, there may be savings in some farm level costs such as regular labour and machinery if a farm moves to a less intensive system. Much depends on farm circumstances, especially whether farms have scope to reduce not only direct costs such as fertilisers but also overhead costs such as labour and machinery and other general expenses in the process of adjustment.

A key factor influencing the impact on a farm business of a change in flood risk on any parcel of land is the proportion of the total area of the farm that is accounted for by this parcel. Generally, the larger is the proportion of the whole farm subject to change in flood defence standards, the bigger is the impact on the whole farm business. In the Parrett flood plain, there is considerable variation in this factor. In some areas, there is a high degree of fragmentation of holdings, with small land parcels used or rented out by owners who have a significant part of their land on higher ground. In other cases, entire holdings may lie within the Levels and Moors. Clearly the impact of changes in water regimes on the farm business as a whole, and possible willingness to adopt flood storage options, will vary between these circumstances.

As referred earlier, farmers may qualify for special payments from Government for adopting extensive or environmentally beneficial practices. Such payments can offset the reduced income because of inability to adopt intensive methods requiring high standards of flood defence. Given the changing policy context and deteriorating terms of trade for farming, farmers have found that switching to extensive systems and drawing assistance under an agri-environmental schemes has helped to maintain the viability of their farm business.

5.5 Economic Analysis of Changes in Agricultural Drainage Conditions

Given that agricultural support is funded from the public purse, benefits and costs must be considered from the economic perspective, valuing extra agricultural output and resource use in terms of contribution to national economic output. This involves stripping away the various subsidies to farming evident in arable set-aside payments and beef and sheep premia.

DEFRA provide guidance on how to reduce farm output values for this purpose (MAFF, 1999). It can be argued, however, that ESA type payments to farmers for environmental enhancements should be included as benefits because, as expressions of willingness to pay, they reflect environmental benefits delivered by land managers and enjoyed by society. (It could be also argued, however, that they are more a reflection of the need to compensate farmers for not responding to artificially protected agricultural markets).

Table 5.6 shows the adjustment factors advised by DEFRA for economic analysis of agricultural impacts associated with flood defence. Where washland creation leads to abandonment of land for agricultural purposes DEFRA advise valuation of loss at 55% of prevailing market prices for the type of land concerned. Where washland reduces the intensity of farming, Scenario III reduction factors are used to estimate the economic value (downwards) of lost output. Broadly, the value of lost output from the economic point of view, is less than that valued from a farmers perspective: financial prices are higher than economic (net of subsidy) prices.

Table 5.6 Economic Adjustment Factors applied to Agricultural Output for Flood Defence Appraisal

	Scenario I Land lost to agriculture	Scenario II * Temporary, one-off loss of agricultural output	Scenario III* Permanent reduction in the value of agricultural output
All agricultural land use	Reduction in land values by 45%		
Cereals		22%	25%
Oil seeds		29%	25%
Beans/peas		35%	25%
Beef		33%	33%
Sheep		12%	12%
Dairy		As wheat	As wheat
Other crops		As wheat	As wheat

* reduction % applied to value of output to farmers inclusive of subsidies such as area payments, beef and sheep premia

5.6 Analysis of Financial Impacts on Farm Incomes

5.6.1 Approach

The analysis seeks to identify the financial performance of existing farming systems and the financial consequences of a change in flooding regime associated with the adoption of flood storage and washland options. The analysis also indicates the order of benefit that might be obtained due to the relief of severe flooding in some areas as a consequence of controlled inundation on the Moors and Levels. It also seeks to identify the type of incentive payments that might encourage adoption of flood storage by farmers.

Although the case study sites provide an indication of what is feasible and what impacts might arise, it is not intended to appraise them as specific project sites for development. A detailed survey of existing drainage conditions, land use and farming practice has not been carried out within these sites. For this reason, and with due regard to the interests of occupiers in the study sites, the analysis adopts a generalised perspective, drawing on a general appreciation of agricultural land management in the Parrett flood plain, of which the study sites are representative.

The analysis uses data from multiple sources, namely national and regional farm business statistics, Parrett catchment specific information from the regional Farm Business Survey Unit, Exeter University, and informal discussions with a small sample of representative farmers in the flood plain.

The method used to assess the financial and economic impacts of changes in drainage conditions and flood risk associated with the adoption of flood storage options is summarised in Figure 5.1. Field drainage conditions determine the physical productivity of farming activity, whether for grassland (energy Mj/ha) or arable crops (t/ha). Energy from grass converts into a potential livestock carrying capacity (livestock units per ha) and, depending on the type and mix of livestock in the floodplain, into financial returns £/ha. Financial returns from arable (£/ha) reflect the type and mix of crops in the flood plain. Estimates of financial returns are net of relevant production expenses (such as seeds, fertilisers, veterinary expenses and machinery operating costs). They also include any receipts from government schemes such as Beef and Sheep Premia, IACS area payments, and ESA membership. Flood damage costs (£/ha/year), which vary according to flood risk and land use, are deducted from financial returns to give an overall estimate of financial performance (£/ha/year) for each major land use type. For the purpose of appraising the impact of flood storage, estimates are derived and compared for 'with' and 'without' storage situations.

Two broad scenarios are identified for the assessment of change on flood regime which are distinguished in terms of their severity and impacts, namely:

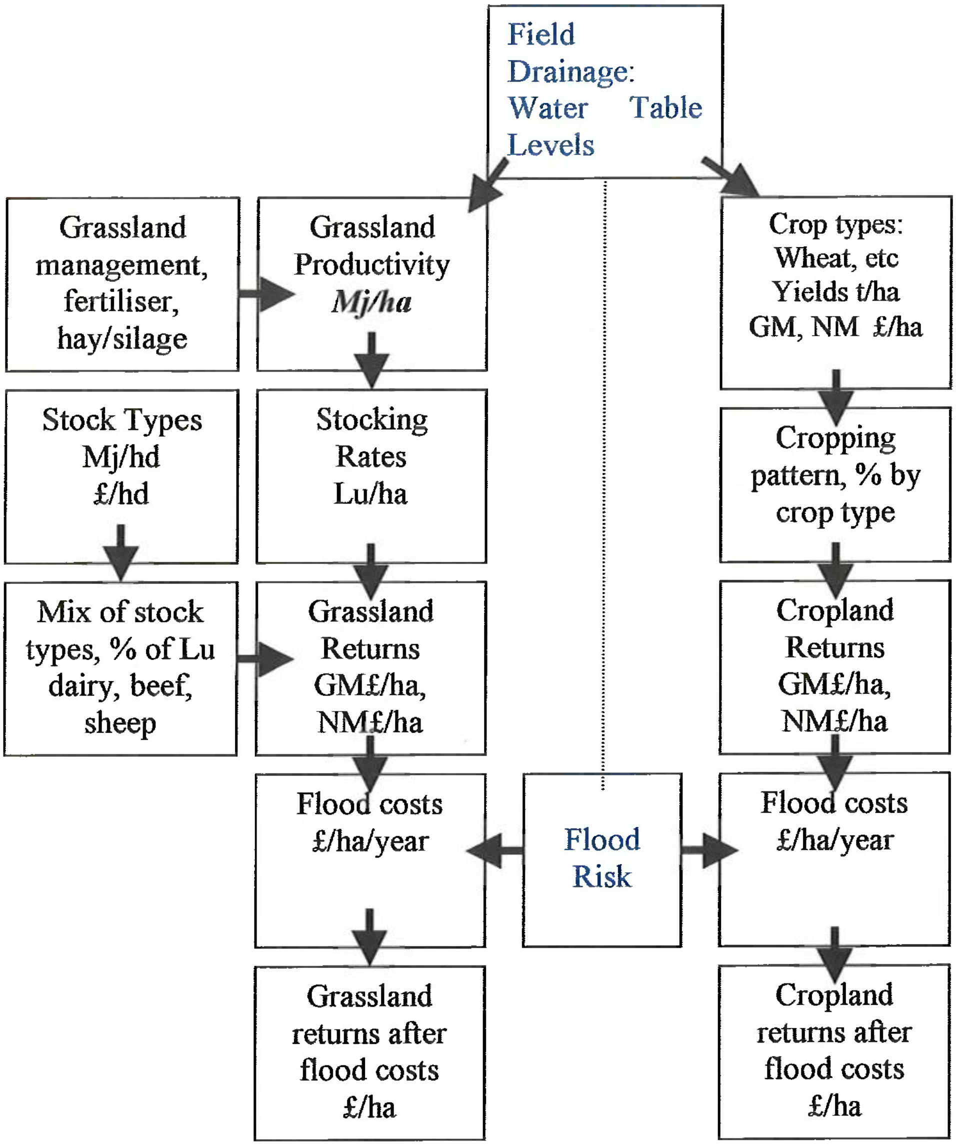
- Damage and recovery scenario: relatively small changes in annual flood risk, which may include infrequent long duration events, but not to the degree that results in changes in agricultural land use. Examples include damage to the yield of standing crops, in some cases requiring reseeding of grass or winter cereals.
- Land use change scenario: significant change in flood risk which results in a shift in land use and farming practice, for example a shift from arable to grassland, or from intensive to extensive grassland.

The biggest financial impacts of flooding are associated with the switch of agricultural land use to that which is compatible with flood risk. The following analysis bears this out.

The analysis is presented in the following order:

- Classification of grassland management systems and drainage-related productivity
- Estimated winter flood damage costs by land use type
- Financial performance of major farming systems and impact on farm incomes of switch in land use associated with changes in flood risk
- Impact on farm incomes assuming whole farm adoption of flood storage options
- Economic performance of major farming systems and impact on contribution to national economy of switch in land use associated with change in flood regime

Figure 5.1 Approach to Financial and Economic Appraisal



- Flood damage cost curves by major land use types, by depth and duration of winter flooding
- Estimates of average changes in financial returns from agriculture on the case study sites for assumed changes in flooding regime
- Estimated costs of implementing flood storage options on farm land

The analysis necessarily requires a number of simplifying assumptions which cannot do justice to what in reality are very diverse circumstances, practices and inter-relationships.

5.6.2 Land Use Associated with Agricultural Drainage Conditions

As previously referred, drainage conditions determine land use options. Table 5.7 summarises the physical characteristics of alternative grassland management systems. (Details are given in Appendix 2). The latter are distinguished by grassland productivity as this determines the ability to support livestock, either by grazing or grass conservation. These systems reflect the prescriptions required under the various ESA tier arrangements. Estimates of productivity are based on those of the plant communities shown Table 4.2 above. Tier 3 is subdivided by two types which reflects what is observed in practice. Tier 3 sedge dominated communities represent what has occurred in many raised water level areas. Tier 3 species rich is the target community for Tier 3 which has in many case failed to occur because of excessive flooding in early spring. Tier '4' represents a targeted inundation species suited to winter flooding.

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Table 5.7 Physical Performance of Alternative Grassland Systems

		Grassland Management Systems							
		Improved Grass	Improved Grass	Extensive Grass Tier 1	Extensive Grass Tier 1A	Wet Grass Tier 2	Wet Grass Tier 3 sedge	Wet Grass Tier 3 species rich	Wet Grass Tier 4 washland
Drainage condition	class	Good	Good	Good	Good	Bad	Very Bad	Very Bad	Bad
Chemical nitrogen	Kg/ha	200	150	75	25	25	0	0	0
Organic Nitrogen	Kg/ha	46	46	37	25	25	15	15	25
Total Nitrogen	Kg/ha	246	196	112	50	50	15	15	25
Tonnes Dry Matter	tDM/ha	9.8	8.7	6.6	4.7	5.5	8.2	2.6	3.5
DM as % of Improved Grass			100%	75%	54%	63%	94%	30%	40%
% graze		45%	45%	45%	50%	50%	50%	50%	50%
Energy UME	Mj/ha	79902	71101	53657	38507	26217	14171	15943	26926
TDM conserved	tDm/ha	4.3	3.8	2.9	1.9	2.2	3.3	1.0	1.4
Livestock units (dairy cow equivalent)	LU/ha	2.1	1.6	1.4	1.0	0.7	0.4	0.4	0.7
Stocking rate as % of Improved Grass			100%	87%	62%	42%	23%	26%	44%

5.6.3 Flood Damage Costs

Table 5.8 estimates average annual cost per ha of short duration (about 1 week) winter flooding by frequency of event and land use type. Grassland is classified into improved (150kgN/ha) and ESA tiers which vary in productivity. The estimates confirm that relatively short duration, even multiple winter flooding on extensive grassland has limited impact. Long duration flooding could however kill improved grasses, requiring reseeding. The impact of winter flooding on arable crops varies according to crop growth stage and duration. Flooding in excess of 1 week will normally require reseeding with a spring crop. The estimates are consistent with the design standards for flood defence.

Table 5.8

Flood Costs: £/ha/year by frequency of flooding

	Winter Floods/year					Summer Fl/yr
Land Use	**3**	**2**	**1**	**1 in 5**	**1in 10**	**1**
Grass						
Improved +	60	32	16	4	2	86
Tier 1	46	24	12	3	1	65
Tier 2	25	18	9	2	1	31
Tier 3 swamp	7	4	2	1	0.2	17
Tier 3 species	15	8	4	1	0.4	19
Tier 4 washland	10	8	6	2	0.6	33
Arable (wheat)						
winter*		100	50	10	5	100
crop loss**		500	400	80	40	500

notes: assumes floods of 1 week duration
grass assumes 50% grazed. 50% hay/silage
* yield reduction without complete crop loss
** assumed loss of winter crop and reseeded
+ excluding reseeding costs on grass at £180/ha , if required

5.6.4 Financial Margins for Livestock and Crop Enterprises

Table 5.9 contains estimates of financial revenues and costs for the main livestock and arable enterprises. More detail is given in Appendix 1. The estimates use the accounting conventions of the gross margin (gross output, including subsidies, less direct costs such as seeds and fertiliser) to denote value-added per head or per ha. Non-direct, so called fixed costs (such as labour, machinery, buildings, land and general expenses) are conventionally treated separately on the assumption that they are not easy to allocate to individual enterprises and are deemed not to vary directly with changes in individual enterprise size.

When a farm business changes its enterprise mix, it is important to determine whether the change will impact on total gross margin only, or whether there will be changes in fixed costs as well. The impact on farm income of minor changes in enterprise type or mix may be adequately reflected by a comparison of gross margins, on the assumption that everything else remains unchanged. However, larger changes, such as a switch from intensive dairy to extensive cattle grazing, or a significant change in total farm size, can result in changes in the overall 'total fixed cost' structure of the farm.

In table 5.9, a further distinction is made between 'semi' and 'total' (full) fixed costs. The conventional definition of gross margin ignores a number of costs which, though usually classified in farm accounts as 'fixed', really behave more like the variable costs used in the definition of the gross margin. These are direct labour (such as for milking and potato harvesting), the use of contractors, machinery operating costs and some animal shelter costs. These have been identified as 'semi' fixed costs per head or ha and charged accordingly. These semi-fixed costs do not include any capital charges for depreciation. Total fixed costs, by comparison, reflect overall average labour, machinery and buildings costs per unit of activity, including depreciation of capital assets such as machinery and buildings. Fixed costs here do not include land and financing charges, because these vary a lot according to farm circumstances.

Thus gross output, gross margin, net margin after semi-fixed costs and net margin after total fixed costs are, each in their own way, indicators of value-added from farm enterprises. The can be used to describe differences between options, such as land use with and without flood storage. Which is the best indicator of value added depends on the degree of change involved. In most cases gross margin gives the highest estimate of financial change, and may be relevant where it is reasonable to assume <u>no</u> increase or decrease in <u>any</u> labour, machinery, and building costs. This may be reasonable where there is a one-off, non-repeated change, such as loss of a standing crop (and there is no net saving in harvesting costs). In cases where there is a permanent albeit small change, such as that associated with lower livestock numbers due to lower drainage standards, there will be changes in some (not all) labour costs and machinery fuels and repairs, and possibly (some) building operations and maintenance. For this reason, it is considered that 'net margin after semi fixed costs' often provides a 'safer' estimate of the financial impact of a change than that of gross margin. It is useful to estimate gross and net margins as part of a sensitivity analysis..

Table 5.9. Parrett Catchment Summary of Livestock and Crop Enterprise Financial Margins

Financial Returns **£ per head** 2001 values	Dairy Cows £/head	Dairy Replacement Unit £/head	Lowland Suckler Beef Cow £/head	Overwintered Grass Finished Beef £/head	24-30 month Beef £/head	Store Cattle medium £/head	Store Cattle heavy £/head	Lowland Lamb £/head	Extensive Arable (wheat) £/ha
Gross Output	1034	490	298	282	577	118	86	53	475
Variable Costs	312	192	100	90	210	28	28	18	240
Gross Margin	722	298	199	192	367	91	59	35	235
GM incl extensification premium	722	298	221-243	214-236	411-455	91	59	35	475
Fixed Costs									(incl area payment)
Semi fixed costs	205	92	59	46	71	11	12	15	157
Full fixed costs	328	215	136	105	166	225	25	37.4	290
Net Margin after semi fixed costs	517	206	162-184	169-190	340-394	80			318
Net Margin after full fixed costs	394	83	85-107	109-131	245-289	68	47	20	185
Livestock Unit (LU) (cow) equiv.	1.0	1.15	0.76	0.41	0.78	0.31	0.38	0.12	-

Semi fixed costs include marginal labour costs, and machinery and building operating and maintenance costs.
Total fixed costs include labour charges at average per head rates, average total machinery and building costs per head, including depreciation of capital assets such as machinery and buildings.
No charges for land, general overheads and financing
See Appendices for details

5.6.5 Financial Performance by Land Use Type: Partial Analysis

Dairy Systems

Table 5.10 indicates the differences in gross margin (output, including subsidies but excluding ESA receipts, less direct costs) and net margin (after stock costs such as labour, machinery and buildings) for dairy based systems by type of grassland. The estimates here are not profit estimates. They are a measure of value added after selected costs are charges. They do not include charges for land, general expenses and financing.

The Tier '4' washland option has the potential to perform similarly to the current Tier 2, and better than Tier 3. The reduction in gross margin/ha after forage costs of the washland option is about £300/ha/yr. After allowing for reductions in stock semi fixed costs such as labour and machinery operating expenses, net margins fall by about £200/ha/yr. If farmers were able to achieve savings in overhead costs associated with livestock, such as buildings and machinery depreciation, the reduction in net margin after full fixed costs, would be around £120/ha/yr.

At present farmers receive £125/ha/yr and £225/ha/yr respectively for Tiers 1 and 2. On this basis, a payment of about £300ha/yr might be required to offer sufficient incentive to encourage adoption of Tier 4 by dairy farmers.

Table 5.10 Grassland Management Options **Dairy systems**

Financial Analysis

£/ha	Improved	Tier 1	Tier1A	Tier 2	Tier 3 sedge	Tier 3 sp rich	Tier '4' washland
Stocking rate Lu/ha	1.60	1.39	1.00	0.68	0.37	0.41	0.70
GM	**566**	**521**	**374**	**254**	**138**	**155**	**261**
Forage	255	168	97	130	140	66	82
GM after forage	**311**	**352**	**277**	**125**	**-2**	**88**	**179**
Stock costs							
semi fixed	172	150	107	73	40	44	75
full fixed	412	358	257	175	94	106	180
Net Margin							
semi fixed	138	203	170	52	-42	44	104
full fixed	**-101**	**-5**	**20**	**-50**	**-97**	**-18**	**0**
ESA payments		**125**	**200**	**225**	**430**	**430**	**300?**

Beef Systems

Table 5.11 presents similar data for beef systems. Tier 4 has the potential to perform as well as Tier 2 in terms of gross margin per ha, and marginally better after forage costs are charged. Compared to Tier 1, gross margin after forage costs reduce by about £175/ha/yr, and net margins by between £60/ha/yr and £120/ha/yr depending on the magnitude of savings in fixed costs. Given existing payments on Tier 1 of £125/ha/yr and on Tier 2 of £225/ha/yr, incentive payments of between £250/ha/yr and £300/ha/yr may be required to make Tier 4 attractive to beef farmers.

Table 5.11 Grassland Management Options — Beef Systems
Financial Analysis

£/ha	Improved	Tier 1	Tier1A	Tier 2	Tier 3 sedge	Tier 3 sp rich	Tier '4' washland
Stocking rate Lu/ha	1.60	1.39	1.00	0.68	0.37	0.41	0.70
GM	**566**	**521**	**374**	**254**	**138**	**155**	**261**
Forage	255	168	97	130	140	66	82
GM after forage	**311**	**352**	**277**	**125**	**-2**	**88**	**179**
Stock costs							
semi fixed	172	150	107	73	40	44	75
full fixed	412	358	257	175	94	106	180
Net Margin							
semi fixed	138	203	170	52	-42	44	104
full fixed	**-101**	**-5**	**20**	**-50**	**-97**	**-18**	**0**
ESA payments		**125**	**200**	**225**	**430**	**430**	**300?**

Beef and Sheep Systems

Table 5.12 shows financial returns for Beef (50%) and Sheep (50%) systems. The switch from Tier 1 to 4 results in a £260/ha/yr drop in gross margin before forage costs and a £170/ha/yr drop after forage costs have been accounted. Net margins fall by up to £100/ha/yr depending on the extent of savings in fixed costs. On this basis, an incentive payment of about £250/ha/yr might be attractive to encourage a switch to the washland option

Table 5.12 Grassland Management Options — Beef and Sheep
Financial Analysis

£/ha	Improved	Tier 1	Tier1A	Tier 2	Tier 3 sedge	Tier 3 sp rich	Tier '4' washland
Stocking rate Lu/ha	1.60	1.39	1.00	0.68	0.37	0.41	0.70
GM	**566**	**521**	**374**	**254**	**138**	**155**	**261**
Forage	255	168	97	130	140	66	82
GM after forage	**311**	**352**	**277**	**125**	**-2**	**88**	**179**
Stock costs							
semi fixed	172	150	107	73	40	44	75
full fixed	412	358	257	175	94	106	180
Net Margin							
semi fixed	138	203	170	52	-42	44	104
full fixed	**-101**	**-5**	**20**	**-50**	**-97**	**-18**	**0**
ESA payments		**125**	**200**	**225**	**430**	**430**	**300?**

Average Parrett Catchment Livestock Systems

Table 5.13 assumes a mixed dairy, beef and sheep systems based on livestock numbers for the Parrett flood plain as a whole, with results that fall between those of the previous two tables. Incentive payments of £300/ha/year may be needed to encourage adoption.

Table 5.13 Grassland Management Options **Parrett Dairy and Livestock Sector**
Financial Analysis

£/ha	Improved	Tier 1	Tier1A	Tier 2	Tier 3 sedge	Tier 3 sp rich	Tier '4' washland
Stocking rate Lu/ha	1.60	1.39	1.00	0.68	0.37	0.41	0.70
GM	791	701	503	343	185	208	352
Forage	255	168	97	130	140	66	82
GM after forage	536	533	407	213	46	142	270
Stock costs							
semi fixed	217	188	135	92	50	56	94
full fixed	403	350	251	171	92	104	176
Net Margin							
semi fixed	320	345	272	121	-4	86	176
full fixed	133	183	156	42	-47	38	94
ESA payments		125	200	225	430	430	300?

Arable Farming

Arable farming would not be feasible on Washland. Estimated gross margins for typical yields and rotations are about £500/ha/yr, with net margins after direct labour and machinery operating costs of about £290/ha/yr, and about £175/ha/yr if full costs for machinery are charged. A switch to Tier 4 would, for the assumptions made, result in a loss of gross margin of about £300/ha/yr, assuming livestock could be accommodated on the farm. In terms of net margins, this reduces by between £90/ha/yr and £150/ha/yr according to the extent to which savings in fixed costs can be achieved.

These relatively low differences in financial returns between arable and washland (before ESA payments) reflect the deteriorating terms for arable farming in the area. Indeed they confirm the observation that Tier 1 grassland compares favourably with arable systems at the moment. Both systems, however, are dependent on continued subsidies. On the face of it, for extensive arable systems, the incentive levels payable to grassland farmers (of £300/ha/yr or so) would appear to be attractive to arable farmers, but there may be an expectation that they should be higher.

Existing payments for set-aside (£240/ha/yr) and Countryside Stewardship arable conversion to grassland payments of £280 – £380/ha/yr (mainly in arable dominated areas) provide a benchmark for payments to farmers to take land out of arable production.

5.7 Financial Impacts at Farm Level

In some cases farms may have the entirety of their land within the flood plain areas. Adoption of a flood storage option could therefore impact on the farm business as a whole, rather than just part of it.

Table 5.14 and Table 5.15 summarise the impact of a change in grassland management systems and consequences for farm income associated with take up of the flood storage option for two dominant types of farm in the study area. The farm models draw on data from the Regional Farm Business Survey (University of Exeter, 2001) for Specialist Dairy Farms below 80ha (200acres) and Cattle and Sheep Farm below 80ha, adjusted to reflect farming performance in the study area.

Table 5.14 shows that a washland option would reduce stocking rates and Gross Margins by about 60%, reduce profit (before family labour and rent) to zero, and make the farm business non viable (excluding ESA payments) with Management and Investment Income (M&II) at around -£400/ha/yr. It would be difficult to maintain a relatively small dairy unit of 30-40 milking cows under a washland option. Conversion to a beef cows system would offer better prospect. The last column of Table 5.14 suggests that this system could be viable with ESA Washland payments of around £300/ha/yr.

Table 5.14 Whole Farm Impacts of Adoption of Washland Option
Dairy Farm under 80ha, average size

60ha £/ha	Grassland Management				
	Improved Dairy	Tier 1 Dairy	*Tier 1 & Tier 4 Dairy	Tier 4 Washland Dairy	Tier 4 Washland Beef Cows
GLU/farm	1.84	1.39	1.04	0.70	0.70
GM	**1124**	**848**	**629**	**410**	**186**
Profit (before family labour and rent)	**499**	**300**	**140**	**-21**	**-24**
Family labour	350	307	274	241	162
Rent	236	207	185	163	100
M & II	-87	-214	-319	-425	-286
ESA receipt		125	213	300	300
M & II after ESA receipt	**-87**	**-89**	**-107**	**-125**	**14**

* 50%/50% mix

Table 5.15 shows estimates for the impact of a washland option on a Cattle and Sheep farm. At present, these farms are not recovering the full cost of family labour and the imputed rental value of land (many farms are owner occupiers, but nevertheless may be mortgage payers). Compared to Tier 1, which is commonly adopted by livestock farmers in the study area, profits fall by about £230/ha/yr and M&II by about

£140/ha/yr. A washland option with a payment of around £300/ha/yr could be attractive for cattle and sheep farmers, especially non-mortgaged owner occupiers.

Table 5.15 Whole Farm Impacts of Adoption of Washland Option
Cattle and Sheep Farm under 80ha, average size 58ha

		Grassland Management		
£/ha	Improved	Tier 1	*Tier 1 & Tier 4 mix	Tier 4
GLU/farm	1.84	1.39	1.04	0.70
GM	**612**	**462**	**326**	**189**
Profit (before family labour and rent)	**281**	**171**	**56**	**-59**
Family labour	262	230	213	197
Rent imputed	133	117	108	100
M & II	-215	-235	-305	-375
ESA receipt		125	213	300
M&II after ESA	**-215**	**-110**	**-92.5**	**-75**

* 50%/50% mix

5.8 Economic Analysis

Economic returns for the range of grassland management systems have been estimated using DEFRA Flood Defence Project Appraisal Guidance as explained in section 5.2. Table 5.16 shows the economic returns for grassland management assuming the overall average mix of livestock systems in the Parrett flood plain areas, that is predominantly dairy and livestock, with some sheep.

Overall, the economic value of gross margins are about 40% of their financial values, and reductions in gross margin due to extensification of grassland are lower than the equivalent financial estimates by a similar percentage. Once differences in fixed costs between grassland systems are allowed for, there appears to be little difference in economic terms between Improved Grass, Tier 1 and Tier '4' Washland on the basis of net margin after semi-fixed costs (the latter includes direct labour, machinery operating costs, and building upkeep). If net margin after full fixed costs is used for comparison (the latter includes charges for overheads including regular labour, and machinery and buildings depreciation, but excluding land, general expenses and financing charges), there appears to be a small economic advantage to switching to less intensive systems.

These estimates need very cautious interpretation. The DEFRA adjustment factors particularly discriminate against dairy production (because as an enterprise subject to quota it is treated as a wheat crop in the economic analysis).

Estimates of economic returns for beef systems are given in Table 5.17. The underlying message is similar. Economic gross margins are lower than financial ones. Tier 1 gives better economic value than improved grass, and there is a relatively small difference (of about £60/ha/yr) between Tier 1 and Tier '4' for the assumptions made. Indeed, in terms of net margins after changes in semi-fixed costs, there is little difference between the latter two systems. If extensification in a Washland option is associated with reductions in full fixed costs, then a switch of this kind appears to offer overall economic advantage. Of course, such a change implies significant change in the fixed costs (labour, machinery buildings) structure of farm businesses as they move to a more extensive system.

Broadly, the economic analysis shows that the loss of value-added due to extensification associated with the adoption of a Washland option is less than that suggested by the financial analysis which reflects income losses (inclusive of subsidies) to farmers.

For beef and sheep systems (Table 5.18), there would appear to be a small economic advantage of switching to less intensive systems, providing savings in overall fixed costs at farm level can be achieved.

Table 5.16 Economic Returns for Dairy Based Systems by Grassland Management

Economic Returns for Grassland Systems in the Parret Catchment									
£/ha, economic prices, 2001 values		**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**
Dairy Based System		**Improved Grass**	**Improved Grass**	**Extensive Grass Tier 1**	**Extensive Grass Tier 1A**	**WetGrass Tier 2**	**WetGrass Tier 3 Swamp**	**WetGrass Tier 3 Species rich**	**Wet Grass Tier '4' Washland**
Gross Margin	**£/ha**	**392**	**304**	**263**	**189**	**129**	**70**	**78**	**132**
Reduction in GM cf B				40	115	175	234	225	171
Forage Costs	£/ha	50	41	27	15	21	22	11	13
Gross Margin after Forage		**342**	**263**	**237**	**174**	**108**	**47**	**68**	**119**
Reduction cf B				26	89	155	216	195	144
Fixed Costs									
semi fixed		189	260	225	162	110	60	67	113
full fixed		359	278	241	173	118	64	72	121
Net Margin after forage costs	£/ha								
after semi-fixed costs		154	3	11	12	-2	-12	1	6
after full fixed costs		**-17**	**-15**	**-5**	**1**	**-10**	**-16**	**-4**	**-2**
Reduction cf B (-ve indicates gain)				-11	-16	-5	1	-11	-13

Note: uses PAG3 economic adjustment factors, dairy and replacements treated as wheat, with % of land area and costs apportioned accordingly
Conversion rate between diary and wheat assumes area average for dairy at 1.6 LU/ha, 1 LU =0.625 ha wheat.

Table 5.17 Economic Returns for Beef Based Systems by Grassland Management

Economic Returns for Grassland Systems in the Parret Catchment £/ha, economic prices, 2001 values Beef Based System		A Improved Grass	B Improved Grass	C Extensive Grass Tier 1	D Extensive Grass Tier 1A	E WetGrass Tier 2	F WetGrass Tier 3 Swamp	G WetGrass Tier 3 Species rich	H Wet Grass Tier '4' Washland
Gross Margin	**£/ha**	**423**	**327**	**284**	**204**	**139**	**75**	**84**	**143**
Reduction in GM cf B				43	123	189	252	243	185
Forage Costs	£/ha	312	255	168	97	130	140	66	82
Gross Margin after Forage		**111**	**72**	**116**	**107**	**9**	**-65**	**18**	**60**
Reduction cf B				-44	-35	63	137	54	12
Fixed Costs									
semi fixed		146	113	98	70	48	26	29	49
full fixed		332	257	223	160	109	59	66	112
Net Margin after forage costs	£/ha								
after semi-fixed costs		-35	-41	18	37	-39	-90	-11	11
after full fixed costs		**-221**	**-185**	**-107**	**-53**	**-100**	**-123**	**-48**	**-51**
Reduction cf B (-ve indicates gain)				-78	-132	-85	-61	-136	-133

Table 5.18 Economic Returns for Beef and Sheep Systems by Grassland Management

Economic returns for Grassland Systems in the Parret Catchment **£/ha, economic prices, 2001 values** **Beef and Sheep Based System**	**A** **Improved Grass**	**B** **Improved Grass**	**C** **Extensive Grass Tier 1**	**D** **Extensive Grass Tier 1A**	**E** **Wet Grass Tier 2**	**F** **Wet Grass Tier 3 Swamp**	**G** **Wet Grass Tier 3 Species rich**	**J** **Wet Grass Tier '4' Washland**
Gross Margin £/ha	**473**	**366**	**318**	**228**	**155**	**84**	**94**	**159**
Reduction in GM cf B			48	138	211	282	272	207
Forage costs £/ha	312	255	168	97	130	140	66	82
Gross Margin after Forage	**161**	**111**	**149**	**131**	**25**	**-56**	**28**	**77**
Reduction cf B			-39	-21	85	166	83	33
Fixed Costs								
semi fixed	206	159	138	99	67	36	41	69
full fixed	488	378	328	235	160	87	97	165
Net margin after forage costs £/ha								
after semi-fixed costs	-45	-49	11	32	-42	-92	-13	8
after full fixed costs	**-328**	**-267**	**-179**	**-104**	**-135**	**-142**	**-69**	**-87**
Reduction cf B (-ve indicates gain)			-89	-163	-132	-125	-198	-180

5.9 Estimated Winter Flood Damage Costs by Depth and Duration

Within the limits of available information, Figures 5.2 and 5.3 contain estimates of the cost of flooding during the winter period on improved and Tier 1 grassland respectively, for specified depths of flooding and duration. The estimates are based on those contained in Table 5.8 above for floods of between 1 and 2 weeks duration using the methods described in Appendix 1. As previously mentioned, grassland is very tolerant to winter flooding, although the effect of repeated relatively short duration floods can be additive. There is very little information on which to estimate the effect of long duration flooding on grassland. Anecdotal evidence from farmers in Somerset suggested long duration flooding of 2 to 3 months or so damaged 'improved' grassland such that reseeding was necessary. Tier 1 land suffered considerable damage to the sward, especially where flood waters were deep, dark and polluted. There were also reports of soil compaction and erosion.

The estimates in Figures 5.2 and 5.3 use the following assumptions

- Flood damage costs are based on estimated loss of energy from grass valued at a substitute feed price, less any savings in grass conservation costs, if relevant, plus clear-up costs, and livestock relocation costs, if relevant. It is assumed that grassland areas are 50% grazed and 50% cut for hay or silage. It is assumed that no stock are lost.

- The impact of flooding on grass is additive for repeat events during the winter period (2 one week floods give twice the total damage cost of a one week flood).

- The effects of long duration flooding are cumulative along an s-shaped (logistic) curve where the highest point (asymptote) approximates to the greatest cost estimate, where, in the case of grassland, the latter is given by the costs of reseeding (for a one-off flood) or the income loss associated with a switch to a flood tolerant land use (for a permanent change in flood risk), for example a switch from Tier 1 to the Washland Tier 4 option.

- Flood damage costs vary by depth according to the following weighting factors: splash flooding = 0.9; 150mm =1; 400 mm = 1.2; 750mm+ = 1.5

Figures 5.2 and 5.3 show that flood damage on improved grassland range from about £13 and £17 /ha for a single one week flood on Tier 1 and improved grassland respectively to £170 to £220 for long duration flooding which results in a switch of land use to the Tier 4 Option. One off damage costs associated with reseeding of grassland would be about £200/ha including clean-up costs. The tolerance to flooding depends on the timing of the flood and whether the period of inundation is continuous or made up of discrete events which might allow some intervening recovery. Continuous flooding of 6 to 8 weeks would probably kill ryegrass (although not necessarily if this occurred in mid winter), but probably not if this was intermittent. A month's flooding in March, however, on the onset of grass growth, could severely damage improved grasses. Thus, on improved grasses, the damage curve is likely to rise more steeply than indicated in Figure 5.2 for continuous flooding of 5 to 8 weeks, after which it would plateau quickly at the maximum damage costs.

For the assumptions made, flooding of up to about 2 months duration in total would cost about £60/ha and about £80/ha on Tier 1 and improved grass for a storage 150mm depth. For arable crops, it is assumed that winter flooding of more than a few days would destroy the crop and require reseeding with a spring cereal, if feasible.

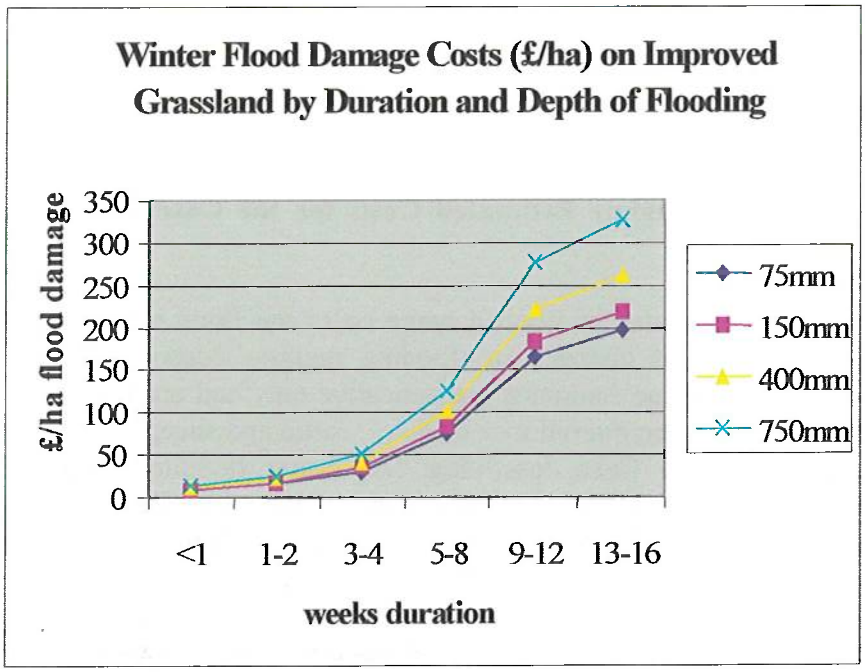


Figure 5.2

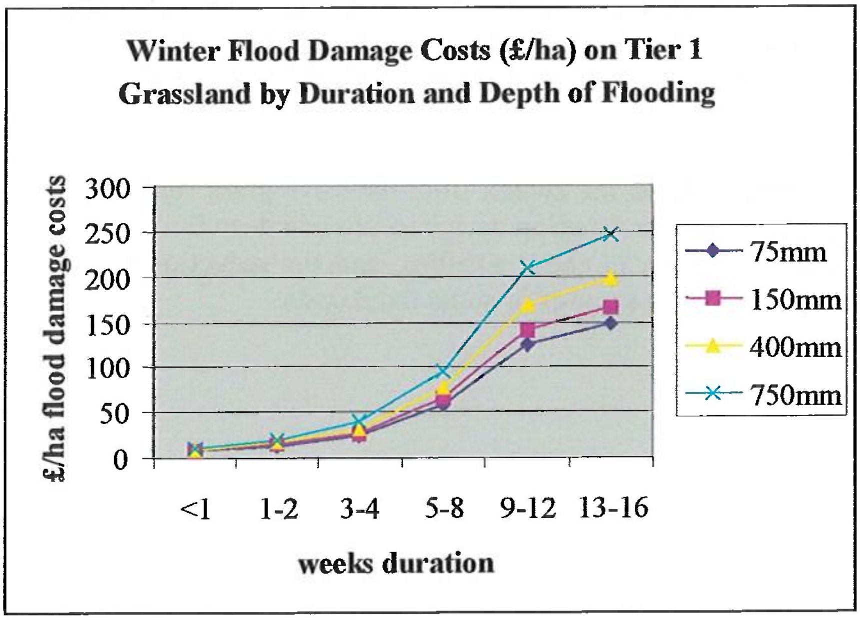


Figure 5.3

It has been assumed that the washland options will not involve significant changes in summer flood risk as shown by the descriptions for the case study sites in Chapter 2.

There may be cases where retention of flood water into summer is desirable in itself, to provide a store of irrigation water, or to provide an environmental benefit. Short term summer flooding on grassland to provide flood alleviation benefits elsewhere is, however, much more damaging than winter flooding, as previously explained, especially if the flood destroys a hay or silage crop. The cost of short single summer events by grass type is given in Table 5.8 above. Such summer flooding may also have some undesirable environmental impacts. The use of washland sites for summer flooding would need to be assessed on a site by site basis, balancing impact on agriculture and wildlife.

These estimates, based as they are on simplifying assumptions and limited data, require very cautious interpretation, especially with respect to cumulative effect of long duration flooding.

5.10 Impact of Changes in Flood Regime Estimated Costs for the Case Study Sites

Table 5.19 applies the preceding estimates of flood damage costs and flood induced land use change to the predictions of changes in flooding regimes described in Chapter 2 for the case study sites. These estimates are indicative only and are based on very broad land use categories and the overall mix of dairy, cattle and sheep in the Parrett Catchment. The Aller Moor Case, involving deep water flooding on a washland option, would result in a reduction in gross margin of between £280 and £340/ha/year, the latter inclusive of ESA receipts on assumed Tier 1 land. In net margin terms, these reductions are between £160 and £230/ha/year respectively.

On King's Sedge Moor there would be some alleviation of flood risk, with an overall benefit of about £13/ha/year. It is assumed that West Sedge Moor would switch to the Washland option, resulting in a reduced gross margin of between £50 and £270/ha/year, the latter inclusive of ESA receipts. There would be little effect on net margin excluding ESA payments, but a reduction of about £230 inclusive of ESA receipts.

The Upper Parrett Valley example shows the switch from intensive grass supporting dairy, cattle and sheep to a Washland Tier 4 option design to provide deep flood water storage. The reduction in gross margin is about £230/ha, and the reduction in net margin of about £100/ha /year, assuming savings in some fixed costs.

Table 5.19 Estimated Costs of Flooding for With and Without Flood Storage Option by Zone assuming Broad Land Use Categories

ZONE	WITHOUT FLOOD STORAGE – SCENARIO	Cost of flood event £/ha	Average Annual cost weighted by area £/ha	WITH FLOOD STORAGE SCENARIO	Cost of flood event £/ha	Average Annual cost weighted by area £/ha
ALLER MOOR / MIDDLE MOOR (area between Church drove and Head wall only)	**Land Use:** **25% arable** **25% Improved Grass** **50% Tier 1**			**Land Use** **Washland option** **Tier 4**		
	WINTER 10% splashed for 2 separate 1 week periods every year on T1 grass only	22	2.2	**WINTER** 100% up to 750mm Dec/Jan/Feb/Mar every year Splashed Apr every year Deeper flooding single 2 week period in Oct/Nov or April 1 year in 10		**Included In Washland option**
	25% up to 150mm for a single 1 week period 1 year in 5 on grass only	16	0.8			
	90% up to 300mm for a single 2 week period 1 year in 10	135	12.2			
	SUMMER 50% splashed for a single 1 week period 1 year in 50	228	2.3	**SUMMER** 50% splashed for a single 1 week period 1 year in 50	33	0.4
	Total annual flood cost		17.5			0.4
	Gross Margin		566			270
	Net Margin		356			176
	ESA receipts		63			
	Change in Gross Margin less Flood Cost					
	- **excl ESA receipts**					-279
	- **incl ESA receipts**					-342
	Change in Net Margin less Flood Cost					
	- **excl ESA receipts**					-163
	incl ESA receipts					-226

Gross Margin after forage costs: output less direct variable costs such feeds and fertiliser.
Net Margin after semi fixed costs: Gross Margin after forage costs less other direct costs such as variable labour costs, machinery operating costs, but excluding depreciation, land charges, general expenses and financing.

Table 5.19 continued

ZONE	WITHOUT FLOOD STORAGE – SCENARIO	Cost of flood event £/ha	Average Annual cost weighted by area £/ha	WITH FLOOD STORAGE SCENARIO	Cost of flood event £/ha	Average Annual cost weighted by area £/ha
KINGS SEDGE MOOR	**Land Use Tier 1**			**Land Use Tier 1**		
	WINTER			**WINTER**		
	50% splashed for two separate 1 week periods every year	22	11.0	50% splashed for two separate 1 week periods every year	22	11.0
	100% up to 150mm for a single 1 week period every other year	13	6.5	100% up to 400mm for a single 2 week period 1 year in 10	30	3
	100% up to 400mm for a single 2 week period 1 year in 5	38	7.5	**SUMMER**		
				50% splashed for a single 1 week period 1 year in 25	65	1.3
	SUMMER					
	50% splashed for a single 1 week period 1 year in 10	65	3.2			
	Total annual flood cost		28.2			15.3
	Gross Margin		533			533
	Net Margin		345			345
	ESA receipts		125			125
	Change in Gross Margin After Flood Costs					
	excl ESA receipts					+12.9
	incl ESA receipts					+12.9
	Change in Net Margin less Flood Cost					
	excl ESA receipts					+12.9
	incl ESA receipts					+12.9

Table 5.19 continued

ZONE	WITHOUT FLOOD STORAGE – SCENARIO	Cost of flood event £/ha	Average Annual cost weighted by area £/ha	WITH FLOOD STORAGE SCENARIO	Cost of flood event £/ha	Average Annual cost weighted by area £/ha
WEST SEDGE MOOR	Land Use 33% currently maintained as T2S or T3 raised winter water level areas by RSPB 67% assumed Tier 1 (excluding withy areas)			Land Use Tier 4 Washland option		Land Use 'Washland Tier 4'
	WINTER 67% splashed for two separate 3 week periods every year (Tier 1)	45	30.1	WINTER 90% splash flooded Dec/Jan/Feb/Mar every year		Included in Washland Option
	50% up to 300mm for a single 3 week period every other year	15	7.5	Deeper flooding up to 600mm deep single 2 week period any time between Oct and Mar 1 year in 5		Reduction in Net Margin £170/ha due to land use change
	90% up to 600mm for a single 4 week period 1 year in 5	37	6.7			
	SUMMER 50% splashed for a single 1 week period 1 year in 5	50	5	SUMMER 50% splashed for a single 1 week period 1 year in 5	15	1.5
	50% up to 300mm for a single 2 week period 1 year in 10	85	4.3	90% up to 150mm for a single 2 week period 1 year in 10	33	3
	90% up to 600mm for a single 3 week period 1 year in 25	108	4.3			
	Total annual flood cost		57.9			4.5
	Gross Margin		372			270
	Net Margin		230			176
	ESA Receipts		225			
	Change in Gross Margin After Flood Costs					
	excl ESA receipts					-49
	incl ESA receipts					-274
	Change in Net Margin less Flood Cost					
	excl ESA receipts					-1
	incl ESA receipts					-226

Table 5.19 continued

ZONE	<u>WITHOUT</u> FLOOD STORAGE – SCENARIO	Cost of flood event £/ha	Average Annual cost weighted by area £/ha	<u>WITH</u> FLOOD STORAGE SCENARIO	Cost of flood event £/ha	Average Annual cost weighted by area £/ha
PAR-RETT VALLEY U/S A303	**Land use: Improved Grass**			**Land Use: Tier 4 washland**		
	WINTER 100% up to 150mm for 3 separate 3 day periods every year	30	30	**WINTER** 100% up to 1500mm for 3 separate 4 week periods every year		**Included In Washland Option**
	100% up to 450mm for a single 5 day period 1 year in 5	20	4			
	SUMMER 50% splashed for a single 1 week period 1 year in 5	77	7.7	**SUMMER** 50% splashed for a single 1 week period 1 year in 5	33	3.3
	100% up to 150mm for a single 3 day period 1 year in 20	86	4.3	100% up to 1500mm for a single 2 week period 1 year in 20	50	2.5
	Total annual flood cost		46.0			5.8
	Gross Margin		536			270
	Net Margin		320			176
	ESA receipts		0			
	Change in Gross Margin After Flood Costs					
	excl ESA receipts					-226
	incl ESA receipts					-226
	Change in Net Margin less Flood Cost					
	excl ESA receipts					-104
	incl ESA receipts					-104

5.11 Estimated Costs of Implementing Flood Storage Options on Farm Land

5.11.1 Flood Damage Costs per Unit of Water Storage

Figures 5.4 and 5.5 show flood damage costs per 1000m3 of water storage by grassland type, according to the duration and depth of flooding. For example a 150mm flood of 5 to 8 weeks would cost about £0.05/m3 of water stored, and a 13-16 week flood about £0.15/m3.

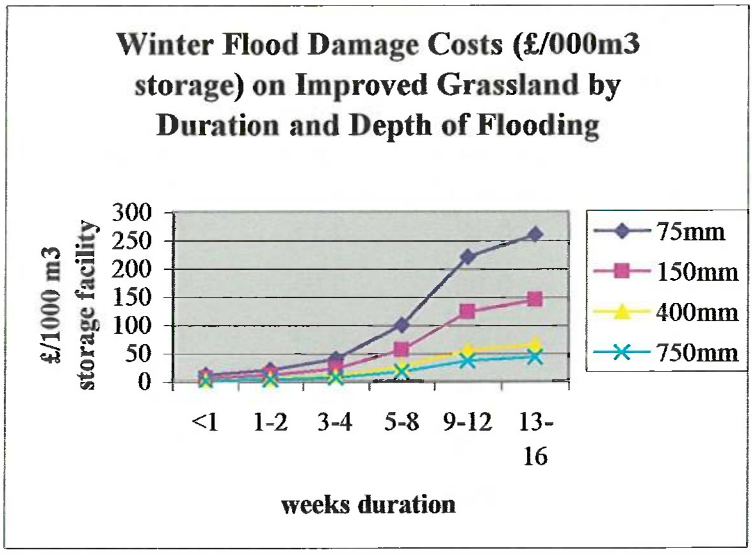


Figure 5.4

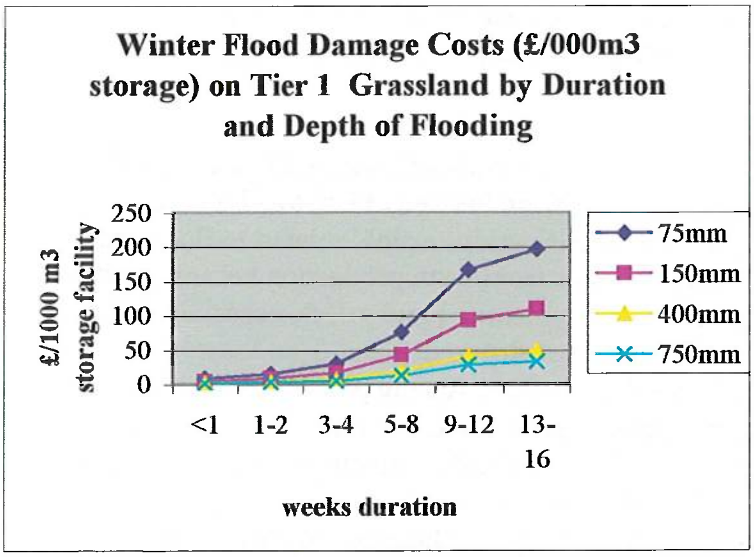


Figure 5.5

5.11.2 Adoption of Washland Options in the Case Study Areas

Within the limits of the data available, and the assumptions made, Table 5.20 summarises the likely impact of adoption of a Washland option for the four case study sites.

Table 5.20 Farm Land Related Costs of Flood Storage

Options for acquisition of flood storage

a	Annual		£/ha/yr	300
b	Purchase		£/ha	3750
c	Easement	80% of b	£/ha	3000

				Costs £/m³ storage*		
Flood		**Purchase capital**	**Easement capital**	**Annual payment**	**Purchase equiv. an.**	**Easement equiv. an.**
m depth	m^3/ha	£/m^3	£/m^3	£/m^3/yr	£/m^3/yr	£/m^3/yr
0.25	2500	1.50	1.20	0.12	0.11	0.09
0.5	5000	0.75	0.60	0.06	0.05	0.04
0.75	7500	0.50	0.40	0.04	0.04	0.03
1.0	10000	0.38	0.30	0.03	0.03	0.02
1.5	15000	0.25	0.20	0.02	0.02	0.01
2.0	20000	0.188	0.150	0.015	0.014	0.011

Notes

*£/m^3 of storage facility which may accommodate multiple events excluding flood storage capital and operating.

Three broad options for achieving flood storage facilities on farm land have been identified (discussed in Chapter 6 below). These, and their likely costs, are summarised as follows:

- Outright purchase of land from owners (with or without leaseback). Land prices in the Levels and Moors vary considerably, from between £800 to £1500 per acre (£2000 to £3750/ha) according to land classification, mainly related to flood risk. Farmland prices are high relative to earnings from farm production because of the inflationary effects of ESA and set-aside payments. Land prices, especially where land has associated built property, also reflect strong demand from the non-farming sector (although this is less so in the more remote parts of the Moors).
- Easement, involving purchase of rights to use the land for winter flooding. The original owner retains all other land rights. Typical easement payments for flood alleviation schemes are about 80% of market values.
- Annual payments under an ESA or Stewardship Washland Component. The preceding analysis identified a possible annual payment of £300/ha/yr. It might be possible to negotiate 'stand-alone' annual payments with farmers for flood storage for specified periods and frequencies, at rates of between £65 and £100/ha according to depth of flooding for a flood period of between 5 and 8 weeks during the winter.

Table 5.21 applies these three financing approaches to the provision of flood storage, (excluding engineering works and operational costs) assuming different depths of flooding. Equivalent annual costs are estimated for the landtake costs of purchase and easement options assuming that the capital costs would be recovered in equal annual instalments with interest over 30 years at 6% (i.e. a 30 year annuity at 6%). At an average depth of 0.25m, the land-based costs of a storage facilities might fall between £0.08 and £0.12m3/yr. For deeper storage, at 0.75m depth, land take costs reduce to about £0.04/m3/yr.

Table 5.21 gives broad estimates of likely costs of providing flood storage facilities (excluding engineering and operations costs) on each of the study sites given the maximum known areas and depth of flood capacity (see Chapter 2 above). Expectedly, costs vary according to depth per unit area. For the assumptions made, land purchase is about 10% cheaper over a 30 year period, but sensitive to assumptions about annuity interest rate and period. Capital costs associated with purchase of land or easement could vary between £0.5 and £1.5/m3, and annual costs between £0.04 and £0.12/m3/yr, depending on site conditions. But these are very rough estimates.

A meaningful estimate of costs needs to include engineering construction and operating costs. These are very site specific, and at the time of writing unidentified. There are likely to be economies of scale in civil works.

Table 5.21 Indicative Costs for Winter Water Storage for Study Sites
(based on payments to land managers only, excl. engineering and operations costs)

	Area	**Maximum Depth (maximum)**	**Flood Capacity**	**Costs Tier type (Annual Payment)**	**Costs Land Purchase (Capital cost)**	**Purchase Land Purchase (Equiv. an. cost)**
Sites	ha	m	$000m^3$	$£/000m^3/yr$	$£/000m^3$	$£/000m^3/yr$
A303	25	0.4	100	75	938	68
Aller Moor	400	0.75	3000	40	500	37
WSM	900	0.6	5400	50	625	46
KSM	2000	0.4	8000	75	938	68

Assuming 30 year period at 6% real interest
Annual charge per £ £0.073

Preliminary cost estimates are available for two pilot site developments in the upper Middle Catchment. One involves a single field option of 7.4 ha, with a capacity of 15,000m3 (hence average depth 0.2m) at a design and build cost of £70,000, equivalent to £ 4.66/m3 storage. Another one involved a reach of river over a 24.3ha area, with a capacity of 100,000m3 (average depth 0.4 m), a design and build cost of £219,000, equivalent to £2.19/m3 of storage.

Land costs would push total capital costs up to £6.5/m3 and £3.1/m3 for the two schemes respectively, and result in equivalent annual costs of about £0.23/m3/yr and £0.47/m3/yr excluding any flood management operating costs. Full cost estimates are not available for lower catchment sites. Costs are likely to vary considerably according to the need to import materials for embankments, especially if these are to be constructed on permeable soil profiles such as peat.

Given the considerable variation in winter storage facilities between sites due to variations in depth or frequency of winter flooding, these aspects might be reflected in the payment scheme to land managers.

5.12 Summary

This Chapter has provided an overview of the financial and economic performance of farming in the Parrett flood plain, the extent to which this is dependent on standards of flood defence and land drainage, and the implications of implementing flood storage options.

Estimates of the cost of frequent and long duration winter flooding on grass land vary according to the quality of grass, an the duration and depth of flooding. Estimated damage costs vary from about £30-50/ha for one month month, rising to about £170-220/ha for the winter season if long duration flooding destroys grass or results in an overall loss of grassland productivity.

The financial analysis examined the feasibility of a Tier '4' washland option which would allow farmers to adopt extensive grassland systems which could withstand winter inundation. A £300/ha/yr incentive might encourage participation by farmers, whether grassland or arable. The economic analysis showed that there was advantage in switching to less intensive grassland systems associated with washlands. This helps to justify the washland creation option, and the use of public funds to deliver it.

Estimated costs of land take per m3 of flood storage facility (excluding engineering works and operations) vary considerably accordingly to site conditions. Capital costs of land purchase could range from £0.5/m3 to £1.5/m3. The equivalent annual costs could range between £0.04/m3/yr and £0.012/m3/yr for the study sites. Design, build and operating costs would add significantly to these, but estimates are not available.

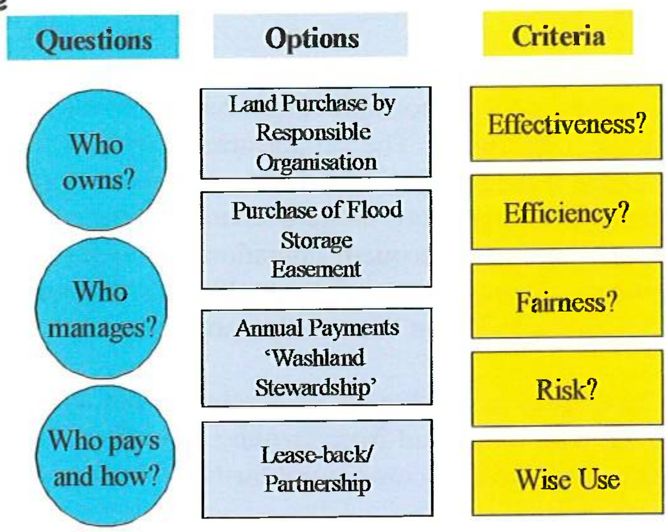
6. Institutional Arrangements for Flood Storage and Washland Management

This Chapter explores institutional arrangements to deliver flood storage and washland creation in the study area. It identifies the main tenure options and considers their relative performance against selected criteria. Factors influencing likely adoption of flood storage options by land managers are reviewed and reference made to actions to promote participation in washland creation

6.1 Approach

Alternative arrangements were identified for land tenure and management which could potentially deliver the flood storage facilities in the study area. Discussions were held with key informants from the Environment Agency, Government and non-Government Conservation organisations and farmers. Key questions regarding land ownership, management arrangements and payments systems (Figure 6.1) were discussed by stakeholders at an evening workshop organised by WUF & LAMP.

Figure 6.1, Selection of Management Options for Flood Storage



6.2 Main Management Options

There are four main types of management arrangements which could be pursued, namely land purchase, easements, management agreements and leaseback partnership. Their suitability varies according to the purposes to be achieved, the longevity of the commitment to change and, linked to these, whether farmers retain ownership and operation of the land or whether ownership and/or operation transfer permanently or temporarily to some other organisation.

All of these options require some kind of Washland Programme Organisation, most likely comprising representatives of all the key stakeholders and acting as a conduit for funding. The key organisations are the Environment Agency, Local Government (eg Somerset County Council and Districts), DEFRA, NFU, FWAG, statutory rural interest bodies (English Nature, Countryside Agency) and voluntary conservation organisations (eg RSPB, Wildlife Trusts). Programme implementation would most likely be carried out through the member organisations, with responsibilities delegated accordingly.

One option is to pursue washland creation under a Community Land Management Initiative. This might involve the appointment of a programme manager (possibly residing within Somerset County Council) reporting to a consortium of member organisations (District and Parish Councils, Countryside Agency, DEFRA, EA, FWAG, NFU, Voluntary Conservation Organisations) with the task of promoting sustainable rural communities with particular reference to land and water management.

The organisational form will reflect the blend of management arrangements and funding mechanism engaged. These issues require further attention.

6.2.1 Land Purchase and Asset Transfer of Ownership

Under this arrangement the land asset is voluntarily sold by owners at prevailing market prices to a responsible organisation which manages it in accordance with programme objectives. The organisation involved may operate the site directly or may manage it indirectly on short term or seasonal tenancy agreements with farmers, with preference to previous owners/tenants. There is a growing experience of this type of purchase, and of subsequent operation and maintenance by voluntary and statutory conservation organisations, often working in partnership. RSPB have adopted this model since the 1970s on West Sedgemoor.

There have been a number of land sales in the study area in the recent past, some associated with retirement from farming. Purchasers have included those whose main interest and source of income is not farming.

6.2.2 Purchase of Flood Storage Easement

This takes the form of an up front payment, expressed as a % of prevailing market prices. This easement reflects the loss of asset value (and related income loss into perpetuity) associated with specified increased flood risk. The arrangement is subject to an easement agreement, which specifies conditions applying in each case. Owners retain rights which are not the subject of the easement and its effects. This model has been used over the last 20 years by Environment Agency in flood alleviation schemes. Payments have ranged between 40% and 80% of market land values reflecting easement against a design flood event.

6.2.3 Annual Payments

Under this arrangement, existing tenure arrangements continue. Farmers sign a management agreement for a specified minimum period with a responsible organisation which specifies land management in accordance with programme objectives. The contract may be for a given flood storage facility, possibly specified by timing, duration and depth. Although these will include environmental protection measures, they may or may not require actions to enhance the environmental quality of the site itself. Farmers receive annual payments in return for services rendered. They are also eligible for other receipts, such as beef and sheep premia.

Management agreements are commonly practised under the prescriptions for the Somerset Levels and Moors ESA. They also feature as part of Countryside Stewardship and Local Authority (LA) Section 29 grant schemes.

Payments may be negotiated on a site specific basis under Countryside Stewardship, or under management agreements with conservation organisations. These agreements focus on particular environmental objectives and are negotiated at rates which reflect individual farm circumstances.

6.2.4 Lease–back/Partnership Initiative

This transfers land entitlement in the form of a lease from farmers to a newly created project organisation for a specified period (20 to 30 years). As partners, farmers operate the land in accordance with programme objectives for which they receive annual payments. At the end of the lease term, the arrangement can be extended or terminated. In the latter case, land returns to partnership farmers. A joint management committee with representation by the major partners would be formed to manage the initiative.

6.3 Criteria for Appraisal of Management Options

The aforementioned options are assessed against the following criteria:

Effectiveness:
- Will they do the job intended and make a difference?
- Will they provide a practical balance of flood, farming and environmental management objectives?
- Will they provide a basis for support to farmers?

Efficiency:
- Will they be practical, easy to understand, put into action and will they work reliably?
- Are they the best, most cost effective way of meeting the objectives?
- Do they give best value for money for the farmer, the funding agency, and the taxpayer?

Equity and distribution of impacts:
- Are the options fair, equitable and obvious in their impact on those who are affected?
- Are the options acceptable to the major interested parties?
- Are the incentives within an option appropriate for participation?

Acceptable Risk
- Do the options contain particular risks with respect to objectives or stakeholder interests?
- Can the risks be managed to acceptable levels?

Wise Use

Will the option deliver the overall purpose of sustainable, wise use of flood plains and the balance of objectives implied? (confirmation of effectiveness against Wise Use of Flood Plain programme objectives).

These criteria were discussed in a workshop with stakeholder representatives.

6.4 Appraisal of Management Options

6.4.1 Land Purchase and Ownership Transfer

The land purchase option, in that it passes responsibility for ownership and operation to a responsible authority, has the potential to deliver effectively against the programme objectives, especially floodwater management and environmental objectives. It is possible that the assets are held by a Trust formed for the purpose with trustees drawn from key stakeholders.

Achievement of the objectives of support to rural livelihoods will vary according to the arrangements for community and farmer engagement in the management process. There is a risk that local and community ties with the land are reduced once ownership becomes institutionalised. This can be guarded against by award of tenancy agreements. This practice has been adopted on land in the study area owned by conservation organisations and appears to have worked reasonably well from a farmer perspective. Indeed, a number of farmers expressed preference for land sale, with retention of user rights under agreement. Anecdotally, one farmer expressed this view as 'I don't mind being told what to do on some one else's land' and by another by 'as long as what is wanted is reflected in the rent'.

Land purchase can offer an efficient mechanism, involving a one-off up front payment which is finite. This also lends itself to capital funding, including eligibility for capital grants (as in the case of flood defence capital projects). Land purchase also avoids long term commitment on the revenue accounts of sponsoring agencies, and is therefore financially less risky. Land purchase removes the challenge of negotiating annual agreements, and variations in these that reflect design or actual water regimes. Some of this complexity, however, transfers to the negotiation of tenancy rules and rental payments.

There are administrative challenges lining up volunteers for land sales, especially in areas characterised by fragmentation of holdings. It is easier if large blocks of land or whole farms can be purchased from a few individual owners. This may be feasible in some locations. Farmers may be inclined to sell if land can be acquired elsewhere in the vicinity. A land bank could be used for this purpose, whereby the sponsoring organisation buys up land locally to achieve land or whole farm swaps. This approach has been used in Denmark and the Netherlands and to a limited extent in Britain.

Land purchase obviously impacts on existing owners, and is potentially unfair on those who would otherwise wish to continue farming as before. There may be impacts on tenant farmers whose landlords wish to sell up. Fairness can be enhanced by reducing these negative impacts, through land swaps or secure tenancy arrangements. Fairness will be reflected in the land prices paid to owners (which will be subject to tax unless recommitted to the farm business). It may be appropriate to pay a premium above the market price for agricultural land to reflect incentive/compensation for transfer of ownership. Land purchase is likely to serve the interests of scheme sponsors for reasons of achievement of programme objectives, funding and risk management. Some farmers will see land sale as an opportunity to exit the industry, relocate or refocus.

In the Danish case, river basin restoration schemes have applied the land purchase model to good effect, supported by land banks, with tenancies on washlands retained by farmers. This model was, however, progressed on the understanding that compulsory purchase powers would be used by Local Government Authorities if necessary. It is unlikely that there would be support for such an approach in Somerset, although where there is a lot of fragmentation of holdings, and voluntary land purchase is the dominant method, compulsory purchase in the public interest could be considered to ensure the integrity of flood storage schemes. In this respect land purchase may be the only option to deliver a large scale, comprehensive scheme.

The land purchase option, in that it involves up-front financing and asset and management transfer for the purpose intended, has a relatively low risk of failure. It offers a good chance of delivering the wise use of the Parrett flood plain areas.

6.4.2 Easements

Easements are designed to accommodate changes in the risk of flooding borne by existing owners and occupier. For the most part they apply to infrequent, major flood events which potentially cause occasional damage rather than significant changes in land use. Owners (and occupiers through reduced rents) receive compensation for absorbing the risk of increased flooding. Occupiers can insure themselves against known risks if they wish.

Easements could potentially deliver the flood defence objectives of washland creation, but are less effective for delivering environmental enhancement or livelihood objectives. Given the proposed frequency of flooding, it is likely that easements would approach the full market value of land, in which case outright purchase might be preferred. (If this is the case, prices for purchased land may need to include a 'purchase' premium compared to easement rates).

Easements are attractive to flood defence organisations because they involve a one- - off negotiated settlement, the cost of which can be charged to a capital scheme and which, in the case of flood defence, is potentially grant-aided from Government. In some cases, easements which serve the public interest can be compulsorily acquired by Government bodies.

Easement are suited to the flood defence function of floodwater storage, where this is the dominant purpose. Compared to land purchase, easements are likely to less efficient at delivering washland objectives. They will produce a one-off injection into the farming community, but will substantially reduce remaining asset values. Initially they could be administratively easy to establish, but there are risks that the terms of the easement may restrict operational flexibility and be a source of contention if water regimes differ from those covered in the agreement.

6.4.3 Annual Payments

Annual payments in return for management agreements under the ESA scheme are common place and well understood in the study area. They have been widely adopted directly by farmers, and by institutional land owners (such as RSPB) who use them as a basis for delivering their own environmental objectives, often through tenanted farmers. Annual payments (ranging from £125 to £430/ha/yr) are now a key component of farm incomes in the dairy and livestock sector in the study area. They also underpin much subletting of land, providing income to owners, and to a degree, low rents to tenants. In this respect they have diverse effects, and have the potential to effectively deliver the floodwater storage, environmental and livelihood objectives of the washland programme. They are compatible with the principles of the new Rural Development Regulation which seeks to strengthen the social and economic viability of rural communities through support to agri-environmental and diversification initiatives.

The actual effectiveness of ESA arrangements in terms of environmental outcomes has been mixed, but they have undoubtedly injected extra income into the farming community. The main reason for farmer adoption has been financial advantage rather than conservation benefit. The payment regime is a critical factor influencing participation and therefore effectiveness.

There is debate regarding the efficiency of annual payments from a public purse viewpoint. They are expensive, may pay farmers for doing what they would do anyway, and can create a dependency and, from this, a future vulnerability. Annual payments may need to exceed 'compensation' levels in order to persuade farmers into adoption. Simultaneously, their magnitude (like land prices) may reflect the extent of subsidy to the farming sector, rather than any economic opportunity cost or added value. At a practical level, annual payments are at risk of policy change and funding availability, especially as they rely on revenue rather than capital funding. This concern applies to farmers and responsible organisations alike. Farmers, perceiving a return to a previous and possibly irreversible wetland condition, will seek security of payments over the medium to long term, probably 20 years. Implementing organisations may also feel vulnerable in their dependency on Government funding.

Given the experience to date of annual payment schemes, a Washland ESA or Stewardship scheme would be relatively easy to set up and administer, and could be an extension of existing arrangements. ESA terms could be drawn up for specific hydraulic units, or sub units to reflect existing and future typical land use, proposed water regimes (flood risk characteristics), environmental enhancements and related compliance costs. Washland payments may therefore vary across the Parrett catchment accordingly to local conditions.

Alternatively, Washland Stewardship agreements could be drawn up with land managers to reflect specific site and farm circumstances. Stewardship places more emphasis on environmental outputs than ESA agreements which tend to focus on compliance. The Stewardship model is advantageous where large contiguous land blocks are involved.

ESA or Stewardship type payments could be designed to accommodate different levels of flood risk, defined in terms of the timing and number of floods per winter, the duration of individual events and their aggregate duration, and typical depths. This could involve payments over the range £50 to about £170/ha per winter season according to land use, and the duration and depth of flooding using the flood damage curves presented in Figures 5.2.and 5.3 above. They could be paid as supplements to ESA payments. Such payments would require farmers to adopt suitable environmental practices.

A Washland Stewardship package could be defined for selected hydraulic units, which combines local area, field and farm specific aspects. Annual payments would be negotiated for 3 year periods within a 20 overall agreement life to give security of participation. Payments would reflect a defined flood facility, environmental enhancement and compliance prescription. There would not be annual negotiation in response to actual flood events during the agreed flood window.

Annual payments have potential to meet the multiple objectives of wise use of flood plains, and the institutional arrangements and experience are already in place. They offer some flexibility to the responsible management organisation to direct change in accordance with changing circumstances and priorities. Their greatest drawback is that they place a high ongoing burden and dependency on continued revenue funding. To be attractive to farmers, they need to be secure for the longer term.

6.4.4 Lease-back Partnership

The lease-back partnership option involves transfer of the management of land assets to a responsible partnership organisation of which the asset owners are part. This has the advantage of focusing on the programme objectives, vesting management responsibility in a programme management unit, and directly engaging farmers in the process of delivery. The 'partnership' approach is consistent with the idea of sustainable and wise use, and is likely to meet with approval from potential sponsors. It is likely to be more administratively and legally complex to establish, and there may be resistance from land owners to engage until the benefits are clear, especially as they, as contributors of the land assets, carry the greatest risk. They would, however, enjoy management participation and security of agreement. It is possible that a partnership approach would lend itself to a private-public partnership/private finance initiative. This leaseback option could suit situations where there is a clear community of interest.

6.5 Funding sources

Potential funding sources for the project include contributions from agri-environmental and rural development schemes, regional flood defence and IDB budgets, Local Government, regional Rural Development Programme funds, National and European Government environmental funding organisations, Voluntary Conservation Organisations and special project designated appeals.

Funding sources and arrangements will reflect the mix of agricultural, environmental and enterprise development objectives and their take up, as well as the dominant form of management arrangements. Detailed project plans will be needed for specific site proposals containing estimates of capital and operating expenditure over the relevant period, and matched to revenue and funding sources. Capital funds are often more readily available than long term financing out of revenue, especially for multi-purpose projects which attract a variety of partners. However, the development of flood storage is well placed to draw on the substantial revenue accounts for flood defence and agri-environmental schemes.

6.6 Summary

This chapter has reviewed the main management options for floodwater storage and washland creation against performance criteria. Outright purchase, annual payments and lease-back have the potential to deliver scheme objectives. Up-front capital spend approaches reduce the dependency on revenue accounts associated with annual payment, and would provide the strategic focus and operational flexibility for the organisation responsible for the washland programme. However, institutionalised land ownership could depreciate the relationship between the farming community and the land, and reduce the potential contribution to rural livelihoods.

The voluntary involvement of the farming community will be a key determinant of feasibility and success. During farmer consultations and the stakeholder workshop, farmer views on preferred approach varied considerably according to circumstances, practices and motivation: there was no one preferred option. Attention was drawn to the diversity of land ownership and use arrangements, and that such a diverse challenge required diverse solutions. It may be that within and between flood storage areas, there could be a mosaic of the land management arrangements. It will be important to ensure, however, that those adopted can achieve the scale, integration and reliability required to meet the objectives of floodwater storage and washland creation

7 Conclusions and Recommendations

This Chapter draws conclusions against the questions posed in the terms of reference, and makes recommendations accordingly.

7.1 Conclusions

The following conclusions are drawn.

It is technically feasible to create facilities in the flood plain and Moors and Levels of the Parrett catchment which will store flood water and create washland. It is possible to identify sites which will potentially meet all or some of the multiple objectives of flood and water resources management, environmental enhancement, and farming livelihoods. This has been done in broad terms to demonstrate feasibility of the concept, but more detailed work is required to progress any site to the project appraisal stage. The focus here has been on winter flood storage, and it is not envisaged that there would be a change in flood risk during summer. It may be possible, however, to use newly created washland for priority summer storage in extreme events, and thereby achieve savings in flood damage costs elsewhere.

There is both synergy and conflict of interest in washlands amongst flood storage, environment and farming objectives. For example, late winter/early spring flooding is good for some environmental features and not for others. Purposeful grassland management by farmers to achieve species rich pastures and inundation grassland will be needed to achieve the objectives of environmental enhancement and sustainable farming. Different sites are likely to have different priorities and management systems. Accordingly, prescriptions for flood facilities, environmental and farming management will require local definition. There are gaps in the knowledge about how best to manage washland sites to meet multiple objectives. This requires action.

The storage of winter floodwater and washland creation on farmland will result in income losses to farmers on land currently occupied by (in order of income loss) improved grassland, arable cropping, Tier 1, 1A and 2 prescriptions. The costs of a one week flood in winter on grassland ranges from about £5/ha to £15/ha according to the quality of grassland. Long duration flooding of 3 months or more is likely to result in damages of between £170/ha and £225/ha because of the need for reseeding of damaged pastures, or in the case of persistent flooding, a switch to less intensive grassland management. The extent of loss of net income (revenues less costs) associated with extensification will depend on whether farmers can achieve savings in costs to offset reductions in revenues.

At present ESA rates, annual payments would probably need to be between £250 and £300/ha/yr (in 2001 values) to attract farmer interest in a washland option. There is scope to develop a ESA or Stewardship type package that caters for the characteristics of a particular washland site, including changes in flood risk and impact on land use and farm income. These agreements would essentially acquire the flood storage facility during the agreed winter flooding period for the implementing organisation. There would also be requirements to undertake positive washland management in order to deliver environmental objectives. In this respect such arrangements would be output rather than compliance oriented. Consideration would be given to additional payments to land managers to meet incremental costs of such management measures, beyond those payments which reflect income loss. Annual payment regimes would need to be of sufficient longevity to offer a secure prospect for farmer, perhaps over 20 years, and transferable with the farm property. (The present high degree of uncertainty in farming heightens rather than decreases the demand for this). The analysis suggests, however, that a washland farming package could potentially prove more viable from a farming viewpoint than the current Tier 3 arrangements.

There is also scope to design a washland flood storage package with payments to reflect different levels of risk, especially the timing, duration and depth of flooding during the season. The analysis identified broad categories of payment, which range between about £50 and £170/ha per season for winter floods according to flood characteristics.

At present land prices, land purchase would involve costs of between £2000 and £3750/ha, according to characteristics. A premium over agricultural land prices may be needed to encourage sales. A land bank to support land swaps would improve the acceptability of this option. The costs of land transactions would be additional.

At current levels of government support, there appears to be an economic advantage in moving to extensive washland farming systems, and given the potential to achieve further social economic and environmental benefit, it would appear in the public interest to redirect funding into flood storage and washland creation.

Capital costs associated with purchase of land or easement could vary between £0.5/m3 and £1.5/m3 of flood storage facility. The annual equivalent costs associated with either purchase or annual payments range between about £0.04/m3/yr and £0.12/m3/yr, depending on site conditions. At current land prices and likely washland payment rates, there is not much difference in annual equivalent cost between land purchase and annual payments. These aforementioned costs are for land acquisition costs only. They exclude design, supervision, engineering works and operation and maintenance costs. A meaningful estimate of costs needs to include the latter and these are not available at present.

There is a diversity of circumstance and practice in the Moors and Levels, which suggests a diversity of approaches to washland tenure arrangements. Land purchase, annual payments and lease-back have their particular advantages, disadvantages and risks, and suit different interest groups. But they are all feasible. The most common view expressed by owner occupier farmers was a preference for land sale 'at a realistic price' with help to acquire land elsewhere or rent back the land under a secure tenancy arrangement. Easements for flood storage are probably not appropriate for achieving environment enhancement. A mosaic of land tenure arrangements may be acceptable provided this can deliver the scale, integration and reliability of service required.

Institutional and administrative arrangements will reflect the management and funding mechanisms. Given the multiple objectives to be served, a Washland Programme organisation, with membership drawn from key stakeholders, could provide strategic direction and management, delegating responsibility for administration of the programme and its constituent projects to member organisations as appropriate. The flood storage facility would obviously be managed by DEFRA, the Environment Agency and the IDBs. Statutory and voluntary conservation organisations could variously manage operations at project area level. It would make sense to administer ESA/Stewardship arrangements through existing mechanisms.

The main barriers to adoption of flood storage options by farmers are likely to be:

- Inadequacy of financial incentives for flood storage and washland creation;
- The perceived adequacy and predictability of existing ESA payments;
- A large proportion of the farm lying in the area of a proposed scheme which will fundamentally affect the whole farm business in a way which is unacceptable;
- A wish to continue farming commercially, and a perception that the washland option is not compatible with this;
- A reluctance to return to the farm to wetland after a lifetime of drainage for agricultural improvement;
- Lack of evidence that washland agriculture is feasible and practical, especially regarding information on the viability of 'new' washland farming practices;
- Lack of confidence and trust in promoting and implementing organisations, based on previous experience or hearsay;
- High degree of uncertainty concerning farming futures and related policy framework.

The major equity issues in the implementation relate to pressures that may be brought to bear on participants who otherwise, for a variety of reasons, would choose not to join a washland scheme. The design and transparency of the management arrangements can reduce this risk. There may be accusations of unfairness to those excluded from the options and the payments provided. In some cases this may come from those who presently endure frequent and long duration flooding. The washland proposals would, in that they will improve the management of floodwater in the whole catchment, provide benefits to this group in the form of flood relief beyond the designated washlands.

7.2 Recommendations

This report has explored the concept of flood storage and concluded on its feasibility. A number of recommendations can be made to progress the topic.

Research, including review of existing knowledge, should be carried out into catchment hydraulic processes in order to produce preliminary designs for a flood water storage programme and constituent projects. This will confirm whether the case study sites identified here, and others, will serve the purposes intended.

Research, including review of existing knowledge, is required to confirm the scope for reconciliation of flood storage, environmental and farming objectives in a Parrett washland context. In particular there is need to evaluate the environmental and farming performance of washland grassland, and determine best practice. There is a need to confirm the impact of long duration flooding on grassland of different types.

Stakeholders in the Parrett Consortium perceive a need for action. The processes of participation are well in place and there is a call for 'projects' on the ground. It is difficult to progress the action plan for floodwater storage further without identifying and progressing the appraisal of 'feasible areas'. Indeed there is an expectation that this should be done. Lines on maps, however, personalise the proposals and the concerns. This needs to be carried out sensitively, drawing on the trust that has been developed as a result of the Consortium's inclusive and participatory approach.

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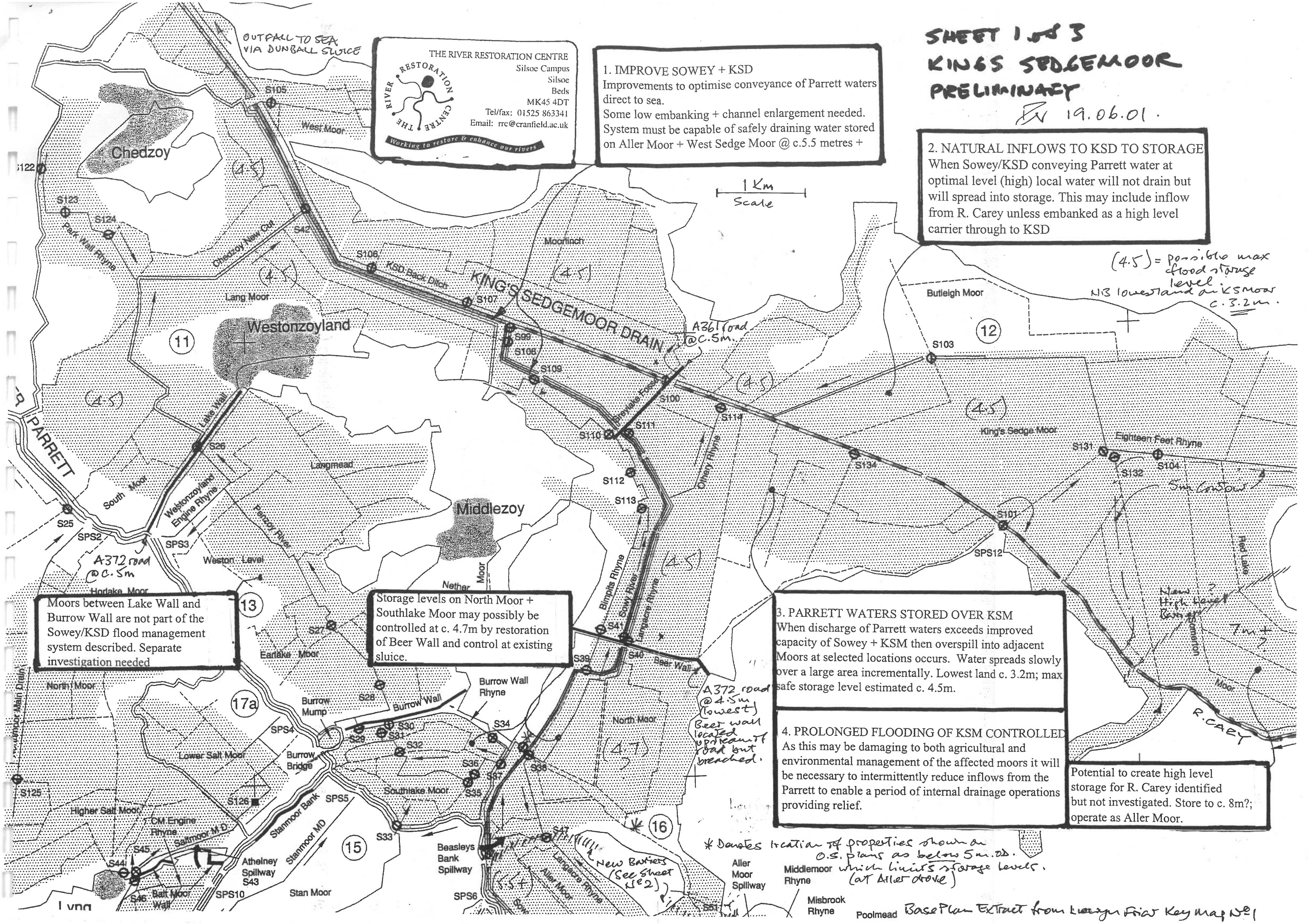
PLANS

Plans 1, 2 and 3

Review of Parrett Flood Plain


SHEET 1 of 3
KINGS SEDGEMOOR
PRELIMINARY
19.06.01.
THE RIVER RESTORATION CENTRE
Silsoe Campus
Silsoe
Beds
MK45 4DT
Tel/fax: 01525 863341
Email: rrc@cranfield.ac.uk
Working to restore & enhance our rivers
1. IMPROVE SOWEY + KSD
Improvements to optimise conveyance of Parrett waters direct to sea.
Some low embanking + channel enlargement needed.
System must be capable of safely draining water stored on Aller Moor + West Sedge Moor @ c.5.5 metres +
2. NATURAL INFLOWS TO KSD TO STORAGE
When Sowey/KSD conveying Parrett water at optimal level (high) local water will not drain but will spread into storage. This may include inflow from R. Carey unless embanked as a high level carrier through to KSD
(4.5) = possible max flood storage level
NB lowest land in KSMoor c. 3.2m.
3. PARRETT WATERS STORED OVER KSM
When discharge of Parrett waters exceeds improved capacity of Sowey + KSM then overspill into adjacent Moors at selected locations occurs. Water spreads slowly over a large area incrementally. Lowest land c. 3.2m; max safe storage level estimated c. 4.5m.
4. PROLONGED FLOODING OF KSM CONTROLLED
As this may be damaging to both agricultural and environmental management of the affected moors it will be necessary to intermittently reduce inflows from the Parrett to enable a period of internal drainage operations providing relief.
Potential to create high level storage for R. Carey identified but not investigated. Store to c. 8m?; operate as Aller Moor.
Moors between Lake Wall and Burrow Wall are not part of the Sowey/KSD flood management system described. Separate investigation needed
Storage levels on North Moor + Southlake Moor may possibly be controlled at c. 4.7m by restoration of Beer Wall and control at existing sluice.
OUTFALL TO SEA VIA DUNBALL SLUICE
1 Km
Scale
A361 road @ c.5m.
A372 road @ c.5m
A372 road @ 4.5m (lowest) Beer wall located upstream of road but breached.
5m contour
New ? High level Bank ?
7m +
R. CAREY
New Barriers (See Sheet No 2)
* Denotes location of properties shown on O.S. plans as below 5m.OD. which limits storage levels. (at Aller drove)
Base Plan Extract from Lowlands Key Map No 1
KING'S SEDGEMOOR DRAIN
KSD Back Ditch
Chedzoy
Chedzoy New Cut
Westonzoyland
Middlezoy
West Moor
Lang Moor
Moorlinch
Butleigh Moor
King's Sedge Moor
Eighteen Feet Rhyne
Langmead
South Moor
Westonzoyland Engine Rhyne
Lake Wall
Penzoy River
Park Wall Rhyne
Weston Level
Nether Moor
Hodake Moor
Earlake Moor
North Moor
Burrow Wall
Burrow Wall Rhyne
Burrow Mump
Burrow Bridge
Lower Salt Moor
Higher Salt Moor
Saltmoor M.D.
CM Engine Rhyne
Stanmoor Bank
Stanmoor MD
Stan Moor
Athelney Spillway
Salt Moor Wall
Lyng
Southlake Moor
Beasleys Bank Spillway
Aller Moor
Aller Moor Spillway
Langacre Rhyne
Middlemoor Rhyne
Misbrook Rhyne
Poolmead
Sowy River
Bimplits Rhyne
Othery Rhyne
Beer Wall
Red Lake
Somerton Moor
R. PARRETT
Challmoor Main Drain
Sowy Fosse
11
12
13
15
16
17a
(4.5)
(4.7)
(5.5)
S105
S122
S123
S124
S42
S106
S107
S99
S108
S109
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S111
S112
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S114
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SPS4
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S126
SPS5
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S45
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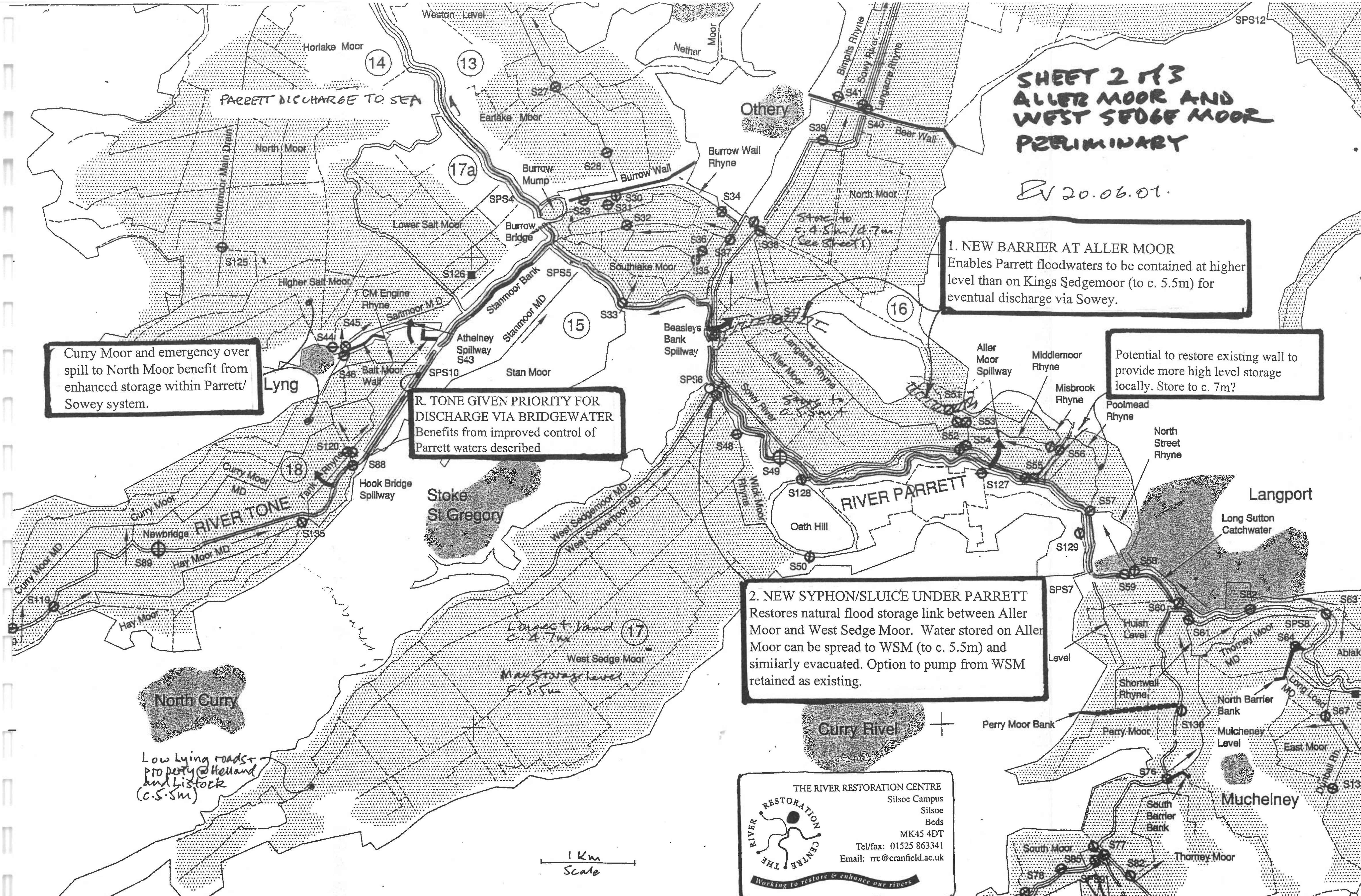
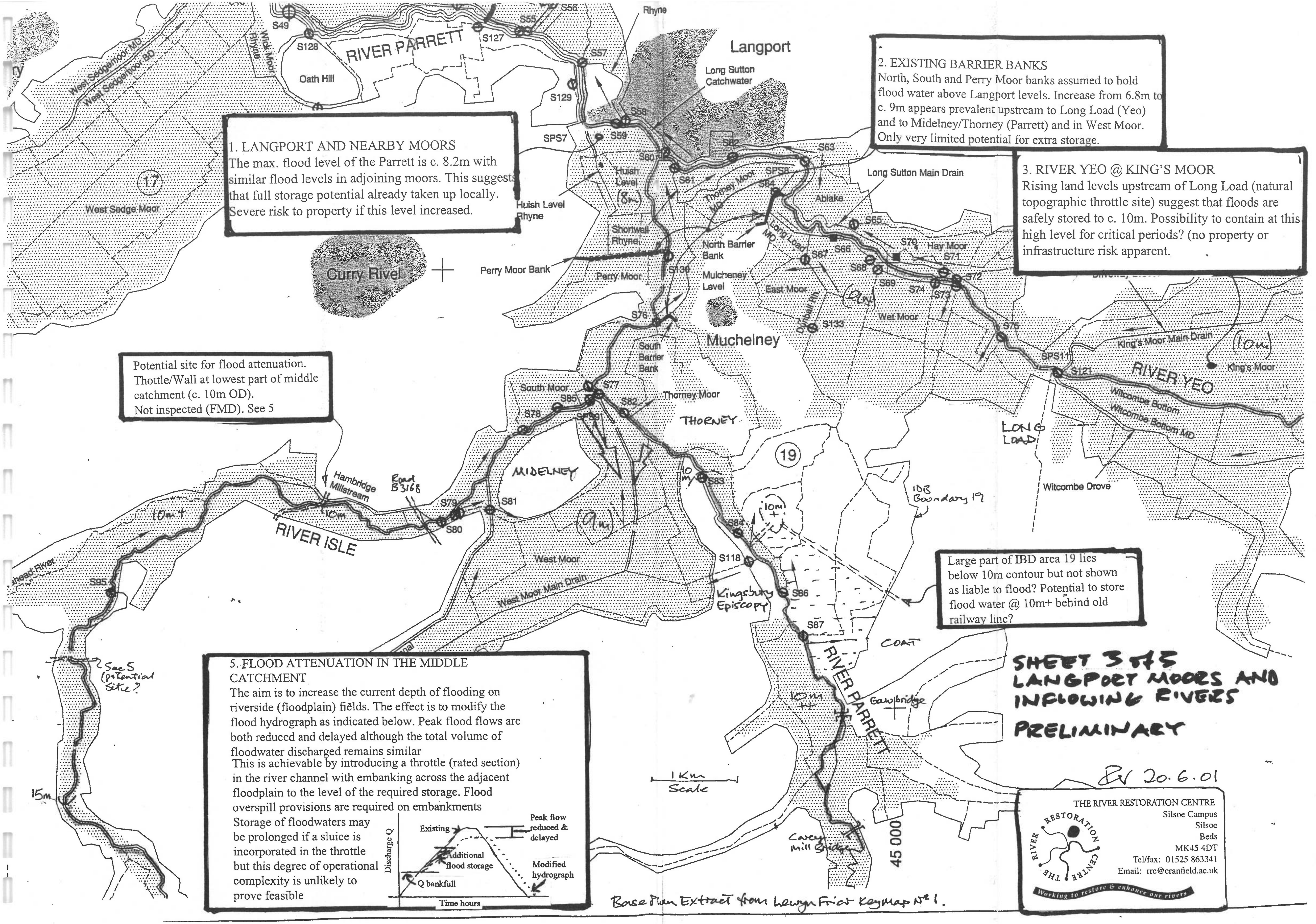
S46
SPS10
SPS6
S51



Base plan extract from Lawyn Friar Keymap No 1.

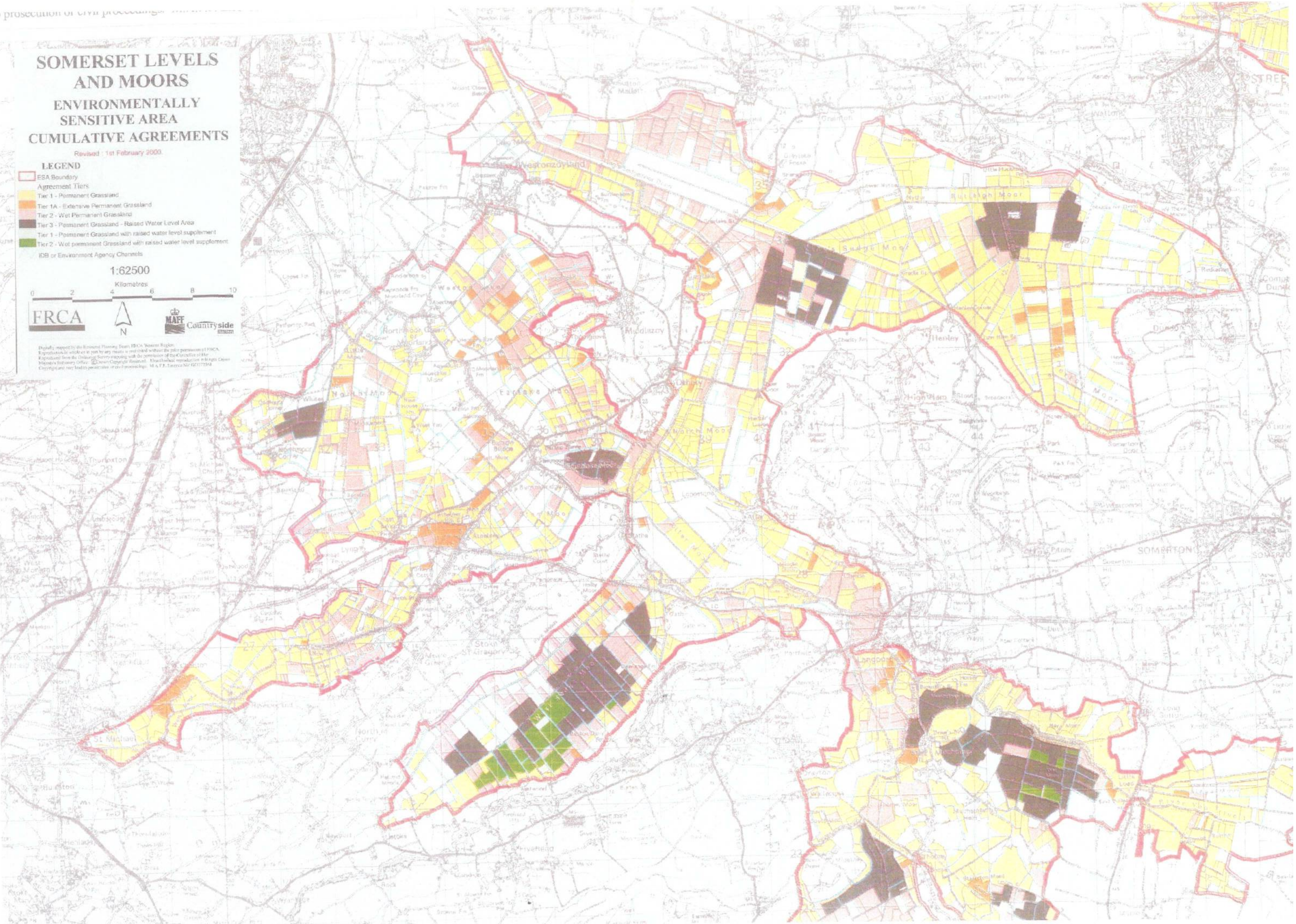


1. LANGPORT AND NEARBY MOORS
The max. flood level of the Parrett is c. 8.2m with similar flood levels in adjoining moors. This suggests that full storage potential already taken up locally. Severe risk to property if this level increased.
2. EXISTING BARRIER BANKS
North, South and Perry Moor banks assumed to hold flood water above Langport levels. Increase from 6.8m to c. 9m appears prevalent upstream to Long Load (Yeo) and to Midelney/Thorney (Parrett) and in West Moor. Only very limited potential for extra storage.
3. RIVER YEO @ KING'S MOOR
Rising land levels upstream of Long Load (natural topographic throttle site) suggest that floods are safely stored to c. 10m. Possibility to contain at this high level for critical periods? (no property or infrastructure risk apparent.
Potential site for flood attenuation. Thottle/Wall at lowest part of middle catchment (c. 10m OD). Not inspected (FMD). See 5
Large part of IBD area 19 lies below 10m contour but not shown as liable to flood? Potential to store flood water @ 10m+ behind old railway line?
5. FLOOD ATTENUATION IN THE MIDDLE CATCHMENT
The aim is to increase the current depth of flooding on riverside (floodplain) fields. The effect is to modify the flood hydrograph as indicated below. Peak flood flows are both reduced and delayed although the total volume of floodwater discharged remains similar
This is achievable by introducing a throttle (rated section) in the river channel with embanking across the adjacent floodplain to the level of the required storage. Flood overspill provisions are required on embankments
Storage of floodwaters may be prolonged if a sluice is incorporated in the throttle but this degree of operational complexity is unlikely to prove feasible
Existing
Peak flow reduced & delayed
Additional flood storage
Modified hydrograph
Q bankfull
Discharge Q
Time hours
RIVER PARRETT
RIVER ISLE
RIVER YEO
Langport
Muchelney
Curry Rivel
Oath Hill
West Sedge Moor
West Sedgemoor MD
West Sedgemoor BD
Wick Moor Rhyne
Rhyne
Long Sutton Catchwater
Huish Level
Huish Level Rhyne
Shortwell Rhyne
Perry Moor Bank
Perry Moor
Thorney Moor MD
North Barrier Bank
Mulcheney Level
Long Load MD
Long Sutton Main Drain
Ablake
Hay Moor
East Moor
Wet Moor
South Barrier Bank
South Moor
Thorney Moor
THORNEY
MIDELNEY
West Moor
West Moor Main Drain
Hambridge Millstream
Road B3168
King's Moor Main Drain
King's Moor
Witcombe Bottom
Witcombe Bottom MD
Witcombe Drove
LONG LOAD
IDB Boondary 19
Kingsbury Episcopy
COAT
Gawbridge
Carey Mill Bridge
See 5 (potential site?
10m+
10m
9m
8m
15m
17
19
45 000
1 Km Scale
SHEET 3 of 5
LANGPORT MOORS AND INFLOWING RIVERS
PRELIMINARY
20.6.01
THE RIVER RESTORATION CENTRE
Silsoe Campus
Silsoe
Beds
MK45 4DT
Tel/fax: 01525 863341
Email: rrc@cranfield.ac.uk
Working to restore & enhance our rivers
Base Plan Extract from Lewyn Frier KeyMap No 1.

Map 1

Environmentally Sensitive Area Scheme Agreements in the Parrett catchment

prosecution of civil proceedings.



APPENDIX 1

Tables for
Financial and Economic Analysis

Parret Catchment
Table A1
Summary of Livestock Enterprise Gross Margins
2001 values

£ per head		Dairy Cows	Dairy Replacement Unit	Lowland Suckler Beef Cow	Overwintered Grass Finished Beef	24 -30 month Beef	Store Cattle medium	Store Cattle heavy	Lowland Lamb	
Financial Returns										
Gross Output		1034.1	490.0	298.2	282.4	577.3	118.4	86.4	53.0	
Variable Costs		312.0	192.0	99.5	90.1	209.9	27.6	27.6	17.9	
Gross Margin		722.1	298.1	198.7	192.3	367.3	90.8	58.8	35.1	
Additional premium for extensification										
low rate: 2 lu/ha to 1.6 lu/ha				22.0	22.0	44.0				
high rate: below 1.6 lu/ha				44.0	44.0	88.0				
Gross Margin incl extensification premia										
low rate: 2 lu/ha to 1.6 lu/ha		722.1	298.1	220.7	214.3	411.3	90.8	58.8	35.1	
high rate: below 1.6 lu/ha		722.1	298.1	242.7	236.3	455.3	90.8	58.8	35.1	
Fixed Costs										
Semi fixed costs										
labour	0.4	136.8	45.6	22.8	19.0	33.1	2.9	3.4	7.6	
machinery	0.6	49.5	37.4	27.5	20.9	28.6	8.3	8.8	5.2	
buildings (housing)	0.3	19.1	8.9	8.6	5.6	8.9	0.0	0.0	2.6	
Total Semi fixed costs		205.4	91.9	58.9	45.5	70.6	11.1	12.2	15.4	
Full Fixed Costs										
labour		180.0	120.0	60.0	50.0	87.0	7.5	9.0	20.0	
machinery		90.0	68.0	50.0	38.0	52.0	15.0	16.0	9.4	
buildings (housing)		58.0	27.0	26.0	17.0	27.0	0.0	0.0	8.0	
Total		328.0	215.0	136.0	105.0	166.0	22.5	25.0	37.4	
Net Margin per head after semi fixed costs										
including extensification premia		516.6	206.1	139.8	146.8	296.7	79.7	46.6	19.7	
low rate: 2 lu/ha to 1.6 lu/ha		516.6	206.1	161.8	168.8	340.7	79.7	46.6	19.7	
high rate: below 1.6 lu/ha		516.6	206.1	183.8	190.8	384.7	79.7	46.6	19.7	
Net Margin per head after full fixed costs										
including extensification premia		394.1	83.1	62.7	87.3	201.3	68.3	33.8	-2.3	
low rate: 2 lu/ha to 1.6 lu/ha		394.1	83.1	84.7	109.3	245.3	68.3	33.8	-2.3	
high rate: below 1.6 lu/ha		394.1	83.1	106.7	131.3	289.3	68.3	33.8	-2.3	
Energy from Grass required		38664.0	44464.0	29536.0	16027.5	30281.0	11800.0	14680.0	4510.0	
Livestock Unit (LU) (cow) equiv.		1.0	1.15	0.76	0.41	0.78	0.31	0.38	0.12	
Estimated average equivalent livestock units in the Parrett and Tone Catchments										
Weighted average		42%	19%	10%	8%	6%	5%	3%	7%	100%
Headage based on average LU/head			0.2							
£/ha contribution based on % LU distribution										
Gross margin: Whole Catchment (weighted)										
excluding extensification		303	49	26	37	28	15	5	21	484
incl low rate extensification		303	49	29	41	32	15	5	21	495
incl high rate extensification		303	49	32	46	35	15	5	21	505
Net Margins										
after semi fixed costs										
excluding extensification		217	34	18	28	23	13	4	12	349
incl low rate extensification		217	34	21	33	26	13	4	12	359
incl high rate extensification		217	34	24	37	29	13	4	12	370
after full fixed costs										
excluding extensification		166	14	8	17	15	11	3	-1	232
incl low rate extensification		166	14	11	21	19	11	3	-1	243
incl high rate extensification		166	14	14	25	22	11	3	-1	253

Economic prices

Economic Returns per head	Dairy Cows	Dairy Replacement Unit	Lowland Suckler Beef Cow	Overwintered Grass Finished Beef	24 -30 month Beef	Store Cattle medium	Store Cattle heavy	Lowland Lamb	Weighted £/lu equiv
Adjustment factor	as wheat	as wheat	0.33	0.33	0.33	0.33	0.33	0.12	
Adjusted Gross Output (incl low exten	335	335	222	211	431	79	58	47	
Variable Costs	150	150	100	90	210	28	28	18	
Gross Margin	185	185	122	121	221	52	30	29	
Fixed costs									
semi fixed	98	98	59	46	71	11	12	15	
total fixed	181	181	136	105	166	23	25	37	
Economic Net Margin									
after semi fixed costs	87	87	63	76	150	41	18	13	
after full fixed costs	4	4	-14	16	55	29	5	-9	
Weighted by distribution of grazing areas									
Adjusted Gross Output (incl low exten)	141	55	29	41	33	13	5	28	345
Variable Costs	63	25	13	17	16	5	2	11	152
Gross Margin	78	31	16	23	17	8	2	17	193
Fixed costs									
semi fixed	41	16	8	9	5	2	1	9	91
total fixed	76	30	18	20	13	4	2	22	185
Economic Net Margin									
after semi fixed costs	37	14	8	15	12	7	1	8	102
after full fixed costs	2	1	-2	3	4	5	0	-5	8

ivalent local average of 1.6 cows/ha, ie 1 lu =.625ha wheat

Parret: Arable Crops
Table A2

Drainage Condition Good		Winter wheat	Winter barley	Potatoes	Oil seed rape	Dried peas	Field beans	Set-aside	Forage Maize
Yield	t/ha	6.60	5.00	40.00	2.50	3.20	3.30	0.00	38
Price	£/t	72.0	74.0	91.0	120.0	82.5	80.0	0.0	17.7
Output	£/ha	475	370	3640	300	264	264	0	673
Area Payment	£/ha	240	240	0	285	280	280	242	0
Gross Output	£/ha	715	610	3640	585	544	544	242	673
Variable Cost	£/ha	240	210	1565	200	200	140	11	220
Gross Margin	£/ha	475	400	2075	385	344	404	231	453
Fixed Costs									
Semi Fixed									
labour	£/ha	49	44	137	40	34	31	6	60
machinery	£/ha	101	92	259	80	70	80	11	91
buildings (dry&store)	£/ha	7	7	0	9	7	9	0	50
other	£/ha	0	0	0	0	0	0	0	5
Sub total	£/ha	157	143	396	129	110	120	17	206
Full Fixed Costs									
labour	£/ha	61	55	171	50	42	39	7	75
machinery	£/ha	184	168	471	146	127	146	20	165
buildings (dry&store)	£/t	6.8	6.8	0.0	8.8	6.8	8.8	0.0	50
other	£/ha								10
Total Fixed Costs	£/ha	290	257	642	218	191	214	27	300
Net Margin/crop									
after Semi Fixed Costs	£/ha	318	257	1679	256	234	284	214	247
after Full Fixed Costs	£/ha	185	143	1433	167	153	190	204	153
Flood Damage Costs									
Costs of a single flood	£/ha	50	47	350	60	80	45	0	45
Economic Returns PAGN Scenario III									
Economic Adjustment factors		25%	25%	wheat	25%	25%	25%	wheat	wheat
Adjusted Gross Output	£/ha	536	458	536	439	408	408	536	536
Gross margin	£/ha	296	248	296	239	208	268	296	296
Net Margin									
after Semi Fixed Costs		140	104	140	110	98	148	140	140
After Full Fixed Costs	£/ha	7	-10	7	21	17	54	7	7

Data sources:
Variable costs based on FBS Exeter
Fixed costs based on unit rates per ha for labour and machinery
Buildings costs include drying only, no charge for storage, except for silage maize
Fixed costs exclude land expenses such as rent and rates

Table A3

Arable Cropping Patterns and Financial and Economic Returns

	Winter wheat	Winter barley	Potatoes	Oil seed rape	Dried Peas	Field beans	Set aside	Forage Maize	Total or Average
Cropping Pattern									
Incl potatoes	55.0%	16.0%	8.0%	8.0%	0%	8.0%	5%	0.0%	100.0%
Excl potatoes	53.0%	15.0%	0.0%	5.0%	0%	7.0%	5%	15.0%	100.0%
			Financial		**Economic**				
			£/ha		£/ha				
Gross Margins			566		282				
			439		284				
Net Returns £ per average cropped hectare									
After Semi Fixed Costs									
Incl potatoes			404		132				
Excl potatoes			288		133				
After Full Fixed Costs									
Incl potatoes			278		9				
Excl potatoes			174		8				

Table A4
Grassland Management Systems and Costs

Financial Prices 2001 values		Improved Grass	Improved Grass	Extensive Grass Tier 1	Extensive Grass Tier 1A	WetGrass Tier 2	WetGrass (raised water levels) Tier 3 non target swamp dominated	WetGrass (raised water levels) Tier 3 target species rich	Wet Grass Washland option Tier '4'
				Grassland Management Systems					
Drainage Condition	class	Good	Good	Good	Good	Bad	Very Bad	Very Bad	Bad
Chemical Nitrogen	Kg/ha	200	150	75	25	25	0	0	0
Organic Nitrogen	Kg/ha	46	46	37	25	25	15	15	25
Total Nitrogen	Kg/ha	246	196	112	50	50	15	15	25
Tonnes Dry Matter		9.81	8.73	6.59	4.74	5.50	8.20	2.62	3.49
DM as % of Improved Grass			100%	75%	54%	63%	94%	30%	40%
% graze		0.45	0.45	0.45	0.50	0.50	0.50	0.50	0.50
energy UME		79902	71101	53657	38509	26217	14171	15943	26926
drainage factor		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
poaching factor		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
adjusted energy		79902	71101	53657	38509	26217	14171	15943	26926
TDM conserved		4.31	3.84	2.90	1.90	2.20	3.28	1.05	1.40
Livestock units (dairy cow equivalent)		2.07	1.60	1.39	1.00	0.68	0.37	0.41	0.70
Stocking rate as % of Improved Grass			100%	87%	62%	42%	23%	26%	44%
Grazing Season									
Extra grazing cf norm									
Days spring		0	0	0	0	-21	-45	-45	-28
autumn		0	0	0	0	-14	-14	-14	-14
Value £/ha spring		0	0	0	0	-8	-9	-10	-11
autumn		0	0	0	0	-3	-2	-2	-3
total		0	0	0	0	-11	-11	-12	-14
Forage Costs									
Ley establishment	£/ha	0	0	0	0	0	0	0	0
Grass production									
agro-chemicals	£/ha	130	96	53	24	24	0	0	0
applications	£/ha	23	17	9	3	3	0	0	0
subtotal	£/ha	152	113	61	26	26	0	0	0
Grass conservation									
silage/hay	£/ha	160	142	107	70	75	112	36	47
topping/control	£/ha					6	6	6	6
Total Forage Costs	£/ha	312	255	168	97	118	129	54	68
Hedge and ditch maint	£/ha	0	0	0	0	0	0	0	0
Total forage and field maint		312	255	168	97	118	129	54	68
ESA payments	£/ha	0	0	125	200	225	430	430	300
Net cost after ESA	£/ha	312	255	43	-103	-107	-301	-376	-232

Grass reseeding may be required for establishment

There may be additional hedge and ditch maintenance required under ESA prescriptions

Table A5

Grass Production Variable and Fixed Costs

Spray cost	£/ha		9.00
	£/kgN		0.06
Fertiliser cost	£/kgN/ha	(0-200kgN/ha)	0.52
		(over 201kgN/ha)	0.45
Lime	£/kgN/ha	over 150kgN	0.092
Other costs		semi fixed costs*	full fixed costs*
Fertiliser placement	£/70kgN	4.40	8
Hay making	£/tDM	21	34.00
Silage making	£/tDM	24	37.00
Ley establishment			
8 year interval	£/ha	53	94

*semi fixed includes operating costs, full fixed costs includes depreciation

Grass Energy Mj/tDM		MJ/tDM	efficiency in use	UME, Mj/tDM	
	graze	11200	70%	7840	
	cut	10500	80%	8400	
		Relative value of Grassland species			
		DM/ha	UME/ha	Relative UME/tDM	Tier Reference
roved agricultural grass;and		1.00	1.00	100%	Impr' Agric Grass
previously improved grassland		0.63	0.37	59%	Tier 2
Inundation grassland		0.40	0.38	95%	Washland Tier
Sedge dominated		0.94	0.20	21%	t3 tendency
species rich		0.40	0.30	75%	t3 target

Value of Grazing Days		£/head/day		
	LU/head	spring	autumn	winter
dairy cow	1.00	1.12	0.80	0.38
beef cattle				
0.5 to 1.5 years	0.50	0.56	0.40	0.19
sheep	0.14	0.16	0.11	0.05

Weighted by livestock type

Table A6

Flood Damage Costs on Grassland

Example applied to Extensive Grass 26925.7 Mj/ha UME

Grass land for silage making

	Loss of UME Yield %	Reduction in Dry Matter conserved %	Cost of replacement feed £	Savings in conservation costs £	Other costs £	Total Loss £	Seasonal weights Winter flood Distribution %	Summer flood Distribution %	Weighted Costs Winter Flood /£/ha	Summer Flood £/ha
January	0	0	0	0	4.3	4.3	26%	0%	1	0
February	0.6	0.6	2	1	4.3	5	21%	0%	1	0
March	7.6	7.6	20	7	4.3	17	13%	0%	2	0
April	29	27.8	78	27	4.3	55	0%	16%	0	9
May	55	35.2	148	34	4.3	118	0%	8%	0	10
June	39.3	17.6	106	17	4.3	93	0%	14%	0	13
July	5.2	0	14	0	10.2	24	0%	16%	0	4
August	3.8	0	10	0	10.2	20	0%	22%	0	4
September	1.8	0	5	0	10.2	15	0%	24%	0	4
October	0.3	0	1	0	10.2	11	4%	0%	0	0
November	0.4	0	1	0	4.3	5	16%	0%	1	0
December	0	0	0	0	4.3	4	20%	0%	1	0
	143	88.8					100%	100%	7	43

UME	yield mj/ha	26925.7				
Relacement feed £/Mj		0.01			Winter	Summer
Conserved DM t.ha		2.6	Costs of annual flood	conserved	7	43
Cost silage making		37.0		grazed	6	22
				Average	6	33
Clean up	£/ha	4.3				
Relocation	£/ha	5.9				

Flood damage costs on Grazed Land: NON RESTRICTED GRAZING

	Loss of UME Yield %	Reduction in Dry Matter conserved %	Cost of replacement feed £	Savings in conservation costs £	Other costs £	Total Loss £	Winter flood Distribution %	Summer flood Distribution %	Costs Winter Flood £/ha	Summer Flood £/ha
January	0	0	0.0	0	4.3	4.3	26%	0%	1	0
February	0	0	0.0	0	4.3	4.3	21%	0%	1	0
March	3.5	0	9.4	0	4.3	13.7	13%	0%	2	0
April	8.6	0	23.2	0	10.2	33.3	0%	16%	0	5
May	6.4	0	17.2	0	10.2	27.4	0%	8%	0	2
June	4.8	0	12.9	0	10.2	23.1	0%	14%	0	3
July	4.6	0	12.4	0	10.2	22.6	0%	16%	0	4
August	3.3	0	8.9	0	10.2	19.1	0%	22%	0	4
September	1.7	0	4.6	0	10.2	14.8	0%	24%	0	4
October	0.4	0	1.1	0	10.2	11.3	4%	0%	0	0
November	0.4	0	1.1	0	4.3	5.4	16%	0%	1	0
December	0	0	0.0	0	4.3	4.3	20%	0%	1	0
	33.7	0					100%	100%	6	22

UME	yield Mj/ha	26925.675
Relacement feed £/Mj		0.01
Conserved DM t.ha		0
Cost silage making		37.0
Clean up	£/ha	4.3
Relocation	£/ha	5.9

Table A7
Parret Catchment: Whole farm budgets: Dairy Farm
Financial prices and economic prices

Farm Size	ha	Improved Grass 60				Tier 1 60				Tier 4 Washland 60				Tier 4 Washland 60 Conversion to Beef Cows		
Agric drainage condition	class	Good				Good									Bad	
Nitrogen	Kg/ha	150				75									0	
Energy From Grass	Mj/ha	71101				53657					26926				26926	
Grazing Season																
Extra grazing of norm																
Days spring		0				0					-28				-28	
autumn		0				0					-14				-14	
Grass Conservation	type	Graze 33%, silage 67%				Graze 33%, hay/silage 67%				Graze 50% Cut 50%				Graze 50% Cut 50%		
Livestock Type		Dairy Cows	Diary Followers	24-30 month Beef	Sheep and Fat Lambs	Dairy Cows	Diary Followers	24-30 month Beef	Sheep and Fat Lambs	Dairy Cows	Diary Followers	24-30 month Beef	Sheep and Fat Lambs	Beef Cows and Sucklers (spring calving)	Medium Store Cattle	Sheep and Fat Lambs
Gross Output	£/hd	1034	490	577	53	1034	490	577	53	1034	490	577	53	298	118	53
Variable Cost	£/hd	312	192	210	18	312	192	210	18	312	192	210	18	298	28	18
Gross Margin	£/hd	722	298	367	35	722	298	367	35	722	298	367	35	100	91	35
Energy Requirements	Mj/hd	38664	44464	30281	4510	38664	44464	30281	4510	38664	44464	30281	4510	29536	11800	4510
Grazing Livestock unit	Glu/head	1.00	1.15	0.78	0.12	1.00	1.15	0.78	0.12	1.00	1.15	0.78	0.12	0.76	0.31	0.12
Stock Numbers / ha	hd/ha	1.84	1.60	2.35	15.77	1.39	1.21	1.77	11.90	0.70	0.61	0.89	5.97	0.91	2.28	5.97
Livestock Units	lu/ha	1.84	1.84	1.84	1.84	1.39	1.39	1.39	1.39	0.70	0.70	0.70	0.70	0.70	0.70	0.70
Gross Margin / ha (before forage costs)	£/ha	1328	477	862	554	1002	360	651	418	503	180	327	210	91	207	210
Proportion of Grass Allocation	%	67	13	20	0	67	13	20	0	67	13	20	0	50	25	25
No of ha allocated	ha	40.2	7.8	12	0	40.2	7.8	12	0	40.2	7.8	12	0	30	15	15
Stock Numbers / farm	hd	74	12	28	0	56	9	21	0	28	5	11	0	27	34	90
Total Enterprise Gross Margin	£/enterprise	53380	3718	10350	0	40284	2805	7810	0	20215	1408	3919	0	2721	3108	3144
Adjustment for grazing season	£/enterprise	0	0	0	0	0	0	0	0	-733	-62	-140	0	-360	-450	-313
Total Livestock Units	lu/farm	110				83				42				42		
Average Stocking Rate	Glu/ha	1.84				1.39				0.70				0.70		
				£/ha	£/farm		£/ha	£/farm			£/ha	£/farm		£/ha	£/farm	
Total Farm Gross Margin				1124	67448		848	50899			426	25542		150	8973	
Forage Variable Costs (seeds and chem)				0	10400		0	0			0	0		0	0	
Grazing Season Adjustment				0	0		0	0			-16	-935		-9	-1124	
Total Farm Gross Margin (after forage costs)				1124	57048		848	50899			410	24607		141	7849	
Farm Fixed Costs																
Labour (excl farmer and family)				220	13200		193	11581			152	9099		60	3600	
Power and Machinery				240	14400		211	12633			165	9927		85	5100	
Property maintenance				30	1800		26	1579			21	1241		15	900	
Other Expenses				135	8100		118	7106			93	5584		50	3000	
Total				625	37500		548	32900			431	25851		210	12600	
Profit before family labour, rent and interest				499	19548		300	18000			-21	-1244		-69	-4751	
Farmer and family labour				350	21000		307	18424			241	14476		162	9720	
Rental value (including buildings)				236	14160		207	12423			163	9761		100	6000	
Interest charges				0	0		0	0			0	0		0	0	
Total Other Fixed Costs				586	35160		514	30847			404	24237		262	15720	
Management and Investment Income before ESA receipts				-87	-15612		-214	-12847			-425	-25481		-331	-20471	
ESA Receipts							125	7500			300	18000		300	18000	
ESA compliance costs							30				50	3000		50		
M and I Income after ESA receipts							-119	-7147			-175	-10481		-31	-1866	
Reduction in Stocking rates							25%				62%			62%		
Fixed cost reduction factor							88%				69%			69%		

Table A8

Parret Catchment: Whole farm budgets : Cattle and Sheep Farm

Financial prices and economic prices

		Improved Grass			Tier 1			Tier 4 Washland		
Farm Size	ha	58			58			58		
Agric drainage condition	class	Good			Good			Bad		
Nitrogen	Kg/ha	150			75			0		
Energy From Grass	Mj/ha	71101			53657			26926		
Grazing Season										
Extra grazing of norm										
Days spring		0			0			-28		
autumn		0			0			-28		
Grass Conservation	type	Silage cut on 67% area			Hay /silage 67% area			Graze 50% / hay 50%		
Livestock Type		Beef Cows and Sucklers (spring calving)	24-30 month Beef	Sheep and Fat Lambs	Beef Cows and Sucklers (spring calving)	24-30 month Beef Beef	Sheep and Fat Lambs	Beef Cows and Sucklers (spring calving)	Medium Store Cattle	Sheep and Fat Lambs
Gross Output	£/hd	298	577	53	298	577	53	298	118	53
Variable Cost	£/hd	100	210	18	100	210	18	100	28	18
Gross Margin	£/hd	199	367	35	199	367	35	199	91	35
Energy Requirements	Mj/hd	29536	30281	4510	29536	30281	4510	29536	11800	4510
Grazing Livestock unit	Glu/head	0.76	0.78	0.12	0.76	0.78	0.12	0.76	0.31	0.12
Stock Numbers / ha	hd/ha	2.41	2.35	15.77	1.82	1.77	11.90	0.91	2.28	5.97
Livestock Units	lu/ha	1.84	1.84	1.84	1.39	1.39	1.39	0.70	0.70	0.70
Gross Margin / ha (before forage costs)	£/ha	478	862	554	361	651	418	181	207	210
Proportion of Grass Allocation	%	25	25	50	25	25	50	25	25	50
No of ha allocated	ha	14.5	14.5	29	14.5	14.5	29	14.5	14.5	29
Stock Numbers / farm	hd	35	34	457	26	26	345	13	33	173
Total Enterprise Gross Margin	£/enterprise	6935	12506	16052	5234	9437	12114	2626	3004	6079
Adjustment for grazing season	£/enterprise	0	0	0	0	0	0	-244	-611	-776
Total Livestock Units	lu/farm	107			80			40		
Average Stocking Rate	Glu/ha	1.84			1.39			0.70		
		£/ha	£/farm		£/ha	£/farm		£/ha	£/farm	
Total Farm Gross Margin		612	35493		462	26785		202	11709	
Forage Variable Costs (seeds and chem)		0	10400		0	0		0	0	
Grazing Season Adjustment		0	0		0	0		-13	-1631	
Total Farm Gross Margin (after forage costs)		612	25093		462	26785		189	10078	
Farm Fixed Costs										
Labour (excl farmer and family)		93	5394		82	4732		70	4050	
Power and Machinery		138	8004		121	7022		104	6010	
Property maintenance		23	1334		20	1170		17	1002	
Other Expenses		77	4466		68	3918		58	3354	
Total		331	19198		290	16843		249	14416	
Profit before family labour, rent and interest		281	5895		171	9942		-59	-4338	
Farmer and family labour		262	15196		230	13332		197	11411	
Rental value		133	7714		117	6768		100	5800	
Interest charges		0	0		0	0		0	0	
Total Other Fixed Costs		395	22910		347	20100		297	17211	
Management and Investment Income before ESA receipts		-114	-17015		-175	-10158		-356	-21549	
ESA Receipts					125	7250		250	14500	
ESA compliance costs					30			50		
M and I Income after ESA receipts					-80	-4648		-156	-9045	
Reduction in Stocking rates					25%			50%		
Fixed cost reduction factor					88%			75%		

Economic Analysis

Reduction in Gross Output to adjust from financial to economic prices

Reduction per Livestock Type	% of GO	33%	33%	12%	33%	33%	12%	33%	33%	12%
	£/head	98	190	6	98	190	6	98	39	6
	£/enterprise	3435	6486	2908	2592	4894	2195	1301	1293	1101
	£/farm	12829			9681			3695		
	£/ha	221			167			64		
Adjusted Econ Gross Margin	£/ha	391			295			126		
Adjusted Profit before family labour, rent and intere:		60			4			-123		
after labour excluding rent		-202			-225			-320		
Adjusted Econ Man & Inv Inc	£/ha	-335			-342			-420		

NB: Assumed Livestock quota available from national reserve for arable reversion schemes. Premium included on beef cows, special beef premium, ewe premium.
All farm systems below 2 livestock units per ha qualify, with extra extensification payment for stocking rates less than 1.4lu/ha.