SEPA
Scottish Environment Protection Agency

Strategic Environmental Assessment: Flood Risk Management Strategies

Environmental Report – consultation

March 2015

Contents

List of Environmental Assessments

Appendix 5: Highland and Argyll

Appendix 6: Outer Hebrides

Appendix 7: Orkney

Appendix 8: Shetland

Appendix 9: Findhorn Nairn and Spey

Appendix 10: North East

Appendix 11: Tay Estuary and Montrose Basin

Appendix 12: Tay

Appendix 13: Forth

Appendix 14: Forth Estuary

Appendix 15: Clyde and Loch Lomond

Appendix 16: Ayrshire

Appendix 17: Tweed

Appendix 18: Solway

SEA Environmental Report Cover Note

PART 1	
To: SEA.gateway@scotland.gsi.gov.uk or SEA Gateway Scottish Government Victoria Quay Edinburgh EH6 6QQ	
PART 2	
An Environmental Report is attached for	Flood Risk Management Strategies
The Responsible Authority is	Scottish Environment Protection Agency (SEPA)
PART 3	
Contact name	Helen Panter
Job title	Senior Policy Officer
Contact address	SEPA ASB, Angus Smith Building, 6 Parklands Avenue, Eurocentral, Holytown, North Lanarkshire, ML1 4WQ
Contact telephone	03000 99 66 99
Contact email	FloodActConsultation@sepa.org.uk
PART 4	
Signature (electronic signature is acceptable)	[redacted]
Date	2 March 2015

Non technical summary

This is the summary of the environmental report for the 14 draft Flood Risk Management Strategies. The environmental report presents the results of a strategic environmental assessment (SEA) carried out as part of the preparation of the Flood Risk Management Strategies. The environmental report and this summary are required to be published with the draft Flood Risk Management Strategies in order that people can understand and comment on how the environmental effects should be taken into account in the development of the final Flood Risk Management Strategies. The final Flood Risk Management Strategies will be published in December 2015. These 14 Flood Risk Management Strategies, taken together, will comprise a national flood risk management plan for Scotland as required by the European Union Floods Directive and the Flood Risk Management (Scotland) Act 2009.

Flood Risk Management Strategies

Flood Risk Management Strategies will set the direction and priorities for flood risk management in Scotland. They are being produced by SEPA, in collaboration with partners, and are required by the European Union Floods Directive and the Flood Risk Management (Scotland) Act 2009.

The Flood Risk Management Strategies aim to reduce overall flood risk in the most sustainable way. They identify the hazards and risks of flooding from river, sea, and surface water; set out objectives for reducing flood risk; select the best combination of actions to meet the objectives; and prioritise the delivery of actions to one of three planning cycles (2015 – 2021, 2021 – 2027, 2027 and beyond). To supplement the Flood Risk Management Strategies, lead local authorities are producing Local Flood Risk Management Plans that describe the delivery and funding arrangements of the prioritised actions. (Note it is only the Flood Risk Management Strategies and not the Local Flood Risk Management Plans that are the focus of this Strategic Environmental Assessment).

The public consultation on the draft Flood Risk Management Strategies seeks views on the proposed flood risk management objectives and the shortlist of feasible actions. Consulting at this stage in the planning process enables SEPA to provide an early and effective opportunity for engagement to ensure views are taken into account before the final actions are selected.

Scotland's environment: current condition and pressures

Scotland has a population of around 5.3 million and this is projected to rise. Around 1 in 22 of all residential properties and 1 in 13 non-residential properties is at medium risk of flooding. Scotland's environment is varied with an extensive coastline, numerous freshwater and sea lochs, large areas of forest, moorlands, peatlands and uplands. Extensive areas of land are protected for their habitats and species. The quality of the environment, landscape and rich cultural heritage make extremely important contributions to Scotland's economy and the wellbeing of its people.

The condition of Scotland's environment is generally good and improving. Water quality is mainly good or excellent and areas of woodland are expanding. Relevant pressures on the environment include water quality pressures from pollution (such as run off from the rural and urban environment), loss of natural habitat due to development and climate change, erosion of peatlands, and fragmentation of habitats such as wetlands and woodlands. Climate change is likely to lead to increased flooding due to sea level rise and changes to patterns of rainfall.

Strategic environmental assessment

We have assessed the likely environmental effects of the draft Flood Risk Management Strategies. Our environmental assessment is strategic: it does not consider the effects of an individual action in a specific location. Instead, it considers the *potential* effects of groups of actions for each of the

14 Flood Risk Management Strategies. The key significant effects for the whole of Scotland are given in this non-technical summary. More detail can be found in the main body of the environmental report and in appendices 5 – 18 (which provide further assessment, mitigation and opportunities for the individual Flood Risk Management Strategies).

Summary of potential significant effects of the draft Flood Risk Management Strategies, opportunities and mitigation

SEA topic	Summary of potential significant effects*	Mitigation and opportunities
Population and human health	Significant positive effects on reducing flood risk and protecting human health. Significant positive effects on promoting healthy lifestyles where actions improve opportunities for recreation, experiencing nature and enhanced urban greenspace. No significant negative effects.	Opportunities to enhance public health through provision of urban greenspace and through improved opportunities to access nature.
Biodiversity, fauna and flora	Significant positive effects on connectivity and health of native woodlands, wetlands, freshwater, and coastal habitats from some actions that help to restore or enhance natural habitats. However, some engineering actions could have negative effects on fragmented or degraded habitats such as wetlands, native floodplain woodlands and coastal habitats. Significant positive effects on freshwater nature conservation sites from actions that help to improve water quality. However, some structural actions could have significant negative effects on nature conservation sites, for example, by altering patterns of river flow or coastal processes or through disturbance.	Potential negative effects can be minimised through sensitive design and should be considered during feasibility and detailed design. Potential negative effects can be mitigated through the identification of impact, sympathetic design and timing of works to avoid or minimise the effects on habitats and wildlife, along with consultation with relevant organisations. Potential negative effects on European protected sites will be assessed by SEPA as part of the Habitats Regulations Appraisal for the Flood Risk Management Strategies and mitigation applied where required. At more detailed stages of planning, Habitats Regulations will also apply during which the responsible authority will need to take steps to mitigate negative effects on protected sites.
Soil	Significant positive effects on restoring carbon rich soils from actions that help to restore wetlands. Significant positive effects on safeguarding productive or carbon rich soils from erosion from actions that help to reduce run off or erosion. Significant negative effects from actions that alter natural processes and lead to increased erosion of carbon rich soils or agricultural land.	Opportunities to contribute to objectives to protect soil quality, for example, the Scottish Soil Framework. Modelling of natural processes can help to better predict and mitigate potential negative effects: this should be addressed during feasibility and detailed design stages.
Water	Significant positive effects on the water environment where actions help to improve water quality or improve the condition of river beds and banks and the coastline. Significant negative effects where actions lead to degradation and/or increased erosion of beds and banks of rivers and the	Opportunities to contribute to river basin management planning objectives. The potential negative effects can be mitigated by minimising potential habitat loss and including habitat creation in flood risk management schemes. Negative effects should be addressed during feasibility and

SEA topic	Summary of potential significant effects*	Mitigation and opportunities
	coastline.	detailed design stages. Actions may be regulated under The Controlled Activities Regulations, which aim to protect the water environment. Mitigation is considered as part of the authorisation process. Some actions, particularly those deemed as development, are regulated under the land use planning system: environmental effects will be addressed through Environmental Impact Assessments.
Climatic factors	Significant positive effects on carbon storage from actions that help to protect or restore carbon rich soils such as peatlands. Significant negative effects from actions that lead to potential loss or degradation of habitats (e.g. wetlands, woodlands, coastal) that help to mitigate and adapt to a changing climate.	Opportunities to contribute towards Scottish Government sector action plans for climate change. The potential negative effects can be mitigated by minimising potential habitat loss and including habitat creation in flood risk management schemes. Negative effects should be addressed during feasibility and detailed design stages.
Material assets	Significant positive effects from reducing flood risk and protecting property and infrastructure. No significant negative effects.	Opportunities to minimise waste and resource use should be examined during feasibility and detailed design stages.
Cultural heritage	No significant effects identified (although assessment is uncertain as effects depend strongly on the type of action and its location).	The potential negative effects can be mitigated through the identification of any heritage assets (including archaeology) and the early engagement of heritage interest organisations during feasibility and detailed design stages.
Landscape	Significant positive effects on seascapes from actions that restore coastal habitats. Significant negative effects on seascapes from coastal defences.	Potential negative effects should be addressed early during feasibility and detailed design stages. Consultation with Scottish Natural Heritage, National Park Authorities and affected communities is recommended.

*Locally noticeable but non-significant effects are detailed in section 5 and in appendices 5 - 18

A wide range of structural and non-structural actions to manage flood risk are being considered by the draft Flood Risk Management Strategies. These actions are anticipated to have significant positive effects on population, human health and material assets, through reducing flood risk and protecting protect people, property and infrastructure. The potential significant effects on other aspects of the environment are described below; the extent of these effects will depend on the actions chosen for inclusion in the final Flood Risk Management Strategies and how the actions are designed and implemented.

Actions that work with the environment to help manage flooding (for example, restoring wetlands, restoring coastal habitats, or reconnecting the river with the floodplain) provide opportunities to deliver a wide range of other positive effects. These types of actions can help to improve and

protect water quality and mitigate climate change (by storing carbon). Human health and wellbeing can also benefit if these actions provide opportunities for recreation and experiencing nature, and protecting the landscape. These benefits are dependent on the type and location of the action and whether opportunities are taken to coordinate actions with other relevant plans and initiatives. These types of actions also have the potential for negative effects, for example, if they lead to loss of agricultural land or if they are inappropriately located with respect to nature conservation sites.

Engineering actions (for example, flood storage, flood defences walls, or structures that regulate the flow of water in rivers) have potential for negative environmental effects by damaging natural habitat and altering natural process. This can lead to degradation of the environment, for example, by increasing erosion or damaging wetlands (which are important for storing carbon and filtering nutrients). Conversely, where the banks and beds or rivers or the coastline have already been physically modified, any new engineering actions present opportunities to make improvements to the environment. For example, moving existing defences back from the river or shoreline can create space for habitat restoration; altering in-river structures to improve water conveyance can help to improve access for migratory fish. Sensitively designed structures can also deliver benefits by improving access for recreation or opportunities to access nature. Actions need to be sensitively location and implemented to avoid negative effects on nature conservation sites.

SEPA will monitor the effects that the Flood Risk Management Strategies are having on the environment. The main mechanism will be through the Flood Risk Management Strategies, which will report on improvements to flood risk management, but also through river basin management planning, which will report on the status of the water environment.

How to respond to this consultation

The consultation closes on 2 June 2015. Please respond via our online consultation hub:

https://frm-scotland.org.uk/

Alternatively you can respond by email or post:
Email: FloodActConsultation@sepa.org.uk
Post: SEPA ASB, Angus Smith Building, 6 Parklands Avenue, Eurocentral, Holytown, North Lanarkshire, ML1 4WQ

Consultation questions

1. **About you**
   - Please provide your name.
   - Please provide your organisation name (if relevant)
   - Please provide your email address
   - Which category best reflects your interest?
     - SEA consultation authority
     - Responsible authority designated under the FRM Act 2009
     - Other public body
     - Interest/community group
     - Consultancy
     - Academia
     - Individual
     - Business
     - Other, please state

2. **Relevant aspects of the current state of the environment**
   Do you think that we have accurately described the relevant aspects of the current state of the environment?
   If no, please provide your reasons.

3. **SEA objectives and assessment method**
   Do you think that our objectives and assessment method have enabled us to adequately assess the potential significant environmental effects of the proposed actions? If no, please provide your reasons.

4. **Reasonable alternatives**
   Are there any actions that should be considered as 'reasonable alternatives' that we have not identified and should be considered as part of the SEA process (see section 4.1)? If yes, please provide further information

5. **Environmental assessment**
   Do you think that we have accurately assessed the potential significant environmental effects of the proposed actions? If no, please provide your reasons

6. **Mitigation**
   Do you think that we have proposed appropriate mitigation of the significant negative environmental effects? If no, please provide your reasons

7. **Monitoring**
   Are there any other ways in which we could monitor the significant environmental effects of the Flood Risk Management Strategies? If yes, please provide details

8. Please provide any further comments on the Environmental Report

9. Please provide any comments on the Environmental Assessment for the individual Local Plan Districts (appendices 5 – 18)

Abbreviations

EIA	Environmental impact assessment
LPD	Local Plan District
PVA	Potentially Vulnerable Area
SAC	Special Area of Conservation
SEA	Strategic environmental assessment
SEPA	Scottish Environment Protection Agency
SNH	Scottish Natural Heritage
SPA	Special Protected Area
SSSI	Site of Special Scientific Interest
SUDS	Sustainable Urban Drainage Systems
WFD	Water Framework Directive

Introduction

1.1. Purpose of this Environmental Report and key facts

As part of the preparation of the Flood Risk Management Strategies, SEPA is carrying out a Strategic Environmental Assessment (SEA). SEA is required by the Environmental Assessment (Scotland) Act 2005 and is a systematic method for considering the likely environmental effects of certain plans, programmes and strategies. SEA aims to:

- integrate environmental factors into the preparation of and decision-making for plans, programmes and strategies;
- improve plans, programmes and strategies and enhance environmental protection;
- increase public participation in decision making; and
- facilitate openness and transparency of decision-making.

The purpose of this environmental report is to:

- provide information on the Flood Risk Management Strategies;
- identify, describe and evaluate the likely significant effects of the Flood Risk Management Strategies and their reasonable alternatives;
- provide an early and effective opportunity for the Consultation Authorities and the public to offer views on any aspect of this environmental report.

The key facts relating to the Flood Risk Management Strategies are set out in table 1.1 below.

Table 1.1: Key facts about the Flood Risk Management Strategies

Responsible Authority	Scottish Environment Protection Agency (SEPA)
Title	Flood Risk Management Strategies
Purpose	To provide strategic direction for the sustainable management of flood risk
What prompted the Flood Risk Management Strategies	The Flood Risk Management (Scotland) Act 2009, which transposes the EU Directive (2007/60/EC) on the assessment and management of flood risks
Period covered	3 planning cycles (2015 – 2021; 2021 – 2027; 2027 and beyond)
Frequency of updates	Every 6 years
Area covered	Scotland, consisting of 14 Local Plan Districts. The main report makes a national assessment across all 14 Flood Risk Management Strategies. The findings in this report are built from individual assessments for each LPD, which can be found in appendices 5 – 18.
Objectives of Flood Risk Management Strategies	To reduce overall flood risk in the most sustainable way

Contact	SEPA ASB, Angus Smith Building, 6 Parklands Avenue, Eurocentral, Holytown, North Lanarkshire ML1 4WQ Tel: 03000 99 66 99 Email: FloodActConsultation@sepa.org.uk

1.2. SEA activities to date

Screening and scooping
SEPA determined that the Flood Risk Management Strategies fall within the scope of the Environmental Assessment (Scotland) Act 2005. We published the screening determination within our scoping report, which was published for consultation from 13 November to 20 December 2013.

We received 11 responses to the scoping report consultation, with the responses indicating broad support to our proposed approach (Appendix 1). We received a small number of specific suggestions for improving our approach and have taken these into consideration when producing the environmental report.

Notification of consultation period
In our scoping report, we proposed a 3 month consultation period for the environmental report with a start date of 22 December 2014 to run in conjunction with the consultation on the draft Flood Risk Management Strategies. We later revised the start date to 2 March 2015 to align with changes to the consultation period for the draft Flood Risk Management Strategies. We informed the Consultation Authorities of the change. The proposed consultation dates were accepted by Scottish Ministers on 22 August 2014.

2. Context of the Flood Risk Management Strategies

2.1. Outline and objectives for the Flood Risk Management Strategies

Schedule 3 of the Environmental Assessment (Scotland) Act 2005 requires that the environmental report includes “an outline of the contents and main objectives of the plan or programme”. The purpose of this section is to explain the nature, contents, objectives and timescale of the Flood Risk Management Strategies.

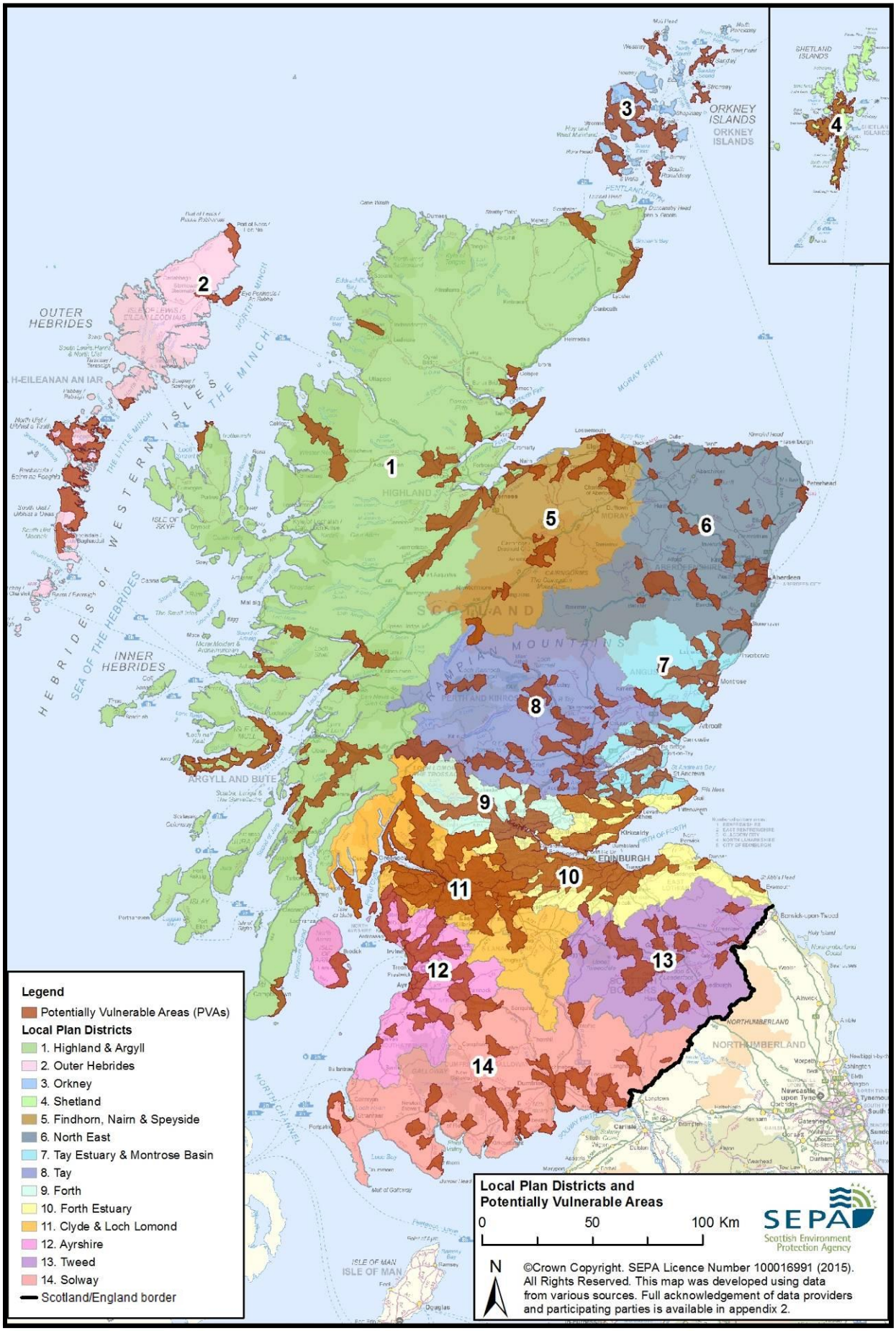
The Flood Risk Management (Scotland) Act 2009 introduced a new plan-led approach to flood risk management in Scotland. The legislation aims to reduce overall flood risk in the most sustainable manner. At the heart of the Flood Risk Management (Scotland) Act 2009 are a series of assessments and maps that underpin the production of the Flood Risk Management Strategies by SEPA and Local Flood Risk Management Plans by lead local authorities.

SEPA, in collaboration with partners, is producing Flood Risk Management Strategies to set out the future direction and priorities for managing flooding. These strategic documents are supplemented with Local Flood Risk Management Plans produced by lead local authorities that describe the delivery and funding arrangements for the agreed priorities. Flood Risk Management Strategies and Local Flood Risk Management Plans are at the heart of efforts to tackle flooding in Scotland.

In 2011 SEPA identified 243 areas where the potential impacts of flooding justified further assessment and appraisal of flood risk management actions. These Potentially Vulnerable Areas (PVAs) form the basis on which local authorities, Scottish Water, SEPA and other responsible authorities are developing Flood Risk Management Strategies and Local Flood Risk Management Plans. The 243 Potentially Vulnerable Areas in Scotland have been grouped together for planning purposes within 14 Local Plan Districts (LPDs) (figure 2.1). In 9 cases significant flood risk outwith PVAs has been identified by SEPA: these cases have been designated as candidate PVAs. In other PVAs, boundaries have been extended to capture significant flood risk or to address areas where the boundary cuts through key settlements. For administrative purposes one PVA has been split in three. Local authorities retain a duty to manage flood risk in all areas but not to the exclusion of the consideration of nationally significant risks identified in the PVAs.

For each PVA, the Flood Risk Management Strategies identify the main flood hazards and impacts, set out objectives for reducing risk and select the best combination of actions to meet the objectives. The delivery of actions will be prioritised into one of three planning cycles (2015-2021, 2021-2027, 2027 and beyond). The Local Flood Risk Management Plans explain what actions will be taken by whom and at what time, to deliver the relevant objectives within a six-year cycle.

Figure 2.1: Local Plan Districts and Potentially Vulnerable Areas[1]



[1] Including candidate PVAs

Environmental assessment

It is the Flood Risk Management Strategies that are the focus of this environmental report. Further environmental assessment (SEA or Environmental Impact Assessment (EIA)) will take place at more detailed level of flood risk management planning where required (figure 2.2). It is likely that the issues addressed in this environmental report will cover many, if not all, of the significant environmental effects of the Local Flood Risk Management Plans.

The environmental report focuses on two spatial scales. The main report makes a national assessment across all 14 Flood Risk Management Strategies. The findings in this report are built from individual assessments for each LPD, which can be found in appendices 5 – 18.

Figure 2.2: Hierarchy of flood risk management planning and environmental assessment

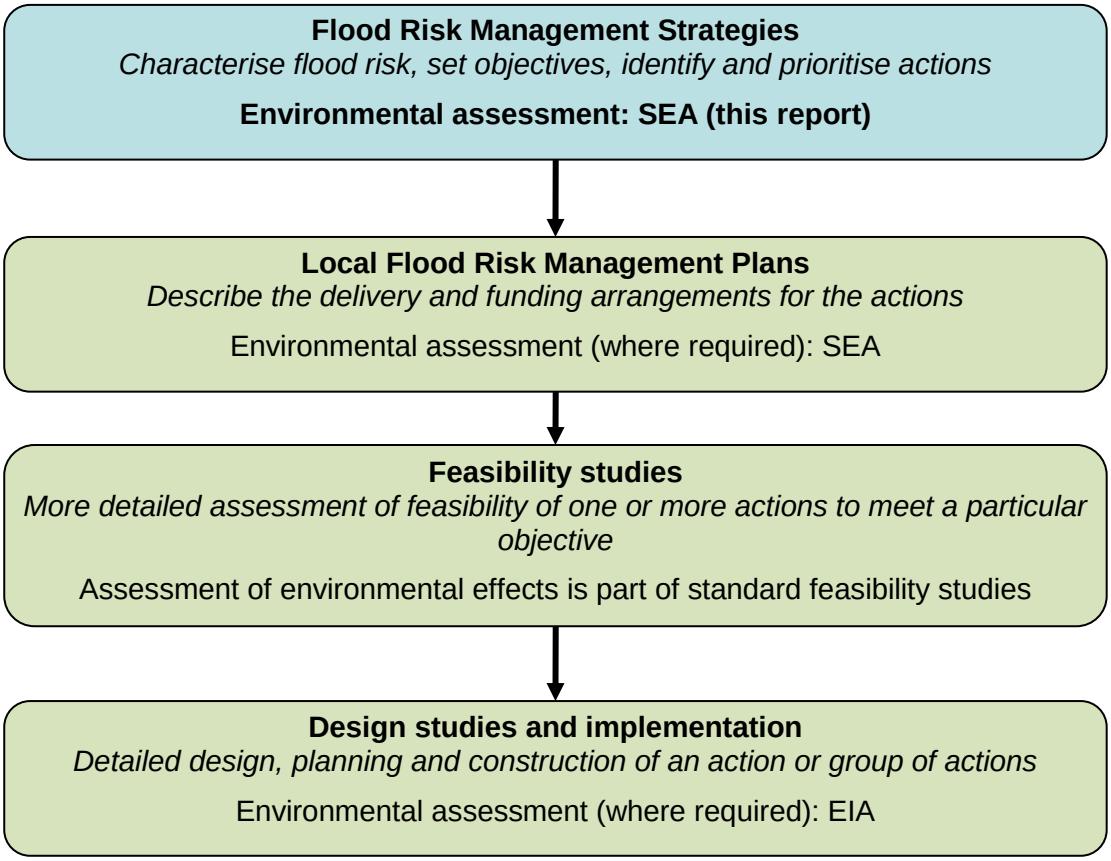


Table 2.1 outlines the contents of the draft Flood Risk Management Strategies and indicates which elements will be assessed by this SEA. Those parts which provide factual information, those that describe existing actions, and those that describe actions set out by other plans, programmes and strategies will not be assessed.

Table 2.1: Elements of the draft Flood Risk Management Strategies assessed in this SEA

Content of draft Flood Risk Management Strategies	Has this been assessed in this SEA?
Local Plan District overview Defines the Local Plan District, the public bodies involved, and a summary of flood risk for the area. The Potentially Vulnerable Areas for the Local Plan District are also identified.	No, this provides factual information about the Local Plan District.
Local Plan District objectives and actions Further information on flood risk management objectives and actions for this Local Plan District that span more than a single Potentially Vulnerable Area. These are in relation to flood warning, surface water management planning, land use planning and generic initial objectives and actions.	Yes, new potential actions have been assessed. See section 4 for more information and exceptions.
Local Plan District: delivery plan A delivery plan developed by the lead local authorities that contains information on the timing and funding arrangements for the Local Plan District level actions. (This delivery plan is optional and may not be produced for all Local Plan Districts.)	No, this information is being prepared by the lead local authority as part of the Local Flood Risk Management Plans and so does not fall within the scope of this SEA. The lead local authorities will determine whether the Local Flood Risk Management Plans require a SEA.
Surface water flooding The impacts of surface water flooding are summarised for each Local Plan District, alongside existing actions to manage these risks. Future impacts due to climate change and links to river basin management are also described.	No, this provides factual information about surface water flooding and existing actions.
River flooding River flooding in the Local Plan District is described here. The impacts are described alongside existing actions to manage river flooding in individual chapters. Future impacts due to climate change, the potential for natural flood management and links to river basin management are also described.	No, this provides factual information about river flooding and existing actions.
Coastal flooding Coastal flooding impacts are summarised alongside an explanation of the coastal processes that influence flooding. Existing actions to manage risk and the future impacts due to climate change are summarised and the potential for natural flood management and links to river basin management are also described.	No, this provides factual information about coastal flooding and existing actions.
Potentially Vulnerable Areas: Characterisation Describes and summarises the likelihood and impact from all types of flooding for Potentially Vulnerable Areas, including the local history of flooding and existing actions to manage floods.	No, this provides factual information about flooding in each Potentially Vulnerable Areas and existing actions.
Potentially Vulnerable Areas: Objectives and actions Further information on flood risk management initial objectives and actions for each Potentially Vulnerable Area	Yes, we will assess the likely significant effects of the initial objectives and potential actions. See section 4 for more information and any exceptions.
Potentially Vulnerable Areas: Delivery plan A draft six year delivery plan that has been developed by the lead local authorities that contains information on proposed funding and timing of potential actions	No, this information is being prepared by the lead local authority as part of the Local Flood Risk Management Plans and so does not fall within the scope of this SEA. The lead local authorities will determine whether the Local Flood Risk Management Plans require a SEA.

2.2. Relationship with other plans, programmes and strategies and environmental policy objectives

Schedule 3 of the Environmental Assessment (Scotland) Act 2005 requires that the environmental report includes an outline of the Flood Risk Management Strategies' relationships with other relevant plans, programmes and strategies, and how environmental protection objectives have been taken into account. This section covers these issues and describes the policy context within which the Flood Risk Management Strategies operate and the constraints and targets that this context imposes on the Flood Risk Management Strategies.

A detailed analysis of how the Flood Risk Management Strategies affect, and are affected by, other relevant plans, programmes and strategies and environmental objectives has been undertaken (see Appendix 3). The key findings from this analysis are:

Population and human health

Flooding can cause risk to life, injury, illness and stress, and impacts may be greater for more socially vulnerable groups. Scottish Planning Policy seeks to reduce the exposure of people to flooding through policies and advice regarding new developments in flood risk areas. In terms of preparing for flooding, the Civil Contingencies Act 2004 forms the basis for emergency planning and preparedness in Scotland and the UK.

There are secondary issues relating to human health, such as the provision of green space and recreation/leisure opportunities, active travel, and also nuisance related to construction works.

Biodiversity, flora and fauna

The international context sets the framework for the conservation, protection and sustainable use of biodiversity, flora and fauna, and there are also national and local priorities.

In relation to flood risk management, the broader policy framework includes the protection of habitats and species that could be adversely affected by flooding, and those that benefit from flooding. It includes the consideration of how enhancing, restoring and creating wetlands and other habitats can provide flood risk management benefits, using techniques known as natural flood management. Furthermore, it includes protecting biodiversity, flora and fauna from negative impacts of flood risk management actions and looking for opportunities to deliver improvements.

Soil

In Scotland there is a significant body of policy providing some direct or indirect protection of soils, such as the Land Use Strategy. In terms of policy specifically developed for soil protection, the Scottish Soil Framework aims to instigate a process by which key stakeholders will work together to achieve better soil protection. There are a number of outcomes in the Framework that are specifically relevant to flood risk management.

The consideration of soils also encompasses geology, and there is a range of international, national and local designations which help to safeguard geodiversity.

Water

There are a number of existing plans and activities related to flood risk management, including:

- Actions taken to protect the coast under the Coast Protection Act 1949.
- Flood and erosion risk and management policies identified in shoreline management plans.
- Planning guidance on water and drainage, which places emphasis on meeting the needs of householders and encouraging the uptake of Sustainable Urban Drainage Systems (SUDS).
- The management of flood risk in England under the Flood Risk Regulations 2009, the Flood Risk (Cross Border) Regulations 2010, and the Flood and Water Management Act 2010.

As flooding can lead to the release of pollutants, the objectives of policies related to groundwater, bathing water quality, nitrates, and Integrated Pollution and Prevention Control sites are also

important.

Other issues relating to water are extensive and driven largely by the EU Water Framework Directive and its transposition into law in the Water Environment and Water Services (Scotland) Act 2003 and the Water Environment (Water Framework Directive) (England and Wales) Regulations 2003. The Water Framework Directive requires the prevention of deterioration of aquatic ecosystems, with the key objectives of achieve good status for all inland and coastal waters. River Basin Management Plans set out the plans for achieving these objectives.

Air
We do not envisage significant air quality impacts arising from the Flood Risk Management Strategies, and, as proposed in our scoping report, this SEA topic has been excluded from this SEA.

Climatic factors
The Climate Change (Scotland) Act 2009 places duties on public bodies around adaptation to and mitigation of climate change. In relation to managing flood risk, this includes adapting to future changes in precipitation and sea level, and to reducing emissions (e.g. from construction and maintenance, land use change, water pumping).

At a UK level, greenhouse gas emission targets are specified under the Climate Change Act 2008.

Material assets
Scottish Government planning policy provides advice regarding new developments in flood risk areas, including policy on the location of particular types of development. In terms of preparing for flooding, the Civil Contingencies Act 2004 forms the basis for emergency planning and preparedness in Scotland and the UK.

Some Flood Risk Management actions, such as flood protection schemes, can use large amounts of materials and also create waste. The Scottish Government's Zero Waste plan aims to make the most efficient use of Scotland's resources.

Cultural heritage
Scotland's historic environment (including the marine environment) contributes to the Scottish Government's strategic objectives and to the National Performance Framework. The Scottish Historic Environment Policy sets out Scottish Ministers' policies for the historic environment, and summarises the statutory designations, including scheduled monuments and listed buildings, which provide various protection against damage (including damage from flooding).

Landscape
Landscape policies related to key areas of recognised values, for example, designated areas, national parks. The protection of wild land is also becoming increasingly important.

There is a broad approach to valuing natural and built landscape in policies in general. In Scotland, national planning policy on landscape and natural heritage is set out in Scottish Planning Policy (SPP), and is supported by Planning Advice Note (PAN) 60 Planning for Natural Heritage. In England, the National Planning Policy Framework sets out the need to protect and enhance landscape, particularly those areas with the highest status of protection.

3. Relevant aspects of the current state of the environment

Schedule 3 of the Environmental Assessment (Scotland) Act 2005 requires that the environmental report includes a description of "the relevant aspects of the current state of the environment and the likely evolution thereof without implementation of the plan or programme", and "the environmental characteristics of areas likely to be significantly affected".

Environmental problems were identified through discussions with colleagues in SEPA, the statutory Consultation Authorities, the consultation on the scoping report and an analysis of the baseline data. The inset tables summarise existing environmental problems and explains whether the Flood Risk Management Strategies are likely to exacerbate, reduce or otherwise affect existing environmental problems. They also identify the likely evolution of the state of the environment without implementation of the Flood Risk Management Strategies.

The overall aim of the section is to describe the environmental context within which the Flood Risk Management Strategies operate and the constraints and targets that this context imposes on them.

3.1. Population and human health

Scotland has a population of around 5.3 million[2] and this is projected to rise. Around 1 in 22 of all residential properties is at medium risk of flooding[3]. Flooding can impact on people through risk to life, health impacts of exposure to water and contaminants, and immediate and long term mental health impacts including the fear of future flooding. People who have been flooded report that the emotional and non-material impacts (e.g. stress, anxiety, inconvenience, loss of sentimental items) are greater than more tangible material impacts (e.g. financial loss)[4].

People and communities exposed to the same flood event can experience very different outcomes in their longer-term well being. Factors such as age, health, income and housing tenure can impact on people's vulnerability to flooding. In particular, the local authorities of Moray, Falkirk, Perth and Kinross and Glasgow City have the largest proportions of their total number of neighbourhoods classed as being 'extremely flood disadvantaged' with respect to coastal and river flooding[5].

Flood alerts/ warnings help people take action to protect themselves and their property and can help reduce anxiety about future flooding. Flood warnings are also required for some flood protection schemes where manual action is required in advance of a flood / watercourse management.

Actions to manage flood risk can have wider positive and adverse impacts on people and human health. For example, some actions can help to create or restore habitats and green spaces, which in turn provide opportunities for recreation, leisure and wildlife watching. There is a clear positive relationship between greenspace and health, and compelling evidence for benefits from urban green space and mental health[6]. Over two thirds (68%) of adults in Scotland have access to

[2] General Register Officer for Scotland. Mid-June 2012 Population Estimates Scotland. http://gro-scotland.gov.uk/statistics/theme/population/estimates/mid-year/2012/index.html [accessed 16/06/2014]

[3] SEPA 2011 National Flood Risk Assessment http://www.sepa.org.uk/flooding/flood_risk_management/national_flood_risk_assessment.aspx

[4] Werritty, A., Houston, D., Ball, T., Tavendale, A. and Black, A. (2007) Exploring the social impacts of flooding and flood risk in Scotland. Scottish Executive Social Research.

[5] Lindley, S. and O'Neill, J. (2013) Flood disadvantage in Scotland: Mapping the potential for losses in well-being. Scottish Government Social Research. (Uses SEPA 2006 Indicative River and Coastal Flood Map.)

[6] Health Scotland, greenspace scotland, Scottish Natural Heritage and Institute of Occupational Medicine (2008) Health Impact Assessment of greenspace: A Guide. http://www.greenspacescotland.org.uk/SharedFiles/Download.aspx?pageid=133&mid=129&fileid=41.

useable greenspace within a five-minute walk from their home (not including their own garden), according to the Scottish Household Survey 2013.

Population and human health
Environmental problems relevant to the Flood Risk Management Strategies
• Flooding has impacts on human health, and impacts of flooding may be greater for some people / communities • Flood risk management actions can contribute to greenspace provision, which also provides benefits in terms of recreation, leisure, amenity, and health benefits • Flood risk management actions can restrict or alter access (both short and long term) to river banks and shorelines, with negative effects on amenity and opportunities for recreation
Likely evolution of the environment without the Flood Risk Management Strategies
• Flooding is predicted to get worse under climate change, leading to an increase in impacts on human health • Trends in greenspace use are uncertain (greenspace use in Scotland increased between 2004 and 2008, but has declined dramatically between 2008 and 2011[7]

3.2. Biodiversity, flora and fauna

Scotland's environment is varied with an extensive coastline, numerous freshwater and sea lochs, large areas of forest, moorlands, peatlands and uplands. Extensive areas of land are protected for their habitats and species at national and European level.

Mountains, moorlands, blanket bog and rough grasslands make up much of Scotland's wild upland areas and contain some of Scotland's rarest plants and animals. Since the 1940s, many upland habitats and the wildlife they support have declined in extent or worsened in condition. However, there have been improvements recently: the majority of features in protected sites in the uplands are now in favourable condition and are continuing to improve[8].

Scotland's woodlands and forests cover around 18% of the land area[9] and are in moderately good condition, with respect to the wildlife that they support. Just over one-fifth of woodlands and forests in Scotland are native woodland. The Native Woodland Survey of Scotland 2013 found that 46% of ancient and native woodland was in good condition, but that woodland was gradually being lost or fragmented in unenclosed uplands[8].

Scotland's farmland and lowland consist of horticultural areas, arable and grassland, crofting land, lowland heaths and unimproved grasslands. These habitats have been shaped by centuries of land management, with a shift towards intensive use for food production. In 2010, 68% of notified features in protected sites in the lowlands were at favourable or recovering condition[8]. Outside of protected sites, around 41% of species rich lowland grasslands are in favourable condition[10]. Populations of some birds and insects in farmland and lowland habitats are in decline, and potentially serious declines in populations of pollinators are of particular concern[8]. The loss of features such as hedgerows, trees, and ponds in farmland may have contributed to a decline in biodiversity by reducing the diversity of habitats.

Wetlands are sensitive habitats and support a wide range of animals and plants that are not found elsewhere. Within protected sites, most wetland features are in favourable condition except for lowland raised bogs where 59% are in unfavourable condition. There is little information on the

[7] greenspace Scotland: greenspace use and attitude survey 2011. http://www.greenspacescotland.org.uk/11greenspace-survey-2011.aspx [accessed 10/07/2014]

[8] Scotland's Environment Web [online]: Get informed: Land. http://www.environment.scotland.gov.uk/get-informed/land/ [accessed 13/06/2014].

[9] Forestry Commission: Forestry Statistics 2013

[10] Dadds, N.J. and Averis, A.B.G. 2014. The extent and condition of non-designated species rich lowland grasslands in Scotland. *Scottish Natural Heritage Commissioned Report No.571.* http://www.snh.org.uk/pdfs/publications/commissioned_reports/571.pdf

condition of wetlands outside of protected areas[8]. Wetlands are at threat from land use management, development, water management and pollution, including nutrient run off.

The wildlife of Scotland's rivers and freshwater lochs is generally in good condition and improving: for example, fish diversity is being restored in the catchments and estuaries of the Forth and Clyde. Some species such as freshwater pearl mussels, however, are still under significant pressure. Ecological quality can be affected by invasive non-native water plants or animals, habitat damage and diffuse pollution (see subsection on Water below).

A wide range of estuarine and coastal habitats support a diversity of life. Many of these habitats and animals are protected. Pressures include development (such as loss of intertidal area), construction, pollution (diffuse sources, waste water and other contaminants), dredging, and climate change.

Urban areas and the green spaces within them contain a wide range of habitats that are valuable for many plants and animals. Linked together to form 'green networks' they can help to reduce habitat fragmentation and can provide a valuable resource for wildlife. Green infrastructure can also contribute to the sustainable management of surface water and drainage.

Actions to manage flood risk can have positive and negative impacts on habitats and species. For example, wetlands can contribute to the management of flooding by slowing the flow of rainwater into rivers, lochs and other watercourses, and by storing water in the floodplain helping to reduce the peak of floodwater passing through towns and cities. However, wetlands can also be damaged by flooding – for example through sedimentation. Where water levels change on a more permanent basis, this can alter the diversity and composition of wetland species. Sensitively designed schemes can lessen impacts (through mitigation) and look to deliver benefits.

Biodiversity, flora and fauna
Environmental problems relevant to the Flood Risk Management Strategies
Biodiversity, flora and fauna is at risk from: • Declining UK BAP priority habitats and protected species • Pressure on wetlands • Fragmentation of semi-natural habitats • Nutrient enrichment affecting river and coastal water quality • Habitats and species may be damaged by sediment or pollutants in flood water or by the actions of flood water • Changing climate Flooding can impact on habitats and species, both positively and negatively: some benefit from regular flooding, whereas others may be damaged by sediment or pollutants in flood water or by the actions of flood water Actions to manage flood risk can have positive and negative impacts on habitats and species • Habitat creation or enhancement (for example as part of natural flood management or sustainable urban drainage systems (SUDS)) can benefit biodiversity, fauna and flora • Actions can also help to protect vulnerable designated sites from significant flood risk and ensure that sites that benefit from flooding continue to flood • Other actions (for example some engineering works) could negatively impact on habitats and species, although sensitively designed schemes can lessen impacts (through mitigation) and look to deliver benefits
Likely evolution of the environment without the Flood Risk Management Strategies
• Policies and programmes are in place to protect and restore biodiversity, flora and fauna, and many areas show signs of improvement

3.3. Soil

Scotland has a rich geodiversity, which includes soils, rocks and landforms. Natural processes including flooding help to shape the land and coast.

Scotland's soils are diverse and often rich in carbon. They provide a range of benefits, which include producing food, growing timber, filtering impurities from water and storing carbon. The state of soil is generally thought to be good, although there is insufficient data to determine trends[11].

Pressures on soils include climate change, and land use and land management change (including compaction and soil sealing). Flooding can impact on soils through deposition of sediments and pollutants. Flooding may exacerbate erosion leading to loss of fertile topsoil from fields, which can damage a range of soil functions. Furthermore, erosion can also increase flooding by increasing sediment deposition in rivers or by degrading habitat that naturally helps to attenuate water. It is estimated that in some arable areas of eastern Scotland, erosion rates caused by water are double natural rates[12]. In upland areas, it is estimated that around 35% of Scotland's peatlands show signs of erosion[13]. This has important implications for loss of soil carbon, as well as for soil biodiversity.

Actions to managing flooding may have both positive and negative impacts on soil. Actions to slow and store water can help to reduce erosion, and can benefit water-dependent wetlands.

Flooding can impact on agriculture by damaging livestock and crops, and affecting soil quality. Around 80% of Scotland's land is used for agriculture and the best-quality agricultural land is found along the east coast[14]. Actions to manage flood risk can help to protect agricultural land from flooding. However, agricultural land can also provide opportunities to store or slow water leading to temporary or permanent change in land use. Other pressures on agricultural land include development and woodland expansion.

The state of Scotland's geodiversity is not fully known as there are no data available on the state of rocks and landforms outside protected sites. Within protected sites, Earth Science features are mostly in good condition or being managed to return them to good condition[8]. Actions to manage flood risk can impact on geodiversity for example, by altering or obscuring an Earth Science feature, or by modifying a coastal or river feature that is actively forming.

Soil
Environmental problems relevant to the Flood Risk Management Strategies
• Soil is at risk from a number of threats including climate change and land use and land management change. Geodiversity can be affected by development that alters natural features and processes • Actions to manage flood risk may have positive impacts on soil and geodiversity through reducing run off and sediment loss. Negative impacts may also occur e.g. due to construction works leading to compaction or soil sealing, or damage to geodiversity
Likely evolution of the environment without the Flood Risk Management Strategies
• Unknown as little information available on trends in soil and geodiversity. However, policies and protection are in place e.g. through protected sites legislation, Scottish Soil Framework and Scotland's Geodiversity Charter

[11] Scotland's Environment Web [online]: Get informed: Soils. http://www.environment.scotland.gov.uk/get-informed/land/soils/ [accessed 11/07/2014]

[12] Dobbie, K.E., Bruneau, P.M.C and Towers, W. (eds) 2011. The State of Scotland's Soil. Natural Scotland, www.sepa.org.uk/land/land_publications.aspx

[13] Scottish Natural Heritage Commissioned Report 325. Climate change, land management and erosion in the organic and organo-mineral soils in Scotland and Northern Ireland. http://www.snh.org.uk/pdfs/publications/commissioned_reports/325.pdf

[14] Scotland's Environment Web [online]: Get informed: Crops and livestock. http://www.environment.scotland.gov.uk/get-informed/land/timber-and-forestry-products/ [accessed 14/07/2014]

3.4. Water

There are approximately 125,000 km of rivers in Scotland. Around 25,000 km of the rivers are monitored and assessed based on a number of indicators including the condition of river banks and beds and water quality. In 2013, 82% of river water bodies were classed as being at good status or better for water quality and 86% were at good status or better for the condition of river banks and beds. This includes most of the rivers in the Highlands and Islands, where there are fewer pressures on the environment. The condition is worse in the central belt of Scotland and in areas with intensive farming. Pressures on rivers include diffuse pollution (both rural and urban), sewage disposal, urban development and climate change.

There are over 25,500 lochs in Scotland. Many lochs are relatively unaffected by human activity: around two thirds of lochs were classed as being at good status or better in 2013. As with rivers, diffuse pollution is a key pressure.

Most of our seas, coasts and estuaries are in good or excellent condition. Relevant pressures include nutrients enrichment (diffuse nitrate pollution run off from land) and microbiological contaminations (including sewage in storm water discharge), and loss of coastal and estuary habitat to development.

Some actions to manage flooding can benefit the water environment by helping to restore beds, banks and coastline to a more natural state. However, other actions may result in beds, banks and coastline becoming more engineered and moving away from a natural state. Flood risk management actions to reduce run off can help reduce diffuse pollution and microbiological contamination from agriculture, forestry and sewage inputs.

Water
Environmental problems relevant to the Flood Risk Management Strategies
• Flooding is a natural process but patterns of flooding can be altered and exacerbated by human influence (for example, changes to land use or hydromorphology such as modification of river channels) • A further key pressure on the water environment is diffuse pollution. As flooding can lead to, or increase, the release of pollutants, actions to manage flood risk (particularly natural flood management actions and SUDS) can deliver benefits. • Other benefits from flood risk management actions can include changes to land use and improvements to the beds and banks of rivers and the coastline (and which may contribute towards River Basin Management Planning objectives) • However, flood risk management actions can also have negative impacts, for example, some types of land use change or degradation to river or coastal morphology
Likely evolution of the environment without the Flood Risk Management Strategies
• Climate change is likely to cause an increase in flooding, which could lead to an increase in pollution from agriculture, sewerage, and run off from development

3.5. Climatic factors

Scotland has a temperate climate with cool summers and mild winters. Rainfall is spread throughout the year but there are regional differences; for example, the west of Scotland has more rain in winter. Over the past century, and in particular the period 1961-2011, there has been an overall increase in rainfall in Scotland. In the winter, total rainfall in the east has increased by 25% and in the north and west by more than 45%. The number of days of heavy rain each year has also increased: an increase of five days in the east, seven days in the north and 12 days in the west[15].

[15] Scotland's Climate Change Handbook. In Scotland's Environment Web [online]: Get informed: Climate. http://www.environment.scotland.gov.uk/get-informed/climate/climate/ [accessed 11/07/2014].

Scotland's climate is likely to change as a result of climate change. Some relevant climate change trends expected for Scotland through the rest of the 21st century are[16]:

- hotter, drier summers;
- milder, wetter autumns and winters.
- increased frequency and intensity of extreme rainfall;
- reduced snowfall;
- rising sea levels.

These expected trends are likely to lead to increases in flooding. Actions to manage flood risk should help to adapt to future flooding, for example by designing structures that can be adapted in future to deal with increased flood risk, or natural flood management actions that can help to create space for water.

Future climate depends on many factors, but particularly the concentration of greenhouse gas emissions in the atmosphere. Net Scottish greenhouse gas emissions have fallen by nearly 30% since 1990 although there was a small increase between 2011 and 2012[17]. A significant amount of carbon is stored in Scotland's soils so careful management of these soils is required to ensure the carbon stays in the soil.

Flood risk management actions can impact on greenhouse gas emissions e.g.

- Changes in land use associated with flood risk management actions can impact on climatic factors by protecting green networks and soil resources that act as carbon sinks
- Construction of flood protection schemes use energy and material resources
- A reduction in flood damages may lead to a reduction in energy and resource use (due to reduction in repair and replacement of property and content).

Climatic factors
Environmental problems relevant to the Flood Risk Management Strategies
• The main climate trends for Scotland are warmer and drier summers and warmer and wetter autumns and winters. However, convective storms, which can cause surface water flooding, are likely to be more intense in summer months • Sea level rises and storm surges are also likely to lead to an increase in flood risk. The risk of flooding can be exacerbated by coastal squeeze (where coastal habitats are squeezed between a fixed (artificial or natural) landward boundary and rising sea level) • Flood risk management actions can impact on greenhouse gas emissions. Actions can also help to adapt to changes in climate
Likely evolution of the environment without the Flood Risk Management Strategies
• Climate change is likely to cause an increase in river flows in autumn and winter leading to increased flooding • Periods of intense rainfall are expected to increase, particularly in the summer, leading to an increased risk of surface water flooding • Sea level rise and increased storms (leading to greater wave action) is likely to cause an increase in coastal flooding

3.6. Material assets

Flooding can cause significant damage to properties and property content, utilities, transport, and community infrastructure. In rural areas, the disruption can be particularly severe where alternative infrastructure may be rare or absent. Actions to manage flood risk can produce positive impacts for material assets, through protecting existing assets and lessening the resource use that would otherwise be needed to repair and replace these assets if they were damaged by flooding.

[16] UK Climate Change Projections (UKCP09). In Scotland's Environment Web [online]: Get informed: Climate. (See above)

[17] Scottish Greenhouse Gas Emissions 2012. In Scotland's Environment Web [online]: Get informed: Climate. (See above)

Timber and forestry products are also important assets for Scotland, and potential timber availability is expected to continue to increase until around 2031[18]. Actions to manage flood risk can include woodland planting, which could lead to an increase in woodland area.

The process of constructing structural flood defences may use significant material resources and also generate waste. The amount of controlled waste generated in Scotland has fallen over the past seven years from approximately 22 million tonnes in 2005 to 13 million tonnes in 2011. Waste from construction and demolition accounts for 46% of the controlled waste generated[19].

Material assets
Environmental problems relevant to the Flood Risk Management Strategies
• Flooding can damage property, content and infrastructure. Actions to manage flood risk can reduce damage to these assets and reduce the resource use that would be required to repair and replace assets • The process of construction, including that of flood management actions, may use significant material resources and generate waste
Likely evolution of the environment without the Flood Risk Management Strategies
• Likely increase in flood damages to material assets due to climate change • Competing pressures on land use between agriculture, forestry and development

3.7. Cultural heritage

Scotland's historic environment contains a rich variety of designated and undesignated sites and buildings. The actual extent of archaeology remains in Scotland is unknown and there are many unrecorded sites and unknown resources throughout the country. Scotland is rich in wetlands (see above), which are particularly good for preserving archaeological remains[20].

Some of the key pressures on the historic environment are development, changing land use, climate change, coastal erosion, flooding, and renewable energy. Archaeology and coastal landscapes are vulnerable to coastal erosion, rises in sea level, flooding and storminess.

Actions to manage flood risk can help to protect cultural heritage from flood damage. However, engineering works can disturb or damage cultural heritage, and flood protection structures in the vicinity of cultural heritage sites can alter the setting. Changes to hydrological patterns can also impact on (both positively and negatively) wetland archaeology, by enhancing or adversely affecting wetlands.

Cultural heritage
Environmental problems relevant to the Flood Risk Management Strategies
• Cultural and historic environment assets and their settings are under pressure from a variety of influences. Some assets may be at significant flood risk • Actions to manage flood risk could impact on cultural heritage, for example, through disturbance or damage from engineering works, through altering the setting, or through altering hydrological patterns
Likely evolution of the environment without the Flood Risk Management Strategies
• Flood risk to cultural heritage is likely to increase as a result of climate change

[18] Scotland's Environment Web [online]: Get informed: Timber and forestry. http://www.environment.scotland.gov.uk/get-informed/land/timber-and-forestry-products/ [accessed 14/07/2014].
[19] Scotland's Environment Web [online]: Get informed: Waste. http://www.environment.scotland.gov.uk/get-informed/people-and-the-environment/waste/ [accessed 14/07/2014].
[20] Historic Scotland [online]: Looking after our heritage: Wetlands. http://www.historic-scotland.gov.uk/wetlands [accessed 14/07/2014]

3.8. Landscape

Scotland's landscape is diverse in character, with particular contrasts between the north, west, south and east of Scotland. Our landscapes have evolved over thousands of years as a consequence of natural and cultural forces, and they are still changing. Flooding can impact on landscape as it shapes our rivers and our coastline.

Key relevant pressures on landscape are:

- Climate change. Semi natural landscapes are likely to change as climate impacts on species distribution. Flooding and erosion are likely to increase.
- Incremental and ongoing development, including infrastructure projects. Currently large areas of semi-natural landscapes in Scotland, particularly in the north and west, show few signs of human influence. These areas include mountains and moorland, stretches of undeveloped coast and large areas of peat bog[21].
- Land use change and intensification of land use. For example, to increase yields, agricultural land use has moved towards monoculture rather than a diverse range of crops and hedgerows. The national target for increasing forest cover will have a significant impact on many parts of Scotland.

Landscape
Environmental problems relevant to the Flood Risk Management Strategies
• Pressures on landscape include climate change, erosion and landslips, land use and development • Flood risk management actions could impact both positively and negatively on landscape. For example, impacts could arise from flood protection schemes, SUDS, or the cumulative impacts of changes to land use or land management
Likely evolution of the environment without the Flood Risk Management Strategies
• Climate change and our response to it will alter landscape • Forest cover is expected to increase

[21] Scotland's environment web [online]: Get informed: Landscape. http://www.environment.scotland.gov.uk/get-informed/land/landscape/ [accessed 14/07/2014]

4. SEA objectives and assessment method

Section 14 of the Environmental Assessment (Scotland) Act 2005 requires the likely significant environmental effects of the Flood Risk Management Strategies and their reasonable alternatives to be identified, described and evaluated. This section outlines the reasons for selecting the reasonable alternatives, sets out the objectives against which the Flood Risk Management Strategies and the reasonable alternatives will be assessed, and describes the method of assessment. Comments from the Consultation Authorities (SNH and Historic Scotland) have been taken into account regarding the methods, scope and level of detail in this Environmental Report.

4.1. Reasonable alternatives

The public consultation on the draft Flood Risk Management Strategies seeks views on the proposed flood risk management objectives and the shortlist of feasible actions: i.e. the consultation takes place prior to the selection of preferred actions. Accordingly, this environmental report assesses the likely environmental impacts of the objectives and the shortlisted actions.

Importantly, for the purposes of SEA, the shortlist of actions constitutes both the 'plan' and the 'Reasonable Alternatives'[22]: each action will be viewed as a "Reasonable Alternative" to achieving the objectives. The outcome of the SEA will be used to inform the wider appraisal, including economic and social aspects, of these actions[23]. Consulting at this stage in the planning process enables SEPA to provide an early and effective opportunity for engagement to ensure views are taken into account when the preferred actions are selected.

The actions are listed in table 4.1. For the purposes of SEA, we have grouped the actions based on the most likely environmental effects.

Table 4.1: Actions being considered to manage flood risk and groupings for SEA purposes

Action	Examples	Environmental effects; reported under:
Relocation of properties/infrastructure away from flood risk areas	Relocation away from flood risk areas	Non-structural actions
Property level protection	Retrofitting protection, enhancing resilience	
Flood warning schemes	Maintain, modify or create new flood warning scheme	
Modelling and other assessments to improve knowledge of flood hazards and impacts	Surface Water Management Plans; Integrated Catchments Studies	
Run off control	Woodland planting, land management, cross slope woodlands, gully woodlands, upland drain blocking, creation and restoration of wetland and ponds	Run off reduction
River or floodplain restoration	Floodplain reconnection, floodplain woodlands, creation of riparian woodland, reach restoration, placing of large woody debris and boulders, creation of washlands	River and floodplain restoration
Sediment management	Managing channel instabilities, sediment traps, bank restoration	

[22] As required by Section 14(2) of the Environmental Assessment (Scotland) Act 2005

[23] As required by Section 28(1) of the Flood Risk Management (Scotland) Act 2009

Action	Examples	Environmental effects; reported under:
Construction of storage	Online and offline storage	Storage, conveyance and control
Modification of conveyance	Channel modification, bypass or relief channel, remove or modify culvert or hydraulic constriction, modify bridges	
Installation / modification of fluvial control structures	Addition or removal of sluice gates, flap valves, weirs, trash screens	
Construction of direct flood defences	Embankments, walls, adaptable walls, temporary / demountable defences	River defences
Sustainable urban drainage systems (SUDS)	Balancing ponds/detention basins, swales, wetlands and reed beds	Sustainable urban drainage systems (SUDS)
Wave attenuation	Beach recharge, shingle reprofiling, restoration of sand dunes, coastal vegetated shingle or machair	Coastal restoration
Creation/restoration of intertidal area and regulated tidal exchange	Mudflats and salt marsh, and regulated tidal exchange	
Coastal management	Revetments, groynes, breakwaters, artificial reefs, gates and tidal barriers	Coastal defences
Construction of direct flood defences	Embankments, walls, adaptable walls, temporary / demountable defences	
Scoped out of the SEA		Reason
Application of national planning policies	Scottish planning policy, planning advice notes	Scoped out: these are existing actions and no new decision is made by the Flood Risk Management Strategies
Application of local planning policies	Specific policies or guidance in local planning policies, use of strategic flood risk assessment in development planning	
Flood forecasting and alerts	Flood forecasting and alerts	
Self help	Business continuity planning, flood insurance, community flood action groups	
Emergency response plans	Emergency response plans	
Maintenance of existing flood protection schemes	Maintenance of flood protection schemes (by Local Authorities)	
Site protection plans	Site-based protection for specific utilities, community, or transport infrastructure (determined by asset owner or manager)	Scoped out: the direction for these actions is taken outwith the Flood Risk Management Strategies and any assessment would be more meaningfully carried out at the site specific plan or project level
Watercourse maintenance	Routine or responsive (determined by Local Authorities)	

4.2. Assessment framework

SEA Objectives

The proposed Flood Risk Management Strategy objectives and the shortlist of actions have been assessed against the SEA objectives and assessment questions in table 4.2. These objectives and assessment questions were developed based on the environmental problems relevant to the Flood Risk Management Strategies (section 3).

Table 4.2: SEA objectives and assessment questions

SEA Topic	SEA objective	Do the Flood Risk Management Strategies…
Population and human health	*Protect human health, reduce health inequalities and promote healthy lifestyles*	• Improve the health and living environment of people and communities? • Reduce flood risk? • Improve opportunities for healthy lifestyles?
Biodiversity, fauna and flora	*Conserve and where appropriate enhance species, habitats and biodiversity, and habitat connectivity*	• Avoid adverse effects on, and improve protected species and habitats? • Avoid adverse effects on and improve wider biodiversity? • Support healthier ecosystems? • Help promote habitat connectivity?
Soil	*Protect and where appropriate enhance the function and quality of the soil resource*	• Safeguard soil quality, quantity and function, including valuable soil resources such as agricultural land and carbon rich soils?
Water	*To prevent deterioration, protect and where appropriate enhance the water environment*	• Protect and enhance the overall water environment? • Avoid adverse effects on the status of water bodies? • Avoid adverse effects on sensitive coastal areas and the marine environment?
Climatic factors	*Contribute to mitigation of and adaptation to climate change*	• Improve adaptability to the effects of climate change? • Contribute to reducing greenhouse gas emissions?
Material assets	*Contribute to protecting property and infrastructure* *Minimise waste and energy consumption and promote resource efficiency*	• Protect material assets e.g. infrastructure, properties? • Promote resource efficiency, including energy, waste, water and minerals?
Cultural heritage	*Protect and where appropriate enhance the character, diversity and special qualities of cultural heritage and the historic environment*	• Protect the historic environment and its setting? • Enhance or restore historic features and their settings? • Improve the quality of the wider built environment?
Landscape	*Protect and where appropriate enhance the character, diversity and special qualities of landscapes*	• Protect, enhance or restore landscape quality? • Avoid adverse effects on protected landscapes?

Assessment method

The assessment is underpinned by an ecosystem services approach. The ecosystem approach is founded on the principle that healthy, functioning ecosystems provide a sustainable flow of services. These ecosystem services underpin our economy, our health and well-being and are fundamental to our continued existence:

Regulating and maintaining services

- Carbon storage
- Local climate regulation
- Water quality regulation
- Pollination
- Pest/disease mechanisms: biological control
- Wave and surge attenuation
- Water flow regulation
- Erosion protection

Provisioning services

- Nutrition: food provision
- Drinking water supply
- (Non–food) Biotic materials: timber, biofuels, hydropower

Cultural services

- Recreation (physical interaction)
- Accessible nature/wildlife experience
- Spiritual and cultural amenity

It is now widely recognised in Scotland and internationally that relevant decision making must take account of human dependency on a range of services that ecosystems provide.

By their very nature flood risk management actions will influence ecosystem structure and ecosystem processes, as well as affecting the provision of ecosystem services. Incorporating an ecosystem services assessment as part of the SEA method will identify the potential change to services from flood risk management actions and ultimately will assist in identifying the most sustainable actions.

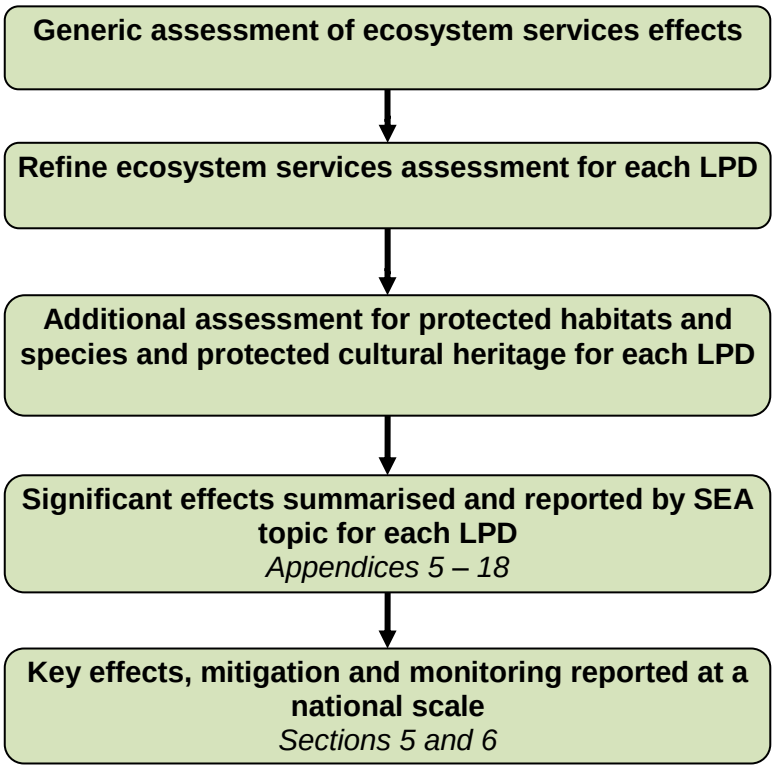
The approach is described below and in figure 4.1 and supporting information can be found in appendix 4.

A generic assessment underpins the whole assessment. It assesses the potential change to ecosystem services arising from different actions. The assessment considers which ecosystems are most likely to be affected by different actions, and the subsequent effects on the services delivered by that ecosystem.

The generic assessment was applied to each Local Plan District, refining it based on information on the ecosystems and services present in the LPD, the condition of the ecosystems (if known), and types and location of actions being considered.

The results are summarised for each group of actions. Potentially significant effects have been identified and reported under the most relevant SEA objective. Recommendations for mitigation and opportunities to contribute to other drivers have been identified.

Figure 4.1: Approach for incorporating ecosystem services assessment into SEA



Timescale and permanency of effects
The assessment includes consideration of whether the effects are short, medium or long-term, and whether the effects are permanent or temporary. We define these effects as follows:

Timescale
As actions have not yet been selected or prioritised for delivery, we are not able to assess when an effect is likely to occur. We are, however, able to consider the duration of likely effects:

- The duration of effects is defined as: Short duration (up to 1 year), moderate duration (1 – 6 years), long duration (>6 years)

Permanency

- The extent to which effects could be reversed: reversible (reversible with no, little or moderate remediation or small – moderate scale works), permanent (not reversible or only reversible with significant remediation or large scale works)

Cumulative, synergistic and secondary effects
Through the use of the ecosystem services, the assessment identifies cumulative, synergistic and secondary effects as follows:

Synergistic and secondary effects
The assessment considers which ecosystems might be affected by the actions both directly (as the action is likely to be located in that ecosystem) and indirectly (e.g. freshwater ecosystem located downstream of the action), and the subsequent effects on the services that these ecosystems provide. In this way, both synergistic and secondary effects are considered.

Cumulative effects
Cumulative effects are assessed by considering the potential extent of different actions within an LPD. For example, the overall environmental effects of river defences are likely to be greater in an LPD where defences are being considered for multiple locations compared to an LPD where defences are only being considered at one location.

Cumulative effects resulting from the combination of different types of actions cannot be assessed at this stage in the production of the Flood Risk Management Strateges as the preferred actions to manage flood risk have not yet been selected or prioritise for delivery. This means we are not able to assess the cumulative effects of combinations of different actions (for example a combination of natural flood management actions and direct defences in a catchment) nor cumulative effects over time (for example, the effects of multiple simultaneous in-river works in a catchment).

Assumptions and limitations
The assessment assumes that flood risk management actions are designed and implemented in line with best practice.

The assessment assumes that all flood risk management actions will deliver significant benefits in terms of reducing overall flood risk. (This might include a planned increase in flood risk for some areas to reduce flood risk elsewhere, for example, by creating or restoring flood storage areas.) Information on the efficacy of different actions is currently being assessed and will be considered as part of the final selection of actions.

The assessment is limited by the availability of information on location, type, scale and timing of the action:

- Some actions are likely to be located near to the area of flood risk (e.g. river defences) but others (e.g. run off reduction) could be located within the PVA or its upstream catchment. For many actions, no additional detail on location is available at this stage in the planning process.
- For some PVAs, additional information was available on the type and/or scale of certain actions (e.g. run off reduction actions for a particular PVA do not include gully woodland planting). We have taken this information into account where available. However, for many actions, no additional detail on the type or scale is available at this stage in the planning process.

To reflect the assumptions and limitations, our assessment describes the *potential* effects of actions. This choice of language is deliberate and emphasises the difficulties with making any definite statements about the likely effects of actions in the absence of detail on the location, type, scale and timing of actions.

Classification
The assessment has been classified using the symbols and descriptions in table 4.3.

Table 4.3 SEA classification, symbols, and description

Symbols		Classification and description
+ +	**+ +**	**Significant positive** Effects are widespread across the LPD; and/or Effects are likely to improve an ecosystem that is in less than good condition
+	**+**	**Positive** A noticeable positive effect that does not meet the description above
0	**0**	**Neutral** No or negligible effect
-	**-**	**Negative** A noticeable negative effect that does not meet the description below
- -	**- -**	**Significant negative** Effects are widespread across the LPD; and/or Effects are likely to cause an adverse effect on an ecosystem that is in less than good condition
+ / -	**+ / -**	**Mixed** The effect is likely to be a combination of positive and negative effects, particularly where effects are considered on sub-issues, areas or criteria.
?	**?**	**Uncertain** The effect is not known, or is too unpredictable to assess. Further assessment may be made at more detailed level of planning.

5. Environmental assessment of the Flood Risk Management Strategies

Section 14 of the Environmental Assessment (Scotland) Act 2005 requires the likely significant environmental effects of the Flood Risk Management Strategies and their reasonable alternatives to be identified, described and evaluated. This section reports the results of the environmental assessment.

The draft Flood Risk Management Strategies were assessed using the framework described in section 4. The findings of the assessment are summarised below: this summary represent the overall potential effects of the 14 Flood Risk Management Strategies. The individual assessments for each LPD (including assessments of any potential cross border effects) can be found in appendices 5 – 18. These individual appendices also set out in detail opportunities for the enhancement of positive effects and the mitigation of negative effects.

5.1. Assessment of environmental effects: flood risk management objectives

The Flood Risk Management Strategies aim to reduce overall flood risk and avoid an increase in flood risk. The aims of the flood risk management objectives, if achieved, should deliver significant benefits in terms of protecting people, properties and infrastructure (SEA objectives for **human health** and **material assets**). Historic buildings may also benefit from a reduction in flood risk (**cultural heritage**). Without action, flood risk is expected to increase due to climate change and urban creep: therefore the flood risk management objectives are consistent with SEA objectives to help adapt to a changing climate (**climatic factors**). These benefits are captured in the assessment of actions below.

5.2. Assessment of environmental effects: shortlisted actions

The environmental effects of the shortlisted actions are summarised below. The potential effects of different actions on SEA objectives are summarised in tables, with the findings justified in the accompanying commentary. The commentary is based on the potential effects on ecosystems and ecosystem services (see section 4); links to specific SEA objectives are identified in bold font.

Non structural actions

A range of non-structural actions are being considered for all LPDs (see table 4.1). Those actions that fall within the scope of this SEA are:

- Relocation of properties / infrastructure away from flood risk areas
- Property level protection
- Flood warning schemes
- Modelling and other assessments (e.g. Surface Water Management Plans) to improve knowledge of flood hazards and impacts.

The potential effects are described in the text below and summarised by SEA topic in table 5.1.

Table 5.1: Summary of potential effects of non structural actions on SEA topics

SEA topic	Potential effects	
	Unless otherwise described: *- the duration of effects is long term (>6 years)* *- effects could be reversible, for example, if the flood warning services are stopped or if people stop using property level protection.*	
Population and human health	**+ +**	Reducing flood risk and protecting human health (through relocation, or by helping people to take action to protect themselves and their property)
Biodiversity, flora and fauna	**0** **?**	No effects for most non-structural actions, with uncertain effects for relocation (as effects are site specific)
Soil	**0** **?**	No effects for most non-structural actions, with uncertain effects for relocation (as effects are site specific)
Water	**0** **?**	No effects for most non-structural actions, with uncertain effects for relocation (as effects are site specific)
Climatic factors	**+**	Contribute to adaptation to climate change
Material assets	**+ +**	Reducing flood risk and protecting property and infrastructure (through relocation, or by helping people to take action to protect their property)
Cultural heritage	**0** **?**	No effects for most non-structural actions, with uncertain effects for relocation (as effects are site specific)
Landscape	**0** **?**	No effects for most non-structural actions, with uncertain effects for relocation (as effects are site specific)

Commentary of potential significant effects

These actions help to reduce the impacts of flooding, for example, relocation can remove people and properties away from the source of flooding; and flood warnings and property level protection help people to take action to protect themselves and their property should flooding occur. This helps to protect human health, property and infrastructure, with potentially significant positive long-term effects on the SEA objectives for **human health** and **material assets.**

Non-structural actions can also help adapt to a changing climate (**climatic factors**) – for example, by retreating from rising sea levels or increased flooding, or by helping people to take action to protect themselves and their property.

Effects on ecosystem services

Non-structural actions typically will have no or negligible effects on ecosystems and ecosystem services. The exception is relocation of properties / infrastructure away from areas of flood risk: however, without information on the scale and location of any relocation, it is not possible at this stage in the planning process to determine what those effects might be.

Run off reduction

Run off reduction actions (see table 4.1) are being considered for all LPDs except for Orkney. All SEA topics outlined in table 4.2 and all ecosystems may be affected by these actions. Effects on ecosystems may either be direct (in terrestrial ecosystems) as the action is located in the ecosystem itself, or indirect (in freshwater and coastal and marine ecosystems) as the ecosystem is located downstream of the action. The potential effects are described in the text below and summarised by SEA topic in table 5.2.

Table 5.2: Summary of potential effects of run off reduction actions on SEA topics

SEA topic	Potential effects	
	Unless otherwise described: *- the duration of effects is long term (>6 years)* *- effects could be reversible, for example, if the land management actions are ceased or woodlands are felled.*	
Population and human health	**+ +**	Reducing flood risk and protecting human health
	+ +	Promoting healthy lifestyles through improved opportunities for recreation and experiencing nature
Biodiversity, flora and fauna	**+ +**	Benefits to connectivity and health of native woodland and wetland ecosystems
	+ / -	Mixed (both positive and negative) and uncertain effects on protected sites. Effects of varying duration (short – long). Any severe adverse effects on rare protected species or habitats could be difficult to reverse.
	?	
Soil	**+ +**	Restoring carbon rich soils
	+ +	Safeguarding soils from erosion
	+ / -	Mixed effects on productivity of agricultural land. Effects of varying duration (short – long).
Water	**+ +**	Improving water quality and reducing sedimentation
Climatic factors	**+ +**	Increased carbon storage through creation of wetlands and woodlands
	+	Contribute to adaptation to climate change
Material assets	**+ +**	Reducing flood risk and protecting property and infrastructure
Cultural heritage	**+ / -**	Mixed effects on cultural heritage. Some uncertainty as the precise type and location of actions is not known.
	?	
Landscape	**+**	Enhancing diversity of the landscape

Commentary on potential significant effects

Regulating and maintaining services
Run off reduction actions help to slow and store water by intercepting rainfall (e.g. woodlands) and/or increasing the extent to which the land can hold any water reaching the ground (both slowing down the flow of run off and increasing the permeability of soils). This in turn can help to regulate the flow of water by reducing the amount of water reaching rivers and slowing or reducing flood flows. This helps to protect people and properties from flooding, with potentially significant benefits to meeting the SEA objectives to protect **human health** and **material assets**. The actions can also help adapt to climate change by improving the ability of a catchment to slow and store the flow of water under increased rainfall (**climatic factors**).

Actions have the potential to lead to improvements in water quality by helping to protect soils from erosion (thus reducing the sediment reaching rivers) and increasing infiltration of nutrients into soils. Given the diffuse pollution pressures on the water environment across Scotland, the actions have potential to deliver significant benefits to meeting the SEA objectives to protect **water** quality and safeguard **soils** from erosion.

The creation or restoration of woodlands and wetlands (including peatlands through upland drain blocking) has the potential to increase the capture and storage of carbon. Although wetlands also have the potential to release carbon dioxide into the atmosphere, the net benefit to carbon storage is more likely to be positive when restoring wetlands. There are therefore potentially significant positive benefits to the SEA objectives to protect carbon rich soils and contribute to the mitigation of climate change (**soil, climatic factors**).

Run off reduction actions can improve the condition and connectivity of wetlands and native woodland ecosystems, which have historically suffered from loss and fragmentation. In the freshwater ecosystem, a reduction in nutrient and sediment load can benefit sensitive species such as Atlantic salmon and freshwater pearl mussel. These habitats and species are important components of a number of designated environmental sites in Scotland. (Further discussion of impacts of designated sites can be found in appendices 5 – 18). There are therefore potentially significant benefits to the SEA objectives for **biodiversity, flora and fauna**. Not all potential effects are beneficial: for example, woodland planting in upland areas should be sensitively located to avoid negative effects on dwarf shrub heath or upland birds such as golden eagles. Implementation could also lead to short term disturbance for birds and other animals. Specific impacts on protected sites will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The potential effects of run off reduction actions on food provisioning are mixed. The actions may enhance the productivity of cultivated land and semi natural grassland by protecting soils from erosion and nutrient loss. Meat production may also benefit through increased shelter for livestock and better biological control of pest and disease. Conversely some areas of productive land may be lost where these actions are implemented; also livestock could be impacted by an increase in livestock pests (as some pests may benefit from wetter land). The effects vary by LPD depending on the type and importance of agriculture and the likely location of actions. Therefore, for the SEA objective to protect the function and quality of agricultural land (**soil**), the potential effects are mixed.

The potential effects on freshwater food provisioning and drinking water supply are likely to be positive due to protection and improvements to **water** quality. There are potential mixed effects on timber production, depending on the type of action and its location.

Cultural services
The potential effects of run off reduction actions on cultural services are mainly positive. For example, the actions are likely to improve habitat diversity and connectivity, leading to better opportunities for recreation, experiencing wildlife and nature, and general wellbeing. These are likely to contribute positively to the SEA objective to promote healthy lifestyles and protect **human health**.

The actions are likely to have positive effects on SEA **landscape** objectives through protecting and enhancing the diversity of landscape.

The historic environment also has the potential to benefit from run off reduction actions: firstly through the reduction of flood risk to historic sites and secondly through the protection of wetland archaeology as a result of creating and restoring wetlands. Conversely, woodland planting can disturb buried archaeology. The structure and setting of historic sites could also be affected but the direction and magnitude of potential effects will need to be assessed during more detailed flood risk management planning. Thus, the effect on the SEA objective for **cultural heritage** is mixed and uncertain.

River and floodplain restoration

River and floodplain restoration actions (see table 4.1) are being considered for all LPDs except for Orkney. All SEA topics outlined in table 4.2 and ecosystems (with the exception of upland heath) could be affected by the actions. The potential effects are described in the text below and summarised by SEA topic in table 5.3.

Table 5.3: Summary of potential effects of river and floodplain restoration actions on SEA topics

SEA topic	Potential effects	
	Unless otherwise described: *- the duration of effects is long term (>6 years)* *- effects could be reversible, for example, if embankments are reinstated or floodplain woodlands are felled.*	
Population and human health	**+ +**	Reducing flood risk and protecting human health
	+ / -	Mixed effects on promoting healthy lifestyles: some types of recreation may benefit, other activities may lose out. Implementation of actions could lead to short to medium term disruption to some types of recreation.
Biodiversity, flora and fauna	**+ +**	Benefits to connectivity and health of native woodland and wetland ecosystems
	+ / -	Mixed (both positive and negative) and uncertain effects on protected sites. Effects of varying duration (short – long). Any severe adverse effects on rare protected species or habitats could be difficult to reverse.
	?	
Soil	**+ +**	Restoring carbon rich soils
	+ +	Safeguarding soils from erosion
	+ / -	Mixed effects on productivity of agricultural land. Effects of varying duration (short – long).
Water	**+ +**	Improving water quality and reducing sedimentation
Climatic factors	**+ +**	Increased carbon storage through creation of wetlands and woodlands (benefits tempered by any loss of woodland)
	+	Contribute to adaptation to climate change
Material assets	**+ +**	Reducing flood risk and protecting property and infrastructure
Cultural heritage	**+ / -**	Mixed effects on cultural heritage. Some uncertainty as the precise type and location of actions is not known.
	?	
Landscape	**+**	Enhancing diversity of the landscape

Commentary on potential significant effects

Regulating and maintaining services
River and floodplain restoration actions slow down in-channel flow by increasing the sinuosity of the river and help reconnect the river with the floodplain, increasing the amount of water stored on land. Floodplain planting can also slow down the flow of run off and increase the permeability of soils, while river bank restoration can reduce bank erosion and sediment deposition in the river. The overall effect helps to regulate the flow of water by slowing and / or reducing flood flows. This helps to protect people and properties from flooding, with potentially significant benefits to meeting the SEA objectives to protect **human health** and **material assets**. The actions can also help adapt to climate change (**climatic factors**).

Restoration actions can lead to improvements to water quality by helping to protect soils from erosion (thus reducing the sediment reaching rivers) and infiltration of nutrients into soils. Wetland vegetation (in this case, vegetation on the floodplain) is particularly effective at storing nutrients. Thus, given diffuse pollution pressures on the water environment across Scotland, there are potentially significant benefits to the SEA objectives for **water** and **soil.**

The creation or restoration of woodlands and wetlands (on floodplains) also has the potential to increase the capture and storage of carbon, although the net benefit may be reduced where

floodplain restoration requires the removal of trees. As stated above, although wetlands have the potential to release carbon dioxide into the atmosphere, the net benefit to carbon storage is more likely to be positive when restoring this ecosystem. There are therefore potentially significant positive benefits to the SEA objectives to protect carbon rich soils and contribute to the mitigation of climate change (**soil, climatic factors**).

By increasing habitat diversity and connectivity, biodiversity, maintaining water quality and reducing sediment loss, there are potential positive effects on designated environmental sites and the species they support. (Further discussion of impacts of designated sites can be found in appendices 5 – 18). There are therefore potentially significant benefits to the SEA objectives for **biodiversity, flora and fauna**. Restoration works, however, could lead to short duration increases in sediment load and could disturb animals; best practice design and timing of any in-river or bank works should be used to avoid or minimise any negative effects. Specific impacts on protected sites will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The potential effects of restoration actions on food provisioning are mixed. The actions may enhance the productivity of cultivated land and semi natural grassland by protecting soils from erosion and nutrient loss. Meat and crop production may also benefit through better biological control of pests and diseases. Conversely some areas of productive land may be lost where these actions are implemented; also livestock could be impacted by an increase in livestock pests (as some pests may benefit from wetter land). The effects vary by LPD depending on the type and importance of agriculture and the likely location of actions. Therefore, for the SEA objective to protect valuable agricultural land (**soil**), the potential effects are mixed.

The potential effects on freshwater food provisioning and drinking water supply are likely to be positive due to protection and improvements to **water** quality. There are potential mixed effects on timber production, depending on the type of action and its location.

Cultural services
The potential effects of restoration actions on cultural services are mainly positive. For example, the actions are likely to improve habitat diversity and connectivity, leading to better opportunities for recreation, experiencing wildlife and nature, and general wellbeing. Conversely, changes to the river beds and banks may affect the quality and access for some types of recreation such as kayaking or angling. There may also be short term loss of access when actions are implemented. There is therefore an overall mixed effect on the SEA objective to promote healthy lifestyles and protect **human health**.

The actions are likely to have positive effects on SEA **landscape** objectives through protecting and enhancing the diversity of landscape.

The historic environment also has the potential to benefit from run off reduction actions: firstly through the reduction of flood risk to historic sites and secondly through the protection of wetland archaeology as a result of creating and restoring wetlands. Conversely, woodland planting can disturb buried archaeology. The structure and setting of historic sites could also be affected but the direction and magnitude of potential effects will need to be assessed during more detailed flood risk management planning. Thus, the effect on the SEA objective for **cultural heritage** is mixed and uncertain.

Storage, conveyance and control

Storage, conveyance and control actions (see table 4.1) are being considered for all LPDs except for Orkney. All SEA topics outlined in Table 4.2 and ecosystems (with the exception of upland heath) could be affected by these actions. The potential effects are described in the text below and summarised by SEA topic in table 5.4.

Table 5.4: Summary of potential effects of storage, conveyance and control actions on SEA topics

SEA topic	Potential effects	
	Unless otherwise described: *- the duration of effects is long term (>6 years)* *- some effects could be reversible, for example, by altering the management or control structures by removing weirs or culverts* *- effects from storage actions may be harder to reverse, for example, large structures may be difficult to remove; frequent or lengthy storage of flood waters may lead to very long duration changes to soil composition.*	
Population and human health	**+ +**	Reducing flood risk and protecting human health
	+ / -	Mixed effects on promoting healthy lifestyles: some types of recreation may benefit, other activities may lose out. Implementation of actions could lead to short to medium term disruption to some types of recreation.
Biodiversity, flora and fauna	**+ / -**	Mixed effects: Potentially significant negative effects due to loss of habitat; however, some actions could lead to improvements
	+ / -	Mixed (both positive and negative) and uncertain effects on protected sites. Effects of varying duration (short – long). Any severe adverse effects on rare protected species or habitats could be difficult to reverse.
	?	
Soil	**+ / -**	Mixed effects on safeguarding soils as erosion potential depends on type and location of action
	+ / -	Mixed effects on productivity of agricultural land. Effects of varying duration (short – long).
Water	**+ / -**	Mixed effects: Potentially significant negative effects due to degradation of beds and banks of rivers/lochs; however, some actions could lead to improvements. Effects of varying duration (short – long).
Climatic factors	**+ / -**	Mixed effects: Potentially significant negative effects due to loss or degradation of floodplain wetland or woodland; however, some actions could lead to improvements
Material assets	**+ +**	Reducing flood risk and protecting property and infrastructure
Cultural heritage	**+ / -**	Mixed effects on cultural heritage. Some uncertainty as the precise type and location of actions is not known.
	?	
Landscape	**-**	Potential landscape degradation

Commentary on potential significant effects

Regulating and maintaining services
Storage, conveyance and control actions alter the storage and flow of water. These actions can help to deliver positive effects through regulating the flow of water and thus reducing flood risk to people and properties. This helps to protect people and properties from flooding, with potentially significant benefits to meeting the SEA objectives to protect **human health** and **material assets**.

Loss of natural habitat and modification to the beds and banks of rivers has potentially negative effects on water quality. The effects, however, are dependent on the type of action and its location. For example, in areas where river channels are highly unmodified, the installation of new structures for storage, conveyance and control may lead to deterioration of the freshwater ecosystem with potentially significant negative effects. Conversely, in areas where river channels are already highly modified, the actions may improve the current state - for example, by removing culverts. Therefore, the overall effects of storage, conveyance and control actions on the SEA

objectives for **water** are mixed although potentially significant negatives effects have been identified for some LPDs.

The ecosystem adjacent to the action may benefit through protection from erosion, but erosion can be exacerbated downstream of the action for example in wetland or cultivated land ecosystems. The effects, however, depend on the type and location of the action, so the overall effects on the SEA objective to protect the function and quality of **soil** is mixed: effects could be significantly positive or significantly negative.

These actions may have mixed effects on the SEA objective to contribute to mitigation of climate change (**climatic factors**). Where actions lead to a disconnection between wetland and the floodplain or lowering of the water table, or a decline in riparian woodland area, there is a potentially negative effect on carbon storage. In LPDs with notable wetlands or woodlands, the effects on carbon storage may be potentially significantly negative. However, some actions such as removing culverts may help to increase connectivity and thus enhance the condition of floodplain habitats and their ability to store carbon.

Increased erosion can increase sediment deposition and nutrient load in water with potentially significant negative effects on aquatic species such as Atlantic salmon and freshwater pearl mussels (**biodiversity, flora and fauna**). Further discussion of potential impacts on protected sites and species can be found in appendices 5 -18; specific impacts on protected sites will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
Actions may help to reduce flooding to some areas of cultivated land or semi natural grassland. However, other areas may suffer increase flooding or erosion, loss of productive land (land used to store flood water), or reduction in pollination or pest control (due to loss of floodplain wetland and vegetation on which some species rely). Therefore, for the SEA objective to protect the function and quality of agricultural land (**soil**), the potential effects are mixed.

Freshwater fisheries production may suffer negative effects through loss of habitat and increased sedimentation. The effects are dependent on the type of action and its location.

Cultural services
Storage, conveyance and control actions have potentially negative effects on cultural services. Loss of natural habitat and reduction in biodiversity can impact opportunities to watch wildlife and interact with nature. Changes to patterns of river flow can also affect sports such as kayaking or angling. However, access for some activities could be improved with sensitive scheme design. There is therefore an overall mixed effect on the SEA objective to promote healthy lifestyles and protect **human health**.

The potential effects on **landscape** are negative: there are a number of actions that could be located in areas of wild land, national scenic areas and national parks. In urban areas, actions may have potentially negative effects by interrupting the views of rivers.

The historic environment may benefit through a reduction in flood risk but there is also potential for negative effects. For example, disconnection of the floodplain could damage wetlands and any archaeology preserved within it. The structure and setting of historic sites could also be affected but the direction and magnitude of potential effects will need to be assessed during more detailed flood risk management planning. Thus, the effect on the SEA objective for **cultural heritage** is mixed and uncertain.

River defences

River defences are being considered for all LPDs except for Orkney. All SEA topics outlined in Table 4.2 could be affected. The actions are most likely to be located in or adjacent to rivers (freshwater lochs and rivers ecosystem) or set back from the river in the urban ecosystem. The potential effects are described in the text below and summarised by SEA topic in table 5.5.

Table 5.5: Summary of potential effects of river defences on SEA topics

SEA topic	Potential effects	
	Unless otherwise described: *- the duration of effects is long term (>6 years)* *- some effects could be reversible, for example, by removing embankments* *- effects of some defences may be harder to reverse depending on construction techniques*	
Population and human health	**+ +**	Reducing flood risk and protecting human health
	+ / -	Mixed effects on promoting healthy lifestyles: some types of recreation may benefit, other activities may lose out. Implementation of actions could lead to short to medium term disruption to some types of recreation.
Biodiversity, flora and fauna	**- -**	Potentially significant negative effects on protected freshwater and estuarine sites; uncertainty over effects due to lack of detail on type and location of action. Any severe adverse effects on rare protected species or habitats could be difficult to reverse.
	?	
Soil	**0**	No or negligible effects
Water	**- -**	Increased erosion and degradation of river beds and banks (although opportunities may exist for improvements depending on the current condition of the river bed and banks)
Climatic factors	**+ / -**	Mixed effects: Negative effects due to loss or degradation of floodplain wetland or woodland; however, some actions could lead to improvements
Material assets	**+ +**	Reducing flood risk and protecting property and infrastructure
Cultural heritage	**+ / -**	Mixed effects on cultural heritage. Some uncertainty as the precise type and location of actions is not known.
	?	
Landscape	**-**	Potential landscape degradation

Commentary on potential significant effects

Regulating and maintaining services
River defences can deliver benefits by regulating water flow, reducing erosion at the site of the action, and reducing flood risk. This helps to protect people and properties from flooding, with potentially significant benefits to meeting the SEA objectives to protect **human health** and **material assets.**

The actions, however, can interfere with natural river processes. For example, the action can cause some or all of the floodplain to be disconnected from the river which can lead to a loss of wetland habitat to capture, filter and recycle nutrients or pollutants. There is also the potential for an increase in erosion upstream or downstream of the defence. Thus, the potential effects of river defences on the SEA objectives for the **water** environment are negative and significantly so for a number of LPDs. There are also potentially negative effects on carbon storage (**climatic factors**) due to loss of wetland habitat to capture and store carbon. These effects are dependent on the type of defence (for example, defences that are set back from the river are likely to have a smaller impact) and the degree to which the banks have already been modified; it is feasible that defences could in some cases improve the current state of the environment for example if existing defences are replaced with new ones that are set further back from the river.

Potential effects on designated environmental sites include alterations to dynamic river processes, increases in sediment load and deposition (both short and long term) with impacts on freshwater species such as Atlantic salmon and freshwater pearl mussels, and disturbance to breeding and wintering birds: these effects could be significantly negative (**biodiversity, flora and fauna**). Further discussion of potential impacts on protected sites and species can be found in appendices 5-18; specific impacts on protected sites will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Regulating and maintaining
River defences have potential negative effects on freshwater species (**biodiversity, flora and fauna**) and associated food production due to the loss of in river and riparian habitat. The effects, however, are dependent on the type of defence and the degree to which the river banks have already been modified.

Cultural services
River defences have potentially negative effects on cultural services. Loss of natural habitat and reduction in biodiversity can impact opportunities to watch wildlife, and interact with nature. Changes to patterns of river flow can also affect sports such as kayaking or angling. However, access for some activities could be improved with sensitive scheme design. There is therefore an overall mixed effect on the SEA objective to promote healthy lifestyles and protect **human health**.

The potential effects on **landscape** are negative as, in urban areas, actions may have potentially negative effects by interrupting the views of rivers.

The historic environment may benefit through a reduction in flood risk but there is also potential for negative effects on the structure and setting of historic sites. The direction and magnitude of potential effects will need to be assessed during more detailed flood risk management planning. Thus, the effect on the SEA objective for **cultural heritage** is mixed and uncertain.

Sustainable urban drainage systems (SUDS)

Sustainable urban drainage systems (SUDS) are being considered for two LPDs (Clyde and Loch Lomond; Ayrshire) to manage surface water flooding and/or river flooding the urban environment. SUDS will be considered for other LPDs as part of surface water management planning (assessed under non structural actions above). All SEA topics outlined in Table 4.2 could be affected. The potential effects are described in the text below and summarised by SEA topic in table 5.6.

Table 5.6: Summary of potential effects of SUDS on SEA topics

SEA topic	Potential effects *Unless otherwise described:* *- the duration of effects is long term (>6 years)* *- some effects could be reversible, for example, by removing the structure*	
Population and human health	**+ +**	Reducing flood risk and protecting human health
	+	Improving the living environment of communities through enhanced urban greenspace and an improved water environment
Biodiversity, flora and fauna	**+**	Freshwater and estuarine species may benefit from improved water quality
Soil	**0**	No or negligible effects
Water	**+ +**	Improving water quality
Climatic factors	**+**	Contribute to adaptation to climate change, for example, by helping to regulate local climate
Material assets	**+ +**	Reducing flood risk and protecting property and infrastructure
Cultural heritage	**+ / -**	Mixed effects on cultural heritage. Some uncertainty as the precise type and location of actions is not known.
	?	
Landscape	**+**	Enhancing urban landscape

Commentary on potential significant effects

Regulating and maintaining
SUDS help to reduce the rate and volume of run off from the urban environment, which helps to manage water as close to the source as possible. This can reduce surface water flooding (from run off) and can help to reduce river flooding by reducing peak flood flows. This helps to protect people and properties from flooding, with potentially significant benefits to meeting the SEA objectives to protect **human health** and **material assets**. The actions can also help adapt to climate change (**climatic factors**), for example, ponds can provide local cooling effects which can be beneficial in a densely populated urban environment.

SUDS have the potential to lead to improvements in water quality by helping to filter pollutants that might run off from the urban environment (e.g. from roads or industrial estates). SUDS can also help to reduce spills from combined –sewer overflows, with potential benefits for freshwater and coastal/marine ecosystems. Given the urban diffuse pollution pressures on the water environment, the actions have potential to deliver significant benefits to meeting the SEA objectives to protect **water** quality.

Wildlife in rivers and estuaries may benefit from improvements to water quality (**biodiversity, flora and fauna**). Any effects on protected sites are likely to be positive by helping to avoid or minimise harmful pollutants that could run off from the water environment. Effects will be assessed through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning
SUDS actions are likely to have no or negligible effects of food provisioning.

Cultural services
SUDS have potentially positive effects on recreation and opportunities to watch wildlife as they can provide natural habitat such as wetlands in the urban ecosystem. Coastal bathing waters may also benefit through improved water quality. The quality of urban **landscape** may be enhanced. There are thus potential benefits for **human health** through improving the living environment of communities and enhanced urban greenspace.

The historic environment may benefit through a reduction in flood risk but there is also potential for negative effects on the undiscovered urban archaeology during construction of SUDS. The direction and magnitude of potential effects will need to be assessed during more detailed flood risk management planning. Thus, the effect on the SEA objective for **cultural heritage** is mixed and uncertain.

Coastal restoration

Coastal restoration actions are being considered for nine LPDs. (The five LPDs where coastal restoration actions are not being considered are Findhorn, Nairn and Speyside; North East; Tay; Forth; and Tweed.) All SEA topics set out in table 4.2 could be affected. The ecosystems most likely to be affected are coastal and marine, urban and cultivated land. The potential effects are described in the text below and summarised by SEA topic in table 5.7.

Table 5.7: Summary of potential effects of coastal restoration actions on SEA topics

SEA topic	Potential effects	
	Unless otherwise described: *- the duration of effects is long term (>6 years)* *- some effects could be reversible, for example, if beach recharge or shingle reprofiling is ceased* *- however, some large scale actions may not be easily reversed so some effects from these actions could be permanent*	
Population and human health	**+ +**	Reducing flood risk and protecting human health
	+ / -	Mixed effects on promoting healthy lifestyles: some recreation may benefit, other activities may lose out. Implementation of actions could lead to short to medium term disruption to some types of recreation.
Biodiversity, flora and fauna	**+ +**	Benefits to connectivity of coastal ecosystems
	+ / -	Mixed (both positive and negative) and uncertain effects on protected sites. Effects of varying duration (short – long). Any severe adverse effects on rare protected species or habitats could be difficult to reverse.
	?	
Soil	**+ / -**	Mixed effects on productivity of agricultural land. Effects of varying duration (short – long).
Water	**+ +**	Benefits to water environment through improving physical condition of the coastline
Climatic factors	**+**	Increased carbon storage through restored coastal habitats
	+	Contribute to adaptation to climate change
Material assets	**+ +**	Reducing flood risk and protecting property and infrastructure
Cultural heritage	**+**	Protecting coastal heritage assets through reduced flood risk and erosion protection. Some uncertainty as the precise type and location of actions is not known.
	?	
Landscape	**+ +**	Restoring landscape quality

Commentary on potential significant effects

Regulating and maintaining
Coastal restoration actions help to provide space to attenuate waves and coastal surge through the creation and restoration of natural habitats. Through attenuating waves and surge, coastal restoration actions have the potential to reduce flood risk. These natural habitats can help to protect from erosion. This helps to protect people and properties from flooding, with potentially significant benefits to meeting the SEA objectives to protect **human health** and **material assets**.

In locations where coastal and estuarine habitats have been modified, coastal restoration actions could have significant positive effects on the **water** environment by restoring the condition of the coastline. The restoration of natural habitats may also provide carbon storage, and help to adapt to future climate change (**climatic factors**).

The restoration and creation of intertidal areas may help to provide nursery areas for fish. Connectivity among habitats may also be improved and help to reverse pressures of coastal squeeze: this could have positive effects (potentially significantly so) for designated coastal sites. Works to implement restoration, however, could lead to short to medium duration negative effects such as smothering of benthic species (from disturbed sediment), or disturbance of birds and mammals. The effects on **biodiversity, flora and fauna** are therefore mixed. Further discussion of potential impacts on protected sites and species can be found in appendices 5 -18; specific impacts on protected sites will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
Coastal restoration actions may help to protect cultivated land and semi natural grassland from erosion and flooding thus helping to maintain the productivity. Creation and restoration of intertidal areas, however, could lead to loss of productive land to the sea. There is therefore a mixed effect on the SEA objective to protect the quality and function of **soil**.

The restoration and creation of intertidal areas may help to provide nurseries for fish.

Cultural services
The effects of coastal restoration action on cultural services are generally positive. By improving the coastal environment, recreation, wildlife experience and cultural amenity are all likely to benefit. Restoration could restrict or alter access to coastal areas which could cause short or long term local negative effects. There is therefore an overall mixed effect on the SEA objective to promote healthy lifestyles and protect **human health**.

Coastal restoration actions have potentially positive effects on **landscape** due to protecting and improving the quality of the coastline. These positive effects could be significant where the coastline has been heavily modified.

The historic environment (**cultural heritage**) is likely to benefit due to reduced risk of flooding and perhaps significantly due to the potential protection from coastal erosion in some LPDs.

Coastal defences

Coastal defences are proposed for 11 LPDs excluding the Tay, Tweed and the Forth. Actions are most likely to be located in coastal and marine ecosystems or urban ecosystems. All SEA topics set out in table 4.2 could be affected. The potential effects are described in the text below and summarised by SEA topic in table 5.8.

Table 5.8 Summary of potential effects of coastal defences on SEA topics

SEA topic	Potential effects	
	Unless otherwise described: *- the duration of effects is long term (>6 years)* *- some effects could be reversible, for example, by removing defences* *- however, some large scale actions may not be easily removed so some effects from these actions may be permanent*	
Population and human health	**+ +**	Reducing flood risk and protecting human health
	+ / -	Mixed effects on promoting healthy lifestyles: some types of recreation may benefit, other activities may lose out. Implementation of actions could lead to short to medium term disruption to some types of recreation.
Biodiversity, flora and fauna	**+ / -**	Mixed (both positive and negative) and uncertain effects on protected sites. Effects of varying duration (short – long). Any severe adverse effects on rare protected species or habitats could be difficult to reverse.
	?	
Soil	**+**	Protecting agricultural land from flooding, particularly where land has been reclaimed from the sea
Water	**+ / -**	Positive / negative effects on the physical condition of the coastline could be significant depending on location and type of action and existing state
Climatic factors	**+ / -**	Climate change mitigation could be negatively affected through loss of natural habitat, but could create new carbon storing habitats such as kelp beds
Material assets	**+ +**	Reducing flood risk and protecting property and infrastructure
Cultural heritage	**+ / -**	Mixed effects on cultural heritage. Some uncertainty as the precise type and location of actions is not known.
	?	
Landscape	**- -**	Significant potential landscape degradation (although effects will be less severe where coastline is already heavily modified)

Commentary on potential significant effects

Regulating and maintaining
By regulating tidal surges, coastal defences can help to reduce flood risk. Some actions also help attenuate waves and can reduce erosion at the site of the action. This helps to protect people and properties from flooding, with potentially significant benefits to meeting the SEA objectives to protect **human health** and **material assets**.

Coastal defences can lead to loss of natural habitat and interfere with natural coastal processes, for example, by changing the patterns of erosion and deposition. Loss of intertidal areas can reduce the filtering and treatment of pollutants provided by these habitats and the species they support. The effect on carbon storage (**climatic factors**) is mixed: loss of natural habitat to sequester carbon will have negative effects; however, some actions might provide suitable substrate for kelp which can act as a carbon store. The effects on the **water** environment are also mixed: defences can lead to significant loss of natural habitat but it is feasible that defences could in some cases improve the current state of the environment for example if existing defences are replaced with new ones that are set further back from the shore. These effects therefore are dependent on the type and location of the defence and the degree to which the coastline has already been modified.

The management of coastal nature conservation sites often include objectives to preserve natural coastal processes and to avoid disturbance of breeding and feeding birds and mammals. Changes to natural coastal processes may alter the movement of gravel, shingle and sands, leading to potentially significant negative effects on coastal habitats and the species they support. Construction of coastal structures can also disturb birds and mammals; however, if sensitively designed, defences can alter public access to sites potentially reducing disturbance to wildlife from visitors. The effects on **biodiversity, flora and fauna** are therefore mixed. Further discussion of potential impacts on protected sites and species can be found in appendices 5 -18; specific impacts on protected sites will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning
Coastal defences can have mixed effects on marine food provisioning: there can be loss of natural habitat and a reduction in productivity, alternatively other edible species can benefit (for example a change from soft sediment feeding fish to lobster and crab fishery). Benefits are dependent on the design of the structure.

Coastal defences can also help to protect productive agricultural land with potential positive effects on terrestrial food provisioning.

Cultural services
As coastal defences can lead to loss of natural habitat, there are potential negative effects on recreation and opportunities to experience nature and wildlife. Sensitive design, however, can improve access and reduce disturbance to wildlife. The effects could restrict or alter access to coastal areas which could cause short or long term local negative effects. There is therefore a mixed effect on the SEA objective to promote healthy lifestyles and protect **human health**.

Given the importance of the seascape to Scotland, there are potentially significant negative effects on **landscape**, especially if actions disrupt the views of the sea or the extent of beaches.

There are potential benefits to cultural heritage through a reduction in flood risk and erosion. However, the exact location of actions is not yet known and there could be adverse effects on the setting of historic features. There are potential negative effects if unscheduled archaeology is exposed on beaches and damaged by machinery and structures. Further assessment is required at more detailed levels of planning. Thus, the effect on the SEA objective for **cultural heritage** is mixed and uncertain.

Table 5.9: Comparison of potential effects of flood risk management actions by SEA topic

SEA topic	Non structural actions	Run off reduction	River restoration	Storage, conveyance and control	River defences	Sustainable urban drainage systems	Coastal restoration	Coastal defences
Population and human health	+ + Reducing flood risk and protecting human health	+ + Reducing flood risk and protecting human health + + Promoting healthy lifestyles through improved opportunities for recreation and experiencing nature	+ + Reducing flood risk and protecting human health +/- Mixed effects on promoting healthy lifestyles: some recreation may benefit, other activities may lose out	+ + Reducing flood risk and protecting human health +/- Mixed effects on promoting healthy lifestyles: some recreation may benefit, other activities may lose out	+ + Reducing flood risk and protecting human health +/- Mixed effects on promoting healthy lifestyles: some recreation may benefit, other activities may lose out	+ + Reducing flood risk and protecting human health + Improving the living environment of communities through enhanced urban greenspace	+ + Reducing flood risk and protecting human health +/- Mixed effects on promoting healthy lifestyles: some recreation may benefit, other activities may lose out	+ + Reducing flood risk and protecting human health +/- Mixed effects on promoting healthy lifestyles: some recreation may benefit, other activities may lose out
Biodiversity, flora and fauna	0 ? No or uncertain effects (as effects of relocation are site specific)	+ + Benefits to connectivity and health of native woodland and wetland ecosystems +/- ? Mixed and uncertain effects on protected sites	+ + Benefits to connectivity and health of native woodland and wetland ecosystems +/- ? Mixed and uncertain effects on protected sites	+/- Potentially significant negative effects due to loss of habitat; however, some actions could lead to improvements +/- ? Mixed and uncertain effects on protected sites with potentially significant negative effects on protected freshwater species	- - ?Potentially significant negative effects on protected freshwater and estuarine sites; uncertainty due to lack of detail on type and location of action	+ Freshwater and estuarine species may benefit from improved water quality	+ + Benefits to connectivity of coastal ecosystems +/- ? Mixed and uncertain effects on protected sites	+/- ? Mixed and uncertain effects on protected sites; with potentially significant negative effects on protected coastal and estuarine sites

SEA topic	Non structural actions	Run off reduction	River restoration	Storage, conveyance and control	River defences	Sustainable urban drainage systems	Coastal restoration	Coastal defences
Soil	**0 ?** No or uncertain effects (as effects of relocation are site specific)	**+ +** Restoring carbon rich soils **+ +** Safeguarding soils from erosion **+ / -** Mixed effects on productivity of agricultural land	**+ +** Restoring carbon rich soils **+ +** Safeguarding soils from erosion **+ / -** Mixed effects on productivity of agricultural land	**+ / -** Mixed (and potentially significant) effects on safeguarding soils as erosion potential depends on type and location of action **+ / -** Mixed effects on productivity of agricultural land	**0** No or negligible effects	**0** No or negligible effects	**+ / -** Mixed effects on productivity of agricultural land	**+** Protecting agricultural land from flooding
Water	**0 ?** No or uncertain effects (as effects of relocation are site specific)	**+ +** Improving water quality and reducing sedimentation	**+ +** Improving water quality and reducing sedimentation	**+/-** Potentially significant negative effects due to degradation of beds and banks of rivers/lochs; however, some actions could lead to improvements	**- -** Increased erosion and degradation of river beds and banks (although some opportunities may exist for improvements)	**+ +** Improving water quality	**+ +** Benefits to water environment through improving coastal morphology	**+/-** Positive / adverse effects on coastal morphology could be significant depending on location and type of action and existing state of coastline
Climatic factors	**+** Contribute to adaptation to climate change	**+ +** Increased carbon storage through creation of wetlands and woodlands **+** Contribute to adaptation to climate change	**+ +** Increased carbon storage through wetland enhancement (benefits tempered by any loss of woodland) **+** Contribute to adaptation to climate change	**+/-** Potentially significant negative effects due to loss or degradation of floodplain wetland or woodland; however, some actions could lead to improvements	**+/-** Negative effects due to loss or degradation of floodplain wetland or woodland; however, some actions could lead to improvements	**+** Contribute to adaptation to climate change	**+** Contribute to adaptation to climate change **+** Increased carbon storage through restored coastal habitats	**+/-** Climate change mitigation could be negatively affected through loss of natural habitat, but could create new carbon storing habitats such as kelp beds

SEA topic	Non structural actions	Run off reduction	River restoration	Storage, conveyance and control	River defences	Sustainable urban drainage systems	Coastal restoration	Coastal defences
Material assets	+ + Reducing flood risk and protecting property and infrastructure	+ + Reducing flood risk and protecting property and infrastructure	+ + Reducing flood risk and protecting property and infrastructure	+ + Reducing flood risk and protecting property and infrastructure	+ + Reducing flood risk and protecting property and infrastructure	+ + Reducing flood risk and protecting property and infrastructure	+ + Reducing flood risk and protecting property and infrastructure	+ + Reducing flood risk and protecting property and infrastructure
Cultural heritage	**0** ? No or uncertain effects (as effects of relocation are site specific)	+/- ? Mixed and uncertain effects on cultural heritage	+/- ? Mixed and uncertain effects on cultural heritage	+/- ? Mixed and uncertain effects on cultural heritage	+/- ? Mixed and uncertain effects on cultural heritage	+/- ? Mixed and uncertain effects on cultural heritage	+/- ? Mixed and uncertain effects on cultural heritage	+/- ? Mixed and uncertain effects on cultural heritage
Landscape	**0** ? No or uncertain effects (as effects of relocation are site specific)	+ Enhancing diversity of the landscape	+ Enhancing diversity of the landscape	- Potential landscape degradation	- Potential landscape degradation	+ Enhancing urban landscape	+ + Restoring landscape quality	- - Significant potential landscape degradation (tempered where coastline already heavily modified)

6. Mitigation and monitoring

6.1. Measures envisaged for the prevention, reduction and offsetting of significant adverse effects

Schedule 3 paragraph 7 of the Environmental Assessment (Scotland) Act 2005 requires an explanation of "the measures envisaged to prevent, reduce and as fully as possible offset any significant adverse effects on the environment of implementing the plan or programme." Table 6.1 sets out any environmental problems that are likely to result from the implementation of the Flood Risk Management Strategies and proposes measures for the prevention, reduction and offset of significant adverse effects. These measures are recommendations that will need to be taken forward at more detailed levels of flood risk management planning, such as at feasibility and design stages. Other organisations, particularly local authorities, will be leading on more detailed stages. We will set out how our recommendations on mitigation will be taken forward in the post adoption statement.

Table 6.1: Measures envisaged for the prevention, reduction and offsetting of any significant negative effects

SEA objective	Potential negative effects of the Flood Risk Management Strategies	Proposed mitigation measures and recommendations
Population and human health: *Protect human health, reduce health inequalities and promote healthy lifestyles*	No significant adverse effects	
Biodiversity, fauna and flora: *Conserve and where appropriate enhance species, habitats and biodiversity, and habitat connectivity*	Storage, conveyance and control actions, river defences, and coastal defences could damage ecosystems such as wetlands and native floodplain woodlands and coastal habitats that are already fragmented / degraded.	Potential negative effects can be mitigated through the identification of impact, sympathetic design and timing of works to avoid or minimise the effects on habitats and wildlife, along with consultation with relevant organisations.
	All structural actions could have significant negative effects on designated nature conservation sites, for example, by altering patterns of river flow or coastal processes or through disturbance.	Potential negative effects on protected sites will be assessed by SEPA as part of the Habitats Regulations Appraisal for the Flood Risk Management Strategies and mitigation applied where required. At more detailed levels of planning, Habitats Regulations will also apply during which the responsible authority will need to take steps to mitigate negative effects on protected sites.
Soil: *Protect and where appropriate enhance the function and quality of the soil resource*	Storage, conveyance and control actions can alter natural processes and lead to increased erosion of carbon rich soils or agricultural land	Modelling of natural processes can help to better predict and mitigate potential negative effects: this should be addressed during feasibility and detailed design stages.

SEA objective	Potential negative effects of the Flood Risk Management Strategies	Proposed mitigation measures and recommendations
Water: *To prevent deterioration, protect and where appropriate enhance the water environment*	Storage, conveyance and control actions, river defences, and coastal defences could lead to potential degradation of beds and banks of rivers and the coastline	The potential negative effects can be mitigated by minimising potential habitat loss and including habitat creation in flood risk management schemes. Negative effects should be addressed during feasibility and detailed design stages. Actions that can affect the freshwater environment (such as river defences or storage actions) are regulated under The Controlled Activities Regulations, which aim to protect the water environment. Mitigation is considered as part of the authorisation process. Some actions, particularly those deemed as development, are regulated under the land use planning system: environmental effects will be addressed through project level Environmental Impact Assessments.
Climatic factors: *Contribute to mitigation of and adaptation to climate change*	Storage, conveyance and control actions, river defences, and coastal defences could lead to potential loss or degradation of habitats (e.g. wetlands, woodlands, coastal) that help to mitigate and adapt to a changing climate	The potential negative effects can be mitigated by minimising potential habitat loss and including habitat creation in flood risk management schemes. Negative effects should be addressed during feasibility and detailed design stages.
Material assets: *Contribute to protecting property and infrastructure* *Minimise waste and energy consumption and promote resource efficiency*	No identified negative effects. Effects on waste, energy and resource efficiency uncertain at this stage.	Opportunities to minimise waste and resource use should be examined during feasibility and detailed design stages.
Cultural heritage: *Protect and where appropriate enhance the character, diversity and special qualities of cultural heritage and the historic environment*	No significant negative effects identified (although assessment is uncertain as effects depend strongly on the type of action and its location)	Potential negative effects can be mitigated through the identification of any heritage assets (including archaeology) and the early engagement of heritage interests during feasibility and detailed design stages.
Landscape: *Protect and where appropriate enhance the character, diversity and special qualities of landscapes*	Coastal defences (and also storage, conveyance and control actions, and river defences) could lead to landscape degradation	Potential negative effects should be addressed early during feasibility and detailed design stages. Consultation with SNH, National Park Authorities and affected communities is recommended.

6.2. Monitoring

Section 19 of the Environmental Assessment (Scotland) Act 2005 requires the Responsible Authority (SEPA) to monitor significant environmental effects of the implementation of the Flood Risk Management Strategies. This must be done in such a way as to also identify unforeseen adverse effects and to take appropriate remedial action.

The monitoring must inform on the effects of the Flood Risk Management Strategies themselves rather than wider trends. The water environment is extensively monitored by SEPA and we propose to take advantage of existing activities rather than undertake any new monitoring. The proposed SEA monitoring activities are set out in table 6.2. The effects of individual projects will be monitored according to plans devised as part of project level environmental impact assessment.

Table 6.2 Proposed SEA monitoring programme

What is being monitored	Data source, frequency of monitoring	Timescale and responsibility
Flood risk to people and properties, cultural heritage and designated environmental sites	SEPA National Flood Risk Assessment and baseline flood risk data updated every 6 years	SEPA, as part of the National Flood Risk Assessment update in 2017 and in the second cycle of flood risk management strategies in 2021
Status of the water environment	WFD classification data; monitored via the river basin management plans (6 yearly publication cycle)	SEPA, as part of the third river basin management plans in 2021.

7. Next steps

7.1. Milestones

The anticipated milestones in the SEA and Flood Risk Management planning processes are outlined in table 7.1.

Table 7.1: Anticipated milestones

Milestone	Date
Consultation closes on the draft Flood Risk Management Strategies and Environmental Report	2 June 2015
Flood Risk Management Strategies and Post Adoption Statement published	22 December 2015
Local Flood Risk Management Plans published	June 2016

7.2. How to respond to this consultation

We are seeking your views on this environmental report and have set out some specific consultation questions below. The consultation closes on 2 June 2015. Please respond via our online consultation hub:

https://frm-scotland.org.uk/

Alternatively you can respond by email or post:
Email: FloodActConsultation@sepa.org.uk
Post: SEPA ASB, Angus Smith Building, 6 Parklands Avenue, Eurocentral, Holytown, North Lanarkshire, ML1 4WQ

Consultation questions

1. About you

- Please provide your name.
- Please provide your organisation name (if relevant)
- Please provide your email address
- Which category best reflects your interest?
    - SEA consultation authority
    - Responsible authority designated under the FRM Act 2009
    - Other public body
    - Interest/community group
    - Consultancy
    - Academia
    - Individual
    - Business
    - Other, please state

2. Relevant aspects of the current state of the environment

Do you think that we have accurately described the relevant aspects of the current state of the environment?
If no, please provide your reasons.

3. SEA objectives and assessment method

Do you think that our objectives and assessment method have enabled us to adequately assess the potential significant environmental effects of the proposed actions? If no, please provide your reasons.

4. Reasonable alternatives

Are there any actions that should be considered as 'reasonable alternatives' that we have not identified and should be considered as part of the SEA process (see section 4.1)? If yes, please provide further information

5. Environmental assessment

Do you think that we have accurately assessed the potential significant environmental effects of the proposed actions? If no, please provide your reasons

6. Mitigation

Do you think that we have proposed appropriate mitigation of the significant negative environmental effects? If no, please provide your reasons

7. Monitoring

Are there any other ways in which we could monitor the significant environmental effects of the Flood Risk Management Strategies? If yes, please provide details

8. Please provide any further comments on the Environmental Report

9. Please provide any comments on the Environmental Assessment for the individual Local Plan Districts (appendices 5 – 18)

Appendix 1: Digest of responses to scoping report consultation

A1.1 Introduction

SEPA consulted on its Strategic Environmental Assessment (SEA) Scoping Report of the Flood Risk Management Strategies from 13 November – 20 December 2013. The purpose of the consultation[24] was to seek the views of the Statutory SEA Consultation Authorities (SNH and Historic Scotland) on:

- The proposed scope and level of detail for the SEA Environmental Report;
- The proposed consultation period for the SEA Environmental Report.

We sought the views of the English SEA Consultation Bodies (Environment Agency, Natural England, and English Heritage) regarding potential cross-border impacts. We also advertised the consultation to Responsible Authorities (via email alert) and to other stakeholders (via SEPA's flood risk management newsletter).

A1.2 Responses

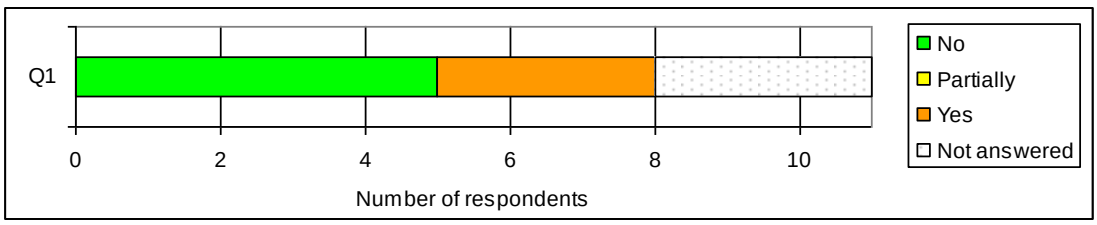
We received 11 responses on the consultation (table A1), four from SEA Consultation Authorities and seven from Local Authorities. The responses to each question are summarised below.

Table A1: Respondents

Respondent	Type
SNH	SEA Consultation Authority (Statutory consultee)
Historic Scotland	SEA Consultation Authority (Statutory consultee)
Dundee City Council	Local Authority
Highland Council	Local Authority
East Ayrshire Council	Local Authority
Glasgow City Council	Local Authority
Falkirk Council	Local Authority
Angus Council	Local Authority
North Ayrshire Council	Local Authority
Natural England	SEA Consultation Body – England
English Heritage	SEA Consultation Body - England

Q1. Are there any plans, programmes, legislation or policy guidance of relevance to the Flood Risk Management Strategies that you consider should be added to the list in Appendix 2 and/or reflected in the summary in section 2.2?

Five respondents had no further suggestions. Two respondents suggested additional documents they consider to be of relevance to the Flood Risk Management Strategies. A third respondent suggested amendments to how the Flood Risk Management Strategies should be influenced by Natura 2000 sites and by Shoreline Management Plans. We have reviewed the suggestions and where appropriate included in the Environmental Report.



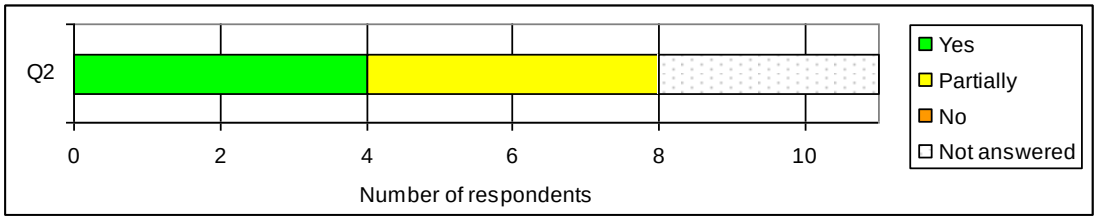
[24] As required by Section 15 of Environmental Assessment (Scotland) Act 2005.

Q2. Have we identified the most appropriate sources of data for the environmental baseline? If not, which other data sources should we consider?

Four of the eight responses to this question suggested amendments to the environmental baseline. We have reviewed the suggested amendments.

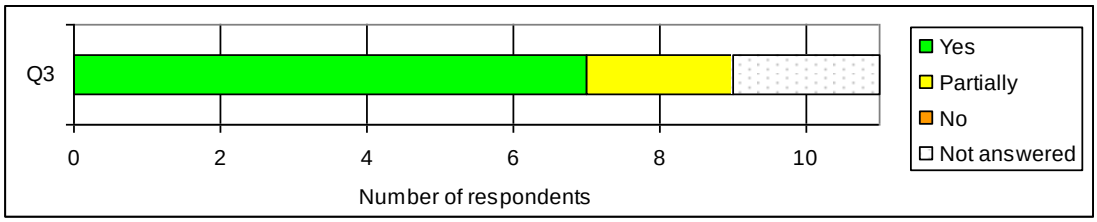
Two respondents raised concerns over use of Houston et al. (2011)[25] as a baseline for pluvial flooding. The intention for using Houston et al. (2011) was to help inform a qualitative assessment on social impacts of flooding, rather than as a baseline of pluvial flood risk. However, Werritty et al. (2007)[26] will be sufficient for this purpose so we have removed the reference to Houston et al.

One respondent raised concern over assumptions and limitation of the baseline flood hazard maps. We passed these comments to the SEPA regional planning manager for flood risk management.



Q3. Do you agree that we have correctly identified the key environmental problems relevant to the Flood Risk Management Strategies and their implications?

The majority (seven out of nine) of respondents felt the key problems were correctly identified. Particular support was given for the consideration of impacts on wetland archaeology and sustainable urban drainage systems (SUDS). One organisation requested improvements to text on the implication of the Flood Risk Management Strategies on Biodiversity, Flora and Fauna: we have amended this in line with the request. One organisation also suggested minor improvements, and identified a dataset on lifeline roads which may be useful for the production of the Flood Risk Management Strategies. We have reviewed the suggestions and amended the environmental problems accordingly.



Q4. Do you agree that we have correctly scoped the likely significant environmental effects?

There was strong agreement (8 out of 9 responses) that we have correctly scoped the likely significant environmental effects of the Flood Risk Management Strategies.

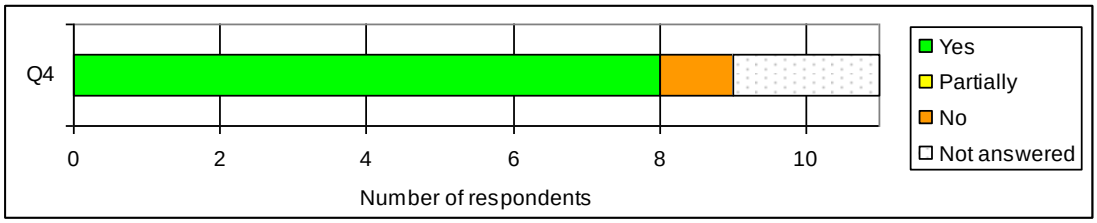
Only one respondent answered negatively for two reasons:

- Firstly, it requested a change to wording used to describe engineering actions – we have reviewed the wording used to describe engineering actions.

[25] Houston, D., Werritty, A., Bassett, D., Geddes, A., Hoolachan, A. and McMillan, M. (2011) Pluvial (rain-related) flooding in urban areas: the invisible hazard. Joseph Rowntree Foundation.

[26] Werritty, A., Houston, D., Ball, T., Tavendale, A. and Black, A. (2007) Exploring the social impacts of flooding and flood risk in Scotland. Scottish Executive Social Research.

- Secondly, it requested that the scope of the SEA should be expanded to include the actions to manage river flooding in the urban environment that may be more akin to actions found in surface water management plans. We have reviewed the scope of our assessment to ensure that all appropriate actions are included in our assessment, including actions more akin to those used to manage surface water.



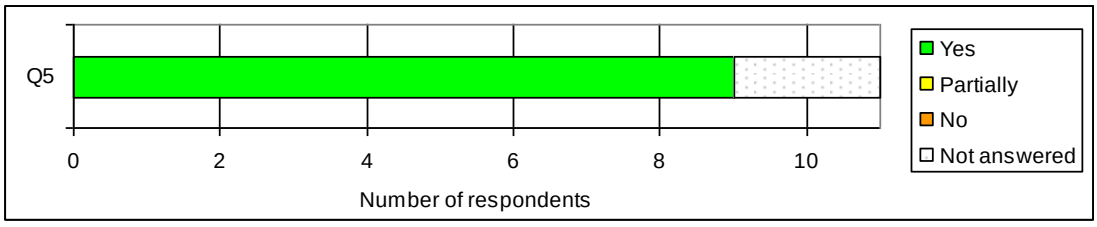
Q5. Do you agree that the SEA objectives and assessment will enable SEPA to make an appropriate strategic assessment?

The nine respondents who answered this question all agreed that the SEA objectives and assessment will enable SEPA to make an appropriate strategic assessment.

One respondent asked for clarification of the time period covered by the SEA: period covered by the SEA is proposed to be for all three planning cycles (as this is the time period covered by the Flood Risk Management Strategies).

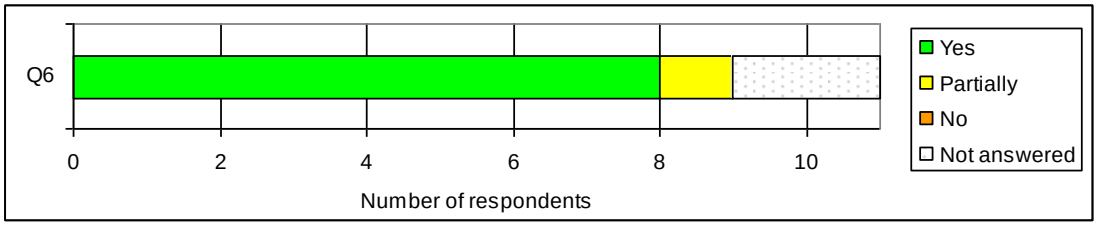
The same respondent also queried whether the proposed scope would also cover the supplementary part of the Local Flood Risk Management Plans. The SEA of the Flood Risk Management Strategies does not set out to cover the supplementary part of the Local Flood Risk Management Plans but in reality it is likely that the Flood Risk Management Strategies' SEA covers all the issues which the supplementary part would also cover.

The comments emphasised the need to make sure the Environmental Report clearly states the scope of the SEA and the relationship with assessments of other plans in the hierarchy.



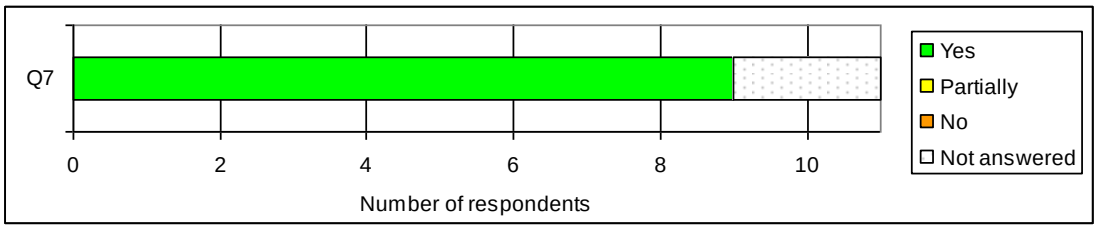
Q6. Do you agree that the assessment matrix will present results in a way that enables Consultation Authorities, other stakeholders and the public to comment on environmental impacts?

Eight of the nine responses to this question were content with the approach; one made suggestions for improvements by including an assessment of the 'do nothing' scenario. We have reviewed this suggestion and ensure that the options considered in the SEA are consistent with those in the Flood Risk Management Strategies.



Q7. Do you agree that the proposed consultation period and format enables early and effective engagement for SEA purposes?

All nine responses to this question agreed that the consultation period would enable early and effective engagement. One response emphasised the need to make sure the Environmental Report clearly states the scope of the SEA and the relationship with assessments of other plans in the hierarchy.



Appendix 2: Map acknowledgments

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including *inter alia*, the following organisations:

Ordnance Survey
Flood maps are based upon Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office © Crown Copyright. Any unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. SEPA Licence number 100016991 (2015).

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology © NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2015), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright © The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

Appendix 3: Environmental context for the Flood Risk Management Strategies

A detailed analysis of how the Flood Risk Management Strategies affect, and are affected by, other relevant plans, programmes and strategies and environmental objectives is presented in table A3.1.

Table A3.1: Relationship with other plans, programmes and strategies and environmental objectives

Name of plan, programme, strategy or relevant legislation	Main objectives of plan, programme, strategy or relevant legislation	How it affects, or is affected by the Flood Risk Management Strategies in terms of SEA issues referred to in Schedule 3 of the Act
Population and human health		
United Kingdom		
Civil Contingencies Act 2004	The Act delivers a framework for civil protection in the United Kingdom. The act defines the responsibilities for responders to emergency which include (among others): - assess the risk of emergencies and use to inform contingency planning - put in place emergency plans - put in place arrangements to make information available to the public about civil protection matters and to maintain arrangements to warn, inform and advise the public in the event of an emergency	The Flood Risk Management Strategies should support the requirements of responders to fulfil their statutory duties
Scotland		
Land Reform (Scotland) Act 2003	Gives legal right of responsible access in Scotland. Promotes the development of core paths for walking, cycling and riding in Local Authority encouraging increased levels of physical activity	The Flood Risk Management Strategies should give consideration to providing recreational benefits and promoting core paths alongside Flood Risk Management actions.
Biodiversity, habitats and species		
International		
Convention on Wetlands of International Importance 1971 (amended 1982 and 1987)	Otherwise known as the Ramsar Convention, this provides a framework for national action and international co-operation for the conservation and sustainable utilization of wetlands and their resources. It recognises the fundamental ecological functions of wetlands and their economic, cultural, scientific, and recreational value, particularly as a key habitat for waterfowl. There is a Ramsar List of designated sites for management & conservation at an international level.	The Flood Risk Management Strategies should ensure that all Ramsar sites are protected from loss or damage as a result of flood management actions. In Scotland, all Ramsar sites are also Special Protection Areas (SPAs) or Special Areas of Conservation (SACs) and so are protected by virtue of being a Natura site (see below).The Flood Risk Management Strategies also offer opportunities for creation or remediation of wetlands and these opportunities should be given suitable consideration.

Name of plan, programme, strategy or relevant legislation	Main objectives of plan, programme, strategy or relevant legislation	How it affects, or is affected by the Flood Risk Management Strategies in terms of SEA issues referred to in Schedule 3 of the Act
UN Convention on Biological Diversity (1992)	Key objective of the Convention is to develop national strategies for the conservation and sustainable use of biological diversity, which should be integrated across other policy sectors. Key biological resources should be identified and protected. Monitoring of potentially damaging processes and activities should also be undertaken. Actions taken under the Convention include: - Publication of a Scottish Biodiversity Strategy - Establishment of a UK Biodiversity Action Plan and Scottish Biodiversity Action Plans to implement the Convention. - Establishment of Local Biodiversity Action Plans to protect, enhance and promote local biodiversity.	The Flood Risk Management Strategies should look for opportunities to conserve, and where possible restore, biodiversity.
European		
Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora ('Habitats Directive')	Builds on the Birds Directive (see below) by protecting natural habitats and other species of wild plants and animals. Together with the Birds Directive, it underpins a European network of protected areas known as Natura 2000: Special Protection Areas (SPAs, classified under the Birds Directive) and Special Areas of Conservation (SACs, classified under the Habitats Directive).	The Flood Risk Management Strategies should aim to prevent loss or damage to Natura 2000 sites (where loss/damage is not a result of natural processes). The Flood Risk Management Strategies are expected to require a Habitats Regulations Appraisal and, as such, may require an 'appropriate assessment' to ensure that they do not adversely affect SPAs and SACs.
Council Directive 79/409/EEC on the conservation of wild birds ('Birds Directive')	Protects all wild birds, their nests, eggs and habitats within the European Community. It gives EU member states the power and responsibility to classify Special Protection Areas (SPAs) to protect birds which are rare or vulnerable in Europe, as well as all migratory birds which are regular visitors.	The Flood Risk Management Strategies should aim to prevent loss or damage to Natura 2000 sites (where loss/damage is not a result of natural processes). (See above)
The Pan-European Biological and Landscape Diversity Strategy (1995)	The Strategy aims to reverse the decline of landscape and biological diversity, by promoting innovation and proactive policy making. It supports preceding measures for protecting natural heritage, and aims to supplement these by further supporting a number of action themes relating to different environmental resources.	The Flood Risk Management Strategies should support the Strategy by considering the contribution that actions could make to protecting biodiversity and landscapes.

Name of plan, programme, strategy or relevant legislation	Main objectives of plan, programme, strategy or relevant legislation	How it affects, or is affected by the Flood Risk Management Strategies in terms of SEA issues referred to in Schedule 3 of the Act
Our life insurance, our natural capital: an EU biodiversity strategy to 2020 (2011)	Aims to reverse biodiversity loss and speed up the EU's transition towards a resource efficient and green economy. Includes targets and actions related to: - halting deterioration in Natura 2000 sites and measurable improvements in status -maintaining and enhancing ecosystems and services through green infrastructure, and restoring degraded ecosystems - combating invasive species - contributing to averting biodiversity loss The Scottish Government has published a 2020 Challenge for Scotland's Biodiversity (see below) in response to this EU Strategy.	The Flood Risk Management Strategies should support the aims and commitments of the Strategy by minimising impacts on biodiversity, and by considering the contribution that actions could make to maintaining and restoring ecosystems.
United Kingdom		
UK Post 2012 Biodiversity Framework	A UK agreement on a framework of priorities for the Convention of Biological Diversity. Biodiversity strategies for England and for Scotland (see below) set out greater detail.	The Flood Risk Management Strategies will have regard to this framework, by virtue of regard to the country level strategies (see below).
Scotland		
The Wildlife and Countryside Act 1981 (as amended for Scotland)	Provides the framework for protection of species other than European Protected Species. Sets out protection objectives for specified birds and wild animals.	The Flood Risk Management Strategies should have regard to the protection of species as per the Act.
The Environment Act 1995	Under this Act, SEPA has several broad, conservation-related duties: Section 32 duties – in particular, in formulating or considering any proposals relating to any of its functions, SEPA should "*have regard to the desirability of conserving and enhancing the natural heritage of Scotland*", and "*to take into account any effect which the proposals would have on the natural heritage of Scotland*" Section 34 duties – SEPA has a duty "*generally to promote the conservation and enhancement of the natural beauty and amenity of inland and coastal waters and of land associated with such waters*", and "*generally to promote the conservation of flora and fauna which are dependent on an aquatic environment".*	The Flood Risk Management Strategies should have regard to conservation of natural heritage, and should promote the conservation of natural heritage and biodiversity of inland and coastal waters.
The Conservation (Natural Habitats, &c) Regulations 1994 (as amended for Scotland)	These regulations relate to the designation of Natura sites, and provision of protection to various plant and animal species.	The Flood Risk Management Strategies should ensure that Natura 2000 sites are protected from loss or damage (see above).

Name of plan, programme, strategy or relevant legislation	Main objectives of plan, programme, strategy or relevant legislation	How it affects, or is affected by the Flood Risk Management Strategies in terms of SEA issues referred to in Schedule 3 of the Act
Nature Conservation (Scotland) Act 2004	This Act sets out the process for designating and protecting SSSIs. Public bodies have a statutory obligation to 'further the conservation of biodiversity'. Under the requirements of the Act, the Scottish Government has produced Scottish Biodiversity Strategy (below), to which all public bodies should pay regard.	The Flood Risk Management Strategies should take into account the protection of SSSIs. The Flood Risk Management Strategies should consider the contribution that can be made to conserving, and where possible restoring biodiversity and avoiding adverse impacts on sites, habitats and species of value as defined in the Scottish Biodiversity Strategy and associated priority lists (see below).
Scottish Biodiversity Strategy: 1. "Scotland's Biodiversity – It's in Your Hands. A strategy for the conservation and enhancement of biodiversity in Scotland" (2004) 2. 2020 Challenge for Scotland's Biodiversity - A Strategy for the conservation and enhancement of biodiversity in Scotland (2013)	These two documents together comprise the Scottish Biodiversity Strategy. The 2020 Challenge document provides greater detail in some areas, responds to the new international targets, and updates some elements of the 2004 document. It sets out principles and approaches to protect biodiversity and how we can harness nature and its many processes and functions to improve our prosperity and welfare.	The Flood Risk Management Strategies should consider the contribution that actions could make to conserving, and where possible restoring, biodiversity. They should also recognise the contribution that biodiversity makes to health and quality of life.
Scottish Executive Scottish Forestry Strategy (2006)	This strategy is a framework for taking forestry forward through the first half of this century and beyond. Amongst other outcomes, it aims to contribute to a high quality, robust and adaptable environment. One of its targets is to increase Scotland's woodlands increase from 17.1% of land area to about 25%.	The Flood Risk Management Strategies should have regard for the objectives and targets set out in the strategy.
England		
The Wildlife and Countryside Act 1981 (as amended for England)	Provides the framework for protection of species other than European Protected Species. Sets out protection objectives for specified birds and wild animals.	The Flood Risk Management Strategies should have regard to the protection of species as per the Act.
The Natural Environment and Rural Communities Act 2006	All public bodies have a legal duty to 'have regard' for biodiversity in their decision-making processes.	The Flood Risk Management Strategies must have regard for biodiversity
The Conservation of Habitats and Species 2010	Implements the Habitats Directive in England and Wales on land and inshore waters (0-12 nautical miles).	The Flood Risk Management Strategies should ensure that Natura 2000 sites are protected from loss or damage.

Name of plan, programme, strategy or relevant legislation	Main objectives of plan, programme, strategy or relevant legislation	How it affects, or is affected by the Flood Risk Management Strategies in terms of SEA issues referred to in Schedule 3 of the Act
Biodiversity 2020: A strategy for England's wildlife and ecosystem services (2011)	It sets out the strategic direction for biodiversity policy in England for the next decade on land (including rivers and lakes) and at sea. By 2020, it aims to put in place measures to maintain and enhance biodiversity, to achieve an overall improvement in the status of our wildlife and to have prevented further human-induced extinctions of known threatened species.	The Flood Risk Management Strategies should look for opportunities to conserve, and where possible enhance biodiversity. They should also look for opportunities to contribute to improvements in the status of wildlife.
Soil		
European		
EU Thematic Strategy for Soil Protection, including proposals for a Soil Framework Directive (2006)	The Soil Thematic Strategy is seeking to: - Establish common principles for the protection and sustainable use of soils; - Prevent threats to soils, and mitigate the affects of those threats; - Preserve soil functions within the context of sustainable use; and - Restore degraded and contaminated soils to approved levels of functionality.	The provisions of the European Strategy should form a framework for soil protection and improvement that the Flood Risk Management Strategies should take into account.
Scotland		
Scottish Soil Framework (2009)	A high level national strategy intended to strengthen and improve the protection of soils in Scotland. It sets out a number of outcomes for soil protection including: - Protect and where appropriate, enhance soil organise matter stock - Reduce/remediate soil erosion - Maintain soil structure - Contribute to sustainable flood management - Reduce soil contamination - Reduce pressure on soils by using brownfield sites in preference to greenfield - Protect soils with significant historical and cultural features	The Soil Framework could benefit the aims of sustainable flood risk management. Flood Risk Management Strategies should consider the contribution that actions (particularly any proposed land use change or physical action) could make to deliver the outcomes of the soil framework.
Water		
European		
Water Framework Directive (2000/60/EC)	The Directive establishes a legal framework for the protection, improvement and sustainable use of surface waters, transitional waters, coastal waters and groundwater across Europe in order to: - Prevent deterioration and enhance status of aquatic ecosystems, including groundwater; - Promote sustainable water use; - Reduce pollution; and - Contribute to the mitigation of floods and droughts. Key objective is for all inland and coastal waters to achieve 'good ecological status' (or 'good ecological potential') by 2015. This is to be achieved through River Basin Management Plans.	The Flood Risk Management Strategies should, where possible, help to achieve the objectives and measures proposed in the River Basin Management Plans.

Name of plan, programme, strategy or relevant legislation	Main objectives of plan, programme, strategy or relevant legislation	How it affects, or is affected by the Flood Risk Management Strategies in terms of SEA issues referred to in Schedule 3 of the Act
Bathing Water Directive 2006 (2006/7/EC)	The Directive aims to protect the public and the environment from faecal pollution at waters used for bathing by a large number of visitors. Achieves this by making information on bathing water available to the public, and by setting standards to be met by 2015.	The Flood Risk Management Strategies should consider the contribution that actions could make towards the attainment of bathing water quality standards.
Nitrates Directive (91/676/EC)	The Nitrates Directive has the objectives of reducing water pollution caused or induced by nitrates from agricultural sources and preventing further pollution. Key requirements are the designation of Nitrate Vulnerable Zones and the establishment of action programmes in relation to these zones.	The Flood Risk Management Strategies should take into account the contribution that actions could make towards reducing nitrate pollution.
Groundwater Directive (80/68/EEC)	The Groundwater Directive aims to prevent the pollution of groundwater by certain substances.	None – the Directive will be repealed in December 2013 under the Water Framework Directive.
Groundwater Daughter Directive (2006/118/EC)	Made under the Water Framework Directive, the Daughter Directive aims to prevent and limit inputs of pollutants to groundwater. It also provides further details on criteria for assessing good groundwater status and for the identification of significant and sustained upwards trends and the starting points for trend reversal.	The Flood Risk Management Strategies should, where possible, contribute to the protection of groundwater from point source and diffuse pollution that could be caused or exacerbated by flooding.
United Kingdom		
Pollution and Prevention and Control Act 1999 (Integrates Directive (96/61/EC))	Regulating industrial and commercial activities which may cause environmental pollution and to prevent and control any emissions that are capable of causing pollution.	The Flood Risk Management Strategies should take into account any significant flood risk from Integrated Pollution Prevention and Control sites.
Coast Protection Act 1949	The Act provides Local Authorities with permissive powers to undertake works to protect the coast against erosion and encroachment by the sea.	The Flood Risk Management Strategies should take account of existing and planned works under this Act.
Shoreline Management Plans	Shoreline Management Plans are non-statutory plans that aim to identify the best approach to managing risks from flooding and coastal erosion for individual areas and the wider coast. These plans have been produced for the entire coastline of England and Wales, and a handful for Scotland.	The Shoreline Management Plans make a more detailed assessment of coastal flooding than that found in the Flood Risk Management Strategies. Flood Risk Management Strategies should be compatible with shoreline management plans.
Scotland		
Water Environment and Water Services (Scotland) Act 2003	This Act implements the requirements of the Water Framework Directive. It defines the environmental standards and conditions to help assess risks to the ecological quality of the water environment and identify the scale of improvements needed to bring those waters not in good condition back to good health. Sets out arrangements for River	The Flood Risk Management Strategy should, where possible, help to achieve the objectives and measures proposed in the River Basin Management Plans.

Name of plan, programme, strategy or relevant legislation	Main objectives of plan, programme, strategy or relevant legislation	How it affects, or is affected by the Flood Risk Management Strategies in terms of SEA issues referred to in Schedule 3 of the Act
	Basin Management Planning and Controlled Activities Regulations.	
Scotland River Basin Management Plan (2009) and Solway Tweed River Basin Management Plan (2009)	Sets out objectives and measures to improve the quality of water bodies, and protect those already in good condition. Draft plans for the second cycle are currently undergoing public consultation.	The Flood Risk Management Strategies should, where possible, help to achieve the objectives and measures proposed in the River Basin Management Plans.
Water Environment (Controlled Activities) (Scotland) Regulations 2011	A Controlled Activities Regulations authorisation is intended to control impacts on the water environment including mitigating the effects on other water users. Certain activities are permitted under the General Binding Rules; other activities require a Controlled Activities Regulations authorisation.	Actions proposed in the Flood Risk Management Strategies may require Controlled Activities Regulations authorisation, however, this would apply later on in the planning process.
SEPA Groundwater Protection Policy for Scotland v3 (2009)	This policy aims to provide a sustainable future for Scotland's groundwater resources by protecting legitimate uses of groundwater and providing a common SEPA framework to: - Protect groundwater quality by minimising the risks posed by point and diffuse sources of pollution; - Maintain the groundwater resource by authorising abstractions and by influencing developments, which could affect groundwater quantity.	Flooding can release or exacerbate pollution – the Flood Risk Management Strategies should aim, where possible, to manage significant flood risk to groundwater from flooding related pollution.
Pollution Prevention and Control (Scotland) Regulations 2000	Regulating industrial and commercial activities which may cause environmental pollution and to prevent and control any emissions that are capable of causing pollution.	The Flood Risk Management Strategies should take into account any significant flooding to Integrated Pollution Prevention and Control sites that results in pollution.
Reservoirs (Scotland) Act 2011	The Act will place a new regulatory duty upon SEPA to ensure reservoirs are monitored, inspected and maintained in accordance with the legislation to ensure their structural integrity. Currently this responsibility lies with local authorities. One part of SEPA's duties will be to assign a risk designation to all sites covered by the legislation, based on the potential adverse consequences of an uncontrolled release of water and the probability of such a release.	In future flood risk management planning cycles, the flood risk from reservoirs will be considered alongside other sources of flooding.
Catchment Management Plans	Catchment Management Plans have been developed for the: - River Annan (2003) - River Dee (2007) - River Nith (2006) - Loch Lomond (2003) - River Tweed (2010) - River Spey (2003) Each individual plan has its own specific	The Flood Risk Management Strategies should have regard for the objectives and actions identified in the Catchment Management Plans.

Name of plan, programme, strategy or relevant legislation	Main objectives of plan, programme, strategy or relevant legislation	How it affects, or is affected by the Flood Risk Management Strategies in terms of SEA issues referred to in Schedule 3 of the Act
	aims, but in general the plans aim to promote sustainable use of natural resources, to improve water quality and biodiversity.	
The Water Industry (Scotland) Act 2002 and Sewerage (Scotland) Act 1968	This gives responsibilities to Scottish Water to manage the discharge of surface water that enters its drainage systems (by providing sewers and public Sustainable Urban Drainage Systems (SUDs)) and to maintain water supplies and drainage infrastructure.	The Flood Risk Management Strategies should have regard to Scottish Water's duties under this Act.
Scottish Water Business Plan 2015 - 2021	The business plan sets out how Scottish Water will deliver improvements to drinking water quality, the environment and customer service required by Scottish Ministers. This includes: - a summary of proposed investment to improve the environment - a commitment to assess the risk of customers being affected by sewer flooding due to overloading - a commitment to work with the local authorities and SEPA to develop plans to reduce flood risk.	The Flood Risk Management Strategies should be developed with regard to the objectives and actions proposed in the Business Plan.
Metropolitan Glasgow Strategic Drainage Partnership	The Metropolitan Glasgow Strategic Drainage Partnership aims to deliver flood risk reduction, river water quality improvements, habitat improvement, integrated investment planning, and to enable economic development in the Metropolitan Glasgow area.	The Flood Risk Management Strategies should seek to coordinate with and complement the plans of the Metropolitan Glasgow Strategic Drainage Partnership.
Marine (Scotland) Act 2010	The Act provides powers for Scottish Ministers to select and manage Marine Protected Areas for the protection and enhancement of marine biodiversity and for the preservation of marine historic assets of national importance. The Act also requires Scottish Ministers to prepare and adopt a National Marine Plan, and allows for a system of regional marine planning.	The Flood Risk Management Strategies should have regard to the protection of Marine Protected Areas and should have regard to the National Marine plan.
England/ England and Wales		
Flood Risk Regulations 2009	The Regulations transpose the EU Floods Directive and set out requirements for the flood risk assessments, flood hazard and risk mapping, and the production of flood risk management plans	The Flood Risk Management Strategies should have regard to any consequences on flood risk in the cross border area, as well as the objectives and actions identified in plans produced for England.
Flood and Water Management Act 2010	The Act required the production of local flood risk management strategies setting out roles and responsibilities and objectives and measures for managing local flood risk.	The Flood Risk Management Strategies should have regard to any consequences on flood risk in the cross border area, as well as the objectives and actions identified in strategies produced for England.

Name of plan, programme, strategy or relevant legislation	Main objectives of plan, programme, strategy or relevant legislation	How it affects, or is affected by the Flood Risk Management Strategies in terms of SEA issues referred to in Schedule 3 of the Act
The Water Environment (Water Framework Directive) (England and Wales) Regulations 2003 and River Basin Management Plans	This Act implements the requirements of the Water Framework Directive in England and Wales. It defines the environmental standards and conditions to help assess risks to the ecological quality of the water environment and identify the scale of improvements needed to bring those waters not in good condition back to good health. Sets out arrangements for River Basin Management Planning.	The Flood Risk Management Strategies should, where possible, help to achieve the objectives and measures proposed in the Solway Tweed River Basin Management Plan.
Catchment Flood Management Plans	Catchment Flood Management Plans give an overview of the flood risk across each river catchment in England and Wales They recommend ways of managing those risks now and over the next 50-100 years.	The Flood Risk Management Strategies should, where relevant, have regard to the objectives and actions identified in these strategies.
River Till Restoration Strategy (2013)	The Strategy is a guide for protecting and improving the River Till.	The Flood Risk Management Strategies should have regard to the aims and actions proposed in the River Restoration Strategy.
Air – scoped out of assessment		
Climatic factors		
International		
United Nations Framework Convention on Climate Change	Sets an overall framework for intergovernmental efforts to tackle climate change. Implementation of the convention is through “protocols,” which are legally binding.	Too high level to be relevant to the Flood Risk Management Strategies, since international policy is subsumed by national policy.
European		
EU Climate change agreement 2007	EU member states agreed to cut greenhouse gas emissions by 20 per cent by 2020.	The Flood Risk Management Strategies should contribute to climate change mitigation. The targets are subsumed by Scottish legislation (see below)
United Kingdom		
Climate Change Act 2008	The Act set a statutory target for the UK as a whole to reduce greenhouse gas emissions by at least 80 per cent by 2050 and provides a framework for shared action.	The Flood Risk Management Strategies should contribute to climate change mitigation. The targets are subsumed by Scottish legislation (see below)
Scotland		
Climate Change (Scotland) Act 2009	The Act sets targets to reduce Scotland's emissions of the basket of six Kyoto Protocol greenhouse gases by at least 42% by 2020 and 80% by 2050, compared to the 1990/1995 baseline. The Act also places duties on public bodies, when exercising their functions, they must act: - in the way best calculated to contribute to delivery of the Act's emissions reduction targets; - in the way best calculated to deliver any statutory adaptation programme;	The Flood Risk Management Strategies should contribute to climate change mitigation and adaptation.

Name of plan, programme, strategy or relevant legislation	Main objectives of plan, programme, strategy or relevant legislation	How it affects, or is affected by the Flood Risk Management Strategies in terms of SEA issues referred to in Schedule 3 of the Act
	and - in a way that it considers most sustainable.	
Scotland's Climate Change Adaptation Framework (2009)	The framework plays a central role in building Scotland's resilience to the changing climate, by setting the strategic direction for Scottish Government actions and providing specific actions for different sectors (see below).	The Flood Risk Management Strategies will take climate change projections into account when assessing flood risk, setting objectives and selecting actions. Actions should, where possible, be adaptable in future to the effects of a changing climate.
Scottish Government Sector Action Plans for Water (2012)	The Sector Action Plan for Water includes flooding-related actions for SEPA: - Developing datasets to support flood risk management - Improved monitoring of flood risk - Investing in demonstration projects. - Study of impact of flows on sewerage network - Flood risk management plans - Floodline expansion	The Flood Risk Management Strategies will take climate change projections into account when assessing flood risk, setting objectives and selecting actions. Actions should, where possible, be adaptable in future to the effects of a changing climate.
Material assets		
United Kingdom		
Civil Contingencies Act 2004	The Act delivers a framework for civil protection in the United Kingdom. The Act defines the responsibilities for responders to emergency which include (among others): - assess the risk of emergencies and use to inform contingency planning - put in place emergency plans - put in place arrangements to make information available to the public about civil protection matters and to maintain arrangements to warn, inform and advise the public in the event of an emergency	The Flood Risk Management Strategies should support the requirements of responders to fulfil their statutory duties
Scotland		
Scottish Government's Infrastructure Investment Plan (2011)	The plan gives an overview of the Scottish Government's plans for infrastructure investment over the coming decades	The Flood Risk Management Strategies should take account of potential impacts (both positive and negative) of actions on existing and planned developments, and the contribution that any planned investment (e.g. into water infrastructure) might be able to make to managing flood risk.
Roads (Scotland) Act 1984	This Act empowers the roads authorities (for trunk roads) and local authorities (for other public roads), to carry out works to protect roads from flooding. The Act also empowers roads authorities to carry out various works to drain roads and to prevent surface water from flowing onto them.	The Flood Risk Management Strategies will identify areas that would benefit from Surface Water Management Plans. These management plans are likely to include a partnership approach to coordinating surface water management for roads, which should benefit the aims of both the Roads Act and the Flood Risk Management Strategies.

Name of plan, programme, strategy or relevant legislation	Main objectives of plan, programme, strategy or relevant legislation	How it affects, or is affected by the Flood Risk Management Strategies in terms of SEA issues referred to in Schedule 3 of the Act
Scottish Government Zero Waste Plan (2010)	The Zero Waste plan aims to make the most efficient use of Scotland's resources. It involves developing a waste plan for all types of waste.	The Flood Risk Management Strategies should, where relevant, aim to minimise creation of waste.
Cultural heritage		
International		
UNESCO World heritage sites	World Heritage Site status is the highest accolade of recognition of an area of globally outstanding natural and/or cultural heritage. A site requires statutory protection and management. There are five sites in Scotland.	The Flood Risk Management Strategies aim to manage any significant flood risk at world heritage sites, and should aim to prevent damage to these sites from any flood risk management actions.
United Kingdom		
Ancient Monuments and Archaeological Areas Act 1979 (as amended by Historic Environment (Amendment) (Scotland) Act 2011)	Protects ancient monuments, including monuments on the foreshore and underwater. It is an offence to carry out, without the prior written consent of the Scottish Ministers (scheduled monument consent), any works which would have the effect of demolishing, destroying, damaging, removing, repairing, altering, adding to, flooding or covering up the monument.	The Flood Risk Management Strategies should have regard to protecting scheduled monuments from flood risk and to preventing damage from the implementation of flood risk management actions.
Scotland		
Scottish Historic Environment Policy (2011)	One of the key outcomes of the policy framework for the historic environment is that the historic environment is cared for, protected and enhanced for the benefit of our own and future generations. Scottish Ministers' policies on the designation of sites and structures which are particularly important features of the historic environment.	The Flood Risk Management Strategies should have regard to the protection of the historic environment.
Planning (Listed Buildings and Conservations Areas) (Scotland) Act 1997 (as amended by Historic Environment (Amendment) (Scotland) Act 2011)	A system to protect and control changes to historic buildings. Any work which affects the character of a listed building or structure will require listed building consent.	The Flood Risk Management Strategies should have regard to the protection of listed buildings (where appropriate to do so at a strategic level of assessment).
Marine (Scotland) Act 2010	The Act enables Scottish Minister to designate part of a Marine Protected Area as a Historic Marine Protected Area. Scottish Ministers can make Marine Conservation Orders to support stated preservation objectives for Historic Marine Protected Areas.	The Flood Risk Management Strategies should have regard to the protection of Marine Protected Areas.
Landscape		
International		

Name of plan, programme, strategy or relevant legislation	Main objectives of plan, programme, strategy or relevant legislation	How it affects, or is affected by the Flood Risk Management Strategies in terms of SEA issues referred to in Schedule 3 of the Act
UNESCO World heritage sites	World Heritage Site status is the highest accolade of recognition of an area of globally outstanding natural and/or cultural heritage. A site requires statutory protection and management. There is one Landscape World Heritage Site in Scotland – the islands of St Kilda.	SEPA's National Flood Risk Assessment has not identified St Kilda as an area of significant flood risk so it will not be affected by the Flood Risk Management Strategies.
European		
European Landscape Convention	The European Landscape Convention is a Council of Europe initiative that highlights the importance of all landscapes and encourages more attention to their care and planning. The UK signed up to the convention in 2006, and it now provides a framework for our work for Scotland's landscapes. Public authorities are encourage to adopt policies and measures at local, regional, national and international level for protecting, managing and planning landscapes.	The Flood Risk Management Strategies should have due consideration to protecting landscapes.
Scotland		
National Parks (Scotland) Act 2000	This Act enables the creation of National Parks, which aim to: (1) to conserve and enhance the natural and cultural heritage of the area, (2) to promote sustainable use of the natural resources of the area, (3) to promote understanding and enjoyment (including enjoyment in the form of recreation) of the special qualities of the area by the public, and (4) to promote sustainable economic and social development of the areas communities, and that in cases of conflict of these aims, the national park authority must give priority to aim (1). There are two national parks in Scotland: - Cairngorms National Park - Loch Lomond and the Trossachs National Park	The Flood Risk Management Strategies should have regard to the purposes of the National Parks and the National Park Plans.
Ancient Monuments and Archaeological Areas Act 1979	Requires Ministers to compile and maintain a list of designated gardens and landscapes of national importance.	The Flood Risk Management Strategies should give due consideration to impacts on designated landscapes.
The Town and Country Planning (Development Management Procedure) (Scotland) Regulations 2008	Planning authorities must consult Scottish Ministers on 'development which may affect a historic garden or designed landscape'	The Flood Risk Management Strategies should give due consideration to impacts on designated landscapes.

Name of plan, programme, strategy or relevant legislation	Main objectives of plan, programme, strategy or relevant legislation	How it affects, or is affected by the Flood Risk Management Strategies in terms of SEA issues referred to in Schedule 3 of the Act
Town and Country Planning (Scotland) Act 1997, as amended by the Planning etc (Scotland) Act 2006	The Act enables the identification of National Scenic Area (as an area "of outstanding scenic value in a national context") and to ensure it is protected from inappropriate development.	The Flood Risk Management Strategies should aim to ensure that actions to manage flood risk to do not adversely affect National Scenic Areas.
England and Wales		
National Parks and Access to the Countryside Act 1949.	This Act enables areas of England and Wales to be designated as National Parks (protected by law for future generations because of their natural beauty and for the opportunities they offer for open air recreation) and Areas of Outstanding Natural Beauty. An area of high scenic quality which has statutory protection in order to conserve and enhance the natural beauty of its landscape). Of potential relevance to the Flood Risk Management Strategies for Scotland are: - Northumberland National Park - Solway Coast Area of Outstanding Natural Beauty	The Flood Risk Management Strategies should have regard to the purposes of National Parks ((1) To conserve and enhance their natural beauty, wildlife and cultural heritage; (2) To promote opportunities for the public understanding and enjoyment of these special qualities.) The Flood Risk Management Strategies should have regard to the purposes of the Solway Coast Area of Outstanding Natural Beauty.
The Countryside and Rights of Way Act 2000.	The Countryside and Rights of Way Act brought in new measures to further protect Areas of Outstanding Natural Beauty. All public bodies have a duty of regard for the purposes of Areas of Outstanding Natural Beauty when undertaking their work.	The Flood Risk Management Strategies should have regard to the purposes of the Solway Coast Area of Outstanding Natural Beauty and any management plan for the area.
Planning and the environment (Cross cutting)		
Scotland		
Scottish Planning Policy (2014)	Scottish Planning Policy (SPP) is the statement of the Scottish Government's policy on nationally important land use planning matters. It introduces a presumption in favour of development that contributes to sustainable development. This means that planning policies and decisions making should: - Support the delivery of infrastructure (including water); - Support climate change mitigation and adaptation including taking account of flood risk; - Improve health and well-being by offering opportunities for social interaction and physical activity, including sport and recreation; - Have regard to the principles for sustainable land use set out in the Land Use Strategy; - Protect, enhance and promote access to cultural heritage, including	Any development associated with or likely to arise out of the Flood Risk Management Strategies should contribute to the aims of the SPP. The aims of the SPP should help achieve sustainable Flood Risk Management by ensuring developments are sited appropriately and that flood risk is taken into account in planning decisions. The Flood Risk Management Strategies should contribute to delivery of SPP aims by - setting objectives and actions related to land use planning - reducing risk to life and impacts on human health - by reducing overall flood risk - help to protect or improve recreational access /open space.

Name of plan, programme, strategy or relevant legislation	Main objectives of plan, programme, strategy or relevant legislation	How it affects, or is affected by the Flood Risk Management Strategies in terms of SEA issues referred to in Schedule 3 of the Act
	the historic environment; - Protect, enhance and promote access to natural heritage, including green infrastructure, landscape and the wider environment; - Reduce waste, facilitating its management and promoting resource recovery; and - Avoid over-development, protect the amenity of new and existing development and consider the implications of development for water, air and soil quality. Of particular relevance are SPP policies relating to: - Sustainable development - Climate change - Place making - Green Infrastructure - Valuing the historic environment - Valuing the natural environment - Flooding and drainage - Coastal Planning	
National Planning Framework 3 (2014)	National Planning Framework 3 is a long term strategy for Scotland that provides the spatial expression of the Government's Economic Strategy and plans for the development and investment in infrastructure. It identifies national developments and other strategically important development opportunities in Scotland. It shows opportunities for growth and regeneration, investment in the low carbon economy, environmental enhancement and improved connections across the country. It states the Scottish Government's expectations that flood risk management plans should become an integral part of strategic and local development planning. It identifies the importance of flood management for regional development in specific areas such as Stirling, Hawick, Selkirk, Galashiels and Grangemouth.	The Flood Risk Management Strategies should aim to tie in with the long-term objectives of the National Planning Framework. The Flood Risk Management Strategies will identify areas at risk of flooding. Objectives and actions, such as avoiding an increase in flood risk and promoting the use of Strategic Flood Risk Assessment, should help to inform the development planning.

Name of plan, programme, strategy or relevant legislation	Main objectives of plan, programme, strategy or relevant legislation	How it affects, or is affected by the Flood Risk Management Strategies in terms of SEA issues referred to in Schedule 3 of the Act
Planning Advice Notes (PANs) PAN 61, 69 and 79 are currently under review and will be replaced by one consolidated PAN	PANs provide advice and information on technical planning matters. Those most relevant include: - PAN 61 Sustainable Urban Drainage Systems - PAN 69 Flooding - PAN 79 Water and Drainage - PAN 65 Planning and Open Space - PAN 60 Natural Heritage - PAN 2 / 2011 Planning and Archaeology - PAN 71 Conservation Area Management	Any development associated with or likely to arise out of the Flood Risk Management Strategies should align with the advice contained in the relevant PANs. The Flood Risk Management Strategies should contribute to delivery of PAN aims by - setting objectives and actions related to land use planning - reducing risk to life and impacts on human health - by reducing overall flood risk - help to protect or improve recreational access /open space.
Town and Country Planning (Scotland) Act 1997, as amended by the Planning etc (Scotland) Act 2006	The Act requires Councils and national park authorities to prepare a development plan for their area: - Strategic development plans set out a vision for the long term development of the city regions and deals with region wide issues such as housing and transport. - Local development plans set out where most new developments will happen and policies that will guide decision making and planning applications. - Supplementary guidance provides more detailed guidance on specific issues.	The Flood Risk Management Strategies should contribute to delivery of development planning by - setting objectives and actions related to land use planning - by reducing overall flood risk - help to protect or improve recreational access /open space.
Scottish Government (2011) Land Use Strategy for Scotland	The Strategy sets outs a long term vision of land use towards 2050, with principles to support the sustainable use of land. These include: - Encouraging land use to deliver multiple benefits - Recognising value of land suited for a primary use (e.g. food production, flood management) in decision making - Decisions based on ecosystem functions and maintaining ecosystem services - Positive and sympathetic management of landscape change - Reducing greenhouse gas emissions associated with land use - Prioritising use of derelict and vacant land - Encourage provision of accessible green space	The Flood Risk Management Strategies should support the Land Use Strategy.
The Environment Act 1995, as amended by the Regulatory Reform (Scotland) Act 2014	Provides a new general purpose for SEPA to carry out its functions for the purpose of protecting and improving the environment (including managing natural resources in a sustainable way). SEPA must also, except where it would be inconsistent with protecting and	The Flood Risk Management Strategies should be developed to ensure that SEPA meets it new general purpose.

Name of plan, programme, strategy or relevant legislation	Main objectives of plan, programme, strategy or relevant legislation	How it affects, or is affected by the Flood Risk Management Strategies in terms of SEA issues referred to in Schedule 3 of the Act
	improving the environment, contribute to improving the health and well being of the people of Scotland and contribute to achieving sustainable economic growth.	
England		
National Planning Policy Framework (2012) and associated policy and guidance	The National Planning Policy Framework sets out planning policies for England which protect the environment and promote sustainable growth. It also sets out how they are expected to be applied and contains guidance for local planning authorities.	Any development associated with or likely to arise out of the Flood Risk Management Strategies and which impacts on English territory should align with the policy and advice contained in the National Planning Policy Framework and relevant associated policy and guidance.

Appendix 4: Environmental assessment method: supporting information

This appendix provides supporting information on the assessment method described in section 4.

Ecosystems and condition
The assessment considers the effects of flood risk management actions on nine ecosystems. These ecosystems are broad habitat classes (formed from the 23 land cover classes) used by the European Nature Information System of habitat classification. They are recommended for use in Ecosystem Service assessment by the European Environmental Protection Agency under its Mapping and Assessing Ecosystem Services Project.

Table A4.1 lists the ecosystems and their extent within Scotland. The geographical distribution of the ecosystems across Scotland can be seen in figure A4.

To determine ecosystem condition for each LPD, we used the information collected for the national environmental baseline (section 3) supplemented with additional data sources where available including:

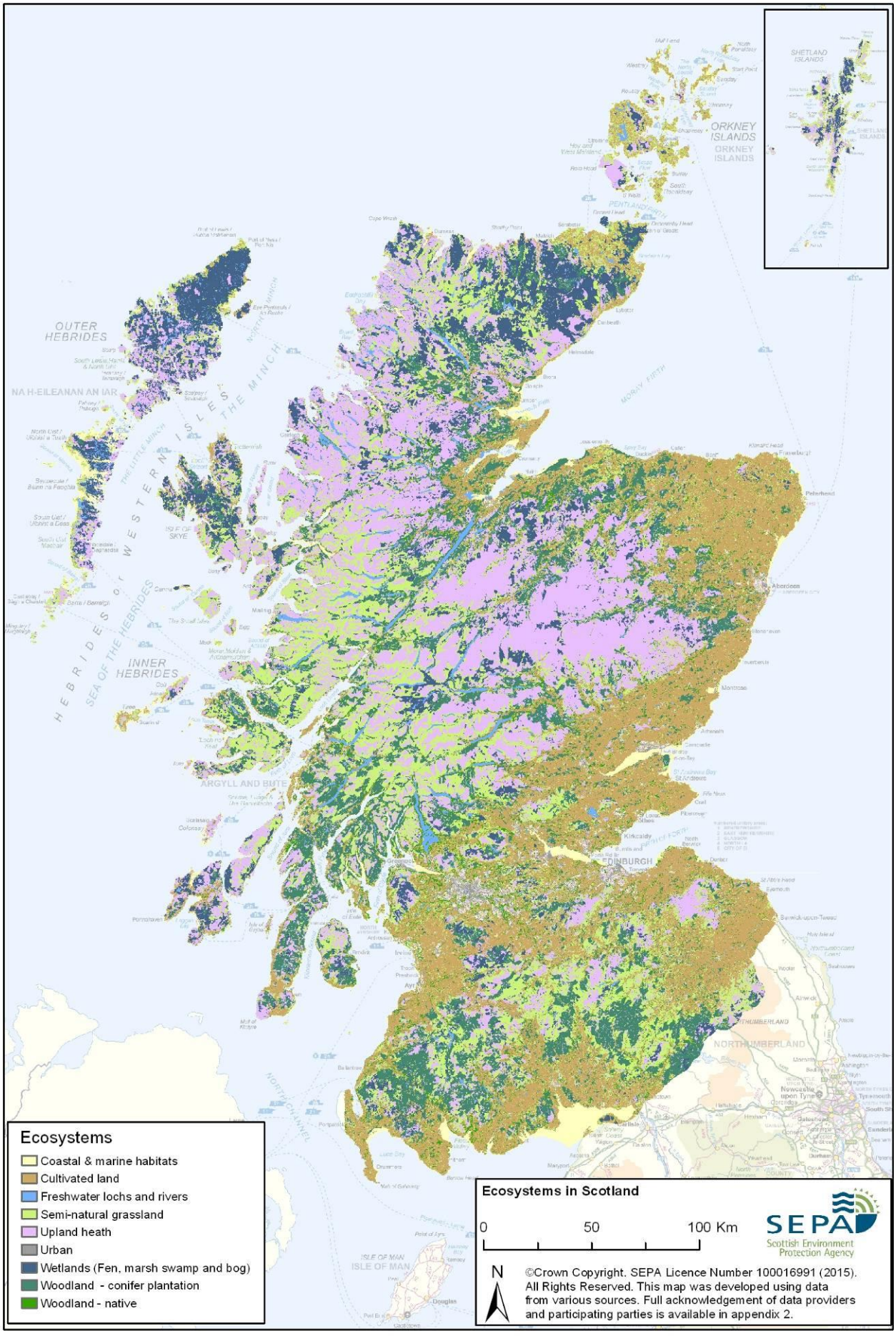
- SNH site condition monitoring for SSSIs, SACs and SPAs
- Scotland's environment web: woodland distribution map
- SEPA Water Framework Directive classification data 2013
- SEPA Bathing Waters classification data 2013
- Scottish Government Marine Atlas: regional summaries
- SEPA draft Flood Risk Management Strategies
- SNH maps of salt marsh, sand dunes and shingle

Table A4.1: Land cover of Scotland by ecosystem

Ecosystem	Land cover class and type	% cover Scotland[27]
Woodland – native	1. Broadleaved woodland	3
Woodland - conifer plantation	2. Coniferous Woodland	13
Farmland	3. Arable and Horticulture	23
	4. Improved Grassland	
Semi-natural grassland	5. Rough grassland	20
	6. Neutral Grassland	
	7. Calcareous Grassland	
	8. Acid grassland	
Wetlands (Fen, marsh swamp and bog)	9. Fen, Marsh and Swamp	10
	12. Bog	
Upland heath	10. Heather	27
	11. Heather grassland	
	13. Montane Habitats	
	14. Inland Rock	
Freshwater lochs and rivers	16. Freshwater	2
Coastal & marine habitats	15. Saltwater	1
	17. Supra-littoral Rock	
	18. Supra-littoral Sediment	
	19. Littoral Rock	
	20. Littoral sediment	
	21. Saltmarsh	
Urban	22. Urban	2
	23. Suburban	

[27] Centre for Ecology and Hydrology Land Cover Map 2007

Figure A4: Distribution of ecosystems in Scotland



Ecosystem services

The ecosystem services used for the assessment have been grouped according to the Common International Ecosystem Services classification (version 4.3). This classification is recommended for use in ecosystem services assessments by the European Environmental Protection Agency under its Mapping and Assessing Ecosystem Services Project. This classification uses three groups of services (regulating and maintaining; provisioning; cultural) and within these three groups splits the ecosystem services. Some ecosystem services have been renamed to make the assessment relevant to a Scottish content (table A4.2).

The most relevant ecosystem services for each LPD are described in appendices 5 – 18. The key data sources used are listed in table A4.2. Other general sources of data used to obtain a picture of the LPD included:

- Local authority and National Park websites
- Tourist information websites
- SNH SSSI site management statements

Table A4.2: Ecosystem services and data sources

Ecosystem service group	Ecosystem services	Description of service	Key data sources
Regulating & Maintaining	Carbon storage	Storing and sequestering carbon in soils, sediments and vegetation to help mitigate climate change and help with global climate regulation	▪ James Hutton Institute soil organic carbon concentration map ▪ Centre for Ecology and Hydrology Land Cover Class Map 2007
	Local climate regulation	Modifying temperature, humidity of the local environment by elements of the ecosystem. For example the cooling and wind protection provided by trees such as plants	▪ No specific data sources
	Air purification	Filtering of air pollutants provided by absorption, binding and filtering by ecosystem elements	Scoped out of this SEA
	Noise regulation	Visual and noise screening from transport corridors and other developments by for example trees	Scoped out of this SEA
	Water quality regulation	Dilution, dispersion, absorption, denitrifying and filtering by elements of the ecosystem such as plants, shell fish and bacteria	▪ No specific data sources
	Pollination	Using the natural interaction between plants and insects to enable the provision of food and materials used by people. It is key to have sources of pollinating plants and hibernating areas to support insect survival even if these are not used directly by people.	▪ No specific data sources
	Pest & disease mechanisms: biological control	Using the natural interaction between elements of the ecosystem to limit the spread and impact of pest and diseases. This includes for example using natural predators to control insect pests to crops, and diverse tree species and woodland structure to limit rapid spread of fungi that damage tree crops	▪ No specific data sources
	Wave and surge attenuation	Reducing the energy of waves or sea surge to damage infrastructure and property through the structure and elements of the ecosystem binding	▪ SEPA draft Flood Risk Management Strategies

Ecosystem service group	Ecosystem services	Description of service	Key data sources
		sediments and absorbing energy	
	Water flow regulation	Reducing the rate of flow, storing and retaining water to reduce the risk of flooding to property and infrastructure through the structure and elements of the ecosystems.	
	Erosion protection	Using the natural interactions between elements of the ecosystem to manage damage to infrastructure from erosion and landslides. For example through: soils storing water, vegetation cover slowing surface water run off; tree roots reducing bank erosion, salt marsh plants and animals binding sediment.	
Provisioning	Nutrition: food provision	Providing crops, farmed and wild foods for people to eat	▪ James Hutton Institute Agricultural Land Capability Class data ▪ Scottish Government Active Marine Finfish and Shellfish farming sites ▪ Scottish Government salmon and sea trout catch statistics
	Water supply (drinking)	Storing and filtering water so that it is available for people to use for drinking	▪ Drinking water protected areas (Scottish Government website)
	(Non–food) Biotic materials: timber, biofuels, hydropower	Providing materials for people to use to produce products, medicines or energy	▪ Scotland's environment web: location of woodland timber processing sites; ▪ Forestry Commission District Forest Strategies
Cultural	Recreation (physical interaction)	The use of different settings to provide for formal and informal activities such as kayaking, walking, mountaineering and the links to tourism from these activities	▪ SEPA River Basin Management Planning consultations on current condition and challenges for the future ▪ Scottish Government National Marine Planning Interactive datasets on marine recreation ▪ SNH National Nature Reserves locations
	Accessible nature/wildlife experience	The use of different settings to provide the views of nature such as dolphin and bird watching, and diving and the links to tourism from these activities	
	Spiritual and cultural amenity	The use of different setting to provide spiritual or cultural significance, such as the enjoyment of land and seascapes, sense of place, opportunities for art and photography.	▪ SNH Wild Land dataset ▪ Locations of National Scenic Areas and National Parks ▪ Locations of protected historic sites ▪ Scottish Government National Marine Planning Interactive datasets on coastal protected historic environment

Appendix 5: Environmental assessment of the Flood Risk Management Strategy for Highland and Argyll

This appendix presents the current state of the environment and the assessment of significant environmental effects for the Flood Risk Management Strategy for the Highland and Argyll Local Plan District (LPD). The purpose of this is to:

- Identify relevant information on the current state of the environment for the Highland and Argyll LPD. This information supplements the description of the current state of Scotland's environment (section 3 of the main Environmental Report).
- Report the significant environmental effects of the actions proposed to manage flood risk in the Highland and Argyll LPD.
- Identify mitigation of significant negative effects and opportunities to deliver wider benefits.
- Recommend further assessment at more detailed planning stages e.g. feasibility studies or design stages.

The overall assessment for all 14 Flood Risk Management Strategies is summarised in section 5 of the main Environmental Report.

A5.1 The Highland and Argyll Local Plan District

The Highland and Argyll LPD (figure A5) covers the northern area of Scotland with a total area of approximately 29,110km^2 and has a coastline approximately 4,190km in length. The population of the LPD is approximately 279,000. The LPD includes the Inner Hebrides which consists of 35 habited islands and a further 44 uninhabited islands. Inverness is the only city in the LPD with a population of over 55,000; the next two largest settlements are Fort William and Oban, with populations of less than 10,000.

There are 40 PVAs within the LPD; these are mainly located close to the coast. The largest source of flooding in the LPD is coastal flooding (which contributes 48% of the Annual Average Damages[1]), followed by river flooding (42% of Annual Average Damages). Surface water flooding contributes around 10% of Annual Average Damages. The source catchments for river flooding in the LPD and the PVAs cover 22% of the LPD. Therefore the analysis for this assessment has been undertaken for the area covered by PVAs and their source catchments rather than the whole LPD.

A range of non-structural and structural actions are being considered to manage flooding in this LPD. Table A5.1 summarises the range of structural actions being considered.

[1] An indicative estimate of the direct economic costs of flooding impacts to residential properties, non-residential properties and agriculture

Figure A5: Highland and Argyll LPD and PVAs

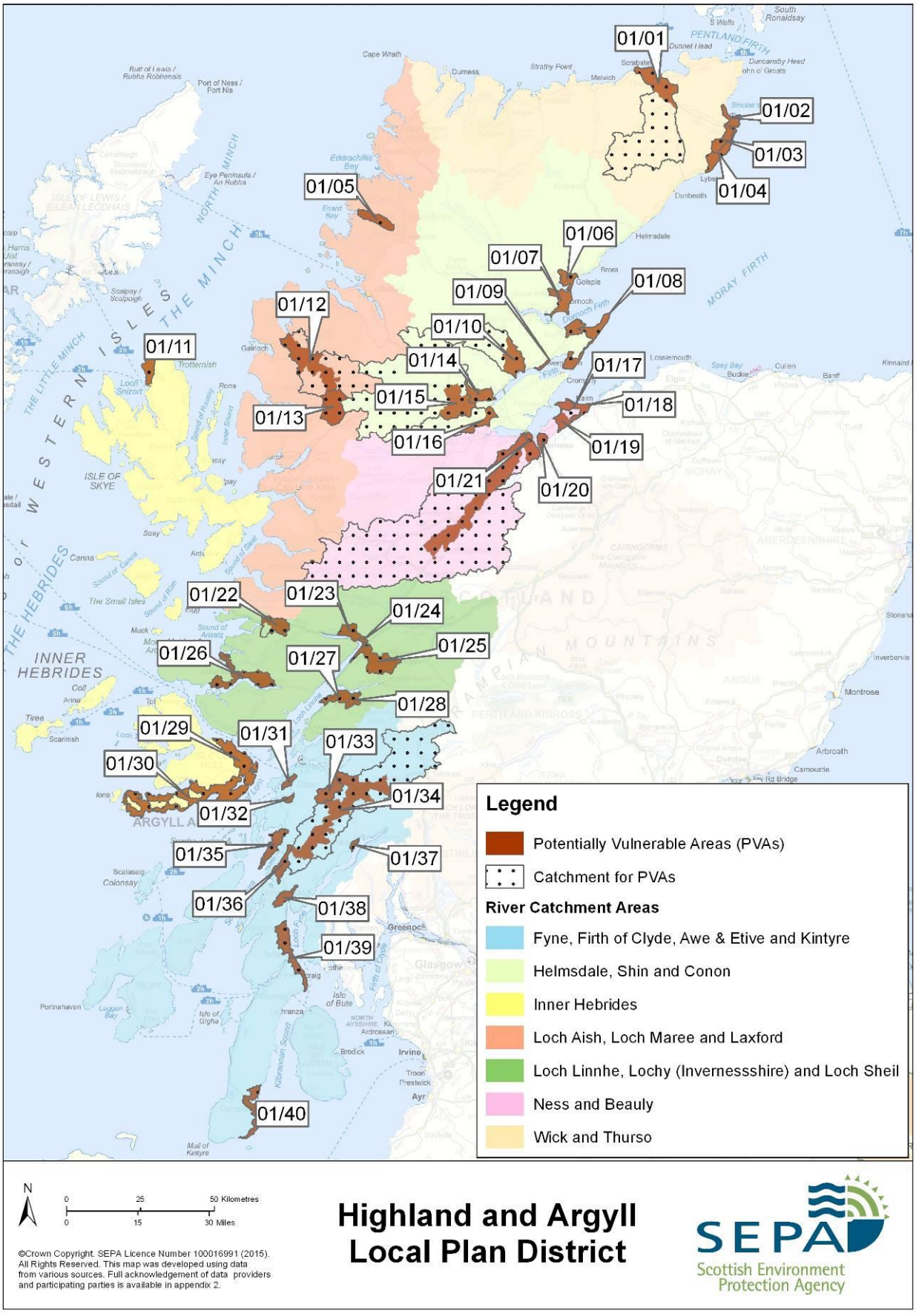


Table A5.1: Shortlisted actions in the Highland and Argyll LPD

Action	Shortlisted for the following PVAs
Run off reduction	01/05, 1/10, 01/13, 01/14, 01/15, 01/21, 01/25, 01/28, 01/31, 01/33, 01/34, 01/38, 01/40
River and floodplain restoration	01/01, 01/03, 01/04, 01/07, 01/10, 01/13, 01/14, 01/15, 01/16, 01/17, 01/18, 01/21, 01/25, 01/28, 01/31, 01/33, 01/34, 01/38, 01/40
Storage conveyance and control	01/01, 01/03, 01/04, 01/07, 01/10, 01/13, 01/14, 01/15, 01/16, 01/17, 01/18, 01/21, 01/25, 01/28, 01/31, 01/33, 01/34, 01/38, 01/40
River defences	01/01, 01/03, 01/04, 01/05, 01/07, 01/10, , 01/13, 01/14, 01/15, 01/16, 01/17, 01/18, 01/21, 01/25, 01/28, 01,31, 01/33, 01/34, 01/38
Coastal restoration	01/06, 01/08, 01/17, 01/21
Coastal defences	01/01, 01/06, 01/08, 01/14, 01/17, 01/18, 01/21, 01/24, 01/25, 01/28, 01/30, 01/31, 01/33, 01/37, 01/39, 01/40

A5.2 Environmental and policy context for the Highland and Argyll LPD

Section 2.2 and Appendix 3 of the main Environmental Report identify the relationships between the Flood Risk Management Strategies and other plans, programmes and strategies.

A5.3 Additional relevant information on the current state of the environment for Highland and Argyll

This sub section identifies relevant information on the current state of the environment for the Highland and Argyll LPD. This information supplements the description of the current state of Scotland's environment (section 3 of the main Environmental Report).

A5.3.1 Ecosystems and condition

The ecosystems present in the PVAs and source catchments and their condition are summarised in Table A5.2. From analysis of the ecosystem extent and condition the ecosystems which have potential for a significant effect on their condition through actions in the strategy are: native woodland, upland heaths, wetlands especially blanket bogs, freshwater rivers and lochs, and coastal and marine.

Table A5.2. Ecosystems within the LPD

Ecosystem	Area (% of PVA catchment in 2007)	Condition of ecosystem
Woodland - native	3	Native woodland, which includes west Atlantic oak woods, alder woods and native pinewoods, is a small proportion (less than 3%) of the PVA catchments. Many native woodlands are in mixed condition.
Woodland - conifer plantation	14	Over 14% of the PVA catchments are conifer plantations. The conifer plantations vary in quality and age structure. In the Argyll area, plantations are predominately Sitka spruce but in the other areas, the plantations are more mixed. There is restoration of plantations to native woodlands on ancient woodland sites and plans to increase diversity and improve age class and structure of plantations. Forestry is a contributing factor to diffuse pollution pressures on the water environment.

Ecosystem	Area (% of PVA catchment in 2007)	Condition of ecosystem
Cultivated land	8	Nationally between 1998 and 2007, the land area used for arable farming and horticulture declined by 13%, whereas improved grassland expanded by 9%. There are no diffuse pollution catchments within this LPD, although arable and mixed farming is a contributing factor to diffuse pollution pressures on the water environment. This indicates there is potential degradation and erosion of soils.
Semi-natural grassland	25	Semi -natural grassland cover 24% of the PVA catchments - and there are only limited areas designated so its condition is uncertain.
Wetlands (fen, marsh, and swamp; bog)	10	Wetlands cover 10% of the PVA catchments, with blanket bog being the most extensive wetland type. Within designated sites, wetland features are in mixed condition.
Upland heath	34	Upland moorland and mountain habitats cover 34% of the PVA catchments. Nationally, recent improvements mean that most features are now in favourable condition and are improving. This was reflected in the site condition information for protected sites in the area.
Freshwater lochs and rivers	4.5	A significant proportion of Scotland's freshwater lochs and rivers are found within the PVA catchments (18%). This is a key area in Scotland for this ecosystem. Overall water bodies are at good WFD status or better condition within the LPD, although a small number of river and loch water bodies are in less than good WFD status for water quality and/or the condition of beds and banks. Water bodies are generally natural except where they are heavily modified for hydro power and drinking water.
Coastal & marine	<0.5*	The coast associated with the PVAs is very diverse and of high quality as represented by its designation of a number of Marine Protected Areas. Generally the physical condition of coastal water bodies is good according to WFD classification. However the condition of designated sites is mixed.
Urban	1	The largest settlement is Inverness where green space and its links to the wider countryside become significant. Whilst green space is described in the Local Development Plan for Inverness there is no assessment of its current quality or proposals to extend it.

*The majority of the coastal and marine ecosystem extends beyond the terrestrial LPD boundary so is not captured in this figure

There are many environmental sites of European and national importance in the PVAs and their source catchments: 30 Special Areas of Conservation (SAC), 27 Special Protection Areas (SPAs), and 111 Sites of Special Scientific Interest (SSSIs). The major protected sites are listed below:

- The Loch Maree catchment contains protected sites (e.g. Loch Maree Complex SAC) associated with PVAs 01/12 and 01/13. The woodlands are in mixed condition. Pressures include grazing by deer and the presence of non-natives species e.g. rhododendron. There has already been extensive native woodland planting linking up fragments of designated woodland.

• Caithness and Sutherland Peatlands SAC (upper catchment of PVA01/01) contains blanket bog, some of which (Blar Nam Faoleag and Coir na Beinne Maes SSSIs) is in unfavourable condition. It is important to maintain the natural water table in peatland habitats so no new drains should be made, nor existing ones cleared. It would be beneficial to block old drains that are still active.
• Glencoe SAC/SSSI (PVA 01/28) contains upland mosaic that is in unfavourable condition. Features in Ben Nevis SAC/SSSI (PVAs 01/24 and 01/25) are in mixed condition: open habitats are in favourable condition except vascular plants. Pressures are related to grazing.
• River Thurso SAC is designated for Atlantic salmon (PVA01/01), which is in unfavourable recovering condition. River Moriston SAC (PVA 01/21) is designated for freshwater pearl mussels (unfavourable no change) and Atlantic salmon (unfavourable recovering).
• Fleet SSSI (Golspie PVA 01/06 and 01/07) contains features such as sand dunes and eel grass beds that are in unfavourable declining condition; Sunart SAC/SSSI: features are in mixed condition with saltmarsh in unfavourable recovering condition (PVA 01/26); Moray Firth SAC includes sandbanks and dolphins as features (PVA01/07, 01/08) but there is no information on condition; Sound of Arisaig SAC (PVA 01/26) is designated for sub-littoral banks, maerl beds and eels grass but there is no information on condition.

There are seven Marine Protected Areas, including East Caithness Cliffs (PVA01/03), Wester Ross (PVA01/12), Sea of Hebrides (PVA 01/26, 01/29, 01/30, 01/31, 01/32, 01/35), Upper Loch Fyne (PVA01/37). There is currently no information on condition of these sites as they have just recently been designated.

A5.3.2 Ecosystem services

This sub section summarises the major ecosystem services to take account of those in the PVA catchments within this LPD.

Regulating and maintaining services

- Water flow is regulated by the areas of existing woodland, especially native woodland, and by un-drained blanket bog and moorland vegetation that is not intensively managed. There has been extensive planting of native woodland in some PVAs already (e.g. Loch Maree (PVAs 01/12 and 01/13)), which as they develop will contribute to water flow regulation.
- Much of the coast line is hard coast with pocket beaches, with localized areas of erosion. The main exception to this is the areas of soft coast around the Firths in the east of the area (PVAs 01/17- 01-20). These are the areas where sand dunes and saltmarshes provide natural wave attenuation and erosion protection to coastal areas behind.
- The majority of the PVA catchments have large areas of carbon rich peat soils, which are associated with wetland and moorland. In a Scottish context, these are core areas for carbon storage in soil to help mitigate climate change. The soils in the coastal PVAs around the Moray Firth (PVAs 01/17-01/20) and the lower parts of the Thurso (PVA 01/01) catchment provide less carbon storage.
- Pollination services throughout the area contribute to products such as wild berry and other wild foods. The lower lying land closer to settlements and the coast are used for producing food where pollination services are essential for producing vegetables and fruit. Key PVA catchments are adjacent to the Moray Firth (PVAs 01/17-01/20) and the lower catchment at Thurso (PVA 01/01).
- Extensive monocultures such as single species conifer plantations in Argyll and heaths managed predominately for ling heather for grouse are at greater risk from pest and disease. Management which diversifies the structure and species of these areas reduces susceptibility to disease.

Provisioning Services

- Black Isle and Dornoch Firth areas north of Inverness contain major areas of cultivated land producing fruit and vegetables (PVAs 01/07- 01/20). Smaller scale production of meat, fruit and vegetables also takes place along the coast and in floodplains.
- Commercial fishing takes place in the Highlands and Argyll area. Shellfish catches are particularly important to a number of areas, including Wick (PVAs 01/03, 01/04), Wester Ross (PVAs 01/12, 01/13), the coast of Argyll (PVAs 01/31, 01/32, 01/35 01/40) and Mull

(PVA 01/35). There are limited scallop fishing areas close to Thurso (PVA 01/01), Wick (PVAs 01/01-01/04). Moray Firth, and Loch Gilphead (PVA 01/39). The good water quality and fast flows of water means that there are key areas for shell fish and fin fish farming are Dornoch Firth (PVAs 01/07,01/08), Loch Etive (PVAs 01/31, 01/33, 01/34), Mull (PVAs 01/29, 01/30), Loch Mefort (PVA 01/35) and Loch Fyne (PVAs 01/39, 01/38, 01/37).

- Rivers and lochs are an important source of drinking water supply, with 26 out of 40 PVA catchments containing areas that are protected for supply of drinking water from rivers and lochs.
- Timber production is important in the Highlands and Argyll area, particularly within the Great Glen and Argyll. There are two major saw mills within the area. Wood fuel is currently small scale and typically supplied from surplus timber and wind blow.
- There are small areas of land suitable for arable based biofuels. The main sources of biofuels within this LPD are from woodland.

Cultural services

- The area is actively promoted to tourists for walking, watersports, cycling, mountain biking, snow sports, angling (sea, river and loch), climbing, horse riding, country sports and wildlife watching (e.g. golden eagles, seals, whales, dolphins, puffins).
- The coast associated with the PVAs is a key area for diving (for example, the west cost sea lochs, the Sound of Mull and the Moray Firth). Beaches with rural seaside awards are predominately on the east coast and surfing locations are on the coast by Thurso and Wick.
- Landscape is particularly important. There are protected landscapes in the form of seven National Nature Reserves, seven National Scenic Areas and one National Park.
- 16 of the Scottish Wild Land areas intersect the PVA catchments. These areas have a distinct and special character, which is increasingly rare to find and many people derive psychological and spiritual benefits from their existence, and they provide increasingly important havens for Scotland's wildlife. These areas are recognized as high value landscapes that are sensitive to development.
- There are hundreds of cultural sites within the PVA catchments: the majority of these are scheduled ancient monuments and prehistoric sites. Some of these monuments are canals such as the Caledonian and Crinan Canals. Wetland ecosystems are good at preserving archaeology.

A5.4 Environmental assessment of the Flood Risk Management Strategy for Highland and Argyll

This sub section provides an assessment of the potential environmental effects of the flood risk management actions under consideration for the PVAs within this LPD. The effects on SEA topics and on ecosystem services are reported under each group of actions. Table A5.9 compares the effects of different groups of actions on ecosystem services.

A5.4.1 Non-structural actions

A range of non-structural actions are being considered for the LPD such as property level protection, relocation of properties / infrastructure away from flood risk areas and flood warning schemes. These actions help to reduce the impacts of flooding and therefore are likely to have significant positive effects on the SEA objectives for human health and material assets. These effects have been assessed nationally rather than at an LPD level and the results are presented in section 4 of the main Environmental Report.

As these actions help to reduce the impacts of flooding rather than the probability of flooding, they are likely to have no or negligible effects on ecosystems and ecosystem services.

A5.4.2 Run off reduction actions

Actions to reduce run off include woodland and gully woodland planting, upland drain blocking, land management, creation or restoration of wetlands and ponds, and shelter belts. These actions are being considered for thirteen PVAs.

All SEA topics and ecosystems may be affected by these actions: either directly (where an action impacts on the ecosystem in which the action is located) or indirectly (e.g. where the freshwater ecosystem benefits from arising land use change and management). The potential effects of the actions are described in the text below and summarised by SEA topic in table A9.3.

Table A9.3 Run off reduction: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	+ + Benefits to connectivity and health of wetland ecosystems, upland heath and cultivated land	Actions should be implemented in line with good practice, avoiding creating sediment that might damage sensitive aquatic species. Site selection for any woodland planting in upland heath should be undertaken with care to avoid impacting on rare dwarf shrub heath. Similarly, actions should avoid causing any further fragmentation of native woodlands in upland areas.
Population and human health	+ + Benefits to flood risk reduction and protection of human health	
Soil	+ + Benefits to safeguarding carbon rich soils	Opportunities to protect carbon rich soils where run off actions are targeted at wetland ecosystems. Design stages should consider protecting livestock from potential exposure to pests. Consultation with land managers recommended
Water	+ + Benefits by enhancing water quality and reducing sedimentation	Opportunities to improve water quality when actions are located in wetland and upland heath ecosystems
Climatic factors	+ + Benefits to carbon storage through wetland enhancement	Opportunities to protect carbon rich soils where run off actions are targeted at wetland ecosystems particularly blanket bogs.
Material assets	+ + Benefits to flood risk reduction and protection of properties and infrastructure	
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	Landscape change should be assessed again once more information is available on the type of action and its location. Therefore landscape character assessments should be used to inform specific actions as part of any feasibility studies.

Commentary on potential significant effects

Regulating and maintaining services

Run off reduction actions help to slow and store water by intercepting rainfall (e.g. woodlands) and/or increasing the extent to which the land can hold any water reaching the ground (both by slowing down the flow of run off and increasing the permeability of soils). This in turn can help to regulate the flow of water by reducing the amount of water reaching rivers and slowing or reducing flood flows: this helps to protect people and properties from flooding.

These actions can lead to improvements in water quality by helping to protect soils from erosion (thus reducing the sediment reaching rivers) and increasing infiltration of nutrients into soils.

Potentially significant benefits for soil and water quality may arise where actions can help improve the condition and diversity of wetlands and upland heath ecosystems.

Run off reduction actions are likely to have positive effects on carbon storage across most ecosystems due to the high carbon content of soils in this LPD. There are significant benefits possible for wetland ecosystems, especially using drain blocking on blanket bogs due to current pressures of erosion and low regeneration. (Although wetlands also have the potential to release carbon dioxide into the atmosphere, the net benefit to carbon storage is more likely to be positive when restoring wetlands.)

Increased habitat diversity and connectivity can provide benefits to pollination and biological control of pests and diseases. However, an increase in the wetness of cultivated land and semi-natural grassland ecosystems may increase the prevalence of some livestock pests.

There are opportunities to use run off reduction actions to improve the condition of protected sites in unfavourable condition. Specifically, restoration of blanket bog components of protected sites could benefit Ben Nevis SSSI/SAC (PVA 01/25), Atlantic salmon in River Thurso SAC (PVA 01/01), and salmon and freshwater pearl mussels in River Moriston SAC (PVA 01/21). The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The effects of run off reduction actions on food provision are likely to be mixed. These actions may enhance the productivity of cultivated land and semi natural grassland by protecting soils from erosion and loss of nutrients. They may also benefit meat and crop production through better biological control of pests and disease and provision of shelter. Conversely, some areas of productive land may be lost where these actions are implemented and livestock may be impacted by an increase in livestock pests.

Actions can help to manage diffuse pollution, therefore, there is likely to be a significant benefit for salmon and sea trout fisheries in rivers that are currently at less than good WFD status.

There is a potential positive effect on drinking water supply due to the importance of the area for drinking water. This is especially the case for drain blocking on blanket bogs as it can reduce effects of water colour and high organic matter in drinking water catchments. This provides an opportunity to reduce treatment costs.

There are likely to be positive effects on cultivated land for biomass production through the increase in sources of local wood fuel, although the scale of this action means that it is unlikely to be significant. The actions that block drains or create wetlands within conifer plantations may lead to loss of timber productivity; however, it is more likely that these actions would be located in other ecosystems.

Cultural services
There are likely to be significant positive effects from run off reduction actions on recreation, wildlife watching, and landscape due to improved habitat diversity. These effects increase opportunities for recreation, especially in upland heath ecosystem. Some landscapes may be sensitive to specific actions and therefore landscape character assessments should be used to inform specific actions as part of any feasibility studies.

The historic environment has potential to benefit from these actions: firstly, through the reduction of flood risk to historic buildings and, secondly through the protection of wetland archaeology as a result of creating and restoring wetlands. Conversely, woodland planting can disturb buried archaeology. The structure and setting of historic sites could be affected but this will need to be assessed at more detailed levels of flood risk management planning.

A5.4.3 River and floodplain restoration actions

Actions to restore river and floodplains include woodland creation, reach restoration, and creation of washlands. Sediment management actions such as bank restoration are also included in this assessment. These actions are being considered for 19 PVAs.

All SEA topics and a wide range of ecosystems may be affected: woodlands, cultivated land and semi natural grassland, wetlands, freshwater rivers and lochs and urban. The potential effects of the actions are described in the text below and summarised by SEA topics in table A5.4.

Table A5.4 River and floodplain restoration: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	+ + Benefits to connectivity and health of wetland and river ecosystems	Feasibility studies should consider opportunities to contribute to other drivers for restoration of wetlands and woodlands, and improvements to salmonids and freshwater pearl mussels. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Actions should be implemented in line with good practise, avoiding creating sediment that might damage sensitive aquatic species. Consultation with relevant organisations (e.g. SNH) recommended during feasibility and design stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits to flood risk reduction and protection of human health	Feasibility studies should consider medium and long duration effects on recreation, such as changes to river flow. Design studies should consider short duration effects on quality and access to recreation. Discussion with stakeholders recommended at both stages.
Soil	No significant effects	Feasibility and design studies should consider potential loss of productive soils, particularly cultivated land. Consultation with land managers recommended.
Water	+ + Benefits by enhancing water quality and reducing sedimentation	Opportunities to deliver wider benefits where actions are targeted at water courses which are less than good status due to habitat loss and sedimentation.
Climatic factors	+ + Benefits to carbon storage through wetland enhancement. Including wet woodland	
Material assets	+ + Benefits to flood risk reduction and protection of properties and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects
Landscape	No significant effects	Landscape change should be assessed again once more information is available on the type of action and its location and feasibility stage.

Commentary on potential significant effects

Regulating and maintaining services

River and floodplain restoration actions slow down in-channel flow by increasing the sinuosity of the river and help reconnect the river with the floodplain, increasing the amount of water stored on land. Floodplain planting can also slow down the flow of run off and increase the permeability of soils, while river bank restoration can reduce bank erosion and sediment deposition in the river.

The effect of all of these actions is to help regulate the flow of water by slowing and/or reducing flood flows: this helps to protect people and properties from flooding.

These actions can lead to improvements to water quality by helping to protect soils from erosion (thus reducing the sediment reaching rivers) and increase infiltration of nutrients into soils. Wetland vegetation (in this case, vegetation on the floodplain) is particularly effective at storing nutrients. Therefore, there are potentially significant positive effects on water quality as wetlands ecosystem may be in less than good condition.

Other potential effects include improvements to pollination (as pollinating insects may benefit from greater food and shelter in a more diverse habitat).

The creation or restoration of woodlands and wetlands (floodplains) also has the potential to increase the capture and storage of carbon, although the net benefit may be less where floodplain restoration requires the removal of trees. As stated above, although wetlands have the potential to release carbon dioxide into the atmosphere, the net benefit to carbon storage is more likely to be positive when restoring this ecosystem.

Water bodies that are less than good condition due to the condition of beds and bank could benefit from river habitat restoration. Increasing habitat diversity, biodiversity, maintaining water quality and minimising sediment loss may have benefits for protected sites and species (e.g. Atlantic salmon in River Thurso SAC (PVA 01/01) and Atlantic salmon and freshwater pearl mussels in River Moriston SAC (PVA 01/21)). Restoration works, however, could lead to short duration increases in sediment load and could disturb habitats: therefore the timing and mechanism of any in river or bank works should be considered to avoid or minimise any negative effects. However, it is difficult to assess these effects at the strategic level: the effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The potential effects of river and floodplain restoration actions on food provision are mixed. As with run off reduction actions, these actions may enhance the productivity of cultivated land and semi natural grassland by protecting soils from erosion and loss of nutrients. There may, however, be some loss of productive farmland although the effects are likely to be small given the limited areas of cultivated land within the PVA catchments.

By protecting water quality and reducing sedimentation, freshwater river fisheries such as salmon and sea trout may benefit.

The effects on provision of biotic materials are also mixed. On cultivated land, woodland creation increases the potential for wood fuel but may adversely affect biofuel crops. In most PVAs catchments in this area it is likely to have a positive effect as very few contain significant areas of cultivated land.

There is a potential positive benefit for drinking water supply due to the removal and storage of sediments on the floodplain.

Cultural services
The potential effects on recreation, wildlife watching and landscape are generally positive, as the actions should improve habitat diversity and biodiversity and increase diversity of the landscape. However, changes to the bed and banks of rivers may affect quality and access of kayaking. Installing / implementing actions may also impede access to the river and its banks for recreation although these effects would be of short duration. Re-connection of the floodplain may mean that access is affected by seasonal flooding.

The actions are likely to take place close to urban areas so any effects on wild land are likely to be limited.

The historic environment has potential to benefit from these actions: firstly, through the reduction of flood risk to historic buildings and, secondly through the protection of wetland archaeology as a result of creating and restoring wetlands. Woodland planting, however, can disturb buried archaeology. The structure and setting of historic sites could be affected but this will need to be assessed at more detailed levels of flood risk management planning.

A5.4.4 Storage conveyance and control

Storage, conveyance and control actions include on and offline flood storage, channel modifications, addition or modification of weirs, bridges, pumping stations. These types of actions are being considered for 19 PVAs.

All SEA topics could be affected. The actions could be located in most ecosystems, except upland heath. Blanket bogs are unlikely to be affected by these actions, but other small ground water fed wetlands could be affected by channel modifications and drainage resulting from increased conveyance. The potential effects of the actions are described in the text below and summarised by SEA topic in table A5.5.

Table A5.5 Storage, conveyance and control: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	- - Loss or damage to wetlands, leading to reduced habitat connectivity and biodiversity - - Negative effects on salmon through increased sediment load	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or damage to wetlands and native woodlands, disturbance of sediment, or barriers to fish passage. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. If existing structures are modified or removed, there are opportunities improve fish passage. Consultation with relevant organisations (e.g. SNH, Fisheries Trusts) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits to flood risk reduction and protection of human health	Feasibility studies should consider medium and long duration effects on recreation, such as changes to river flow. Design studies should consider short duration effects on quality and access to recreation. Discussion with stakeholders recommended at both stages.
Soil	No significant effects	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or damage to wetlands. Feasibility and design stages should consider potential loss of productive soils, particularly cultivated land. Consultation with land managers recommended.
Water	- - Loss of river habitats and changes to channel morphology could affect the status of rivers	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or damage to rivers, especially for rivers that are under pressure from habitat loss, disturbance of sediment, or barriers to fish passage. If existing structures are modified or removed, there are opportunities to improve fish passage.
Climatic factors	- - Reduction in carbon sequestration due to loss of or damage to wetlands and native woodlands	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or damage to wetlands and native woodlands.

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Material assets	+ + Benefits to flood risk reduction and protection of properties and infrastructure	Design stages should consider how to minimise waste and energy consumption
Cultural heritage	Uncertain	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects
Landscape	- - Artificial structures and channel modifications in predominately natural channels and high quality landscape	Feasibility and design stages should include consultation with communities, SNH and National Park Authorities to avoid or minimise negative effects on landscape.

Commentary on potential significant effects

Regulating and maintaining services
Storage, conveyance and control actions alter the storage and flow of water. These actions can deliver positive effects through regulating the flow of water and thus reducing flood risk to people and property. As rivers in the PVA and catchments are mostly natural channels, there are potentially significant negative effects on water quality through loss of habitat to filter, capture and store pollutants. This affects all ecosystems with the greatest effect on native woodland (for example through increase fragmentation) and river ecosystems.

The ecosystem adjacent to the structures may benefit through protection from erosion – this may have noticeable benefits in urban areas and in cultivated land and semi natural grassland. However, erosion can be exacerbated downstream of the structure with potentially significant negative effects on any wetlands that may already be in unfavourable condition. Increased erosion can increase sediment and nutrient load of water, with potentially significant negative effects on protected species such as salmon and freshwater pearl mussels.

There are potential significant negative effects on carbon storage through disconnection of wetland from floodplain or lowering of water table, and potential decline in river bank habitats and woodland habitats through disconnection or artificial channels.

Some pollinators and pest controllers such as hoverflies are potentially adversely affected by the loss of wetland habitats in the floodplain, and areas riparian and floodplain vegetation used for hibernation.

For River Thurso SAC (PVA 01/01) the actions are proposed away from the main river to avoid having an adverse effect, but there are still potential adverse effects from sediment from increased conveyance and channel modifications: these may affect migration of salmon into smaller tributaries to access spawning areas. There are also possible indirect effects from changes in water quality to Loch Fleet and Dornoch SSSIs (PVA 01/07). The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
There are potential negative effects on freshwater fisheries, due to potential loss of habitat and also potential impacts on erosion downstream of structures.

Effects on agricultural land are mixed. Actions may deliver benefits through reducing flooding to some areas of cultivated land or semi natural grassland. However land may also be used for storage of flood waters leading to loss of productivity during and after flood events. Soil structure may also change depending on the frequency and duration of flooding. These effects could lead to permanent changes in land use.

Cultural services
Storage, conveyance and control actions have potentially negative effects on cultural services. Loss of natural habitat and negative effects on biodiversity can impact opportunities to watch

wildlife and interact with nature, and recreation such as angling. Changes to patterns of river flow can also affect sports such as kayaking. However, access for some activities could be improved with sensitive scheme design.

Actions in PVAs 01/07 and 01/25 could adversely affect landscapes in national scenic areas and actions in PVA 01/25 could also adversely affect a Wild Land area, as these are landscapes that are sensitive to development.

The historic environment may benefit through a reduction in flood risk, but there is also potential for negative effects: the disconnection of the floodplain could damage wetlands and the archaeology preserved within it. The historic environment may be negatively affected altering the setting of historic sites or through damage to sites when the action is implemented. Further assessment is required at more detailed levels of flood risk management planning.

A5.4.5 River defences

River defences may include walls, embankments or demountable / temporary defences. These are being considered for 19 PVAs.

The actions are most likely to be located in or adjacent to rivers (freshwater lochs and rivers ecosystem) or set back from the river in the urban environment (urban ecosystem). All SEA topics could be affected. The potential effects of the actions are described in the text below and summarised by SEA topic in table A5.6.

Table A5.6 River defences: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	- - Negative effects on salmon through increased sediment load / barriers to fish passage - - Loss or damage to floodplain wetlands, leading to reduced habitat connectivity and biodiversity	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or disturbance of sediment, or loss of natural floodplain wetlands. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits to flood risk reduction and protection of human health	Feasibility studies should consider medium and long duration effects on recreation, such as changes to river flow. Design studies should consider short duration effects on quality and access to recreation. Discussion with stakeholders recommended at both stages.
Soil	No significant effects	
Water	- - Loss of river habitats and changes to channel morphology could affect the status of rivers	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or damage to rivers, especially those already under pressure from habitat loss.
Climatic factors	- - Loss of floodplain habitat especially wetlands which act as a carbon store	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or damage to floodplain wetlands
Material assets	+ + Benefits to flood risk reduction and protection of properties and infrastructure	Design stages should consider how to minimise waste and energy consumption
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Landscape	- - Artificial structures and channel modifications in predominately natural channels and high quality landscape	Feasibility and design stages should include consultation with communities, SNH and National Park Authorities to avoid or minimise negative effects on urban landscape and protected landscapes

Commentary on potential significant effects

Regulating and maintaining services
River defences can deliver benefits by regulating water flow and reducing flood risk. The actions, however, can interfere with natural process: the defences may cause some or all of the floodplain to be disconnected from the river, which can lead to loss of natural habitat to capture, filter and recycle nutrients or pollutants. This can lead to a reduction in water quality and a loss of carbon storage. Erosion may also increase upstream or downstream of a defence due to changes in river processes. A potential decline in water quality and increase in sediment load can have potentially negative effects on freshwater species such as salmon.

The type and precise location of actions are not known at this stage in the planning process. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning. In particular, further assessment is needed of impacts on SSSIs, SACs and SPAs in PVAs 01/01, 01/03, 01/05, 01/07, 01/10, 01/13, 01/16, 01/21, 01/25, 01/33, 01/34. For example, within SPAs, the creation of flood embankments can encourage people to walk along them and disturb breeding and wintering birds on the floodplain.

Provisioning services
River defences have potential negative effects on freshwater food production due to the loss of in river and riparian habitat. However, this is dependent on the type of defence (for example, defences that are set back from the river are likely to have a smaller impact) and the degree to which the river banks have already been modified.

Cultural services
River defences may have mixed effects on recreation and accessing nature / experiencing wildlife. Loss of natural habitat and biodiversity, and changes to river flow, can reduce the quality of the environment for recreation and wildlife watching. However, depending on their design, some defences can improve access for some types of recreation.

Within the urban landscape, river defences have potentially negative effects through disrupting the setting and view of the river and floodplain. Seven PVAs contain National Scenic Areas and four of these are also within Wild Land Areas, which are particularly sensitive to development. There is potential for embankments to significantly adversely affect the landscape of these areas with knock on effects for tourism. More information is needed to assess the effects of these actions once the types and specific locations of actions are known (PVAs 01/13, 01/15, 01/07, 01/05, 01/25, 01/38).

Historic buildings and monuments may benefit through reduced flood risk, but the defences may alter the setting of the site. Historic sites may also be affected, either for a short or long duration, by construction of the defences; however, the effects cannot be assessed at this level of planning as more information is required about the precise nature and location of the defences.

A5.4.6 Coastal restoration

Coastal restoration actions to attenuate waves and/or surge are being considered for four PVAs.

The ecosystems most likely to be affected are coastal and marine ecosystems and cultivated land. All SEA topics could be affected. The potential effects of the actions are described in the text below and summarised by SEA topic in table A5.7

Table A5.7 Coastal restoration: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	- - Negative effects on protected coastal habitats through habitat loss	Feasibility studies should consider how to avoid or minimise potential negative effects such as increased erosion. Design studies should aim to achieve sympathetic timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits to flood risk reduction and protection of human health	
Soil	No significant effects	
Water	No significant effects	
Climatic factors	No significant effect	
Material assets	+ + Benefits to flood risk reduction and protection of properties and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effect	Consider effects on Dun an Eidh SAC once detailed location is known. Design stage should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects on hidden and exposed archaeology.
Landscape	No significant effects	

Commentary on potential significant effects

Regulating and maintaining
The actions attenuate waves and surge by enhancing the natural ability of beaches to protect assets behind them from flood risk.

There are mixed effects on erosion protection: some actions, such as sand dune restoration, can provide protection from erosion; other actions, such as shingle re-profiling, can make the beach more susceptible to the effects of erosion for example by removing vegetated areas that are more stable.

Restoration of coastal habitats is likely to have positive effects, but actions such as re-profiling shingle and beach recharge could have an adverse effect on existing designated habitat (e.g. Moray Firth SAC (PVAs 01/06, 01/17)). The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
There are no or negligible effects of coastal restoration on provisioning services.

Cultural services
Restoring sand dunes and re-vegetating shingle can improve the diversity of the coastal landscape. These habitats can also provide opportunities to access and experience nature and wildlife.

No coastal scheduled monuments have been identified as being potentially impacted by restoration actions, but effects are uncertain as the location of actions is not fully known at this stage in the planning process. There are potential negative impacts if unscheduled archaeology are exposed on the beaches and damaged directly by machinery.

A5.4.7 Coastal defences

Coastal defences under consideration for this LPD include walls, embankments, temporary barriers, revetments, tidal gates and barriers, and breakwaters. These actions are being considered for 16 PVAs.

The ecosystems most likely to be affected are urban, and coastal and marine. All SEA topics could be affected. The potential effects of the actions are described in the text below and summarised by SEA topic in table A5.8.

Table A5.8 Coastal defences: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	- - Negative effects on protected coastal habitats through increased erosion and disruption of natural processes - - Negative effects on migratory fish from tidal barrier	Feasibility studies should consider how to avoid or minimise potential negative effects such increased erosion. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits to flood risk reduction and protection of human health	Feasibility studies should consider medium and long duration effects on recreation, such as changes to beaches. Design studies should consider short duration effects on quality and access to recreation. Discussion with stakeholders recommended at both stages.
Soil	No significant effects	
Water	- - Tidal barriers could alter water flow and migratory fish populations with impacts on WFD status	Feasibility and design studies should consider how to minimise negative effects such as potential barriers to fish migration. Consultation with relevant organisations (e.g. SNH, Rivers Trusts) recommended at both stages.
Climatic factors	+ + - - Significant mixed effects from loss of intertidal areas and increase in hard substrate habitats	Assess overall changes in carbon effects once locations and design are known at feasibility and design stages.
Material assets	+ + Benefits to flood risk reduction and protection of properties and infrastructure - - Property and infrastructure may experience an increased erosion risk outside of the area of protection	Further modelling required at feasibility and design stages to better understand erosion risks. Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	- - Views of seas and beaches especially bathing beaches and those in National Scenic Areas	Feasibility and design stages should include consultation with communities to avoid or minimise negative effects on urban and coastal landscapes.

Commentary on potential significant effects

Regulating and maintaining services

By attenuating waves and tidal surges, coastal defences can help to reduce flood risk and can reduce erosion at the site of the action. However, these actions can lead to the loss of natural habitat and interfere with coastal processes. Actions that affect coastal processes can have significant positive and negative effects in soft coast areas by changing patterns of sediment erosion and deposition outside the immediate area. Further modeling of the effects on coastal processes is recommended at feasibility and design stages.

There are significant mixed effects to carbon storage. Defences such as embankments, walls tidal barriers can result in loss of coastal habitats such as saltmarshes which help store and sequester carbon in coastal areas. However at some locations well-designed structures could provide a greater diversity of habitat by including features that promote good carbon stores such as kelp.

There are significant adverse effects on water quality. Coastal engineering actions can erode inter-tidal areas which reduce the filtering and treatment of pollutants provided by these areas. Changes in sediment distribution can adversely affect other key natural filterers such as mussels. (However the defences may provide alternative habitat for shellfish such as mussels which may help mitigate this effect at some locations.)

There are a number of potential negative effects on protected sites, with examples given below. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning:

- There is potential for significant adverse effects from the actions due to direct loss of coastal habitats and wider effects on coastal processes. Sites that might be affected include coastal and river SACs and Marine Protected Areas, e.g. River Thurso SAC, Sunart SAC/SSSI, Moray Firth and Dornoch Firth, Loch Fleet SPA/SSSI, Morrich More SSSI, Dornoch Firth and Morrich More SAC/SPA, and Sound of Arisaig SAC.
- There is also particular concern for soft sediment features already in unfavourable declining condition for example SACs and SSSIs within or adjacent to PVAs 01/06, 01/07 and 01/08 and for potential impact on migratory fish from barriers e.g. River Thurso SAC (PVA 01/01). There is a need to consider changes to natural coastal processes at the feasibility stage. There may be changes to the movement of gravel, shingle and sands, leading to potentially significant negative effects.
- Embankments may increase access by people to previously undisturbed areas; this may have an adverse effect by disturbing birds on inter-tidal areas in SPAs.

Provisioning services
Coastal engineering can have mixed effects on marine food provision: whilst there can be loss of natural habitat which can reduce productivity, sometimes other edible species can benefit (for example, a change from soft sediment feeding fish to lobster and crab fishery. The design of the action is critical to whether these benefits are realized.

Cultural services
The effects of coastal engineering on recreation and opportunity to experience nature and wildlife may be reduced through loss of natural habitat and access. With sensitive design, however, access may be improved and disturbance to wildlife may be reduced.

There are potentially significant negative effects on seascapes, especially if actions interfere with views of the sea or the extent of beaches. Actions are being considered for numerous locations: therefore, there is a need to understand the overall effects of on landscape and amenity use of these for all the actions in combination once locations are known (particularly within National Scenic Areas that are sensitive to development (PVAs 01/07 and 01/08)).

There are likely to be benefits to the historic environment, through a reduction in flood risk and erosion. The main PVAs with coastal historic features are 01/01, 01/24, 01/26, 01/30 and 01/39. The richest of these areas in terms of cultural features is PVA 01/39 where there are standing stones, the Shiaba deserted town, a castle and a crannog. Other major features include the Caledonian Canal in 01/24 and several castle sites. The exact locations of actions are not known and there could also be adverse effects on the settings of these features once more information is known. There are potential negative impacts if unscheduled archaeology are exposed on the beaches and damaged directly by machinery and structures. Further assessment is required at more detailed planning about the precise nature and location of the action.

Table A5.9 Shortlisted actions for Highland and Argyll: Summary of potential effects on ecosystem services

Source of flooding	All		River					Coastal	
Ecosystem service	Non-structural actions		Run off reduction	River and floodplain restoration	Storage, conveyance, control	River defences		Coastal restoration	Coastal engineering
Carbon storage	**0**		**+ +**	**+/-**	**--**	**--**		**0**	**+/-**
Local climate regulation	**0**		**0**	**0**	**0**	**0**		**0**	**0**
Water quality regulation	**0**		**+ +**	**+ +**	**--**	**--**		**0**	**--**
Pollination	**0**		**+**	**+**	**-**	**0**		**0**	**0**
Biological control of pests and disease	**0**		**+/-**	**0**	**-**	**0**		N/A	N/A
Wave / surge attenuation	**0**		N/A	N/A	N/A	N/A		**+ +**	**+ +**
Water flow regulation	**0**		**+ +**	**+ +**	**+ +**	**+ +**		N/A	N/A
Erosion protection	**0**		**+ +**	**+ +**	**+/-**	**+/-**		**+/-**	**+/-**
Nutrition: food provision	**0**		**+/-**	**+/-**	**+/-**	**-**		**0**	**+/-**
Drinking water supply	**0**		**+**	**+**	**0**	**0**		**0**	**0**
Biotic materials: timber, biofuels	**0**		**+**	**+/-**	**0**	**0**		**0**	**0**
Recreation (physical interaction)	**0**		**+ +**	**+/-**	**+/-**	**+/-**		**0**	**+/-**
Accessible nature/wildlife experience	**0**		**+ +**	**+**	**-**	**+/-**		**+**	**+/-**
Spiritual and cultural amenity (landscape)	**0**		**+**	**+**	**-**	**-**		**+**	**--**

KEY					
	+ +	**Significant positive** Effects are widespread across the LPD; and/or Effects are likely to improve an ecosystem that is in less than good condition	**-**	**Negative** A noticeable negative effect that does not meet the description below
	+	**Positive** A noticeable positive effect that does not meet the description above	**- -**	**Significant negative** Effects are widespread across the LPD; and/or Effects are likely to cause an adverse effect on an ecosystem that is in less than good condition
	0	**No or negligible effects**	**+/-**	**Mixed:** The effect is likely to be a combination of positive and negative effects, particularly where effects are considered on sub-issues, areas or criteria

Map acknowledgments

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including *inter alia*, the following organisations:

Ordnance Survey
Flood maps are based upon Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office © Crown Copyright. Any unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. SEPA Licence number 100016991 (2015).

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology © NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2015), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright © The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC.

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

Appendix 6: Environmental assessment of the Flood Risk Management Strategy for the Outer Hebrides

This appendix presents the current state of the environment and the assessment of significant environmental effects for the Flood Risk Management Strategy for the Outer Hebrides Local Plan District (LPD). The purpose of this is to:

- Identify relevant information on the current state of the environment for the Outer Hebrides. This information supplements the description of the current state of Scotland's environment (section 3 of the main Environmental Report).
- Report the significant environmental effects of the actions proposed to manage flood risk in the Outer Hebrides.
- Identify mitigation of significant negative effects and opportunities to deliver wider benefits
- Recommend further assessment at more detailed planning stages e.g. feasibility studies or design stages.

The overall assessment for all 14 Flood Risk Management Strategies is summarised in section 5 of the main Environmental Report.

A6.1 The Outer Hebrides Local Plan District

The Outer Hebrides LPD (figure A6) comprises all of the islands which form the Outer Hebrides. The LPD has a total area of approximately of 3100km^2 and a coastline approximately 2300km in length. The population of the Outer Hebrides is approximately 28,000. There are 14 inhabited islands and more than 60 uninhabited islands.

The main source of flooding is coastal flooding which accounts for approximately 69% of the Annual Average Damages[1]. River flooding contributes around 27% of the Annual Average Damages, whilst surface water flooding is the least significant source, contributing an estimated 4% of Annual Average Damages. There are eight Potentially Vulnerable Areas (PVAs) within the LPD.

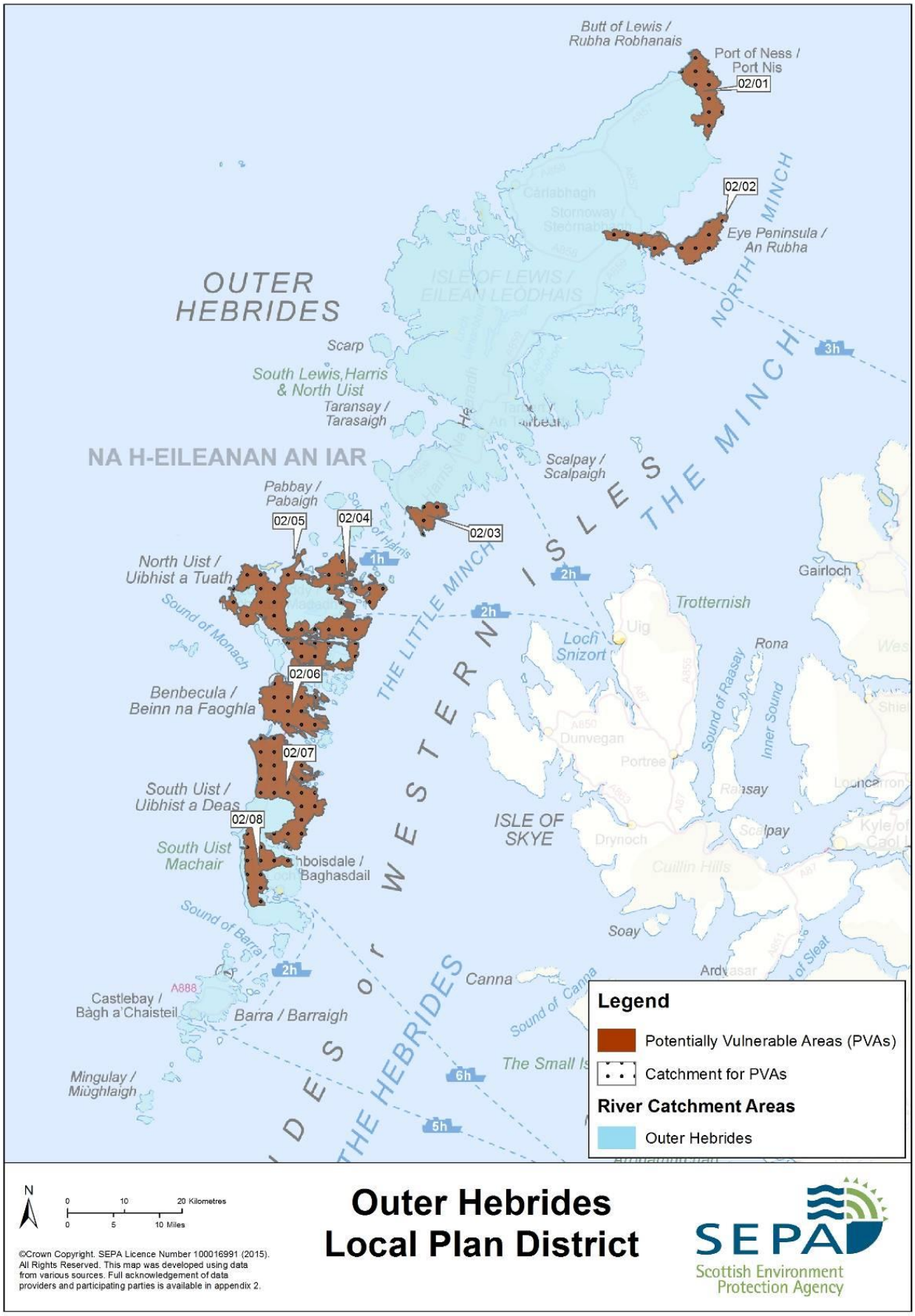
A range of non-structural and structural actions are being considered to manage flooding in this LPD. Structural actions have been shortlisted to manage coastal flooding in seven of eight PVAs and to manage river flooding in three PVAs (table A6.1).

Table A6.1 Shortlisted actions in the Outer Hebrides LPD

Action	PVAs							
	02/01	02/02	02/03	02/04	02/05	02/06	02/07	02/08
Run off reduction							●	●
River and floodplain restoration						●	●	●
Storage conveyance and control						●	●	●
River defences						●	●	●
Coastal restoration		●			●	●	●	●
Coastal defences		●	●	●	●	●	●	●

[1] An indicative estimate of the direct economic costs of flooding impacts to residential properties, non-residential properties and agriculture

Figure A6: Outer Hebrides LPD and PVAs



A6.2 Environmental and policy context for the Outer Hebrides LPD

Section 2.2 and Appendix 3 of the main Environmental Report identify the relationships between the Flood Risk Management Strategies and other plans, programmes and strategies.

A6.3 Additional relevant information on the current state of the environment for the Outer Hebrides

This sub section identifies relevant information on the current state of the environment for the Outer Hebrides LPD. This information supplements the description of the current state of Scotland's environment (section 3 of the main Environmental Report).

A6.3.1 Ecosystems and condition

The predominant ecosystem in the Outer Hebrides is wetlands (mainly bog; small areas of wetland, fen and marsh), which covers 46% of the LPD. Around 18% of Scotland's bog habitat is found in the Outer Hebrides. Other common ecosystems in the Outer Hebrides are upland heath ecosystem (27% of the LPD) and semi-natural grassland (13% of the LPD). The semi-natural grassland includes machair grassland, a rare and distinct type of coastal grassland that supports a huge diversity of wildlife: it is a habitat that is of national and European importance. The coastal and marine habitats are a mix of hard rock and soft substrate (sand and dunes).

Table A6.2 lists the extent of different ecosystems within the LPD, and provides an assessment of ecosystem condition.

Table A6.2. Ecosystems within the LPD

Ecosystem	Area (% of LPD in 2007)	Condition of ecosystem
Woodland - native	<0.5	There is very little native woodland remaining in the Outer Hebrides, and the small areas that remain are highly fragmented. Small areas of relic woodland on islands in Loch Druidibeg (PVA 02/07) are in unfavourable condition due to invasive species and overgrazing.
Woodland - conifer plantation	1	There is very little coniferous plantation woodland in the Outer Hebrides. The condition is unknown.
Cultivated land	3	There are no diffuse pollution priority catchments in the Outer Hebrides although there are some localised diffuse pollution pressures. This indicates that there could be degradation and erosion of soils in some locations.
Semi-natural grassland	13	Semi natural grasslands include areas of machair grasslands. The condition is generally favourable, although some areas are under threat from erosion. No other information is available on the condition of other grasslands.
Wetlands (fen, marsh, and swamp; bog)	46	Within protected sites, most wetlands are in favourable condition. There is little information on the quality of wetlands outside of protected areas. Nationally, wetlands are at threat from land use management, development, water management and pollution, including nutrient run off.
Upland heath	27	Within protected sites that fall within river PVA catchments, upland heath is in favourable condition (Loch Druidibeg; PVA 02/07)

Ecosystem	Area (% of LPD in 2007)	Condition of ecosystem
Freshwater lochs and rivers	6	River and loch condition is generally good. Of 89 river water bodies, only 9% are at less than good status for water quality. For the condition of beds and banks, all are at good status. Of 42 loch water bodies, 19% are at less than good overall status. Lochs within protected sites (within relevant PVA catchments) are in favourable condition with the exception of standing open waters in the South Uist Machair (PVAs 02/07 and 02/08).
Coastal & marine	3	The condition of coastal and marine habitats is good: the physical condition of the coastline is at good or high WFD status; and designated coastal habitats are in favourable condition. However, some dunes are under threat from erosion.
Urban	<0.5	Over two thirds (68%) of adults in Scotland have access to useable greenspace within a five-minute walk from their home (not including their own garden)

*The majority of the coastal and marine ecosystem extends beyond the terrestrial LPD boundary so is not captured in this figure

There are many environmental sites of European and national importance in this LPD: 15 Special Areas of Conservation (SAC), 14 Special Protection Areas (SPAs), and 48 Sites of Special Scientific Interest (SSSIs).

These sites are mainly located in coastal areas, and encompass coastal and marine ecosystems, freshwater lochs, wetlands, and semi-natural grassland (e.g. South Uist Machair, North Uist Machair, Tong Saltings, Loch Bee, Loch Hallan, Benbecula Lochs). A small number of sites extend further inland, encompassing some upland heath (e.g. Loch Druidibeg). The condition of features in protected sites in the Outer Hebrides is generally favourable. There is one nature conservation Marine Protected Area (Monach Isles) to the west of Benbecula / North Uist.

Opportunities to contribute to site management objectives include ensuring flood risk management actions do not adversely affect machair habitats or natural coastal processes, avoiding increasing nutrient load or altering established drainage patterns, minimising bank disturbance, and minimising disturbance to breeding birds.

A6.3.2 Ecosystem services

This sub section summarises the major ecosystem services within this LPD.

Regulating and maintaining services

- Carbon storage and sequestration is provided by wetlands and marine habitats (specifically kelp forests); notably 18% of Scotland's bog is found within this LPD.
- The large areas of wetlands, semi natural grassland and upland heath help to filter and maintain good water quality. These ecosystems also help to regulate the flow of water.
- Sand dunes and saltmarsh help to attenuate waves and regulate water flow. Semi-natural grassland (namely machair) also provides significant protection from coastal storms. Some of the sand and dune coastline is susceptible to erosion.
- Hard coast (islands, rock outcrops, reefs and kelp forests) is common and provides significant wave energy dissipation.
- Semi natural grassland (machair) provides important sources of food for pollinators, and habitat for invertebrates that help to control crop pests; wetlands provide food and shelter for pollinators.

Provisioning services

- Farming is primarily rough grazing on semi natural grassland with some stretches of improved grazing along coastal areas .The farmland is used primarily for crofting activities, which produce sheep and cattle.
- Commercial fishing takes places in the waters around the Outer Hebrides and provides an important source of income for the community. There are many active fish and shellfish farming sites in the coastal environment, primarily along the east coast of the islands.
- There are a small number of freshwater fish farming sites: of potential relevance to the river flooding actions are sites in South Uist within PVAs 02/07 and 02/08.
- Notable numbers of sea trout are caught and retained (8% of Scottish catch in 2013), particularly in sea pools and shallow machair lochs.
- PVA 02/06 (Benbecula) contains a drinking water protected area.
- Wetlands are sometimes used for peat cutting to provide fuel for domestic use.

Cultural services

- The high quality of the environment supports a wide range of recreational opportunities including walking, cycling, rock climbing, sea kayaking, sailing, surfing, angling, shooting. All ecosystems contribute to recreational services.
- The area provides habitat for iconic wildlife, and provides significant opportunities for viewing wildlife, including birds and seals.
- The coastal landscape and high quality environment is key to the promotion of tourism in this area. Protected landscapes include National Scenic Areas in southern Lewis / Harris/ North Uist (PVAs 02/03, 02/04 and 02/05) and along the eastern coast of South Uist (PVAs 02/08 and 02/07). In North Uist (PVA 02/05), site management objectives for Loch An Duin SSSI include the aim to maintain the visibility of land forms.
- South Uist contains areas of wild land: wild land areas have a distinct and special character, which is increasingly rare to find. Many people derive psychological and spiritual benefits from their existence, and they provide increasingly important havens for Scotland's wildlife.
- The Outer Hebrides has hundreds of archaeological sites situated along the coast and the low lying areas beyond. Many of these are in a relatively good condition and have minimal disturbance. The main threat to these sites is from coastal erosion.

A6.4 Environmental assessment of the Flood Risk Management Strategy for the Outer Hebrides

This sub section provides an assessment of the potential environmental effects of the flood risk management actions under consideration for the PVAs within this LPD. The effects on SEA topics and on ecosystem services are reported under each group of actions. Table A6.9 compares the effects of different groups of actions on ecosystem services.

A6.4.1 Non-structural actions

A range of non-structural actions are being considered for the LPD such as property level protection, relocation of properties / infrastructure away from flood risk areas and flood warning schemes. These actions help to reduce the impacts of flooding and therefore are likely to have significant positive effects on the SEA objectives for human health and material assets. These effects have been assessed nationally rather than at an LPD level and the results are presented in section 4 of the main Environmental Report.

As these actions help to reduce the impacts of flooding rather than the probability of flooding, they are likely to have no or negligible effects on ecosystems and ecosystem services.

A6.4.2 Run off reduction actions

Actions to reduce run off include gully woodland planting, upland drain blocking, land management, and creation or restoration of wetlands and ponds. These are being considered for two PVAs on South Uist.

Terrestrial ecosystems may be directly affected by these actions as the action is located in the ecosystem itself; freshwater ecosystems may be indirectly affected where they are located downstream of the action. In this LPD, run off reduction actions are not expected to impact on coastal and marine ecosystems. All SEA topics may be affected.

The potential effects of the actions are described in the text below and summarised by SEA topic in table A6.3.

Table A6.3 Run off reduction: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	No significant effects	Feasibility studies should consider opportunities to contribute to reducing nutrient pressures on lochs; and to avoid adverse effects of any changes to drainage patterns. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects particularly on breeding birds. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	
Soil	No significant effects	Feasibility studies should consider potential loss of productive crofting land. Design stages should consider protecting livestock from potential exposure to pests. Consultation with land managers recommended at both stages.
Water	No significant effects	
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	

Commentary on potential significant effects

Regulating and maintaining services
Run off reduction actions help to slow and store water by intercepting rainfall (e.g. woodlands) and/or increasing the extent to which the land can hold any water reaching the ground (both by slowing down the flow of run off and increasing the permeability of soils). This in turn can help to regulate the flow of water by reducing the amount of water reaching rivers and slowing or reducing flood flows: this helps to protect people and properties from flooding.

These actions can lead to improvements in water quality by helping to protect soils from erosion (thus reducing the sediment reaching rivers) and increasing infiltration of nutrients into soils.

The creation or restoration of woodlands and wetlands (including peatlands through upland drain blocking) also has the potential to increase the capture and storage of carbon. (Although wetlands also have the potential to release carbon dioxide into the atmosphere, the net benefit to carbon storage is more likely to be positive when restoring wetlands.)

Increased habitat diversity and connectivity can provide benefits to biological control of pests and diseases. However, an increase in the wetness of cultivated land and semi-natural grassland ecosystems may increase the prevalence of some livestock pests.

Any water quality benefits and erosion protection will help to maintain the low nutrient and low sediment load that is essential for some protected lochs in South Uist. Any changes to drainage patterns could impact on machair and lochs downstream of the actions, but the direction of any effects is not known at this level of planning. The implementation of actions could disturb breeding birds. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The effects on food provision are likely to be mixed. The actions may enhance the productivity of cultivated land and semi natural grassland by protecting soils from erosion and loss of nutrients, and through providing a more diverse habitat for biological control of pests and disease. However, some areas of productive land may be lost and there is potential to increase the prevalence of some livestock pests.

By protecting water quality and reducing sedimentation, freshwater fisheries such as salmon and sea trout, may benefit.

Cultural services
There is potential for positive effects on recreation (such as angling) and wildlife watching as the actions may improve habitat diversity and biodiversity.

The historic environment has potential to benefit from these actions: firstly, through the reduction of flood risk to historic sites and, secondly through the protection of wetland archaeology as a result of creating and restoring wetlands. Woodland planting, however, can disturb buried archaeology. The structure and setting of historic sites could be affected but this will need to be assessed at more detailed levels of flood risk management planning.

A6.4.3 River and floodplain restoration actions

Actions to restore river and floodplains include floodplain and riparian woodland creation, reach restoration, and placing of large woody debris. Sediment management actions such as bank restoration are also included in this assessment. These actions are being considered for three PVAs.

All SEA topics and a wide range of ecosystems may be affected: cultivated land and semi natural grassland, wetlands, freshwater rivers and lochs and urban. The potential effects of the actions are described in the text below and summarised by SEA topics in table A6.4.

Table A6.4 River and floodplain restoration: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	No significant effects	Feasibility studies should consider opportunities to contribute to other drivers to improve connectivity of woodlands. Feasibility studies should also ensure that feeding and breeding birds do not experience increased predation due to additional cover for predators. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address any negative effects on SACs and SPAs.

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Population and human health	+ + Benefits from reducing flood risk and protecting human health	
Soil	+ + Benefits from reducing erosion of channel banks and thus helping to reduce soil loss	Feasibility and design stages should consider both positive and negative effects on productive soils, particularly cultivated land. Consultation with land managers recommended.
Water	No significant effects	
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design studies should consider how to minimise waste and energy consumption
Cultural heritage	No significant effects	Design studies should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects
Landscape	No significant effects	Design studies for woodland creation should consider how best to protect saplings from deer damage whilst avoiding negative effects of deer fences on wild land areas

Commentary on potential significant effects

Regulating and maintaining services
River and floodplain restoration actions slow down in-channel flow by increasing the sinuosity of the river and help reconnect the river with the floodplain, increasing the amount of water stored on land. Floodplain planting can also slow down the flow of run off and increase the permeability of soils, while river bank restoration can reduce bank erosion and sediment deposition in the river. The effect of all of these actions is to help regulate the flow of water by slowing and/or reducing flood flows: this helps to protect people and properties from flooding.

These actions can also lead to improvements to water quality by helping to protect soils from erosion (thus reducing the sediment reaching rivers) and increase infiltration of nutrients into soils. Wetland vegetation (in this case, vegetation on the floodplain) is particularly effective at storing nutrients.

Other potential positive effects include improvements to pollination (as pollinating insects may benefit from greater food and shelter in a more diverse habitat) and increase in carbon storage through creation of woodlands and enhancement of wetlands.

Any water quality benefits and erosion protection will help to maintain the low nutrient and low sediment load that is essential for some protected lochs in South Uist. Any changes to water levels could impact on machair and lochs downstream of the actions, but the direction of any effects is not known at this level of planning. However, restoration works could lead to short duration increases in sediment load and could disturb feeding and breeding birds, therefore the timing and implementation of actions needs to be carefully planned. Additionally, increased woodland could increase predation to birds. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The effects on food provision are likely to be mixed. By protecting water quality and reducing sedimentation, freshwater fisheries such may benefit. The actions may lead to the loss of cultivated land and semi natural grassland, although there are some potential benefits in semi-natural grassland through increased shelter for livestock.

Any positive effects on the drinking water protected area in Benbecula are likely to be negligible due to the scale of the actions and the existing good water quality on this island.

Any woodland creation may provide sources of material for local craft but there is unlikely to be any noticeable benefits in terms of timber production.

Cultural services
The effects on recreation, wildlife watching and landscape are generally likely to be positive, as the actions should improve habitat diversity and biodiversity. In particular, woodland creation may offer noticeable benefits as this ecosystem is now rare and fragmented in the Outer Hebrides.

The historic environment has potential to benefit from these actions: firstly, through the reduction of flood risk to historic sites and, secondly through the protection of wetland archaeology as a result of creating and restoring wetlands. Woodland planting, however, can disturb buried archaeology. The structure and setting of historic sites could be affected but this will need to be assessed at more detailed levels of flood risk management planning.

A6.4.4 Storage conveyance and control

Conveyance and control actions include modification of conveyance by altering culverts and bridges, modifying existing sluice gates and flap valves, and introducing pumping stations. These types of actions are being considered for three PVAs. Storage actions (maintaining or altering existing online flood storage) are also being considered for one PVA.

All SEA topics could be affected. The actions could be located in most ecosystems, except upland heath and coastal and marine ecosystems. In the Outer Hebrides, these actions are almost always focussed on maintaining or altering existing structures such as culverts, brides and sluice gates. Therefore, the effects on many ecosystems and services are likely to be negligible. Potential effects of the actions are described in the text below and summarised by SEA topic in table A6.5

Table A6.5 Storage, conveyance and control: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	No significant effects	Feasibility studies should consider how to avoid or minimise potential negative effects on protected lochs and grasslands through changes to water levels, or patterns of erosion and sediment deposition. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	
Soil	No significant effects	Feasibility and design stages should consider potential loss of productive soils, particularly cultivated land. Consultation with land managers recommended.
Water	No significant effects	
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects
Landscape	No significant effects	

Commentary on potential significant effects

Regulating and maintaining services
Storage, conveyance and control actions alter the storage and flow of water. These actions can deliver positive effects through regulating the flow of water and thus reducing flood risk to people and property.

The ecosystem adjacent to the structures may benefit through protection from erosion – this may have noticeable benefits in urban areas and in cultivated land and semi natural grassland. However, erosion can be exacerbated downstream of the structure: as there is active erosion in some channels, care will be needed to ensure that the actions don't lead to increased erosion downstream.

Changes to hydrological processes may affect water levels and deposition of sediments in lochs, many of which are protected habitats. Construction works could have short duration impacts on feeding and breeding birds, therefore the timing and implementation of actions needs to be carefully planned. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The effect on food provision is mixed. The actions may help to reduce flooding and erosion to some areas of cultivated land or semi natural grassland. However, other areas may suffer increased flooding or erosion. These effects could lead to longer duration change in land use.

Cultural services
Storage, conveyance and control actions can have potentially negative effects on cultural services: however, as the actions being considered for the Outer Hebrides are typically focussed on altering existing structures, the effects are likely to be negligible.

The historic environment may benefit through a reduction in flood risk, but may also be negatively affected by altering the setting of historic sites. Further assessment is required at more detailed levels of flood risk management planning.

A6.4.5 River defences

River defences may include walls, embankments or demountable / temporary defences. These are being considered for three PVAs.

The actions are most likely to be located in or adjacent to rivers (freshwater lochs and rivers ecosystem) or set back from the river in the urban environment (urban ecosystem). All SEA topics could be affected. The potential effects of the actions are described in the text below and summarised by SEA topic in table A6.6.

Table A6.6 River defences: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	No significant effects	Feasibility studies should consider how to avoid or minimise potential negative effects on protected lochs and grasslands through changes to water levels, or patterns of erosion and sediment deposition. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies should consider medium and long duration effects on recreation and accessibility to nature. Short duration effects should be considered in design studies. Discussion with stakeholders recommended at both stages.
Soil	No significant effects	
Water	No significant effects	
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	Feasibility and design stages should include consultation with communities to avoid or minimise negative effects on urban and suburban landscape.

Commentary on potential significant effects

Regulating and maintaining services
River defences can deliver benefits by regulating water flow and reducing flood risk. The actions, however, can interfere with natural process: the defences cause some or all of the floodplain to be disconnected from the river, which can lead to loss of natural habitat to capture, filter and recycle nutrients or pollutants. This can lead to a reduction in water quality and a loss of carbon storage. Erosion may also increase upstream or downstream of a defence due to changes in river processes

Changes to hydrological processes may affect water levels and deposition of sediments in lochs, many of which are protected habitats. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
River defences are unlikely to have any noticeable effects on provisioning services in this LPD.

Cultural services
River defences may have mixed effects on recreation and opportunities to access nature and experience wildlife. Loss of natural habitat and biodiversity, and changes to river flow, can reduce the quality of the environment for recreation and wildlife watching. Conversely, depending on their design, some defences can improve access for some types of recreation.

Within the urban landscape, river defences have potentially negative effects through disrupting the setting and view of the river and floodplain.

Historic buildings and monuments may benefit through reduced flood risk, but the defences may alter the setting of the site. Historic sites may also be affected, either for a short or long duration, by construction of the defences – however, this cannot be assessed at this stage of planning as more information is required about the precise nature and location of the defence.

A6.4.6 Coastal restoration

Coastal restoration includes actions to help attenuate waves, such as beach recharge schemes, shingle reprofiling, and restoration of sand dunes, machair and coastal vegetated shingle. These actions are being considered for five PVAs in a number of locations. The creation and restoration of intertidal areas is also being considered to help attenuate coastal surge between Benbecula and South Uist (PVAs 02/06 and 02/07).

The ecosystems most likely to be affected are coastal and marine ecosystems, but also semi natural grassland and cultivated land. All SEA topics could be affected. The potential effects of the actions are described in the text below and summarised by SEA topic in table A6.7.

Table A6.7 Coastal restoration: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	+ + Benefits from restoring coastal habitats (machair, dunes)	Feasibility studies should consider opportunities to help protect and restore protected coastal habitats. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects, for example, on breeding or feeding birds, and on marine species through short duration sediment disturbance. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies and design studies should consider the short and medium duration effects on coastal access. Discussion with stakeholders recommended at both stages.
Soil	+ + Benefits from protecting coastal soils from erosion	Feasibility and design stages should consider potential loss of productive soils, particularly cultivated land. Consultation with land managers recommended.
Water	No significant effects	
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	+ + Benefits from protecting coastal historic environment from coastal erosion	
Landscape	No significant effects	

Commentary on potential significant effects

Regulating and maintaining services
Coastal restoration actions help to provide space to attenuate waves and coastal surge through the creation and restoration of natural habitats. They can also help to protect the coastline from erosion– this effect may deliver significant benefits to the Outer Hebrides where coastal habitats are showing signs of erosion in places. Through attenuating waves and surge and protecting from erosion, coastal restoration actions have the potential to reduce flood risk.

The restoration of natural habitats may help to provide carbon storage.

Protected habitats and species may benefit from restoration actions, through the restoration of machair and dunes. However, implementation of works could cause disturbance to feeding and breeding birds. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
Coastal restoration actions in the Outer Hebrides may help to protect cultivated land and semi natural grassland from erosion and flooding thus helping to maintain the productivity of crofting land. The restoration and creation of intertidal areas may help to provide nurseries for fish, but could lead to some loss of productive land. There is therefore a mixed effect on food provisioning.

Cultural services
The effects of coastal restoration actions on cultural services are generally positive. By improving the coastal environment, recreation, wildlife experience and cultural amenity are all likely to benefit. However, implementation of works could restrict access to coastal areas which could cause short to medium duration local negative effects on recreation.

The historic environment is likely to benefit due to reduced risk of flooding and perhaps significantly due to the potential protection from coastal erosion.

A6.4.7 Coastal defences

Coastal defences under consideration for the Outer Hebrides include walls, embankments, temporary barriers, revetments, groynes, and modifications to existing gates and tidal barriers. These actions are being considered in seven PVAs.

The ecosystems most likely to be affected are urban, and coastal and marine. All SEA topics could be affected. The potential effects of the actions are described in the text below and summarised by SEA topic in table A6.8.

Table A6.8 Coastal defences: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	- - Negative effects on coastal habitats through increased erosion and disruption of natural processes	Feasibility studies should consider how to avoid or minimise potential negative effects such increased erosion. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Soil	- - Negative effects on coastal soils through increased erosion (however, actions can protect the area immediately behind any defences)	Feasibility studies should consider how to avoid or minimise potential negative effects such increased erosion. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with land managers recommended.
Water	No significant effects	
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure - - Property and infrastructure may experience an increased erosion risk outside of the area of protection	Further modelling required at feasibility and design stages to better understand erosion risks. Design stages should consider how to minimise waste and energy consumption
Cultural heritage	- - Negative effects on the historic environment through increased erosion	Further modelling required at feasibility and design stages to better understand erosion risks. Consultation with relevant organisations (e.g. Historic Scotland) is recommended.
Landscape	- - Negative effects on coastal landscape	Feasibility and design stages should include consultation with communities to avoid or minimise negative effects on urban and coastal landscapes

Commentary on potential significant effects

Regulating and maintaining services
By attenuating waves and surge, coastal defences can help to reduce flood risk. Some defences can also help to reduce erosion at the site of the defence. However, these actions can lead to the loss of natural habitat and interfere with coastal processes, potentially changing patterns of erosion and deposition elsewhere along the coast. This LPD already has coastline that is in places showing signs of erosion, and so coastal defences could have potentially significant negative effects on the natural ability of coastal habitats to protect against erosion.

Loss of natural habitat can degrade water quality by reducing the ability of the environment to filter, capture and recycle nutrients / pollutants. The effects on carbon storage are mixed: loss of natural habitat to sequester carbon will have negative effects; however, some actions might provide suitable substrate for kelp which can act as a carbon store.

Coastal defences could have potentially significant adverse effects on natural coastal processes and habitats such as sand dune and machair. The defences could also impact on breeding and feeding birds. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
Coastal defences can have mixed effects on marine food provision: whilst there can be loss of natural habitat which can reduce productivity, sometimes other edible species can benefit (for example, a change from soft sediment feeding fish to lobster and crab fishery). Food provision from crofting may experience mixed effects: there may be benefits from maintaining land drainage and a reduction in flood risk to some areas, but other areas could experience an increase in erosion leading to loss of productive land.

Cultural services
The effects of coastal defences on recreation and opportunity to experience nature and wildlife may be reduced through loss of natural habitat and access. Conversely, with sensitive scheme design, access to coastal areas may be improved and disturbance to wildlife may be reduced.

There are potential significant negative effects on landscape, particularly to the coastal and marine ecosystem given the important of the landscape to culture, amenity and tourism to the Outer Hebrides.

Some aspect of the historic environment may benefit through a reduction in flood risk, however, there could also be an increase in coastal erosion, which could pose a significant threat to coastal historic sites. Further assessment is required at more detailed planning about the effects on coastal processes.

Table 6.9 Shortlisted actions for the Outer Hebrides: Summary of potential effects on ecosystem services

Source of flooding	All		River					Coastal	
Ecosystem service	Non-structural actions		Run off reduction	River and floodplain restoration	Storage, conveyance, control	River defences		Coastal restoration	Coastal defences
Carbon storage	**0**		**+**	**+**	**0**	**0**		**0**	**+/-**
Local climate regulation	**0**		**0**	**0**	**0**	**0**		**0**	**0**
Water quality regulation	**0**		**+**	**+**	**0**	**-**		**0**	**-**
Pollination	**0**		**0**	**+**	**0**	**0**		**0**	**0**
Biological control of pests and disease	**0**		**+/-**	**0**	**0**	**0**		N/A	N/A
Wave / surge attenuation	**0**		N/A	N/A	N/A	N/A		**+ +**	**+ +**
Water flow regulation	**0**		**+ +**	**+ +**	**+ +**	**+ +**		N/A	N/A
Erosion protection	**0**		**+**	**+ +**	**+/-**	**+/-**		**+ +**	**+/-**
Nutrition: food provision	**0**		**+/-**	**+/-**	**+/-**	**0**		**+/-**	**+/-**
Drinking water supply	**0**		**0**	**0**	**0**	**0**		**0**	**0**
Biotic materials: timber, biofuels	**0**		**0**	**0**	**0**	**0**		**0**	**0**
Recreation (physical interaction)	**0**		**+**	**+**	**0**	**+/-**		**+**	**+/-**
Accessible nature/wildlife experience	**0**		**+**	**+**	**0**	**+/-**		**+**	**+/-**
Spiritual and cultural amenity (landscape)	**0**		**+**	**+**	**0**	**-**		**+**	**--**

KEY				
	+ +	**Significant positive** Effects are widespread across the LPD; and/or Effects are likely to improve an ecosystem that is in less than good condition	**-**	**Negative** A noticeable negative effect that does not meet the description below
	+	**Positive** A noticeable positive effect that does not meet the description above	**- -**	**Significant negative** Effects are widespread across the LPD; and/or Effects are likely to cause an adverse effect on an ecosystem that is in less than good condition
	0	**No or negligible effects**	**+/-**	**Mixed:** The effect is likely to be a combination of positive and negative effects, particularly where effects are considered on sub-issues, areas or criteria

Map acknowledgments

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including *inter alia*, the following organisations:

Ordnance Survey
Flood maps are based upon Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office © Crown Copyright. Any unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. SEPA Licence number 100016991 (2015).

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology © NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2015), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright © The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC.

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

Appendix 7: Environmental assessment of the Flood Risk Management Strategy for Orkney

This appendix presents the current state of the environmental and the assessment of significant environmental effects for the Flood Risk Management Strategy for Orkney Local Plan District. The purpose of this is to:

- Identify relevant information on the current state of the environment for Orkney. This information supplements the description of the current state of Scotland's environment (section 3 of the main Environmental Report).
- Report the significant environmental effects of the actions proposed to manage flood risk in the Orkney LPD.
- Identify mitigation of significant negative effects and opportunities to deliver wider benefits.
- Recommend further assessment at more detailed planning stages e.g. feasibility studies or design stages.

The overall assessment for all 14 Flood Risk Management Strategies is summarised in section 5 of the main Environmental Report.

A7.1 The Orkney Local Plan District

The Orkney LPD (figure A7) comprises all of the Orkney Islands. It has a total area of approximately 1,000km^2 and a coastline approximately 860km in length. The population of the Orkney Islands is approximately 21,500. There are around 70 islands, of which 20 are inhabited. The largest settlement with a population of around 8,500 is Kirkwall which is located on Orkney Mainland.

The main source of flooding is coastal flooding, which accounts for approximately 91% of the Annual Average Damages[1]. Surface water flooding contributes around 5% and river flooding 4% to Annual Average Damages. There are eight Potentially Vulnerable Areas (PVAs) within the LPD.

A range of non-structural and structural actions are being considered to manage flooding in this LPD. Structural actions have been shortlisted to manage coastal flooding in seven PVAs (table A7.1).

Table A7.1: Shortlisted actions in the Orkney LPD

Action	PVAs							
	03/01	03/02	03/03	03/04	03/05	03/06	03/07	03/08
Coastal restoration	●						●	
Coastal defences	●	●		●	●	●	●	●

[1] An indicative estimate of the direct economic costs of flooding impacts to residential properties, non-residential properties and agriculture

Figure A7: Orkney LPD and PVAs

A7.2 Environmental and policy context for the Orkney LPD

Section 2.2 and Appendix 3 of the main Environmental Report identify the relationships between the Flood Risk Management Strategies and other plans, programmes and strategies.

A7.3 Additional relevant information on the current state of the environment for Orkney

This sub section identifies relevant information on the current state of the environment for the Orkney LPD. This information supplements the description of the current state of Scotland's environment (section 3 of the main Environmental Report).

A7.3.1 Ecosystems and condition

The predominant ecosystems present are cultivated land and semi-natural grassland, which cover 39% and 29% of Orkney respectively. Other commonly occurring ecosystems include upland heath (mainly heather grassland) which covers 17% and wetlands (mainly bog) which covers 8% of Orkney. Although less than 1% of Orkney is covered with fen, marsh and swamp, this contributes 23% of this ecosystem type in Scotland.

Table A7.2 lists the extent of different ecosystems within the LPD, and provides an assessment of ecosystem condition.

Table A7.2 Ecosystems within the LPD

Ecosystem	Area (% of LPD in 2007)	Condition of ecosystem
Woodland - native	<0.5	There is very little native woodland in Orkney. However, between 2007 and 2013 over 300 acres of native tree species have been planted though various projects.
Woodland - conifer plantation	<0.5	There is little or no conifer plantation in Orkney.
Cultivated land	39	Many small watercourses in Orkney are threatened by diffuse pollution. This indicates that there could be potential degradation and erosion of soils.
Semi-natural grassland	29	In Scotland, this ecosystem is thought to be in moderate condition.
Wetlands (fen, marsh, and swamp; bog)	8	In Scotland, within protected sites, condition is generally good with the exception of lowland raised bog. In the protected sites near Kirkwall, the condition of upland assemblage (including blanket bog) was assessed as unfavourable recovering in 2006. Little is known about condition beyond the boundaries of protected sites.
Upland heath	17	In Scotland, upland habitats are generally in good condition and improving.
Freshwater lochs and rivers	3	There are 18 river water bodies in Orkney. The RBMP overall status of river water bodies is generally good or better, with 17% less than good status for water quality and 28% less than good status due to the condition of beds and banks. Pressures include straightening of river channels (often for land drainage) and nutrient enrichment (from agriculture and sewerage).

Ecosystem	Area (% of LPD in 2007)	Condition of ecosystem
Coastal & marine habitats	<2*	The ecological status of the coastal water bodies in Orkney is good or better. There are a number of important coastal ecosystems in the areas at risk of coastal flooding with designated sites in variable condition ranging from favourable maintained to unfavourable no change.
Urban	1	Access to greenspace in Orkney is good.

*The majority of the coastal and marine ecosystem extends beyond the terrestrial LPD boundary

There are many environmental sites of European and national importance in this LPD: six Special Areas of Conservation (SAC), 11 Special Protection Areas (SPAs), and 27 Sites of Special Scientific Interest (SSSIs). Sites that may be of particular relevance for flood risk management actions are described below:

The Stromness Heaths and Coast SSSI and SAC are designated for various features, all in favourable condition.

Kettletoft Bay is part of the SSSI Central Sanday designated for machair, saltmarsh and sand dune habitats. The saltmarsh (littoral sediment) is in favourable maintained condition. However, the sand dunes and machair (supralittoral sediment) are in unfavourable condition. Objectives for site management include safeguarding against damage or erosion caused by coastal works, engineering works or inappropriate extraction of sand and gravel; also avoiding the use of vehicles on saltmarsh which can lead to surface damage.

East Sanday Coast is a SSSI, SAC and SPA for various features in mixed condition. Coastal protection structures could exacerbate erosion further along the coast. Therefore, careful consideration should be given to the effects of any works which impact upon the natural processes. Natural features such as sandflats can dissipate wave energy, thus reducing damage to coastal defences and other coastal structures. They also help to provide protection to saltmarshes and reduce the risk of flooding to low lying land. Sanday is also an SPA with a conservation objective to reduce the decline of the common seal.

A7.3.2 Ecosystem services

This sub section summarises the major ecosystem services within this LPD.

Regulating and maintaining services

- Carbon storage and sequestration is provided by wetlands (mainly bog but also some fen, marsh, and swamp).
- Areas of wetlands, semi natural grassland and upland heath help to filter and maintain good water quality. These ecosystems also help to regulate the flow of water.
- There are some sand dune ecosystems present in Stronsay and Sanday. These help to attenuate waves and surge. However, these areas are also more naturally susceptible to erosion.

Provisioning services

- Agriculture is mainly grassland based farming and rough grazing.
- There are three active marine finfish sites near Kirkwall and one near Stromness, but none in the waters around Sanday or Stronsay. Trout fishing and commercial wild marine fisheries are also present in Orkney.
- There are no significant woodlands located in Orkney or potential to support woodland and timber processing sites or production of biofuels from crops.

Cultural services

- The area provides a wide range of recreational opportunities, including angling, kayaking, sailing, swimming, and diving.
- Landscape is particularly important. Stromness is located within the Hoy and West Mainlands National Scenic Area. This stone built settlement rises steeply out of the harbour and enhances the character of the area.
- The area is also rich in historic sites, including scheduled monuments and some gardens and designed landscapes. The Heart of Neolithic Orkney is a UNESCO World Heritage Site.

A7.4 Environmental assessment of the Flood Risk Management Strategy for Orkney

This sub section provides an assessment of the potential environmental effects of the flood risk management actions under consideration for the PVAs within this LPD. The effects on SEA topics and on ecosystem services are reported under each group of actions. Table A7.5 compares the effects of different groups of actions on ecosystem services.

A7.4.1 Non-structural actions

A range of non-structural actions are being considered for the LPD such as property level protection, relocation of properties / infrastructure away from flood risk areas and flood warning schemes. These actions help to reduce the impacts of flooding and therefore are likely to have significant positive effects on the SEA objectives for human health and material assets. These effects have been assessed nationally rather than at an LPD level and the results are presented in section 4 of the main Environmental Report.

As these actions help to reduce the impacts of flooding rather than the probability of flooding, they are likely to have no or negligible effects on ecosystems and ecosystem services.

A7.4.2 Coastal restoration

Coastal restoration actions to attenuate waves and reduce surge are being considered in two PVAs.

The ecosystems most likely to be affected are coastal and marine ecosystems, but also semi natural grassland and cultivated land. All SEA topics could be affected. The potential effects of the actions are described in the text below and summarised by SEA topic in table A7.3.

Table A7.3 Coastal restoration: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	+ + Much of Sanday is protected for habitats such as sand dunes and machair. Some of this is in currently in unfavourable condition so could be significantly improved through restoration.	Any work undertaken should be timed to minimise disruption to the common seal, which is protected and declining on Sanday. Opportunities to enhance existing habitats should be discussed with other relevant organisations (e.g. SNH). Habitat Regulations Appraisal will address any negative effects on SACs and SPAs.
Population and human health	+ + Benefits to the community from reducing the risk of flooding to people and properties	
Soil	No significant effects	
Water	No significant effects	
Climatic factors	No significant effects	

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Material assets	+ + Benefits from reducing the risk of flooding to properties and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	+ + Benefits from reducing coastal erosion to the historic environment	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise any negative effects.
Landscape	No significant effects	Feasibility and design stages should include consultation with communities to avoid or minimise negative effects on urban and coastal landscapes,

Commentary on potential significant effects

Regulating and maintaining services
Coastal restoration actions help to provide space to attenuate waves and coastal surge through the creation and restoration of natural habitats. They can also help to protect the coastline from erosion. Through attenuating waves and surge and protecting from erosion, coastal restoration actions have the potential to reduce flood risk.

Restoration actions can help to improve the quality of the water environment.

Restoration of sand dunes could deliver significant benefits to Sanday where these habitats are currently in unfavourable condition. Any work undertaken should be timed to minimise disruption to the common seal, which is protected and declining on Sanday. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
Coastal restoration actions in Orkney may help to protect cultivated land and semi natural grassland from erosion and flooding thus helping to maintain the grazing productivity. Grazing is essential for the formation and maintenance of machair, an internationally rare habitat. The restoration and creation of intertidal areas may help to provide nurseries for fish, but could lead to some loss of productive grazing land. There is therefore a mixed effect on food provisioning.

Cultural services
Coastal restoration actions provide will help provide or maintain existing cultural and spiritual amenity and opportunities for accessing nature / experiencing wildlife. However, implementation of works could restrict access to coastal areas, which could cause short to medium duration local negative effects on recreation.

The historic environment is likely to benefit due to reduced risk of flooding and perhaps significantly due to the potential protection from coastal erosion.

A7.4.3 Coastal defences

Coastal defences (including coastal management) are being considered for seven PVAs.

The ecosystems most likely to be affected are urban, and coastal and marine. All SEA topics could be affected. The potential effects of the actions are described in the text below and summarised by SEA topic in table A7.4.

Table A7.4 Coastal defences: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	- - Negative effects on protected coastal habitats through increased disruption of natural processes, coastal squeeze and possible increased to coastal erosion risk.	Any work undertaken should be timed to minimise disruption to the common seal, which is protected and declining on Sanday. Any work undertaken should try to avoid damage to rare habitats such as saltmarsh. Consultation with relevant organisations (e.g. SNH) should be undertaken to ensure protected environmental sites and habitats such as sand dunes and saltmarsh are not damaged. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits to the community from reducing the risk of flooding to people and property - - Negative effects to the community if increases the risk of erosion risk to other important areas.	Feasibility studies are required to ensure actions are located appropriately and better understand the erosion risks.
Soil	No significant effects	
Water	No significant effects	
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing the risk of flooding to properties, transport, community facilities, utilities and environmental sites. - - Negative effects to the community if increases the risk of erosion risk to other important areas.	Feasibility studies are required to ensure actions are located appropriately and better understand the erosion risks. Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	- - Negative effects on coastal landscape	Stromness is located within the West Mainland National Scenic Area. Actions that could significantly change this landscape should be avoided. Feasibility and design stages should include consultation with communities to avoid or minimise negative effects on urban and coastal landscapes.

Commentary on potential significant effects

Regulating and maintaining services
By attenuating waves and surge coastal defences can help to reduce flood risk. Some defences can also help to reduce erosion at the site of the defence. However, these actions can lead to the loss of natural habitat, interfere with coastal processes, and could increase the risk of erosion in other locations along the coast.

Loss of natural habitat can degrade water quality by reducing the ability of the environment to filter, capture and recycle nutrients / pollutants. The effects on carbon storage are mixed: loss of natural habitat to sequester carbon will have negative effects; however, some actions might provide suitable substrate for kelp which can act as a carbon store.

There are protected habitats and nationally rare habitats near the areas where actions are proposed. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
Coastal defences can have mixed effects on marine food provision: any loss of natural habitat could lead to reduced productivity but other edible species can benefit (for example, a change from soft sediment feeding fish to lobster and crab fishery).

Cultural services
The effects of coastal defences on recreation and opportunities to experience nature and wildlife may be reduced through loss of natural habitat and access. There are also potential negative effects on urban and coastal landscapes: these could be significant given the importance of the landscape in this LPD. With sensitive design of defences, however, access for recreation may be improved and disturbance to wildlife may be reduced.

There are some coastal listed buildings in the PVAs: these may benefit from a reduction in flood risk but the setting may be negatively affected by the defences. Furthermore, changes to coastal processes may increase the risk of erosion to cultural heritage sites away from the immediate location of the defences. Further assessment is required at more detailed planning stages about the precise nature and location of the defences.

Table A7.5 Shortlisted actions for Orkney: Summary of potential effects of actions to on ecosystem services

Source of flooding	All		Coastal	
Ecosystem service	Non-structural actions		Coastal restoration	Coastal defences
Nutrition: food provision	**0**		**+/-**	**+/-**
Drinking water supply	**0**		**0**	**0**
Biotic materials: timber, biofuels	**0**		**0**	**0**
Carbon storage	**0**		**+**	**+/-**
Local climate regulation	**0**		**0**	**0**
Water quality regulation	**0**		**+**	**-**
Pollination	**0**		**0**	**0**
Biological control of pests and disease	**0**		N/A	N/A
Wave / surge attenuation	**0**		**+ +**	**+ +**
Water flow regulation	**0**		N/A	N/A
Erosion protection	**0**		**+**	**+/-**
Recreation (physical interaction)	**0**		**+/-**	**+/-**
Accessible nature/wildlife experience	**0**		**+**	**+/-**
Spiritual and cultural amenity (landscape)	**0**		**+**	**- -**

KEY				
	+ +	**Significant positive** Effects are widespread across the LPD; and/or Effects are likely to improve an ecosystem that is in less than good condition	**-**	**Negative** A noticeable negative effect that does not meet the description below
	+	**Positive** A noticeable positive effect that does not meet the description above	**- -**	**Significant negative** Effects are widespread across the LPD; and/or Effects are likely to cause an adverse effect on an ecosystem that is in less than good condition
	0	**No or negligible effects**	**+/-**	**Mixed:** The effect is likely to be a combination of positive and negative effects, particularly where effects are considered on sub-issues, areas or criteria

Map acknowledgments

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including *inter alia*, the following organisations:

Ordnance Survey
Flood maps are based upon Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office © Crown Copyright. Any unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. SEPA Licence number 100016991 (2015).

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology © NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2015), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright © The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC.

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

Appendix 8: Environmental assessment of the Flood Risk Management Strategy for Shetland

This appendix presents the current state of the environment and the assessment of significant environmental effects for the Flood Risk Management Strategy for Shetland Local Plan District (LPD). The purpose of this is to:

- Identify relevant information on the current state of the environment for Shetland. This information supplements the description of the current state of Scotland's environment (section 3 of the main Environmental Report).
- Report the significant environmental effects of the actions proposed to manage the risk of flooding in the Shetland.
- Identify mitigation of significant negative effects and opportunities to deliver wider benefits.
- Recommend further assessment at more detailed planning stages e.g. feasibility studies or design stages.

The overall assessment for all 14 Flood Risk Management Strategies is summarised in section 5 of the main Environmental Report.

A8.1 The Shetland Local Plan District

The Shetland LPD (figure A8) comprises all the islands which are part of the Shetland Islands. The population of the Shetland Islands is approximately 23,200 and only 16 of the approximately 100 islands which make up the area are inhabited. The capital and largest settlement is Lerwick, which has a population of around 7,500.

The main source of flooding is coastal flooding, which contributes around 77% of the Annual Average Damages[1]. There are three Potentially Vulnerable Areas (PVAs) within the Shetland LPD; these are all located on Mainland.

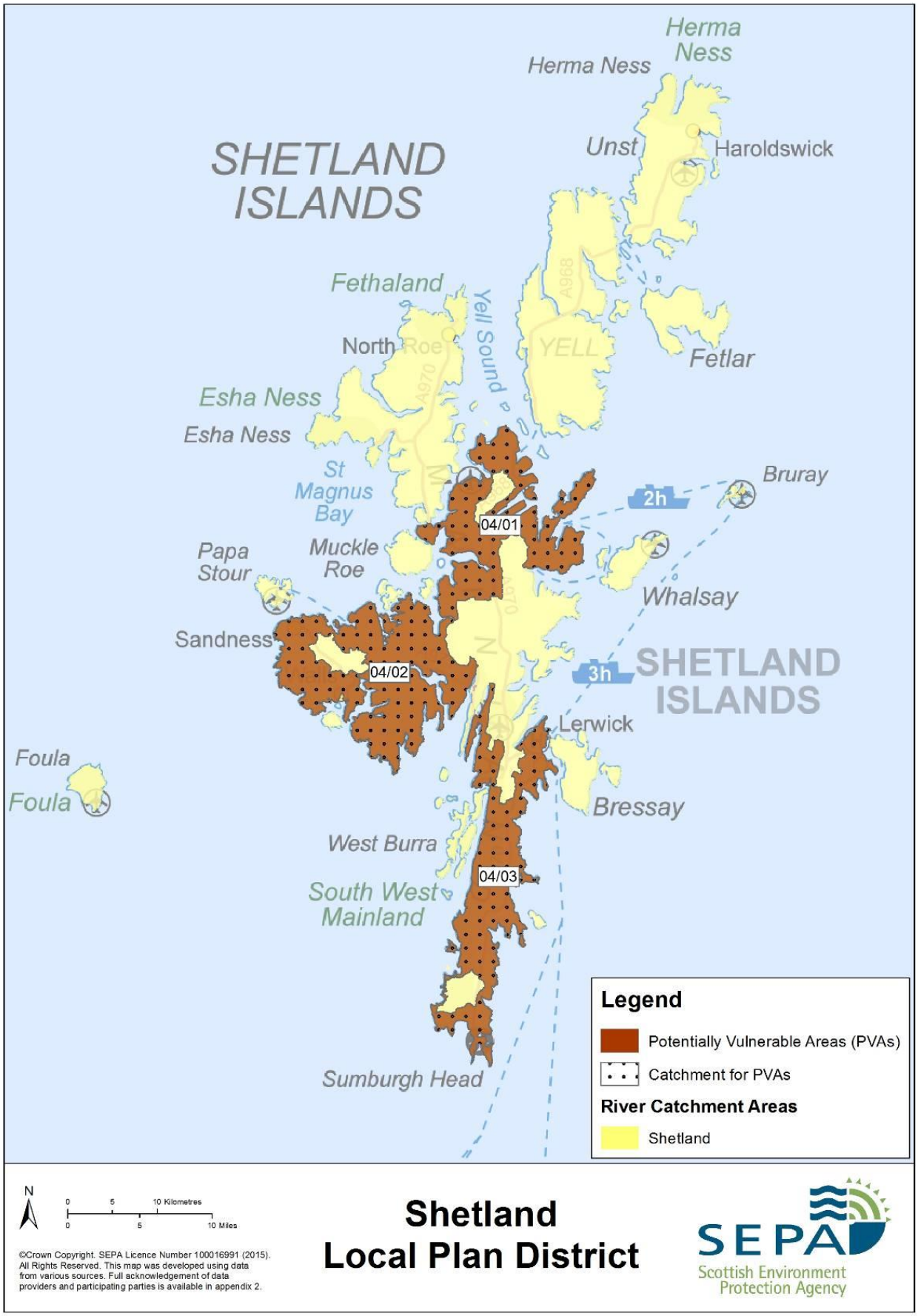
A range of non-structural and structural actions are being considered to manage flooding in this LPD. Two PVAs have structural actions shortlisted to manage coastal flooding and two for river flooding (table A8.1). There are no actions shortlisted to manage surface water flooding.

Table A8.1: Shortlisted actions in the Shetland LPD

Action	PVAs		
	04/01	04/02	04/03
Run off reduction			●
River and floodplain restoration	●		●
Storage conveyance and control	●		●
River defences			●
Coastal defences	●	●	

[1] An indicative estimate of the direct economic costs of flooding impacts to residential properties, non-residential properties and agriculture

Figure A8. Shetland LPD and PVAs



A8.2 Environmental and policy context for Shetland LPD

Section 2.2 and Appendix 3 of the main Environmental Report identify the relationships between the Flood Risk Management Strategies and other plans, programmes and strategies.

A8.3 Additional relevant information on the current state of the environment for Shetland LPD

This sub section identifies relevant information on the current state of the environment for the Shetland LPD. This information supplements the description of the current state of Scotland's environment (section 3 of the main environmental report).

A8.3.1 Ecosystems and condition

The predominant landcover in the Shetland Islands is bog, covering around 31% of the LPD. Rough grassland and heather grassland are also significant, covering around 23% and 21% of the land area respectively. Although less than 3% of the LPD is neutral grassland (a type of semi-natural grassland), this makes up 36% of this landcover type in Scotland so is important nationally. Less than 0.5% of Shetland is classified as urban. The coastline is predominantly rocky in nature and is heavily embayed with many inlets, voes and bays.

Table A8.2 lists the extent of different ecosystems within the LPD, and provides an assessment of ecosystem condition.

Table A8.2 Ecosystems within the LPD

Ecosystem	Area (% of LPD in 2007)	Condition of ecosystem
Woodland – native	<0.5	There is very little native woodland present in Shetland. However, there are many initiatives to replant trees and create community woodlands; these are usually a mixture of native and non native species. Woodlands have been established in Kergord, Sullom, Loch of Voe and Clickimin.
Woodland - conifer plantation	<0.5	There are little or no conifer plantations in Shetland.
Upland heath	30	Nationally, upland habitats are generally in good condition and improving.
Cultivated land	5	Some small watercourses in Shetland are threatened by diffuse pollution. This suggests that there could be degradation and erosion of soils in some locations.
Semi-natural grassland	3	Nationally, this ecosystem is thought to be in moderate condition.
Wetlands (fen, marsh, and swamp; bog)	31	Large areas of Shetland are covered with bog, including large areas of the PVAs. Wetlands in protected sites are in mixed condition.
Freshwater lochs and rivers	2	There are 17 river water bodies identified for river basin management planning purposes in Shetland. There is only one river water body located within a PVA; this is the Burn of Laxadale / Burn of Voxter (PVA 04/03) and it is at less than good status for water quality. There are five loch water bodies identified for river basin management planning purposes in Shetland; one of these is at less than good overall status. There are also a number of protected mesotrophic lochs in varying condition.

Ecosystem	Area (% of LPD in 2007)	Condition of ecosystem
Coastal & marine	<3*	The coastline of Shetland is mainly rocky. However, there are some extensive sand dune systems around the South West Mainland Of 65 coastal and transitional WFD water bodies, all are at good overall status or better. Some small watercourses in Shetland are threatened by diffuse pollution.
Urban	1	Access to greenspace in Scotland's urban environment is generally good. Over two thirds (68%) of adults in Scotland have access to useable greenspace within a five-minute walk from their home (not including their own garden).

*The majority of the coastal and marine ecosystem extends beyond the terrestrial LPD boundary so is not captured in this figure

There are many environmental sites of European and national importance in this LPD: 12 Special Areas of Conservation (SAC), 11 Special Protection Areas (SPAs), and 77 Sites of Special Scientific Interest (SSSIs).

There are a number of SPAs and SSSIs for breeding sea birds in varying condition including Sumburgh Head with objectives to avoid significant disturbance during the breeding season. Sullom Voe is designated as an SAC and is in favourable condition for lagoons, reefs and shallow inlets and bays. Other sites include Yell Sound Coast SSSI and SAC, designated for otters and harbour seals, which are in unfavourable declining condition.

The Aith Meadows and Burn of Aith SSSI is north of Cunningsburgh (PVA 04/03), where actions to reduce the risk of flooding from rivers are being considered. It is designated for lowland neutral grassland and fen meadow, which were assessed in 2009 as being in unfavourable declining condition and favourable declining condition respectively. Objectives include regular clearance of the Burn of Aith and ditches necessary to allow hay cutting or grazing.

A8.3.2 Ecosystem services

This sub section summarises the major ecosystem services within this LPD.

Regulating and maintaining services

- The coastline is predominately rocky. However, there are some sand dunes systems that may help to attenuate waves. The largest of these is located in the Bay of Quendale and Sumburgh. Most of Shetland is not vulnerable to erosion due to the rocky nature of most of the coastline.
- Carbon storage and sequestration is provided by bog, which makes up a large proportion of the land cover. The large areas of wetlands help to filter and maintain good water quality and regulate the flow of water.

Provisioning services

- The marine fish farming industry is a major component of the Shetland economy. There are also a small number of hatcheries producing salmon or brown trout for restocking. Shetland produces 30% of the total Scottish salmon production and 65% of the farmed mussel production.
- Most of Shetland is rough grazing with some grassland-based farming. Farming is mainly concerned with raising Shetland sheep, known for their wool. Crops raised include oats and barley.
- PVA 04/03 contains important sources of drinking water.

Cultural services

- The area provides a wide range of recreational opportunities, including angling, wildfowling, kayaking, walking, sailing, swimming, and diving. It provides habitat for wildlife and bird watching and wildlife tourism is important. There are two National Nature Reserves in Shetland.
- Landscape is important to Shetland. The west of PVA 04/03 is part of a National Scenic Area for the coastal landscape.
- There are numerous historic sites located through Shetland, including gardens and designed landscapes and scheduled monuments of various types including prehistoric, secular, ecclesiastical, industrial, ritual, funerary and defensive.

A8.4 Environmental assessment of the Flood Risk Management Strategy for Shetland

This sub section provides an assessment of the potential environmental effects of the flood risk management actions under consideration for the PVAs within this LPD. The effects on SEA topics and on ecosystem services are reported under each group of actions. Table A8.8 compares the effects of different groups of actions on ecosystem services.

A8.4.1 Non-structural actions

A range of non-structural actions are being considered for the LPD such as property level protection, and relocation of properties / infrastructure away from flood risk areas. These actions help to reduce the impacts of flooding and therefore are likely to have significant positive effects on the SEA objectives for human health and material assets. These effects have been assessed nationally rather than at an LPD level and the results are presented in section 4 of the main Environmental Report.

As these actions help to reduce the impacts of flooding rather than the probability of flooding, they are likely to have no or negligible effects on ecosystems and ecosystem services.

A8.4.2 Run off reduction actions

Actions to reduce run off include land management (including soil and bare earth improvements, changing agricultural field drainage), creation or restoration of wetlands and ponds, upland drain blocking and gully woodland planting. These are being considered in one PVA.

All SEA topics and ecosystems may be affected by these actions: either directly (in terrestrial ecosystems) if the action is located in the ecosystem itself, or indirectly if the ecosystem (freshwater or coastal and marine ecosystems) is located downstream of the action.

The potential effects of the actions are described in the text below and summarised by SEA topic in table A8.3.

Table A8.3 Run off reduction: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	No significant effects	Feasibility studies should consider opportunities to contribute to other drivers for restoration of wetlands and improvements to fisheries. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address any negative effects on SACs and SPAs.

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Population and human health	+ + Benefits to the community from reducing the risk of flooding	
Soil	No significant effects	Design stages should consider protecting livestock from potential exposure to pests. Consultation with land managers recommended.
Water	No significant effects	
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects
Landscape	No significant effects	

Commentary on potential significant effects

Regulating and maintaining services
Run off reduction actions help to slow and store water by intercepting rainfall (e.g. woodlands) and/or increasing the extent to which the land can hold any water reaching the ground (both by slowing down the flow of runoff and increasing the permeability of soils). This in turn can help to regulate the flow of water by reducing the amount of water reaching rivers and slowing or reducing flood flows: this helps to protect people and properties from flooding.

These actions can lead to locally noticeable improvements in water quality by helping to protect soils from erosion (thus reducing the sediment reaching rivers) and increasing infiltration of nutrients into soils. As these actions are being considered for one PVA and are likely to be small scale, other effects are likely to be negligible.

Run off reduction actions are not likely to affect to protected sites in Shetland LPD. This assessment, however, will be confirmed through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The effects on terrestrial food provision are not likely to be significant as most livestock is grown for wool. The actions may enhance the productivity of semi natural grassland by protecting soils from erosion and loss of nutrients, and through providing a more diverse habitat for pollinators and biological control of pests and disease. However, some areas of productive land may be lost and there is potential to increase the prevalence of some livestock pests.

By protecting water quality and reducing sedimentation, freshwater fisheries such as salmon and sea trout, may benefit. Actions may also provide benefits to drinking water supply by helping to remove nutrients and pollutants. These benefits, however, are dependent on the location of the action.

Cultural services
The effects on recreation, wildlife watching and landscape are likely to be positive, as the actions should improve habitat diversity and biodiversity. However, the Shetland mainland already has high levels of cultural services and large protected areas so any benefits are unlikely to be significant.

The actions have potential to benefit wetland archaeology as a result of creating and restoring wetlands. The structure and setting of historic sites is unlikely to be affected but this will need to be assessed at more detailed levels of flood risk management planning.

A8.4.3 River and floodplain restoration actions

Actions being considered to improve sediment management include sediment traps, bank restoration and managing sediment transport. These actions are being considered for two PVAs; however, the actions proposed are likely to be small scale.

All SEA topics and a wide range of ecosystems could be affected: semi natural grassland, wetlands, freshwater rivers and lochs and urban. The potential effects of the actions are described in the text below and summarised by SEA topics in table A8.4.

Table A8.4 River and floodplain restoration: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	No significant effects	Feasibility studies should consider opportunities to contribute to other drivers such as improvements to salmonids. Habitat Regulations Appraisal will address any negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	
Soil	No significant effects	
Water	No significant effects	
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	
Cultural heritage	No significant effects	
Landscape	No significant effects	

Commentary on potential significant effects

Regulating and maintaining services

Sediment management actions help to maintain and enhance the storage capacity of burns and regulate water flow, thus reducing the risk of flooding.

These actions are being considered for two PVAs for small burns and are likely to be small scale. However, they may have a locally noticeable effect on water quality and erosion protection as excessive deposition of sediment has been identified as a problem.

The effects on protected habitats and species are not likely to be significant. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services

As these actions are to restore small burns, only small areas of land will be affected and it is unlikely actions will significantly affect food provision. By protecting water quality and reducing sedimentation, freshwater fisheries such as salmon and sea trout could benefit.

Cultural services

The effects on recreation, wildlife watching and landscape are generally likely to be positive, as the actions should improve habitat diversity and biodiversity. However, there is good access to wildlife in Shetland so these effects are unlikely to be significant.

The historic environment has potential to benefit from these actions: firstly, through the reduction of flood risk to historic buildings and, secondly through the protection of wetland archaeology as a result of creating and restoring wetlands. This would depend on the location of the actions and would need to be assessed at more detailed levels of flood risk management planning.

A8.4.4 Storage conveyance and control

Storage, conveyance and control actions include creating flood storage areas, improving or adding new control structures (to manage interactions between burns and tides); and creating or improving culverts at road crossings. The actions are being considered for two PVAs.

All SEA topics could be affected. The actions could be located in most ecosystems, except upland heath and coastal and marine ecosystems. Potential effects of the actions are described in the text below and summarised by SEA topic in table A8.5.

Table A8.5 Storage, conveyance and control: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	No significant effects	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or damage to wetlands, disturbance of sediment, or barriers to fish passage. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	
Soil	No significant effects	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or damage to wetlands. Feasibility and design stages should consider potential loss of productive soils, particularly cultivated land. Consultation with land managers recommended.
Water	No significant effects	
Climatic factors	No significant effects	Feasibility studies should consider how to avoid or minimise potential negative effects to carbon stores such as loss or damage to wetlands.
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	

Commentary on potential significant effects

Regulating and maintaining services

Storage, conveyance and control actions alter the storage and flow of water. These actions can deliver positive effects through regulating the flow of water and thus reducing flood risk to people and property.

The ecosystem adjacent to the structures may benefit through protection from erosion – this may

have noticeable benefits in urban areas and in cultivated land and semi natural grassland.

However, there can be disruption to natural processes and loss of habitat, and erosion can be exacerbated downstream of the structure. These effects can lead to potentially negative effects on water quality (due to loss of habitat to filter nutrients).

Provisioning services
The potential effects on food provision are mixed: actions could help to reduce flooding and erosion to some areas of cultivated land or semi natural grassland. However, other areas may suffer increased flooding or erosion. These effects could lead to longer duration change in land use.
Freshwater production could suffer negative effects through loss of habitat or increased sedimentation; however, actions that alter existing conveyance or control structures could improve fish passage.

Cultural services
Opportunities for recreation such as angling could be improved if actions that modify existing structures lead to improvements to fish passage; however, potential degradation in water quality could have a negative effect on fish populations and thus reduce the quality of angling. The effects on recreation are therefore mixed.

Flood storage actions could have negative impacts on landscape.

The historic environment may benefit through a reduction in flood risk, but there is also potential for negative effects: the disconnection of the floodplain could damage wetlands and the archaeology preserved within it. The historic environment may be negatively affected altering the setting of historic sites or through damage to sites when the action is implemented. Further assessment is required at more detailed levels of flood risk management planning.

A8.4.5 River defences

River defences may include walls, embankments or demountable / temporary defences. These actions are being considered for one PVA and are likely to be small scale local works to protect roads.

The actions are most likely to be located in or adjacent to rivers (freshwater lochs and rivers ecosystem) or set back from the river. All SEA topics could be affected. The potential effects of the actions are described in the text below and summarised by SEA topic in table A8.6.

Table A8.6 River defences: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	No significant effects	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or disturbance of sediment. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility and design studies should consider effects on quality and access to recreation. Discussion with stakeholders recommended at both stages.
Soil	No significant effects	
Water	No significant effects	
Climatic factors	No significant effects	

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	Feasibility and design stages should include consultation with communities to avoid or minimise negative effects on the landscape.

Commentary on potential significant effects

Regulating and maintaining services
River defences can deliver benefits by regulating water flow and reducing flood risk. The actions, however, can interfere with natural process: the defences cause some or all of the floodplain to be disconnected from the burns, which can lead to loss of natural habitat to capture, filter and recycle nutrients or pollutants. This can lead to a reduction in water quality and a loss of carbon storage. Erosion may also increase upstream or downstream of a defence due to changes in river processes. A potential decline in water quality and increase in sediment load can have potentially negative effects on freshwater species such as salmon. However, while these effects may be locally noticeable, they are unlikely to be significant due to the small scale of proposed actions.

Provisioning services
River defences have potential negative effects on freshwater food production due to the loss of in river and riparian habitat. However, this is dependent on the type of defence (for example, defences that are set back from the river are likely to have a smaller impact) and the degree to which the river banks have already been modified.

Cultural services
Given the small scale of works proposed, river defences are unlikely to have noticeable effects on recreation, landscape or opportunities to access nature / experience wildlife.

Historic buildings and monuments may benefit through reduced flood risk, but the defences may alter the setting of the site. Historic sites may also be affected, either for a short or long duration, by construction of the defences – however, this cannot be assessed at this level of planning as more information is required about the precise nature and location of the defences.

A8.4.6 Coastal defences

Coastal defences include walls, embankments, revetments, breakwaters and temporary defences and are being considered for two PVAs.

The ecosystems most likely to be affected are urban, and coastal and marine; all SEA topics could be affected. The potential effects of the actions are described in the text below and summarised by SEA topic in table A8.7.

Table A8.7 Coastal defences: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	- - Negative effects on coastal habitats through increased erosion and disruption of natural processes	Feasibility studies should consider how to avoid or minimise potential negative effects such increased erosion. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies and design studies should consider short and medium duration effects on coastal access. Discussion with stakeholders recommended at both stages.
Soil	No significant effects	
Water	No significant effects	
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure - - Property and infrastructure may experience an increased erosion risk outside of the area of protection	Further modelling required at feasibility and design stages to better understand erosion risks. Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	Feasibility and design stages should include consultation with communities to avoid or minimise negative effects on urban and coastal landscapes.

Commentary on potential significant effects

Regulating and maintaining services
Coastal defences help to reduce the risk of flooding to people, properties transport and environmental sites in the locations they are designed to protect. However, these actions can lead to the loss of natural habitat, interfere with coastal processes and potentially increase the risk of erosion elsewhere along the coast.

Loss of natural habitat can degrade water quality by reducing the ability of the environment to filter, capture and recycle nutrients / pollutants. The effect on carbon storage is mixed: loss of natural habitat to sequester carbon will have negative effects; however, some actions might provide suitable substrate for kelp which can act as a carbon store.

Changes to natural coastal processes by engineered structures could alter the movement of gravel, shingle and sands, leading to potentially significant negative effects on protected coastal habitats. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
Coastal defences can have mixed effects on marine food provision: whilst there can be loss of natural habitat which can reduce productivity, sometimes other edible species can benefit (for example, a change from soft sediment feeding fish to lobster and crab fishery).

The effect actions could have on the aquaculture industry should also be carefully considered, changes in sediment dynamics or alterations to currents and water flow could impact negatively or positively on this industry.

Cultural services
The effects of coastal defences on recreation and opportunity to experience nature and wildlife may be reduced through loss of natural habitat and access. However, there may also be benefits as access may be improved and disturbance to wildlife may be reduced.

There are potential negative effects on urban and coastal landscape. However, sensitively designed defences may help to improve amenity.

There are many coastal listed buildings, scheduled monuments and coastal built heritage sites in the PVAs. These may benefit from reduced risk of flooding but the setting may be negatively affected by the defences. Further assessment is required at more detailed planning about the nature and location of the defences.

Table 8.8 Shortlisted actions for Shetland: Summary of potential effects on ecosystem services

Source of flooding	All		River					Coastal	
Ecosystem service	Non-structural actions		Run off reduction	River and floodplain restoration	Storage, conveyance, control	River defences		Coastal restoration	Coastal defences
Carbon storage	**0**		**+**	**0**	**0**	**0**		N/A	**+/-**
Local climate regulation	**0**		**0**	**0**	**0**	**0**		N/A	**0**
Water quality regulation	**0**		**+**	**+**	**-**	**-**		N/A	**+/-**
Pollination	**0**		**0**	**0**	**0**	**0**		N/A	**0**
Biological control of pests and disease	**0**		**0**	**0**	**0**	**0**		N/A	N/A
Wave/ surge attenuation	**0**		N/A	N/A	N/A	N/A		N/A	**+ +**
Water flow regulation	**0**		**+ +**	**+ +**	**+ +**	**+ +**		N/A	N/A
Erosion protection	**0**		**+**	**+**	**+/-**	**+/-**		N/A	**+/-**
Nutrition: food provision	**0**		**+/-**	**+**	**+/-**	**+/-**		N/A	**+/-**
Drinking water supply	**0**		**+**	**+**	**0**	**0**		N/A	**0**
Biotic materials: timber, biofuels	**0**		**0**	**0**	**0**	**0**		N/A	**0**
Recreation (physical interaction)	**0**		**+**	**+**	**+/-**	**0**		N/A	**+/-**
Accessible nature/wildlife experience	**0**		**+**	**+**	**0**	**0**		N/A	**+/-**
Spiritual and cultural amenity (landscape)	**0**		**+**	**+**	**-**	**0**		N/A	**-**

KEY					
	+ +	**Significant positive** Effects are widespread across the LPD; and/or Effects are likely to improve an ecosystem that is in less than good condition	**-**	**Negative** A noticeable negative effect that does not meet the description below
	+	**Positive** A noticeable positive effect that does not meet the description above	**- -**	**Significant negative** Effects are widespread across the LPD; and/or Effects are likely to cause an adverse effect on an ecosystem that is in less than good condition
	0	**No or negligible effects**	**+/-**	**Mixed:** The effect is likely to be a combination of positive and negative effects, particularly where effects are considered on sub-issues, areas or criteria

Map acknowledgments

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including *inter alia*, the following organisations:

Ordnance Survey
Flood maps are based upon Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office © Crown Copyright. Any unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. SEPA Licence number 100016991 (2015).

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology © NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2015), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright © The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC.

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

Appendix 9: Environmental assessment of the Flood Risk Management Strategy for Findhorn, Nairn and Speyside

This appendix presents the current state of the environment and the assessment of significant environmental effects for the Flood Risk Management Strategy for the Findhorn, Nairn and Speyside Local Plan District (LPD). The purpose of this is to:

- Identify relevant information on the current state of the environment for Findhorn, Nairn and Speyside. This information supplements the description of the current state of Scotland's environment (section 3 of the main Environmental Report).
- Report the significant environmental effects of the actions proposed to manage flood risk in the Findhorn, Nairn and Speyside LPD.
- Identify mitigation of significant negative effects and opportunities to deliver wider benefits
- Recommend further assessment at more detailed planning stages e.g. feasibility studies or design stages.

The overall assessment for all 14 Flood Risk Management Strategies is summarised in section 5 of the main Environmental Report.

A9.1 The Findhorn, Nairn and Speyside Local Plan District

The Findhorn, Nairn and Speyside LPD (figure A9) covers a total area of approximately 4,800km^2 with a population of approximately 100,000. The area extends from Lossiemouth in the north, down to Dalwhinnie in the south and includes part of the Cairngorms National Park. The largest settlement is Elgin.

The major river catchments are the Findhorn and the Spey. The LPD has a coastline approximately 70km in length.

The main source of flooding in the LPD is river flooding (87% of Annual Average Damages[1]), followed by surface water flooding (10% of Annual Average Damages) and coastal flooding (3% of Annual Average Damages). There are fourteen Potentially Vulnerable Areas (PVAs) located across the LPD with a significant number located adjacent to the coast in the lower catchments.

A range of non-structural and structural actions are being considered to manage flooding in this LPD. Structural actions are being considered to manage river flooding in five PVAs and to manage coastal flooding in one PVA (table A9.1).

[1] An indicative estimate of the direct economic costs of flooding impacts to residential properties, non-residential properties and agriculture

Figure A9: Findhorn, Nairn and Speyside LPD and PVAs

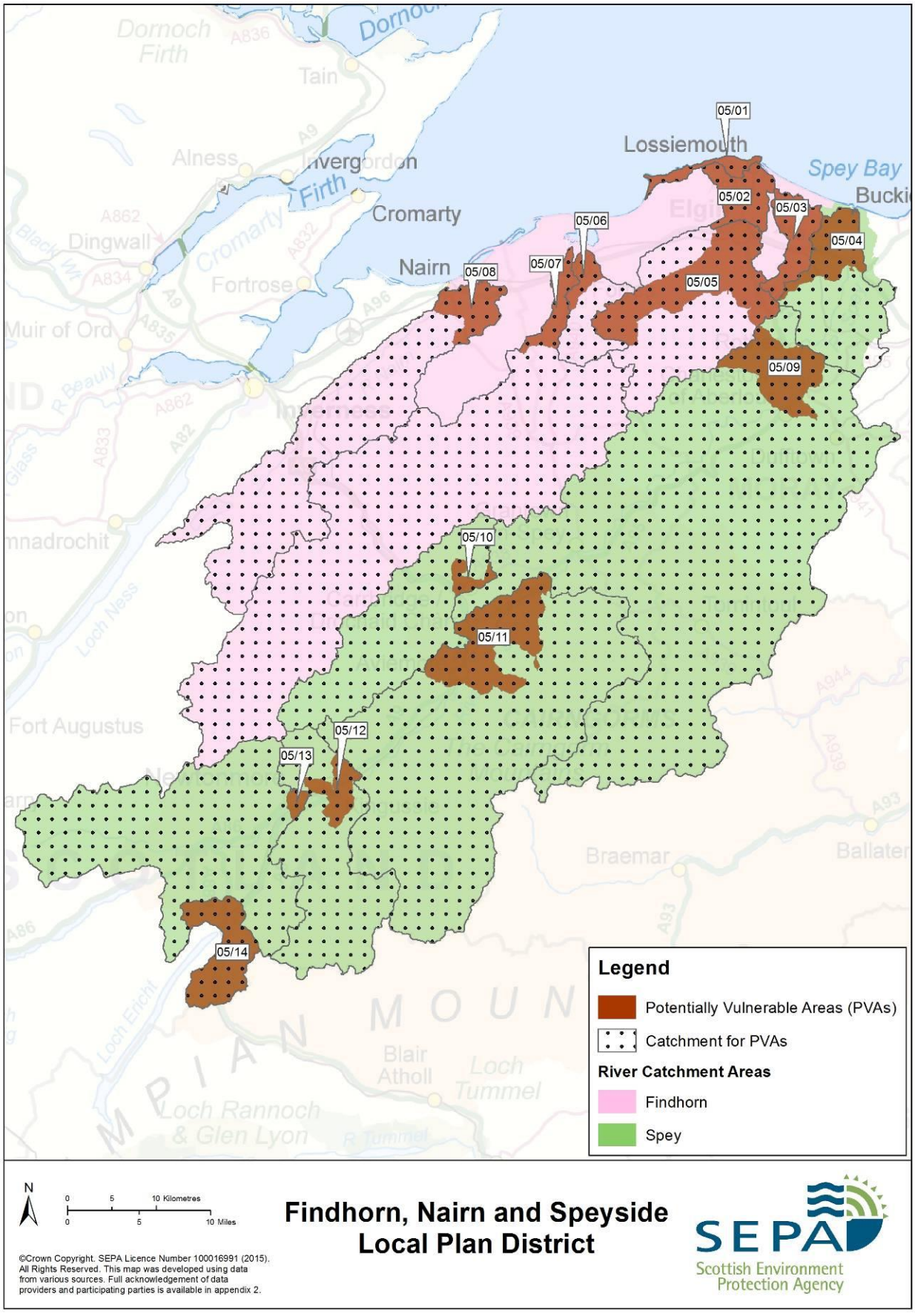


Table A9.1: Shortlisted actions in Findhorn, Nairn and Speyside LPD

Action	PVAs													
	05/01	05/02	05/03	05/04	05/05	05/06	05/07	05/08	05/09	05/10	05/11	05/12	05/13	05/14
Run off reduction											●	●		●
River and floodplain restoration		●						●			●	●		●
Storage conveyance and control		●						●				●		●
River defences		●						●			●	●		●
Coastal defences		●												

A9.2 Environmental and policy context for the Findhorn, Nairn and Speyside LPD

Section 2.2 and Appendix 3 of the main Environmental Report identify the relationships between the Flood Risk Management Strategies and other plans, programmes and strategies.

A9.3 Additional relevant information on the current state of the environment for Findhorn, Nairn and Speyside LPD

This sub section identifies relevant information on the current state of the environment for the Findhorn, Nairn and Speyside LPD. This information supplements the description of the current state of Scotland's environment (section 3 of the main Environmental Report).

A9.3.1 Ecosystems and condition

The predominant ecosystem in Findhorn, Nairn and Speyside is upland heath (heather, heather grassland, montane, inland rock), which covers 43% of the area. Other common ecosystems are coniferous plantation, cultivated land, semi natural grassland and wetlands (fen, marsh, and swamp; bog), which each cover between 10% and 17% of the area. Around 20% of Scotland's montane habitat and 20% of fen, marsh, and swamp habitat are found in this LPD. The coastal and marine habitats are predominantly soft substrate: sand, shingle, dunes and saltmarshes.

Table A9.2 lists the extent of different ecosystems within the LPD, and provides an assessment of ecosystem condition.

Table A9.2 Ecosystems within the LPD

Ecosystem	Area (% of LPD in 2007)	Condition of ecosystem
Woodland - native	3	In this area, many native woodlands are being created and/or put into positive management. The area of native woodland cover has increased since the 2007 due to native woodland expansion.
Woodland - conifer plantation	17	Nationally, the area of forest plantation is increasing. There is no information on the condition. Forestry is a contributing factor to diffuse pollution pressures on the water environment.

Ecosystem	Area (% of LPD in 2007)	Condition of ecosystem
Cultivated land	14	There are some rivers with rural diffuse pollution pressures although these are confined to the lower catchment. This indicates that there may be potential degradation and erosion of soils.
Semi-natural grassland	12	Nationally, this ecosystem is thought to be in moderate condition.
Wetlands (fen, marsh, and swamp; bog)	10	Nationally, within protected sites, condition is generally good with the exception of blanket bog. In this LPD, some wetland areas show signs of erosion, low regeneration and reduction in area. Little known beyond the condition of protected sites.
Upland heath	43	Nationally, upland habitats are generally in good condition and improving.
Freshwater lochs and rivers	1	There are 151 WFD river water bodies in this LPD. The condition of river water bodies is generally good, with 12% at less than good status for water quality and 13% at less than good status due to the condition of beds and banks. The condition of lochs is also generally good in this LPD. Of 11 WFD loch water bodies, 18% are at less than good overall status. There are some rivers with rural diffuse pollution pressures although these are confined to the lower catchment. A large part of the central and eastern area of this LPD is designated as a Nitrate Vulnerable Zone. These indicate that freshwater ecosystems may be under pressure from excess nitrates and phosphorus.
Coastal & marine	<0.5*	All WFD transitional and coastal water bodies are at good status or better for the physical condition of coastline. Bathing waters all achieved mandatory passes or better in 2013.
Urban	1	Access to greenspace in Scotland's urban environment is generally good. Over two thirds (68%) of adults in Scotland have access to useable greenspace within a five-minute walk from their home (not including their own garden).

*The majority of the coastal and marine ecosystem extends beyond the terrestrial LPD boundary so is not captured in this figure

There are many environmental sites of European and national importance in the PVAs and their source catchments: 16 Special Areas of Conservation (SACs), 13 Special Protected Areas (SPAs) and 56 Sites of Special Scientific Interest (SSSIs). The largest areas of designated sites are found in the upper catchment and contain large areas of upland heath (e.g. Cairngorms, Monadhliath), wetlands (e.g. Carn nan Tri-tighearnan, Insh Marshes) or a mix of woodland, upland heath, wetland and semi natural grassland (e.g. Abernethy Forest, Kinveachy Forest). The River Spey and Lower River Spey are designated as both SACs and SSSIs. Much of the coastline is designated as an SAC (Moray Firth, Spey Bay) and/or an SPA (Moray and Nairn Coast SPA), and there are a number of coastal SSSIs. There are no Marine Protected Areas adjacent to this LPD.

The condition of features in protected sites in this LPD is mixed. Relevant pressures include river and coastal protection works (e.g. River Spey; Lower River Spey; Spey Bay); woodland expansion in low altitude dwarf shrub heath (e.g. Cairngorms SAC, which is the foremost site in Britain for dwarf shrub heath); erosion and drying out of wetlands (e.g. Carn nan Tri-tichearnan; Spey Bay). The condition of salmon and freshwater pearl mussels in the River Spey SSSI / SAC is

unfavourable. Opportunities to contribute to site management objectives include increasing riparian woodland (River Spey), expanding and restoring blanket bog and bog woodland (Abernethy Forest), maintaining fast, free flowing and low nutrient water and promoting riparian vegetation (River Spey), and maintaining active river and coastal processes (Lower River Spey; Spey Bay).

A9.3.2 Ecosystem services

This sub section summarises the major ecosystem services in the Findhorn, Nairn and Speyside LPD.

Regulating and maintaining services

- Carbon storage and sequestration is provided by woodlands and wetlands; notably 20% of Scotland's fen, marsh, and swamp are found within this LPD.
- The large areas of wetlands, semi natural grassland and upland heath help to filter and maintain good water quality. (This is important for the whisky industry, particularly around the River Spey and its tributaries.) These three ecosystems and woodland ecosystems also help to regulate the flow of water.
- The coastal ecosystems are predominantly sand, shingle, dunes and saltmarsh, which help to attenuate waves and surge. There is very little hard coastline. Consequently, significant lengths of coastline, such as the Spey Bay area, are susceptible to erosion.

Provisioning services

- Findhorn, Nairn and Speyside is an important agricultural area. The upland areas contain predominantly rough grazing; alongside rivers and in the lower catchment, grassland based farming is more common. There are smaller areas of arable farming in the fertile coastal plain.
- Commercial fishing takes places in the Moray Firth, and the rivers and bays provide wild salmon and sea trout. There are no active fish farming sites in the freshwater or coastal environment.
- There is significant woodland cover throughout the catchment, with large areas of commercial forestry plantation.
- There are a number of rivers that are important sources of drinking water, including the River Spey.

Cultural services

- The area provides a wide range of recreational opportunities, including angling, wildfowling, kayaking, walking, sailing, swimming, and diving. It provides habitat for iconic wildlife, and bird watching and wildlife tourism is important to this area.
- Landscape is particularly important. There are protected landscapes in the form of seven National Nature Reserves, one National Scenic Area and the Cairngorms National Park. There are large swathes of wild land in the upper catchments (Monadhliath, Cairngorms, and Braeroy/Glenshirra/Creah Meagaidh): these areas have a distinct and special character, which is increasingly rare to find. Many people derive psychological and spiritual benefits from their existence, and they provide increasingly important havens for Scotland's wildlife.
- The area is also rich in historic sites, including scheduled monuments, listed buildings, and some gardens and designed landscapes.

A9.4 Environmental assessment of the Flood Risk Management Strategy for the Findhorn, Nairn and Speyside LPD

This sub section provides an assessment of the potential environmental effects of the flood risk management actions under consideration for the PVAs within this LPD. The effects on SEA topics and on ecosystem services are reported under each group of actions. Table A9.8 compares the effects of different groups of actions on ecosystem services.

A9.4.1 Non-structural actions

A range of non-structural actions are being considered for the LPD such as property level protection, relocation of properties / infrastructure away from flood risk areas and flood warning schemes. These actions help to reduce the impacts of flooding and therefore are likely to have significant positive effects on the SEA objectives for human health and material assets. These effects have been assessed nationally rather than at an LPD level and the results are presented in section 4 of the main Environmental Report.

As these actions help to reduce the impacts of flooding rather than the probability of flooding, they are likely to have no or negligible effects on ecosystems and ecosystem services.

A9.4.2 Run off reduction actions

Actions to reduce run off include woodland and gully woodland planting, upland drain blocking, land management, creation or restoration of wetlands and ponds, and shelter belts. These actions are being considered for three PVAs, all of which are in the middle and upper catchment of the Spey.

All SEA topics and ecosystems may be affected by these actions: either directly (where an action impacts on the ecosystem in which the action is located) or indirectly (e.g. where the freshwater ecosystem benefits from arising land use change and management). The potential effects of the actions are described in the text below and summarised by SEA topic in table A9.3.

Table A9.3 Run off reduction: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	+ + Benefits to connectivity and health of wetland ecosystems	Feasibility studies should consider opportunities to contribute to other drivers for restoration of wetlands and woodlands, and improvements to salmonids and freshwater pearl mussels. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address any negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	
Soil	+ + Benefits to safeguarding carbon rich soils	Design stages should consider protecting livestock from potential exposure to pests. Consultation with land managers recommended.
Water	+ + Benefits by enhancing water quality and reducing sedimentation	
Climatic factors	+ + Benefits to carbon storage through wetland enhancement	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects
Landscape	No significant effects	

Commentary on potential significant effects

Regulating and maintaining services
Run off reduction actions help to slow and store water by intercepting rainfall (e.g. woodlands) and/or increasing the extent to which the land can hold any water reaching the ground (both by slowing down the flow of run off and increasing the permeability of soils). This in turn can help to regulate the flow of water by reducing the amount of water reaching rivers and slowing or reducing flood flows: this helps to protect people and properties from flooding.

These actions can lead to improvements in water quality by helping to protect soils from erosion (thus reducing the sediment reaching rivers) and ncreasing infiltration of nutrients into soils. Wetland vegetation is particularly effective at storing nutrients: as this ecosystem may be under pressure from erosion and poor regeneration in some parts of this LPD, there are potentially significant benefits to water quality and erosion protection through the restoration and creation of wetlands.

The creation or restoration of woodlands and wetlands (including peatlands through upland drain blocking) has the potential to increase the capture and storage of carbon. (Although wetlands also have the potential to release carbon dioxide into the atmosphere, the net benefit to carbon storage is more likely to be positive when restoring wetlands.) Actions that restore wetlands may deliver significant benefits as they are likely to improve the current condition of this ecosystem and also because the LPD contains a significant amount of Scotland's fen, marsh and swamp.

By increasing habitat diversity and connectivity, the actions can improve biological control of pests and diseases; however, an increase in the wetness of cultivated land and semi-natural grassland ecosystems may increase the prevalence of some livestock pests.

Water quality improvements and erosion protection may help to maintain the low nutrient and low sediment load that is essential for some protected aquatic species in the Spey catchment such as salmonids and freshwater pearl mussels. Protected wetlands are also likely to benefit. However, there is a potential negative effect of woodland planting in upland heath, because of the risk of loss or fragmentation of rare dwarf shrub heath; and potential negative effect of wetland restoration in bog woodland habitat as changes in water levels can affect regeneration of the woodland. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The effects of run off reduction actions on food provision are likely to be mixed. The actions may enhance the productivity of cultivated land and semi natural grassland by protecting soils from erosion and loss of nutrients, and through providing a more diverse habitat for pollinators and biological control of pests and disease. However, some areas of productive land may be lost and there is potential to increase the prevalence of some livestock pests. By protecting water quality and reducing sedimentation, freshwater fisheries such as salmon and sea trout may benefit.

Run off reduction actions may provide benefits to drinking water supply by helping to remove nutrients and pollutants.

Actions that block drains or create wetlands within conifer plantations may lead to loss of timber productivity; however, it is more likely that these actions would be located in other ecosystems.

Cultural services
Run off reduction actions are likely to improve habitat diversity, connectivity and biodiversity, leading to potentially positive effects on recreation (e.g. angling), wildlife watching and landscape. Any actions in the upper catchment could be located in highly valued landscape (National Scenic Area / Area of wild land / Cairngorms National Park): although the actions are unlikely to be detrimental to these areas, further consideration of potential effects is recommended as part of any

feasibility studies.

The historic environment has potential to benefit from these actions: firstly, through the reduction of flood risk to historic buildings and, secondly through the protection of wetland archaeology as a result of creating and restoring wetlands. Woodland planting, however, can disturb buried archaeology. The structure and setting of historic sites could be affected but this will need to be assessed at more detailed levels of flood risk management planning.

A9.4.3 River and floodplain restoration actions

Actions to restore river and floodplains include woodland creation, reach restoration, large wood debris / boulders, and creation of washlands. Sediment management actions such as bank restoration are also included in this assessment. These types of actions are being considered for five PVAs, which are located throughout the LPD.

All SEA topics and a wide range of ecosystems may be affected: woodlands, cultivated land and semi natural grassland, wetlands, freshwater rivers and lochs and urban. The potential effects of the actions are described in the text below and summarised by SEA topics in table A9.4.

Table A9.4 River and floodplain restoration: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	+ + Benefits to connectivity and health of wetland ecosystems	Feasibility studies should consider opportunities to contribute to other drivers for restoration of wetlands and woodlands, and improvements to salmonids and freshwater pearl mussels. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address any negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies should consider medium and long duration effects on recreation, such as changes to river flow. Design studies should consider short duration effects on quality and access to recreation. Discussion with stakeholders recommended at both stages.
Soil	+ + Benefits to safeguarding carbon rich soils	Feasibility and design stages should consider potential loss of productive soils, particularly cultivated land. Consultation with land managers recommended.
Water	+ + Benefits by enhancing water quality and reducing sedimentation	Actions should be coordinated with any morphology or diffuse pollution priority catchments proposed in the second river basin management plans.
Climatic factors	+ + Benefits to carbon storage through wetland enhancement. However, loss of woodland could reduce these benefits	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Landscape	No significant effects	Feasibility stages should consider landscape changes in the upper catchment. Consultation with SNH and the Cairngorms National Park Authority is recommended.

Commentary on potential significant effects

Regulating and maintaining services
River and floodplain restoration actions slow down in-channel flow by increasing the sinuosity of the river and help reconnect the river with the floodplain, increasing the amount of water stored on land. Floodplain planting can also slow down the flow of run off and increase the permeability of soils, while river bank restoration can reduce bank erosion and sediment deposition in the river. The effect of all of these actions is to help regulate the flow of water by slowing and/or reducing flood flows: this helps to protect people and properties from flooding.

The restoration and creation of habitat (woodlands, washlands, woody debris etc) within the river and floodplain and reduced erosion of the river bed and banks can help to filter nutrients and reduce sediments. Wetland vegetation (in this case, vegetation on the floodplain) is particularly effective at storing nutrients. Where restoration reconnects the river with floodplain wetlands, there are potentially significant positive effects on water quality as wetlands ecosystem may be in less than good condition.

The creation or restoration of woodlands and wetlands (floodplains) also has the potential to increase the capture and storage of carbon. If floodplain restoration requires the removal of trees, the effects on carbon storage could be negative. Therefore, the net effects may be positive or negative.

Other potential positive effects include improvements to pollination (as pollinating insects may benefit from greater food and shelter in a more diverse habitat). Increasing habitat diversity can improve biological control of pests and diseases; however, an increase in the wetness of cultivated land and semi-natural grassland ecosystems may increase the prevalence of some livestock pests.

Water quality improvements and erosion protection will help to maintain the low nutrient and low sediment load that is essential for some protected aquatic species in the Spey catchment such as salmonids and freshwater pearl mussels. Protected wetlands are also likely to benefit. However, restoration works could lead to short duration increases in sediment load and could disturb breeding birds, therefore the timing and implementation of actions needs to be carefully planned. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The potential effects on food provision are mixed. As with run off reduction actions, these actions may enhance the productivity of cultivated land and semi natural grassland by protecting soils from erosion and loss of nutrient, increasing shelter for livestock and improvements to pollination. There may, however, be some loss of cultivated land and semi natural grassland. By protecting water quality and reducing sedimentation, freshwater fisheries such as salmon and sea trout may benefit.

Restoration actions may provide benefits to drinking water supply by helping to remove nutrients and pollutants.

The effects on provision of biotic materials are also mixed. Potential loss of cultivated land reduces opportunities for producing biofuels; however, the creation of woodland may provide timber.

Cultural services
The potential effects on recreation, wildlife watching and landscape are positive, as the actions should improve habitat diversity and biodiversity. However, changes to the bed and banks of rivers

may affect quality and access of kayaking. Installing / implementing actions may also impede access to the river and its banks for recreation although these effects would be of short duration.

Actions are likely to take place close to urban areas so any effects on wild land are likely to be limited.

The historic environment has potential to benefit from these actions: firstly, through the reduction of flood risk to historic buildings and, secondly through the protection of wetland archaeology as a result of creating and restoring wetlands. Woodland planting, however, can disturb buried archaeology. The structure and setting of historic sites could be affected but this will need to be assessed at more detailed levels of flood risk management planning.

A9.4.4 Storage conveyance and control

Storage, conveyance and control actions include on and offline flood storage, channel modifications, addition or modification of weirs, bridges, pumping stations. These types of actions are being considered for four PVAs.

All SEA topics could be affected. The potential effects of the actions are described in the text below and summarised by SEA topic in table A9.5.

Table A9.5 Storage, conveyance and control: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	- - Loss or damage to wetlands, leading to reduced habitat connectivity and biodiversity - - Negative effects on freshwater pearl mussels and salmon through increased sediment load	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or damage to wetlands, disturbance of sediment, or barriers to fish passage. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH, Fisheries Trusts) recommended at both stages. Habitat Regulations Appraisal will address any negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies should consider medium and long duration effects on recreation, such as changes to river flow. Design studies should consider short duration effects on quality and access to recreation. Discussion with stakeholders recommended at both stages.
Soil	- - Loss or damage to carbon rich soils found in wetlands due to habitat loss - - Erosion of carbon rich soils downstream of the structure	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or damage to wetlands. Feasibility and design stages should consider potential loss of productive soils, particularly cultivated land. Consultation with land managers recommended.
Water	- - Increase in sediment load due to increased erosion + + Potential improvements to morphology, sediment dynamics and fish passage if existing structures are removed or altered	Feasibility and design stages should consider how to avoid or minimise potential negative effects such as an increase in erosion.
Climatic factors	- - Reduction in carbon sequestration due to loss or damage to wetlands	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or damage to wetlands.

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	Feasibility and design stages should include consultation with communities, SNH, and National Park Authorities to avoid or minimise negative effects on landscape.

Commentary on potential significant effects

Regulating and maintaining services
Storage, conveyance and control actions are engineered actions that alter the storage and flow of water. These actions can deliver positive effects through regulating the flow of water and thus reducing flood risk to people and property.

These actions can lead to disruption to natural processes and loss of habitat. These may have a negative effect on water quality and carbon storage. Negative effects are potentially significant where actions lead to loss or deterioration of wetlands that are currently in unfavourable condition. However, the removal of structures can also restore habitats to a more natural state and improve water quality. Overall effects on water quality are mixed.

The ecosystem adjacent to the structure may benefit through protection from erosion – this may have noticeable benefits in urban areas and in cultivated land and semi natural grassland. However, erosion can be exacerbated downstream of the structure, with potentially significant negative effects on any wetlands that may already be in unfavourable condition.

Loss or damage to wetlands may have locally noticeable negative effects such as reductions in pollination or pest and disease control.

Any actions that could lead to an increase in erosion and sediment load in the freshwater ecosystem could have significantly negative effects in the River Spey where Atlantic salmon and freshwater pearl mussels are in unfavourable condition. Implementation of actions could also lead to short duration increases in sediment load and could disturb birds, therefore the timing and implementation of actions needs to be carefully planned. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The effects on terrestrial food provision and production of biofuels are mixed: the actions may help to reduce flooding to some areas of cultivated land or semi natural grassland but other areas may suffer increased flooding (or erosion). These effects could lead to longer duration changes in land use.

Freshwater production may suffer negative effects through loss of habitat and increased sedimentation.

Cultural services
Storage, conveyance and control actions have potentially negative effects on cultural services. Loss of natural habitat and negative effects on biodiversity can impact on opportunities to watch wildlife and interact with nature, and on recreation such as angling. Changes to patterns of river flow can also affect sports such as kayaking. However, access for some activities could be improved with sensitive scheme design.

There are protected landscapes and wild land in the upper catchment that could experience negative change from storage actions in PVA 05/12 (Kinguissie). In urban areas, storage, conveyance and control actions may have potentially negative effects by affecting the views of rivers.

The historic environment may benefit through a reduction in flood risk, but there is also potential for negative effects: the disconnection of the floodplain could damage wetlands and the archaeology preserved within it. The historic environment may be negatively affected altering the setting of historic sites or through damage to sites when the action is implemented. Further assessment is required at more detailed levels of flood risk management planning.

A9.4.5 River defences

River defences may include walls, embankments or demountable / temporary defences. These are being considered for five PVAs that are located throughout the LPD.

The actions are most likely to be located in or adjacent to rivers (freshwater lochs and rivers ecosystem) or set back from the river in the urban environment (urban ecosystem). All SEA topics could be affected.

The effects are dependent on the type of defence (for example, defences that are set back from the river are likely to have a smaller impact) and the degree to which the river banks have already been modified: however, the type and location of defences are not known at this strategic level of planning. The potential effects of the actions are described in the text below and summarised by SEA topic in table A9.6.

Table A9.6 River defences: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	- - Negative effects on freshwater pearl mussels and salmon through increased sediment load	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or disturbance of sediment. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address any negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies should consider medium and long duration effects on recreation, such as changes to river flow. Design studies should consider short duration effects on quality and access to recreation. Discussion with stakeholders recommended at both stages.
Soil	No significant effects	
Water	No significant effects	
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	Feasibility and design stages should include consultation with communities to avoid or minimise negative effects on urban landscape.

Commentary on potential significant effects

Regulating and maintaining services
River defences can deliver benefits by regulating water flow, reducing erosion at the site of the structure, and reducing flood risk. The actions, however, can interfere with natural process: the defences cause some or all of the floodplain to be disconnected from the river, which can lead to loss of natural habitat to capture, filter and recycle nutrients or pollutants. This can lead to a reduction in water quality and a loss of carbon storage. Erosion may also increase upstream or downstream of a defence due to changes in river processes.

A potential decline in water quality and increase in sediment load can have potentially negative effects on freshwater species such as Atlantic salmon and freshwater pearl mussel – these effects may be significant as these species are in unfavourable condition in the River Spey SSSI and SAC. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
River defences have potential negative effects on freshwater food production due to the loss of in river and riparian habitat. However, this is dependent on the type of defence (for example, defences that are set back from the river are likely to have a smaller impact) and the degree to which the river banks have already been modified.

Cultural services
River defences may have mixed effects on recreation and opportunities to access nature and experience wildlife. Loss of natural habitat and biodiversity, and changes to river flow, can reduce the quality of the environment for recreation and wildlife watching. However, depending on their design, some defences can improve access for some types of recreation.

Within the urban landscape, river defences have potentially negative effects through disrupting the setting and view of the river and floodplain.

Historic buildings and monuments may benefit through reduced flood risk, but the defences may alter the setting of the site. Historic sites may also be affected, either for a short or long duration, by construction of the defences – however, this cannot be assessed at this level of planning as more information is required about the precise nature and location of the defence.

A9.4.6 Coastal defences

Coastal defences under consideration for this LPD include walls, embankments, temporary barriers, revetments, and tidal gates and barriers. These actions are being considered for one PVA.

The ecosystems most likely to be affected are urban, and coastal and marine. All SEA topics could be affected. The potential effects of the actions are described in the text below and summarised by SEA topic in table A9.7.

Table A9.7 Coastal defences: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	- - Negative effects on protected coastal habitats through increased erosion and disruption of natural processes	Feasibility studies should consider how to avoid or minimise potential negative effects such increased erosion. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address any negative effects on SACs and SPAs.

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies should consider medium and long duration effects on recreation. Design studies should consider short duration effects on quality and access to recreation. Discussion with stakeholders recommended at both stages.
Soil	No significant effects	
Water	No significant effects	
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure - - Property and infrastructure may experience an increased erosion risk outside of the area of protection	Further modelling required at feasibility and design stages to better understand erosion risks. Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	Feasibility and design stages should include consultation with communities to avoid or minimise negative effects on urban and coastal landscapes.

Commentary on potential significant effects

Regulating and maintaining services
By attenuating waves and surge, coastal defences can help to reduce flood risk. Some defences may also help to reduce erosion at the site of the defence. However, these actions can lead to the loss of natural habitat and interfere with coastal processes including changes to patterns of erosion and deposition. This LPD already has coastline that is relatively susceptible to erosion, and so coastal defences could have potentially significant negative effects on the natural ability of coastal habitats to protect against erosion. The magnitude and direction of potential effects, however, also depends on the current condition of the coastline.

Loss of natural habitat can degrade water quality by reducing the ability of the environment to filter, capture and recycle nutrients / pollutants. The effect on carbon storage is mixed: loss of natural habitat to sequester carbon will have negative effects; however, some actions might provide suitable substrate for kelp which can act as a carbon store.

The management of coastal protected sites (some of which are in unfavourable condition) aims to preserve the natural dynamic processes of this area. Changes to natural coastal processes may alter the movement of gravel, shingle and sands leading to potentially significant negative effects. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
Coastal defences can have mixed effects on marine food provision: whilst there can be loss of natural habitat which can reduce productivity, sometimes other edible species can benefit (for example, a change from soft sediment feeding fish to lobster and crab fishery).

Cultural services
The effects of coastal defences on recreation and opportunity to experience nature and wildlife may be reduced through loss of natural habitat and access. However, there may also be benefits as access may be improved and disturbance to wildlife may be reduced.

There are potential negative effects on the urban and coastal landscape. However, sensitively designed defences may help to improve amenity.

There are some coastal listed buildings in the PVA: these may benefit from reduced flood risk but the setting may be negatively affected by the defences. Further assessment is required at more detailed planning about the precise nature and location of the defence.

Table A9.8 Shortlisted actions for Findhorn, Nairn and Speyside: Summary of potential effects on ecosystem services

Source of flooding	All		River					Coastal	
Ecosystem service	Non-structural actions		Run off reduction	River and floodplain restoration	Storage, conveyance, control	River defences		Coastal restoration	Coastal defences
Carbon storage	**0**		**+ +**	**+/-**	**- -**	**-**		N/A	**+/-**
Local climate regulation	**0**		**0**	**0**	**0**	**0**		N/A	**0**
Water quality regulation	**0**		**+ +**	**+ +**	**+/-**	**-**		N/A	**-**
Pollination	**0**		**0**	**+**	**-**	**0**		N/A	**0**
Biological control of pests and disease	**0**		**+/-**	**+**	**-**	**0**		N/A	N/A
Wave/surge attenuation	**0**		N/A	N/A	N/A	N/A		N/A	**+ +**
Water flow regulation	**0**		**+ +**	**+ +**	**+ +**	**+ +**		N/A	N/A
Erosion protection	**0**		**+ +**	**+ +**	**+/-**	**+/-**		N/A	**+/-**
Nutrition: food provision	**0**		**+/-**	**+/-**	**+/-**	**-**		N/A	**+/-**
Drinking water supply	**0**		**+**	**+**	**0**	**0**		N/A	**0**
Biotic materials: timber, biofuels	**0**		**-**	**+/-**	**+/-**	**0**		N/A	**0**
Recreation (physical interaction)	**0**		**+**	**+/-**	**+/-**	**+/-**		N/A	**+/-**
Accessible nature/wildlife experience	**0**		**+**	**+**	**-**	**+/-**		N/A	**+/-**
Spiritual and cultural amenity (landscape)	**0**		**+**	**+**	**-**	**-**		N/A	**-**

KEY				
	+ +	**Significant positive** Effects are widespread across the LPD; and/or Effects are likely to improve an ecosystem that is in less than good condition	**-**	**Negative** A noticeable negative effect that does not meet the description below
	+	**Positive** A noticeable positive effect that does not meet the description above	**- -**	**Significant negative** Effects are widespread across the LPD; and/or Effects are likely to cause an adverse effect on an ecosystem that is in less than good condition
	0	**No or negligible effects**	**+/-**	**Mixed:** The effect is likely to be a combination of positive and negative effects, particularly where effects are considered on sub-issues, areas or criteria

Map acknowledgments

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including *inter alia*, the following organisations:

Ordnance Survey
Flood maps are based upon Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office © Crown Copyright. Any unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. SEPA Licence number 100016991 (2015).

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology © NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2015), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright © The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC.

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

Appendix 10: Environmental assessment of the Flood Risk Management Strategy for the North East

This appendix presents the current state of the environment and the assessment of significant environmental effects for the Flood Risk Management Strategy for the North East Local Plan District (LPD). The purpose of this is to:

- Identify relevant information on the current state of the environment for the North East LPD. This information supplements the description of the current state of Scotland's environment (section 3 of the main Environmental Report).
- Report the significant environmental effects of the actions being considered to manage flood risk in the North East LPD.
- Identify mitigation of significant negative effects and opportunities to deliver wider benefits
- Recommend further assessment at more detailed planning stages e.g. feasibility studies or design stages.

The overall assessment for all 14 Flood Risk Management Strategies is summarised in section 5 of the main Environmental Report.

A10.1 The North East Local Plan District

The North East LPD (figure A10) covers a total area of approximately 6,480km^2 with a population of approximately 501,500. The largest settlement is the city of Aberdeen.

The LPD covers the north-eastern area of Scotland from Inverbervie on the east coast to Buckie on the north coast, and inland to Braemar, with a coastline of 220km. The main river catchments in the LPD are the Deveron, Ythan, Don (Aberdeenshire) and Dee (Aberdeenshire).

The main source of flooding in the LPD is river flooding, which contributes around 79% of the Annual Average Damages[1]. Surface water flooding contributes approximately 20% of Annual Average Damages and coastal flooding contributes around 1%. There are 23 PVAs within the LPD which are located inland along major rivers and along the coast.

A range of non-structural and structural actions are being considered to manage flooding in this LPD. Structural actions are being considered to manage river flooding in 13 PVAs and to manage coastal flooding in five PVAs (table A10.1).

[1] An indicative estimate of the direct economic costs of flooding impacts to residential properties, non-residential properties and agriculture

Figure A10: North East LPD and PVAs

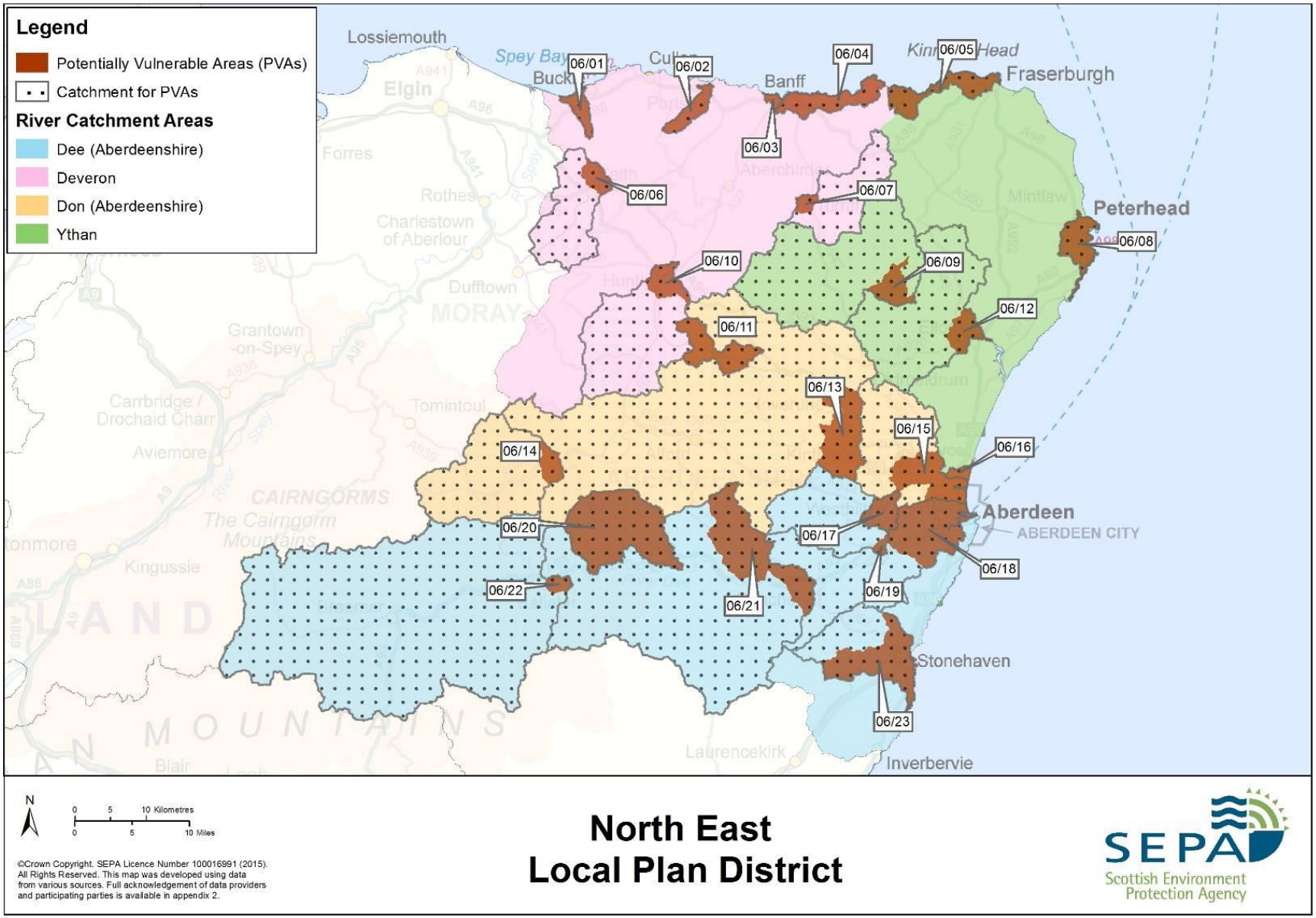


Table A10.1: Shortlisted actions in North East LPD

Action	Shortlisted for the following PVAs
Run off reduction	06/02, 06/20, 06/23
River and floodplain restoration	06/02, 06/10, 06/11, 06/12, 06/13, 06/14, 06/15, 06/18, 06/19, 06/20, 06/22
Storage conveyance and control	06/02, 06/10, 06/11, 06/12, 06/13, 06/15, 06/16, 06/18, 06/19, 06/20, 06/23
River defences	06/10, 06/11, 06/12, 06/13, 06/14, 06/15, 06/16, 06/18, 06/19, 06/20, 06/22, 06/23
Coastal restoration	06/23
Coastal defences	06/01, 06/03, 06/08, 06/18, 06/23

A10.2 Environmental and policy context for the North East LPD

Section 2.2 and Appendix 3 of the main Environmental Report identify the relationships between the Flood Risk Management Strategies and other plans, programmes and strategies.

A10.3 Additional relevant information on the current state of the environment for the North East LPD

This sub section identifies relevant information on the current state of the environment for the North East LPD. This information supplements the description of the current state of Scotland's environment (section 3 of the main Environmental Report).

A10.3.1 Ecosystems and condition

The predominant ecosystem in the North East LPD is cultivated land, which covers 48% of the LPD and makes a significant contribution to the total cultivated land in Scotland (17% of Scottish cultivated land). There are large areas of upland heath (23% of LPD) and conifer plantation woodland (12% of LPD) and smaller areas of wetlands, semi-natural grassland, native woodland and urban ecosystems (between 2% and 8% of the LPD). The northern coastline of the North East LPD is a mix of small bays and headlands with numerous sections of coastal defences and harbour structures. The eastern coastline has some long sandy beaches, rocky bays and cliffs.

Table A10.2 lists the extent of different ecosystems within the North East LPD, and provides an assessment of ecosystem condition.

Table A10.2 Ecosystems within the LPD

Ecosystem	Area (% of LPD in 2007)	Condition of ecosystem
Woodland - native	3	This LPD contains important native Caledonian woodland. Native woodland is fragmented but woodland expansion is helping to restore connectivity. There are opportunities to help meet objectives for native woodland expansion in the upper Dee. The condition of woodland in protected sites is mixed.
Woodland - conifer plantation	12	There are large areas of productive conifer plantations; the condition is unknown.

Ecosystem	Area (% of LPD in 2007)	Condition of ecosystem
Cultivated land	48	Cultivated land is highly productive in this LPD; however, diffuse pollution from this ecosystem is a key source of pollution to the water environment in this LPD. This indicates that there is potential degradation and erosion of soils. The Dee, Deveron and Ugie catchments are priority catchments for the management of diffuse pollution.
Semi-natural grassland	8	There is limited information on the condition of this ecosystem in this LPD. There is some evidence of unfavourable status of upland grassland in the Cairngorms SAC.
Wetlands (fen, marsh, and swamp; bog)	3	The condition of wetlands within protected sites is mixed. Bogs in the Cairngorms SAC (relevant for PVAs 06/18 and 06/22) and Hill of Towanreef SAC (PVA 06/10) are in unfavourable condition. There is little information on the quality of wetlands outside of protected areas. Wetlands are at threat from land use management, development, water management and pollution, including nutrient run off.
Upland heath	23	The condition of upland heath within protected sites is mixed.
Freshwater lochs and rivers	<0.5	The condition of freshwater lochs and rivers is mixed. Of 189 WFD river water bodies, 26% are at less than good status for water quality and 40% for at less than good status for the condition of beds and banks; three out of four WFD loch water bodies are at less than good overall status. Rural diffuse pollution is a pressure on the water environment in this LPD (including in the Dee, Deveron and Ugie catchments which are priority areas for the management of diffuse pollution). The Ythan catchment is designated as a Nitrate Vulnerable Zone. Water flow is under pressure in the Dee due to abstraction.
Coastal & marine	<0.5*	The condition of coastal and marine ecosystems is generally good. Of the 17 WFD coastal water bodies, three are at less than good status for the condition of the shoreline. There is some erosion pressure on beaches and dunes along the eastern coast of this LPD as well as coastal squeeze. The Ythan Estuary is suffering from eutrophication. There are also pressures on bathing water quality due to microbiological pressures. Relevant pressures on the coastal environment include coastal squeeze and coastal protection works.
Urban	2	Access to greenspace in Scotland's urban environment is generally good. Over two thirds (68%) of adults in Scotland have access to useable greenspace within a five-minute walk from the home (not including their own garden).

*The majority of the coastal and marine ecosystem extends beyond the terrestrial LPD boundary so is not captured in this figure

There are many environmental sites of European and national importance in this LPD: 21 Special Areas of Conservation (SACs), 14 Special Protected Areas (SPAs), and 87 Sites of Special Scientific Interest (SSSIs). The largest areas of designated sites are found in the upper catchment and contain large areas of upland heath, native woodland and wetlands (e.g. Cairngorms, Glen Tanar, Ladder Hills, Greenhills of Strathdon).These sites contain unique habitat and support nationally scarce and iconic species such as golden eagle and capercaillie. The River Dee and its

tributaries are designated as an SAC for Atlantic salmon, otters and freshwater pearl mussels. Freshwater pearl mussels are in unfavourable condition.

Relevant pressures on terrestrial and freshwater protected sites include: inappropriate woodland expansion into upland heath and loss of open moorland, changes in grazing activity, diffuse water pollution and sedimentation. There are opportunities to contribute to site management objectives such as sensitive expansion and restoration of native woodland (e.g. Cairngorms, Glen Tanar, Muir of Dinnet).

Of relevance to coastal PVAs (namely PVAs 06/03 and 06/08) are SSSIs with geological or physical features could be affected by coastal flood risk management actions. Breeding sea birds are also of importance and are designated features in SACs / SSSIs along the eastern coastline (for consideration for PVAs 06/08 and 06/23). Opportunities to contribute to site management objectives include: minimising impacts on areas of exposed protected geological features (e.g. Whitehills to Melrose Coast SSSI), allowing natural coastal process such as wave action to continue (Bullars of Buchan Coast SSSI) and avoiding disturbance to breeding birds (all SPAs).

The Southern Trench Nature Conservation Marine Protected Area is adjacent to the north coastline of this LPD.

A10.3.2 Ecosystem services

This sub section summarises the major ecosystem services in the North East LPD.

Regulating and maintaining services

- Carbon storage and sequestration is primarily provided by woodlands and smaller areas of wetlands
- Native woodlands, wetlands, semi natural grassland and upland heath help to regulate water flow and water quality. Water is abstracted for irrigation. It is also used for hydropower notably in the Don but also in the Deveron.
- The coastal ecosystems are a mix of rocky headlands, small bays and long sandy beaches. The habitats help to attenuate waves and surge, and rocky habitats help to protect from erosion.

Provisioning services

- The North East LPD is an important agricultural area and contains prime agricultural land. It provides mix of rough grazing and grassland based farming in upper river catchments, and grassland based farming and horticulture (particularly cereals and potatoes) in the lower catchments.
- Commercial fishing is an important part of the economy with major landing ports at Fraserbrough and Peterhead. Rivers and bays provide wild salmon and sea trout. There are no active fish farming sites in the coastal environment, and there is one salmon hatchery in the river Don.
- There is significant woodland cover throughout the catchment, with large areas of commercial forestry plantation and three major sawmills.
- There are a number of rivers/ lochs that are important sources of drinking water and are designated as drinking water protected areas. PVAs where actions have the potential to affect drinking water protected areas in the Dee catchment (PVAs 06 /22, 06/20, 06/19 and 06/18) and the Deveron catchment (PVA 06/10).

Cultural services

- The area provides a wide range of recreational opportunities, including sport shooting, angling, kayaking, walking, sailing, swimming, diving and surfing. There is habitat for iconic wildlife, and there are seven National Nature Reserves within the Local Plan District.
- There are protected landscapes in the upper catchment of the Dee: two National Scenic Areas and part of the Cairngorms National Park. The upper Dee catchment and a small area of the upper Don catchment contain areas of wild land: these areas have a distinct and special character, which is increasingly rare to find. Many people derive psychological

and spiritual benefits from their existence, and they provide increasingly important havens for Scotland's wildlife.

- The area is also rich in historic sites including scheduled monuments, battlefields, listed buildings, and gardens and designed landscapes.

A10.4 Environmental assessment of the Flood Risk Management Strategy for the North East LPD

This sub section provides an assessment of the potential environmental effects of the flood risk management actions under consideration for the PVAs within this LPD. The effects on SEA topics and on ecosystem services are reported under each group of actions. Table A10.9 compares the effects of different groups of actions on ecosystem services.

A10.4.1 Non-structural actions

A range of non-structural actions are being considered for the LPD such as property level protection, relocation of properties / infrastructure away from flood risk areas and flood warning schemes. These actions help to reduce the impacts of flooding and therefore are likely to have significant positive effects on the SEA objectives for human health and material assets. These effects have been assessed nationally rather than at an LPD level and the results are presented in section 4 of the main Environmental Report.

As these actions help to reduce the impacts of flooding rather than the probability of flooding, they are likely to have no or negligible effects on ecosystems and ecosystem services.

A10.4.2 Run off reduction actions

Actions to reduce run off include woodland and gully woodland planting, upland drain blocking, land management, creation or restoration of wetlands and ponds, and shelter belts. These actions are being considered for three PVAs. All SEA topics and all ecosystems may be affected by these actions: either directly (where an action impacts on the ecosystem in which the action is located) or indirectly (e.g. where the freshwater ecosystem benefits from arising land use change and management). The potential effects of the actions are described in the text below and summarised by SEA topic in table A10.3.

Table A10.3 Run off reduction: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	+ + Benefits to freshwater ecosystems due to improvements to water quality, with potential significant benefits to freshwater pearl mussels in the River Dee SAC	Feasibility studies should consider opportunities to contribute to other drivers for catchment restoration including improvements to salmonids and freshwater pearl mussel populations. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise any negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	
Soil	+ + Benefits to protecting soil quality in cultivated land through reducing run off of sediment and nutrients	Feasibility and design stages should consider potential loss of productive soils, particularly cultivated land. Design stages should consider protecting livestock from potential exposure to pests. Consultation with land managers recommended.

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Water	+ + Benefits by enhancing water quality and reducing sedimentation	
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	

Commentary on potential significant effects

Regulating and maintaining services
Run off reduction actions help to slow and store water by intercepting rainfall (e.g. woodlands) and/or increasing the extent to which the land can hold any water reaching the ground (both by slowing down the flow of run off and increasing the permeability of soils). This in turn can help to regulate the flow of water by reducing the amount of water reaching rivers and slowing or reducing flood flows: this helps to protect people and properties from flooding.

These actions can lead to improvements in water quality by helping to protect soils from erosion (thus reducing the sediment reaching rivers) and increasing infiltration of nutrients into soils. Wetland vegetation is particularly effective at storing nutrients. Of particular note are potential significant benefits to water quality and erosion protection through the reduction of run off from cultivated land (which is one of the contributors to diffuse pollution in the rivers and lochs in the North East).

The creation or restoration of woodlands, wetlands (including peatlands through upland drain blocking) has the potential to increase the capture and storage of carbon. (Although wetlands also have the potential to release carbon dioxide into the atmosphere, the net benefit to carbon storage is more likely to be positive when restoring wetlands.)

Increased habitat diversity and connectivity can provide benefits to pollination and biological control of pests and diseases. However, an increase in the wetness of cultivated land and semi-natural grassland ecosystems may increase the prevalence of some livestock pests.

Water quality improvements and erosion protection in PVA 06/20 could provide benefits to the River Dee SAC: in particular, the benefits to freshwater pearl mussels may be significant as this feature is in unfavourable condition. Other protected sites are unlikely to be affected. Any effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The potential effects of run off reduction actions on food provision are mixed. The actions may enhance the productivity of cultivated land and semi natural grassland by protecting soils from erosion and loss of nutrients (and, as identified above, through providing a more diverse habitat for pollinators and biological control of pests and disease). However, some areas of valuable productive land may be lost and there is potential to increase the prevalence of some livestock pests.

Run off reduction actions may provide benefits to drinking water supply by helping to remove nutrients and pollutants.

Actions that block drains or create wetlands within conifer plantations have the potential to lead to reduction in timber productivity.

Cultural services
Run off reduction actions are likely to improve habitat diversity, connectivity and biodiversity, leading to potentially positive effects on recreation (e.g. angling), wildlife watching and landscape.

The historic environment has potential to benefit from these actions: firstly, through the reduction of flood risk to historic buildings and, secondly through the protection of wetland archaeology as a result of creating and restoring wetlands. Woodland planting, however, can disturb buried archaeology. The structure and setting of historic sites could be affected but this will need to be assessed at more detailed levels of flood risk management planning.

A10.4.3 River and floodplain restoration actions

Actions to restore river and floodplains include floodplain reconnection, floodplain and riparian woodland creation, large woody debris and boulders, and the creation of washlands. Sediment management actions such as bank restoration are also included in this assessment. These actions are being considered for 11 PVAs: two PVAs are in the Deveron catchment group, one in the Ythan catchment group, four in the Don and four in the Dee.

The actions are most likely to be located in cultivated land, semi natural grassland and native woodland or within the river channel itself, although other ecosystems such as wetlands and freshwater rivers and lochs could be affected. All SEA topics may be affected. The potential effects of the actions are described in the text below and summarised by SEA topic in table A10.4.

Table A10.4 River and floodplain restoration: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	+ + Benefits to the freshwater fauna (such as protected species in the River Dee SAC) through protecting and improving water quality	Feasibility studies should consider opportunities to contribute to other drivers for restoration of wetlands and woodlands, and improvements to salmonids and freshwater pearl mussels. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address any negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies should consider medium and long duration effects on recreation, such as changes to river flow. Design studies should consider short duration effects on quality and access to recreation. Discussion with stakeholders recommended at both stages.
Soil	+ + Benefits to reducing loss of sediment and nutrients from productive cultivated land	Feasibility and design stages should consider potential loss of productive soils, particularly cultivated land. Design stages should consider protecting livestock from potential exposure to pests. Consultation with land managers recommended.
Water	+ + Benefits by enhancing water quality and reducing sedimentation	
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	Feasibility studies and design studies should look for opportunities to contribute to the Cairngorms National Park Partnership Plan.

Commentary on potential significant effects

Regulating and maintaining services
River and floodplain restoration actions slow down in-channel flow by increasing the sinuosity of the river and help reconnect the river with the floodplain, increasing the amount of water stored on land. Floodplain planting can also slow down the flow of run off and increase the permeability of soils, while river bank restoration can reduce bank erosion and sediment deposition in the river. The effect of all of these actions is to help regulate the flow of water by slowing and/or reducing flood flows: this helps to protect people and properties from flooding.

The restoration and creation of habitat (woodlands, washlands, woody debris etc) within the river and floodplain, and reduced erosion of the river bed and banks can help to filter nutrients and reduce sediments. Wetland vegetation (in this case, vegetation on the floodplain) is particularly effective at storing nutrients. If these actions are located in cultivated land, there may be potentially significant benefits to water quality and erosion protection due to the diffuse pollution pressures in this LPD.

Other potential positive effects include improvements to pollination (as pollinating insects may benefit from greater food and shelter in a more diverse habitat). Increasing habitat diversity can improve biological control of pests and diseases; however, an increase in the wetness of cultivated land and semi-natural grassland ecosystems may increase the prevalence of some livestock pests.

The net effects on carbon storage may be positive or negative – improvements to the condition and/or extent of wetlands on floodplains may help to increase carbon storage, but any loss of woodland is likely to have negative effects. As stated above, although wetlands have the potential to release carbon dioxide into the atmosphere, the net benefit to carbon storage is more likely to be positive when restoring this ecosystem.

Water quality improvements and erosion protection in the Dee catchment (PVAs 06/18, 06/19, 06/20 and 06/22) may benefit the River Dee SAC: in particular, the benefits to freshwater pearl mussels may be significant as this feature is in unfavourable condition. Other protected sites are unlikely to be affected (as they are not in the floodplain within or upstream of the PVAs). River restoration works could lead to short duration increases in sediment load, therefore the timing and implementation of actions needs to be carefully planned. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The potential effects on food provision are mixed. As with run off reduction actions, these actions may enhance the productivity of cultivated land and semi natural grassland by protecting soils from erosion and loss of nutrient, and increasing shelter for livestock. There may, however, be some loss of cultivated land and semi natural grassland.

By protecting water quality and reducing sedimentation, freshwater fisheries such as salmon and sea trout, may benefit.

The potential effects on provision of biotic materials are also mixed. Potential loss of cultivated land reduces opportunities for producing biofuels; however, the creation of woodland may provide timber.

There are potential positive effects on drinking water supply as restoration actions will help to protect water quality.

Cultural services
The effects on recreation, wildlife watching and landscape are generally likely to be positive, as the actions should improve habitat diversity and biodiversity. However, changes to the bed and banks of rivers may affect quality and access of kayaking. Installing / implementing actions may also impede access to the river and its banks for recreation although these effects would probably be of short duration.

Some restoration actions (in PVAs 06/14 and 06/22, and potentially, but unlikely, for PVA 06/20) would fall within the Cairngorms National Park: if well planned, these actions are likely to contribute to the aims of the National Park. Actions are unlikely to affect areas of wild land.

The historic environment has potential to benefit from these actions: firstly, through the reduction of flood risk to historic buildings and, secondly through the protection of wetland archaeology as a result of creating and restoring wetlands. Woodland planting, however, can disturb buried archaeology. The structure and setting of historic sites could be affected but this will need to be assessed at more detailed levels of flood risk management planning.

A10.4.4 Storage conveyance and control

Storage and conveyance and control actions include online and offline storage and the modification of existing channels, culverts and structures. There are very few new conveyance structures proposed. It is the storage actions that are likely to have the greatest environmental impacts, as most of the other actions involve modifying existing relatively small structures. These actions are proposed for 11 PVAs.

The actions are most likely to be located in cultivated land, semi natural grassland, freshwater rivers and lochs and in urban ecosystems. All SEA topics could be affected. The potential effects of the actions are described in the text below and summarised by SEA topic in table A11.5.

Table A11.5 Storage, conveyance and control: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	- - Negative effects on freshwater pearl mussels and salmon through increased sediment load	Feasibility studies should consider how to avoid or minimise potential negative effects such as disturbance of sediment. Opportunities to help maintain or improve ecosystem connectivity and resilience should be examined. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH, Fisheries Trusts) recommended at both stages. Habitat Regulations Appraisal will address any negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies should consider medium and long duration effects on recreation, such as changes to river flow. Design studies should consider short duration effects on quality and access to recreation. Discussion with stakeholders recommended at both stages.
Soil	No significant effects	Feasibility and design stages should consider potential loss of productive soils, particularly cultivated land, if used for storage. Consultation with land managers recommended.

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Water	- - Increased pressure on water quality due to reduction in ability to filter nutrients and pollutants, and potential increase in sediment loss	Feasibility and design stages should consider how to avoid or minimise potential negative effects such as an increase in erosion.
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	Feasibility and design stages should include consultation with communities, SNH, and National Park Authorities to avoid or minimise negative effects on landscape.

Commentary on potential significant effects

Regulating and maintaining services
Storage, conveyance and control actions are engineered actions that alter the storage and flow of water. These actions can deliver positive effects through regulating the flow of water and thus reducing flood risk to people and property.

These actions can lead to disruption to natural processes and loss of habitat. These may have a negative effect on water quality and carbon storage. As water quality is under pressure from diffuse pollution in the North East LPD, any loss of ability to filter nutrients and any increase in sediment loss could have potentially significant negative effects on freshwater rivers and lochs. However, the removal or alteration of existing structures can also restore habitats to a more natural state with potential improvements to water quality.

The ecosystem adjacent to the structure may benefit through protection from erosion – this may have noticeable benefits in urban areas and in cultivated land and semi natural grassland. Conversely, erosion can be exacerbated downstream of the structure. There are therefore mixed effects on erosion protection.

Loss of natural habitat may have negative effects on pollination.

The potential effects on water quality in freshwater rivers and lochs could have significant negative effects on the River Dee SAC, particularly as freshwater pearl mussels are in unfavourable condition. However, there are potential benefits to Atlantic salmon as the removal or modification of existing structures may improve passage to fish. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The effects on terrestrial food provision and production of biofuels are mixed. The actions may help to reduce flooding to some areas of cultivated land or semi natural grassland. However, other areas may suffer increased flooding (or erosion). These effects could lead to longer duration change in land use.

Freshwater production may suffer negative effects through loss of habitat and increased sedimentation. As described above, however, some actions could help to reduce barriers to fish passage.

Cultural services
Storage, conveyance and control actions have potentially mixed effects on cultural services. Loss of natural habitat and negative effects on biodiversity can impact on opportunities to watch wildlife

and interact with nature, and on recreation such as angling. Changes to patterns of river flow can also affect sports such as kayaking. Angling and wildlife watching could benefit if fish passage improves through removal or modification of existing culverts or other barriers. Sensitive scheme design may help to improve access for some recreational activities.

In urban areas and around freshwater rivers and lochs, storage, conveyance and control actions may have potentially negative effects by affecting the views of rivers and altering landscape. Actions are not likely to affect areas of wild land.

The historic environment may benefit through a reduction in flood risk, but there is also potential for negative effects through altering the setting of historic sites or through damage to sites when the action is implemented. Further assessment is recommended at more detailed levels of flood risk management planning.

A10.4.5 River defences

River defences may include walls, embankments or demountable / temporary defences. These are being considered for 12 PVAs that are located throughout the LPD.

The actions are most likely to be located on the river banks (freshwater lochs and rivers ecosystem) or set back from the river in the urban environment (urban ecosystem). Some actions under consideration are new defences; others involve modifying existing embankments or walls. All SEA topics may be affected.

The effects are dependent on the type of defence (for example, defences that are set back from the river are likely to have a smaller impact) and the degree to which the river banks have already been modified: however, the type and location of defences are not known at this strategic level of planning. The potential effects of the actions are described in the text below and summarised by SEA topic in table A10.6.

Table A10.6 River defences: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	- - Negative effects on freshwater pearl mussels and salmon through increased sediment load	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or disturbance of sediment. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address any negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies should consider medium and long duration effects on recreation, such as changes to river flow. Design studies should consider short duration effects on quality and access to recreation. Discussion with stakeholders recommended at both stages.
Soil	No significant effects	
Water	- - Increased pressure on water quality due to reduction in ability to filter nutrients and pollutants, and potential increase in sediment load.	Feasibility studies should consider how to avoid or minimise potential negative effects on water quality and river habitat, including nutrient inputs, sedimentation and direct loss or damage to river habitats.
Climatic factors	No significant effects	
Material assets	No significant effects	Design stages should consider how to minimise waste and energy consumption.

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	Feasibility and design stages should include consultation with communities to avoid or minimise negative effects on urban landscape.

Commentary on potential significant effects

Regulating and maintaining services
River defences can deliver benefits by regulating water flow, reducing erosion at the site of the structure, and reducing flood risk. The actions, however, can interfere with natural process: the defences may cause some or all of the floodplain to be disconnected from the river, which can lead to loss of natural habitat to capture, filter and recycle nutrients or pollutants. This could lead to potentially significant negative effect on water quality, as water quality is under pressure in the North East LPD through diffuse pollution. Erosion may increase upstream or downstream of a defence due to changes in river processes and there could also be a loss of carbon storage due to loss of natural habitat.

A potential decline in water quality and increase in sediment load can have potentially negative effects on freshwater species such as Atlantic salmon and freshwater pearl mussel – these effects could be significant for the River Dee SAC where freshwater pearl mussels are in unfavourable condition. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
River defences have potential negative effects on freshwater food production due to the loss of in river and riparian habitat. However, this is dependent on the type of defence (for example, defences that are set back from the river are likely to have a smaller impact) and the degree to which the river banks have already been modified.

Cultural services
River defences may have mixed effects on recreation and opportunities to access nature and experience wildlife. Loss of natural habitat and biodiversity, and changes to river flow, can reduce the quality of the environment for recreation and wildlife watching. However, depending on their design, some defences can improve access for some types of recreation.

Within the urban landscape, river defences have potentially negative effects through disrupting the setting and view of the river and floodplain. Defences in PVA 06/14 (and potentially, but unlikely, for 06/20) would fall within the Cairngorms National Park. Actions are not likely to affect areas of wild land.

Historic buildings and monuments may benefit through reduced flood risk, but the defences may alter the setting of the site. Historic sites may also be affected, either for a short or long duration, by construction of the defences – however, this cannot be assessed at this level of planning as more information is required about the precise nature and location of the defences.

A10.4.6 Coastal restoration

There is only one coastal restoration action under consideration for the North East LPD: beach recharge in Stonehaven (PVA 06/23).

The ecosystems that could be affected are urban and coastal and marine. All SEA topics could be affected. The potential effects of the actions are described in the text below and summarised by SEA topic in table A10.7

Table A10.7 Coastal restoration: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	No significant effects	Feasibility studies and design studies should aim to achieve sympathetic design and timing of works to avoid or minimise negative effects, for example, on breeding or feeding birds, and on marine species through short duration potential sediment disturbance. Design stages should also consider the source of sediment to avoid introducing flora or fauna that is foreign to the site. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address any negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies and design studies should consider the short and medium duration effects on recreation and coastal access. Discussion with stakeholders recommended at both stages.
Soil	No significant effects	
Water	No significant effects	
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider the source of beach recharge material in order to minimise energy consumption.
Cultural heritage	+ + Benefits from protecting coastal historic environment from coastal erosion	
Landscape	No significant effects	Feasibility and design stages should include consultation with communities to examine effects on urban landscape.

Commentary on potential significant effects

Regulating and maintaining services
Beach recharge can help to attenuate waves and provide protecting from erosion, and thus has the potential to reduce flood risk. There is likely to be little habitat creation in this instance as the coast line is already modified and is backed by walls rather than natural habitat.

Fine sediment from beach recharge can temporarily smother intertidal benthic communities and nearshore fisheries. Further examining of the potential effects on feeding sites for Fowlsheugh SPA should be considered. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
Sediment from beach recharge could have negative effects on nearshore fisheries, but the effects are likely to be of short duration and negligible.

Cultural services
Beach recharge may have positive effects on cultural services: it may help to maintain the aesthetics and accessibility of the coast for recreation. There are some potential negative effects (short duration reduction in quality of sea angling; some restrictions to accessing the coast during on-site works) but these are likely to be of short duration and negligible.

The historic environment is likely to benefit due to reduced risk of flooding.

A10.4.7 Coastal defences

Coastal defences under consideration for this LPD include walls, embankments, temporary barriers, alteration or installation of revetments, and tidal gates and barriers: these are being considered for five PVAs around the coast.

The ecosystems most likely to be affected are urban, and coastal and marine. All SEA topics could be affected. The potential effects of the actions are described in the text below and summarised by SEA topic in table A10.8.

Table A10.8 Coastal defences: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	No significant effects	Feasibility studies should consider how to avoid or minimise potential negative effects on protected sites. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address any negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies should consider medium and long duration effects on recreation and accessibility to the coast. Design studies should consider short duration effects on quality and access to recreation. Discussion with stakeholders recommended at both stages.
Soil	No significant effects	
Water	No significant effects	
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	Feasibility and design stages should include consultation with communities to avoid or minimise negative effects on urban and coastal landscapes.

Commentary on potential significant effects

Regulating and maintaining services

By attenuating waves and surge, coastal defences can help to reduce flood risk. Some defences can also reduce erosion at the site of the defence. However, these actions can lead to the loss of natural habitat and interfere with coastal processes, altering rates of erosion and deposition elsewhere. The magnitude and direction of potential effects also depends on the current condition of the coastline.

Loss of natural habitat can degrade water quality by reducing the ability of the environment to filter, capture and recycle nutrients / pollutants. Any loss of natural habitat may also have negative effects on carbon storage.

There are a number of protected sites around the coast of the LPD that could be affected by the actions; these include:

- Whiltehills to Melrose Coast SSSI (relevant to PVA 06/03) – actions could obscure the area of visible rock;

- River Dee SAC (PVA 06/18) – actions near the mouth of the River Dee could affect the migration of salmon;
- Fowlsheugh SPA (PVA 06/23) – actions could disrupt the feeding grounds of birds that breed at this site.

The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
Coastal defences can have mixed effects on marine food provision: whilst there can be loss of natural habitat which can reduce productivity, sometimes other edible species can benefit (for example, a change from soft sediment feeding fish to lobster and crab fishery).

Cultural services
The effects of coastal defences on recreation and opportunities to experience nature and wildlife may be reduced through loss of natural habitat and access. However, there may also be benefits as access may be improved and disturbance to wildlife may be reduced.

There are potential negative effects on urban and coastal landscape. However, sensitively designed defences may help to improve amenity particularly in areas where the coastline is already modified.

There are some coastal listed buildings in the PVAs: these may benefit from reduced flood risk but the setting may be negatively affected by the defences. Further assessment is recommended at more detailed stages of planning about the precise nature and location of the defences.

Table A10.9 Shortlisted actions for the North East: Summary of potential effects on ecosystem services

Source of flooding	All		River					Coastal	
Ecosystem service	Non-structural actions		Run off reduction	River and floodplain restoration	Storage, conveyance, control	River defences		Coastal restoration	Coastal defences
Carbon storage	**0**		**+**	**+/-**	**-**	**-**		**0**	**-**
Local climate regulation	**0**		**0**	**0**	**0**	**0**		**0**	**0**
Water quality regulation	**0**		**+ +**	**+ +**	**--**	**--**		**0**	**-**
Pollination	**0**		**+**	**+**	**-**	**0**		**0**	**0**
Biological control of pests and disease	**0**		**+/-**	**+/-**	**0**	**0**		N/A	N/A
Wave / surge attenuation	**0**		N/A	N/A	N/A	N/A		**+ +**	**+ +**
Water flow regulation	**0**		**+ +**	**+ +**	**+ +**	**+ +**		N/A	N/A
Erosion protection	**0**		**++**	**+ +**	**+/-**	**+ / -**		**+**	**+/-**
Nutrition: food provision	**0**		**+/-**	**+/-**	**+/-**	**-**		**0**	**+/-**
Drinking water supply	**0**		**+**	**+**	**0**	**0**		**0**	**0**
Biotic materials: timber, biofuels	**0**		**-**	**+/-**	**+/-**	**0**		**0**	**0**
Recreation (physical interaction)	**0**		**+**	**+/-**	**+/-**	**+/-**		**+**	**+/-**
Accessible nature/wildlife experience	**0**		**+**	**+**	**-**	**+/-**		**+**	**+/-**
Spiritual and cultural amenity (landscape)	**0**		**+**	**+**	**-**	**-**		**+**	**-**

KEY					
	+ +	**Significant positive** Effects are widespread across the LPD; and/or Effects are likely to improve an ecosystem that is in less than good condition	**-**	**Negative** A noticeable negative effect that does not meet the description below
	+	**Positive** A noticeable positive effect that does not meet the description above	**- -**	**Significant negative** Effects are widespread across the LPD; and/or Effects are likely to cause an adverse effect on an ecosystem that is in less than good condition
	0	**No or negligible effects**	**+/-**	**Mixed:** The effect is likely to be a combination of positive and negative effects, particularly where effects are considered on sub-issues, areas or criteria

Map acknowledgments

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including *inter alia*, the following organisations:

Ordnance Survey
Flood maps are based upon Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office © Crown Copyright. Any unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. SEPA Licence number 100016991 (2015).

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology © NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2015), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright © The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC.

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

Appendix 11: Environmental assessment of the Flood Risk Management Strategy for the Tay Estuary and Montrose Basin

This appendix presents the current state of the environment and the assessment of significant environmental effects for the Flood Risk Management Strategy for the Tay Estuary and Montrose Basin Local Plan District (LPD). The purpose of this is to:

- Identify relevant information on the current state of the environment for the Tay Estuary and Montrose Basin LPD. This information supplements the description of the current state of Scotland's environment (section 3 of the main Environmental Report).
- Report the significant environmental effects of the actions being considered to manage flood risk in the Tay Estuary and Montrose Basin LPD.
- Identify mitigation of significant negative effects and opportunities to deliver wider benefits.
- Recommend further assessment at more detailed planning stages e.g. feasibility studies or design stages.

The overall assessment for all 14 Flood Risk Management Strategies is summarised in section 5 of the main Environmental Report.

A11.1 The Tay Estuary and Montrose Basin Local Plan District

The Tay Estuary and Montrose Basin LPD (figure A11) has an area of 2,712km^2 with a population of approximately 340,000. The LPD includes Dundee, Arbroath, St Andrews, Leuchars, Forfar, Carnoustie and Montrose.

The main river catchments areas in the LPD are the North Esk, South Esk, Kincardine and Angus, and the Firth of Tay. The LPD has 233km of coastline stretching from Inverbervie in the north to Fife Ness in the south. The coastline includes the Montrose Basin, the Firth of Tay and the Angus and Fife coastlines that are exposed to the North Sea.

The main source of flooding in the LPD is river flooding (45% of Annual Average Damages[1]), followed by surface water flooding (30% of Annual Average Damages) with the remaining damages caused by coastal flooding (25% of Annual Average Damages). There are 19 Potentially Vulnerable Areas (PVAs) located throughout the LPD (excluding the upper river catchments of the North Esk and South Esk).

A range of non-structural and structural actions are being considered to manage flooding in this LPD. Structural actions are being considered to manage river flooding in 13 PVAs and to manage coastal flooding in five PVAs (table A11.1).

[1] An indicative estimate of the direct economic costs of flooding impacts to residential properties, non-residential properties and agriculture

Figure A11: Tay Estuary and Montrose Basin LPD and PVAs

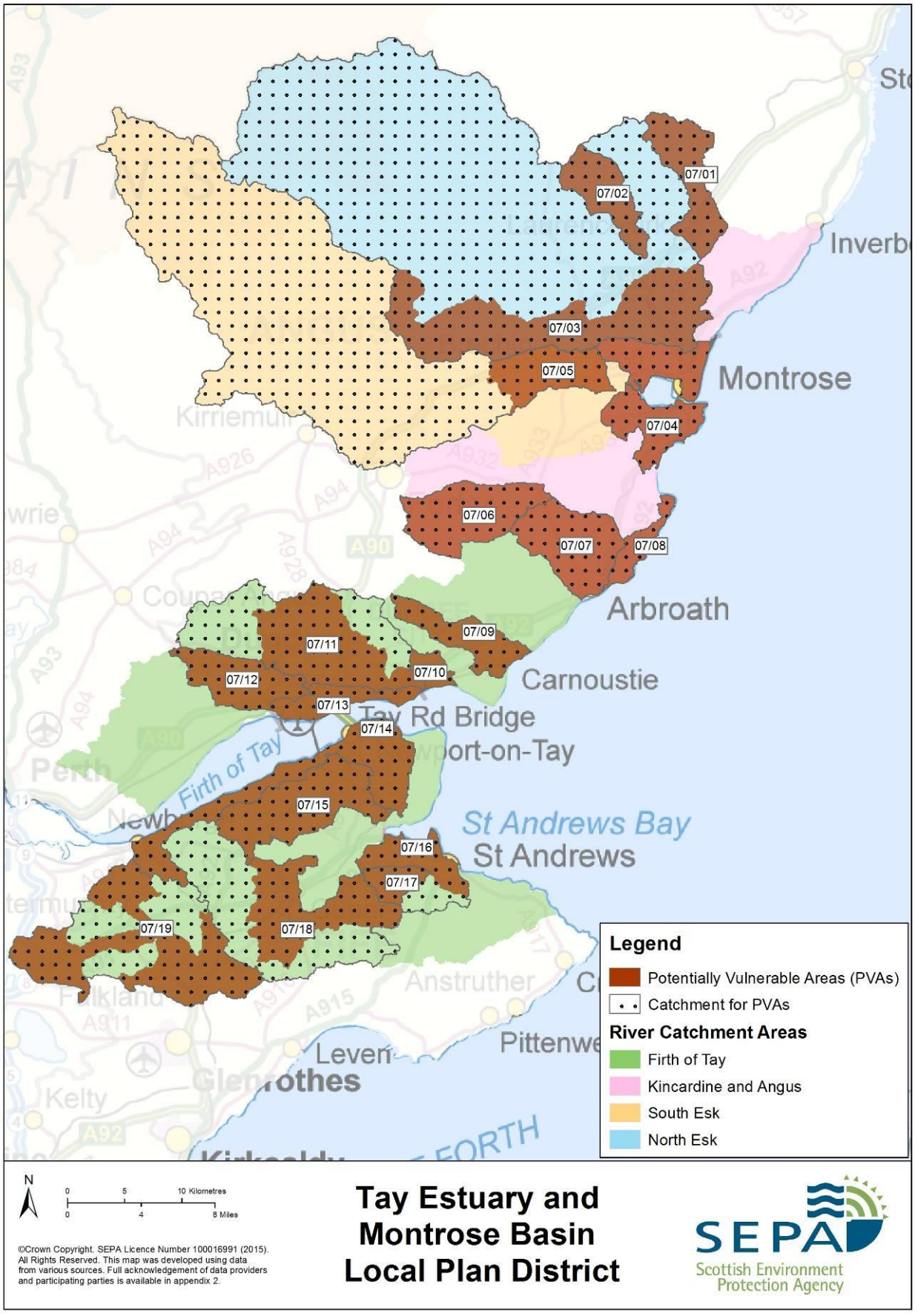


Table A11.1: Shortlisted actions in Tay Estuary and Montrose Basin LPD

Action	Shortlisted for the following PVAs
Run off reduction	07/02, 07/05, 07/09, 07/16, 07/17, 07/18
River and floodplain restoration	07/02, 07/05, 07/07, 07/09, 07/10, 07/11, 07/12, 07/14, 07/16, 07/17, 07/18, 07/19
Storage conveyance and control	07/02, 07/05, 07/07, 07/09, 07/10, 07/14, 07/17, 07/18, 07/19
River defences	07/02, 07/05, 07/07, 07/09, 07/10, 07/11, 07/16, 07/17, 07/18, 07/19
Coastal restoration	07/04, 07/09, 07/13, 17/14, 07/16
Coastal defences	07/04, 07/09, 07/13 , 07/14

A11.2 Environmental and policy context for the Tay Estuary and Montrose Basin LPD

Section 2.2 and Appendix 3 of the main Environmental Report identify the relationships between the Flood Risk Management Strategies and other plans, programmes and strategies.

A11.3 Additional relevant information on the current state of the environment for the Tay Estuary and Montrose Basin LPD

This sub section identifies relevant information on the current state of the environment for the Tay Estuary and Montrose Basin LPD. This information supplements the description of the current state of Scotland's environment (section 3 of the main Environmental Report).

A11.3.1 Ecosystems and condition

The predominant ecosystem in the Tay Estuary and Montrose Basin is cultivated land (horticulture and improved grassland) which covers 56% of the LPD. There are also large areas of upland ecosystem (covering 20% of the LPD), mainly in the upper, steeper catchments of the North and South Esk. There are smaller areas of other ecosystems (woodlands, semi-natural grassland and wetlands) throughout the LPD. The LPD is relatively urbanised (4% of area is urban ecosystem), with Dundee City and many large towns in the district.

Freshwater river and loch ecosystems cover a small area (<0.5%). The coastal and marine habitats are predominantly soft substrate (mudflats, sandy beaches and dunes, salt marsh) interspersed with rocky headlands. The area of reedbeds on the north shore of the Inner Tay is the largest continuous stand in the UK.

Table A11.2 lists the extent of different ecosystems within the LPD, and provides an assessment of ecosystem condition.

Table A11.2. Ecosystems within the LPD

Ecosystem	Area (% of LPD in 2007)	Condition of ecosystem
Woodland - native	3	There are small fragmented areas of native woodland, although new areas are being developed. In protected sites in this LPD, the condition of native woodland features is mixed. Nationally, the Native Woodland Survey for Scotland 2013 found that 46% of native woodlands were in good condition.
Woodland - conifer plantation	6	The condition of conifer plantations is unknown although forestry is one of the contributing factors to water quality pressures in this LPD.
Cultivated land	56	Diffuse pollution pressures affect the LPD, with agriculture being one of the contributing factors. Models suggest high risk of sediment loss (due to water erosion) from arable areas in Eastern Scotland. These factors indicate that there is potential degradation and erosion of soils.
Semi-natural grassland	9	There is limited information on the condition of semi natural grassland in this LPD. In the Caenlochan protected site in the upper South Esk, acid and calcareous grassland habitats are in unfavourable condition.
Wetlands (fen, marsh, and swamp; bog)	1	Very small areas of inland wetlands remain. Within protected sites, wetlands are mainly in favourable condition except for those in the Caenlochan protected site in the upper South Esk.
Upland heath	20	In protected sites, upland heath is in unfavourable condition although it is recovering in some area (e.g. at protected sites in the Firth of Tay catchment)
Freshwater lochs and rivers	<0.5	There are diffuse pollution pressures throughout this LPD and the South Esk catchment is a diffuse pollution priority catchment. Of 78 WFD river water bodies, 41% are at less than good status for water quality and 38% at less than good status for the condition of beds and banks. Of two WFD loch water bodies, both are at less than good overall status. The condition of river and loch features in protected sites is mainly unfavourable except for those in the Caenlochan protected site in the upper South Esk. With the exception of the upper North Esk and upper South Esk, the remaining catchments are within the Strathmore / Fife Nitrate Vulnerable Zone.
Coastal & marine	<0.5*	There are some eutrophication problems in coastal areas: the whole coastal area is part of the Strathmore / Fife Nitrate Vulnerable Zone, and there are relatively high nitrate concentrations in the Tay Estuary and the Montrose Basin. Of the 8 WFD transitional and coastal water bodies, all are at good status for the physical condition of the coastline. Coastal habitats within protected sites are in mixed condition.
Urban	3	Access to greenspace in Scotland's urban environment is generally good. Over two thirds (68%) of adults in Scotland have access to useable greenspace within a five-minute walk from their home (not including their own garden).

*The majority of the coastal and marine ecosystem extends beyond the terrestrial LPD boundary so is not captured in this figure

There are five Special Areas of Conservation (SACs), six Special Protected Areas (SPAs) and 69 Sites of Special Scientific Interest (SSSIs) within this LPD. Of particular relevance to potential flood risk management actions are the following sites:

- River South Esk SAC (PVA 07/05 and upstream catchment) is designated for Atlantic salmon (unfavourable recovering condition) and freshwater pearl mussel (unfavourable declining condition). Relevant pressures include water quality (nutrients and sediments) and river engineering.
- In the upper South Esk catchment (upstream catchment of PVA 07/05) are the Cairngorms Massif SPA and the Caenlochan SPA/SAC/SSSI. These sites provide protection to features such as golden eagles and upland heaths, wetlands and grassland. A number of the habitats are in unfavourable condition; pressures include overgrazing (by deer) and high density forestry.
- The Montrose Basin SPA and SSSI (PVAs 07/04 and 07/05, and upstream catchments) are designated for a number of species of non-breeding birds. The SSSI is also designated for its saltmarsh. All features are in favourable maintained condition.
- The Firth of Tay and Eden Estuary is an SAC and SPA, and the adjacent Barry Links is an SAC and SSSI. This estuarine and coastal area also contains a number of SSSIs including the Inner Tay Estuary, the Eden Estuary, the Barry Links, and the Tayport and Tentsmuir Coast. The sites contain a number of protected breeding and non-breeding birds, which are vulnerable to disturbance and habitat loss. The harbour seal is in unfavourable declining condition. Protected habitats include sandbanks, mudflats and saltmarsh, which are in mixed condition. Relevant pressures include changes to natural processes, artificial drainage and coastal protection works. The sand dunes in the Eden Estuary are vulnerable to erosion.

There are also a number of other smaller protected sites: relevant pressures on these sites include: erosion, land claims and sea defences (Rickle Craig and Sardie Ness SSSI (PVA 07/04)), drain blockages and other changes to water levels (Blacklaw Hill Mire SSSI (PVA 07/12); Gagie Marsh SSSI (PVA 07/11)) and diffuse pollution (Lindores Loch SSSI (PVA 07/14)).
There are no nature conservation or historic Marine Protected Areas adjacent to this LPD.

A11.3.2 Ecosystem services

This sub section summarises the major ecosystem services in the Tay and Montrose Estuary LPD.

Regulating and maintaining services

- Carbon storage and sequestration is relatively low. There are some small areas of woodland and wetlands, with carbon rich soils limited mainly to upland areas in the South Esk and North Esk catchments.
- The small areas of wetlands, semi natural grassland and riparian woodland help to manage water quality and to regulate the flow of water.
- The coastal ecosystems are predominantly soft substrate (mudflats, sandy beaches and dunes, salt marsh) which help to attenuate waves and surge.
- Some of the soft substrate around Carnoustie and Montrose and the outer Firth of Tay is relatively susceptible to erosion (although there are structures in place that help to protect from erosion).
- Native woodland, wetland and semi natural grasslands help to provide habitats for insects that provide pollinating services. These services are important for soft fruit crops.

Provisioning services

- The Tay Estuary and Montrose Basin is an important and productive agricultural area. It contains nearly 15% of Scotland's horticultural land and nearly 5% of its improved grassland. Cattle, potatoes and soft fruit are important products. Horticulture and grassland based farming is located in the lowland areas, with rough grazing in the upland areas. The rivers provide an important source of water for Irrigation for agriculture.
- The marine areas provide relatively small amounts of commercial fishing. There are no active fish farming sites in the coastal environment. Estuarine and coastal habitats provide

nurseries for juvenile marine fish.
- The rivers and bays provide wild salmon and sea trout. Around a third of all wild salmon caught and retained in Scotland are caught in (or upstream) of this LPD.
- Commercial forestry covers around 6% of the LPD and is an important to the local economy. The forests tends to be numerous and small in area.
- Drinking water protected areas (for rivers / lochs) are found in the North Esk (upstream of 07/03) and South Esk catchments (upstream of 07/05). The South Esk is an important source of drinking water for private water supplies.

Cultural services
- The area provides a wide range of recreational opportunities, including angling, wildfowling, kayaking, walking, sailing, swimming and diving.
- It provides habitat for iconic wildlife (e.g. golden eagles, Atlantic salmon, harbour seals). There are three National Nature Reserves: St Cyrus (outflow of the North Esk, downstream of 07/01 – 07/03), Corrie Fee (upper South Esk, upstream of 07/05), and Tentsmuir (mouth of the Tay Estuary, 07/14),
- There are areas of wild land in the upper catchments of the South Esk and North Esk: these areas have a distinct and special character, which is increasingly rare to find. Many people derive psychological and spiritual benefits from their existence, and they provide increasingly important havens for Scotland's wildlife. The areas of wild land overlap with the edge of the Cairngorms National Park. The upper catchment of the South Esk is also a National Scenic Area.
- The area is rich in scheduled monuments, gardens and designed landscapes and listed buildings.

A11.4 Environmental assessment of the Flood Risk Management Strategy for the Tay Estuary and Montrose Basin LPD

This sub section provides an assessment of the potential environmental effects of the flood risk management actions under consideration for the PVAs within this LPD. The effects on SEA topics and on ecosystem services are reported under each group of actions. Table A11.9 compares the effects of different groups of actions on ecosystem services.

A11.4.1 Non-structural actions

A range of non-structural actions are being considered for the LPD such as property level protection, relocation of properties / infrastructure away from flood risk areas and flood warning schemes. These actions help to reduce the impacts of flooding and therefore are likely to have significant positive effects on the SEA objectives for human health and material assets. These effects have been assessed nationally rather than at an LPD level and the results are presented in section 4 of the main Environmental Report.

As these actions help to reduce the impacts of flooding rather than the probability of flooding, they are likely to have no or negligible effects on ecosystems and ecosystem services.

A11.4.2 Run off reduction actions

Actions to reduce run off include woodland and gully woodland planting, upland drain blocking, land management, creation or restoration of wetlands and ponds, and shelter belts. These actions are being considered for six PVAs.

All SEA topics and ecosystems could be affected by these actions: either directly (where an action impacts on the ecosystem in which the action is located) or indirectly (e.g. where the freshwater ecosystem benefits from arising land use change and management). The potential effects of the actions are described in the text below and summarised by SEA topic in table A11.3.

Table A11.3 Run off reduction: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	+ + Benefits to freshwater ecosystems due to improvements to water quality and erosion protection, with potential significant benefits to salmon and freshwater pearl mussels in the River South Esk SAC	Feasibility studies should consider opportunities to contribute to other drivers for restoration of wetlands and woodlands, and improvements to salmonids and freshwater pearl mussels. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH, Fisheries Boards/Trusts) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	
Soil	+ + Benefits to protecting soil quality in cultivated land through reducing loss of sediment and nutrients to watercourses - - However, productivity of agricultural land could be reduced in some areas by increasing the wetness of the soil or altering the land use.	Feasibility stages should consider the potential changes to agricultural land productivity in more detail. Design stages should consider protecting livestock from potential exposure to pests. Consultation with land managers recommended.
Water	+ + Benefits by enhancing water quality and reducing sedimentation	Actions should be coordinated with any morphology or diffuse pollution priority catchments proposed in the second river basin management plans.
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	Feasibility stages should consider landscape changes in the upper South Esk catchment. Consultation with SNH and Cairngorms National Park Authority is recommended.

Commentary on potential significant effects

Regulating and maintaining services
Run off reduction actions help to slow and store water by intercepting rainfall (e.g. woodlands) and/or increasing the extent to which the land can hold any water reaching the ground (both by slowing down the flow of runoff and increasing the permeability of soils). This in turn can help to regulate the flow of water by reducing the amount of water reaching rivers and slowing or reducing flood flows: this helps to protect people and properties from flooding.

These actions can lead to improvements in water quality by helping to protect soils from erosion (thus reducing the sediment reaching rivers) and increasing infiltration of nutrients into soils. Wetland vegetation is particularly effective at storing nutrients. Given the diffuse pollution pressures in this LPD, the benefits to water quality and erosion protection could be significant where actions are located in conifer plantation or cultivated land.

The creation or restoration of woodlands and wetlands (including peatlands through upland drain

blocking) has the potential to increase the capture and storage of carbon. (Although wetlands also have the potential to release carbon dioxide into the atmosphere, the net benefit to carbon storage is more likely to be positive when restoring wetlands.)

Increased habitat diversity and connectivity can provide benefits to pollination, which could be significant given the importance of this service for soft fruit production in this LPD. Increasing habitat diversity can improve biological control of pests and diseases; however, an increase in the wetness of cultivated land and semi-natural grassland ecosystems may increase the prevalence of some livestock pests.

Water quality improvements and erosion protection may significantly benefit protected aquatic species in the South Esk such as salmonids and freshwater pearl mussels that are in unfavourable condition. However, there is a potential negative effect of woodland planting in upland heath, because of the risk of loss or fragmentation of rare dwarf shrub heath. Implementation of actions could disturb protected bird species (Cairngorms Massif SPA, Caenlochan SPA; both upstream of PVA 07/05). The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The potential effects of run off reduction actions on food provision are mixed. The actions may enhance the productivity of cultivated land and semi natural grassland by protecting soils from erosion and loss of nutrients (and, as identified above, through providing a more diverse habitat for pollinators and biological control of pests and disease). However, some areas of valuable productive land may be lost and there is potential to increase the prevalence of some livestock pests.

By protecting water quality and reducing sedimentation, freshwater fisheries such as salmon and sea trout may benefit.

Run off reduction actions may provide benefits to drinking water supply by helping to remove nutrients and pollutants.

Actions that block drains or create wetlands within conifer plantations may lead to loss of timber productivity; however, woodland creation may generate small amounts of timber.

Cultural services
Run off reduction actions are likely to improve habitat diversity, connectivity and biodiversity, leading to potentially positive effects on recreation (e.g. angling), wildlife watching and landscape. Any actions in the upper South Esk (upstream of PVA 07/05) could be located in highly valued landscape (National Scenic Area / Area of wild land / Cairngorms National Park): although the actions are unlikely to be detrimental to these areas, further consideration of potential effects is recommended as part of any feasibility studies.

The historic environment has potential to benefit from these actions: firstly, through the reduction of flood risk to historic buildings and, secondly through the protection of wetland archaeology as a result of creating and restoring wetlands. Woodland planting, however, can disturb buried archaeology. The structure and setting of historic sites could be affected but this will need to be assessed at more detailed levels of flood risk management planning.

A11.4.3 River and floodplain restoration actions

Actions to restore river and floodplains include floodplain reconnection, riparian and floodplain woodland creation, large woody debris/boulders, and washland creation. Sediment management actions such as bank restoration are also included in this assessment. These types of actions are being considered for 12 PVAs.

All SEA topics and a wide range of ecosystems may be affected, but particularly cultivated land and semi natural grassland and freshwater rivers and lochs. The potential effects of the actions are described in the text below and summarised by SEA topic in table A11.4.

Table A11.4 River and floodplain restoration: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	+ + Benefits to freshwater ecosystems due to improvements to water quality and erosion protection, with potential significant benefits to salmon and freshwater pearl mussels in the River South Esk SAC	Feasibility studies should consider opportunities to contribute to other drivers such as improvements to salmonids and freshwater pearl mussels. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies should consider medium and long duration effects on recreation, such as changes to river flow. Design studies should consider short duration effects on quality and access to recreation. Discussion with stakeholders recommended at both stages.
Soil	No significant effects	Feasibility and design stages should consider potential loss of productive soils, particularly cultivated land. Consultation with land managers recommended.
Water	+ + Benefits by enhancing water quality and reducing sedimentation	Actions should be coordinated with any morphology or diffuse pollution priority catchments proposed in the second river basin management plans.
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	Feasibility stages should consider landscape changes in the upper South Esk catchment. Consultation with SNH and Cairngorms National Park Authority is recommended.

Commentary on potential significant effects

Regulating and maintaining services
River and floodplain restoration actions slow down in-channel flow by increasing the sinuosity of the river and help reconnect the river with the floodplain, increasing the amount of water stored on land. Floodplain planting can also slow down the flow of run off and increase the permeability of soils, while river bank restoration can reduce bank erosion and sediment deposition in the river. The effect of all of these actions is to help regulate the flow of water by slowing and/or reducing flood flows: this helps to protect people and properties from flooding.

The restoration and creation of habitat (woodlands, washlands, woody debris etc) within the river and floodplain, and reduced erosion of the river bed and banks can help to filter nutrients and reduce sediments. Wetland vegetation (in this case, vegetation on the floodplain) is particularly effective at storing nutrients. Given the diffuse pollution pressures in this LPD, the benefits to water quality and erosion protection could be significant where actions are located in cultivated land.

The creation or restoration of woodlands and wetlands (floodplains) has the potential to increase the capture and storage of carbon. The net benefit may be less where floodplain restoration requires the removal of trees but any loss of existing woodland is likely to be small. As stated above, although wetlands have the potential to release carbon dioxide into the atmosphere, the net benefit to carbon storage is more likely to be positive when restoring this ecosystem.

Other potential positive effects include improvements to pollination (as pollinating insects may benefit from greater food and shelter in a more diverse habitat). Increasing habitat diversity can improve biological control of pests and diseases; however, an increase in the wetness of cultivated land and semi-natural grassland ecosystems may increase the prevalence of some livestock pests.

Water quality improvements and erosion protection may significantly benefit protected aquatic species in the South Esk such as salmonids and freshwater pearl mussels that are in unfavourable condition. Restoration works could lead to short duration increases in sediment load and could disturb birds, therefore the timing and implementation of actions needs to be carefully planned. Other protected sites close to areas of floodplain storage potential (e.g. Gagie Marsh SSSI (PVA 07/11), Den of Fowlis SSSI (PVA 07/12) and Lindores Loch SSSI (PVA 07/14)) could be affected. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The potential effects on food provision are mixed. As with runoff reduction actions, these actions may enhance the productivity of cultivated land and semi natural grassland by protecting soils from erosion and loss of nutrient, increasing shelter for livestock and improvements to pollination. There may, however, be some loss of cultivated land and semi natural grassland.

By protecting water quality and reducing sedimentation, freshwater fisheries such as salmon and sea trout may benefit.

Restoration actions may provide benefits to drinking water supply by helping to remove nutrients and pollutants.

The potential effects on provision of biotic materials are mixed. Potential loss of cultivated land reduces opportunities for producing biofuels; however, the creation of woodland may provide timber.

Cultural services
The potential effects on recreation, wildlife watching and landscape are positive, as the actions should improve habitat diversity and biodiversity. However, changes to the bed and banks of rivers may affect the quality of some forms of recreation e.g. kayaking. Installing / implementing actions may also impede access to the river and its banks for recreation although these effects would be of short duration.

There is potential for actions for PVA 07/05 to be located in the upper South Esk catchment and, although unlikely, it is possible that actions could be located within the boundaries of the Cairngorms National Park. Further consideration of potential effects is recommended as part of any feasibility studies.

The historic environment has potential to benefit from these actions: firstly, through the reduction of flood risk to historic buildings and, secondly through the protection of wetland archaeology as a result of creating and restoring wetlands. Woodland planting, however, can disturb buried archaeology. The structure and setting of historic sites could be affected but this will need to be assessed at more detailed levels of flood risk management planning.

A11.4.4 Storage conveyance and control

Storage, conveyance and control actions include on and offline flood storage, addressing hydraulic constrictions (e.g. culverts, bridges), adding or removing trash screens and weirs. These actions are being considered for nine PVAs.

The actions are most likely to be located in cultivated land, semi natural grassland, freshwater and urban ecosystems. Small areas of native woodland, conifer woodland and wetlands could also be affected. All SEA topics could be affected. The potential effects of the actions are described in the text below and summarised by SEA topic in table A11.5.

Table A11.5 Storage, conveyance and control: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	- - Negative effects on freshwater pearl mussels and salmon through increased sediment load	Feasibility studies should consider how to avoid or minimise potential negative effects such as an increase in erosion. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH, Fisheries Trusts) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies should consider medium and long duration effects on recreation, such as changes to river flow. Design studies should consider short duration effects on quality and access to recreation. Discussion with stakeholders recommended at both stages.
Soil	- - Erosion of productive agricultural soils downstream of the structure	Feasibility and design stages should consider potential loss of productive soils, particularly cultivated land. Consultation with land managers recommended.
Water	- - Increase in sediment load due to increased erosion + + Potential improvements to morphology, sediment dynamics and fish passage if existing structures are removed or altered	Feasibility and design stages should consider how to avoid or minimise potential negative effects such as an increase in erosion.
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	Feasibility and design stages should include consultation with communities and SNH (and where appropriate) the Cairngorms National Park Authority to avoid or minimise negative effects on landscape.

Commentary on potential significant effects

Regulating and maintaining services

Storage, conveyance and control actions are engineered actions that alter the storage and flow of water. These actions can deliver positive effects through regulating the flow of water and thus reducing flood risk to people and property.

These actions can lead to disruption to natural processes and loss of habitat. These may have a negative effect on water quality and carbon storage. However, the removal of structures can also restore habitats to a more natural state and improve water quality. Overall effects on water quality are mixed.

The ecosystem adjacent to the structure may benefit through protection from erosion – this may have locally noticeable benefits in urban areas and in cultivated land and semi natural grassland. However, erosion can be exacerbated downstream of the structure, with potentially significant negative effects on cultivated land and freshwater ecosystems as these ecosystems are already under pressure as a result of sediment loss.

Loss of natural habitat may lead to locally noticeable negative effects on pollination and pest and disease control.

Any actions that could lead to an increase in erosion and sediment load in the freshwater ecosystem could have significantly negative effects on protected aquatic species in the South Esk such as salmonids and freshwater pearl mussels that are in unfavourable condition. Implementation of actions could also lead to short duration increases in sediment load and could disturb birds, therefore the timing and implementation of actions needs to be carefully planned. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The effects on terrestrial food provision and production of biofuels are mixed: the actions may help to reduce flooding to some areas of cultivated land or semi natural grassland but other areas may suffer increased flooding (or erosion). These effects could lead to longer duration changes in land use.

Freshwater production may suffer negative effects through loss of habitat and increased sedimentation.

Cultural services
Storage, conveyance and control actions have potentially negative effects on cultural services. Loss of natural habitat and negative effects on biodiversity can impact opportunities to watch wildlife and interact with nature, and recreation such as angling. Changes to patterns of river flow can also affect sports such as kayaking. However, access for some activities could be improved with sensitive scheme design.

Actions are unlikely to affect protected landscapes and wild land – for example, the only actions under consideration for the River South Esk catchment are related to improving conveyance and control in the Brechin area; there are no storage actions under consideration. In urban areas, storage, conveyance and control actions may have potentially negative effects by affecting the views of rivers.

The historic environment may benefit through a reduction in flood risk, but there is also potential for negative effects, for example, where actions might affect listed buildings or other protected structures. Further assessment is required at more detailed levels of flood risk management planning.

A11.4.5 River defences

River defences may include walls, embankments or demountable / temporary defences. These are being considered for nine PVAs.

The actions are most likely to be located in or adjacent to rivers (freshwater lochs and rivers ecosystem) or set back from the river in the urban environment (urban ecosystem). All SEA topics could be affected.

The effects are dependent on the type of defence (for example, defences that are set back from the river are likely to have a smaller impact) and the degree to which the river banks have already been modified: however, the type and location of defences are not known at this strategic level of planning. The potential effects of the actions are described in the text below and summarised by SEA topic in table A11.6.

Table A11.6 River defences: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	- - Negative effects on freshwater pearl mussels and salmon through increased sediment load	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or disturbance of sediment. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies should consider medium and long duration effects on recreation, such as changes to river flow. Design studies should consider short duration effects on quality and access to recreation. Discussion with stakeholders recommended at both stages.
Soil	No significant effects	
Water	No significant effects	
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	Feasibility and design stages should include consultation with communities to avoid or minimise negative effects on urban landscape.

Commentary on potential significant effects

Regulating and maintaining services
River defences can deliver benefits by regulating water flow, reducing erosion at the site of the structure and reducing flood risk. The actions, however, can interfere with natural process: the defences can cause some or all of the floodplain to be disconnected from the river, which can lead to loss of natural habitat to capture, filter and recycle nutrients or pollutants. This can lead to a reduction in water quality and a loss of carbon storage. Erosion may also increase upstream or downstream of the defences due to changes in river processes.

A potential decline in water quality and increase in sediment load can have potentially negative effects on freshwater species such as Atlantic salmon and freshwater pearl mussel – these effects may be significant as these species are in unfavourable condition in the River South Esk SAC. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
River defences have potential negative effects on freshwater food production due to the loss of in river and riparian habitat. However, this is dependent on the type of defence (for example, defences that are set back from the river are likely to have a smaller impact) and the degree to which the river banks have already been modified.

Cultural services
River defences may have mixed effects on recreation and opportunities to access nature and experience wildlife. Loss of natural habitat and biodiversity, and changes to river flow, can reduce the quality of the environment for recreation and wildlife watching. However, depending on their design, some defences can improve access for some types of recreation.

Within the urban landscape, river defences have potentially negative effects through disrupting the setting and view of the river and floodplain.

Historic buildings and monuments may benefit through reduced flood risk, but the defences may alter the setting of the site. Historic sites may also be affected, either of short or long duration, by construction of the defences – however, this cannot be assessed at this level of planning as more information is required about the precise nature and location of the defence.

A11.4.6 Coastal restoration

Coastal restoration includes actions to help attenuate waves, such as beach recharge schemes, shingle reprofiling, and restoration of sand dunes and coastal vegetated shingle. These actions are being considered for five PVAs. The creation and restoration of intertidal areas is also being considered to help attenuate coastal surge in two PVAs.

The ecosystems most likely to be affected are coastal and marine ecosystems and cultivated land. All SEA topics could be affected. The potential effects of the actions are described in the text below and summarised by SEA topic in table A11.7

Table A11.7 Coastal restoration: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	+ + Benefits from protecting and restoring coastal habitats (e.g. saltmarsh, dunes)	Feasibility studies should consider opportunities to help protect and restore protected coastal habitats. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects, for example, on birds / seals/ fish through short duration disturbance. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies and design studies should consider the short, medium and long duration effects on coastal access and recreation. Discussion with stakeholders recommended at both stages.
Soil	No significant effects	Feasibility and design stages should consider potential loss of productive soils, particularly cultivated land. Consultation with land managers recommended.
Water	No significant effects	
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption
Cultural heritage	No significant effects	
Landscape	No significant effects	

Commentary on potential significant effects

Regulating and maintaining services
Coastal restoration actions help to provide space to attenuate waves and coastal surge through the creation and restoration of natural habitats. They can also help make soft coastal sediment less susceptible to erosion – this effect may deliver significant benefits to some parts of the coastline (e.g. sand dunes in the Eden Estuary) where coastal habitats are showing signs of erosion. Through attenuating waves and surge and protecting from erosion, coastal restoration actions have the potential to reduce flood risk.

The restoration of natural habitats may help to provide carbon storage.

Protected habitats and species may benefit from restoration of intertidal and coastal habitats. For example, restoration and stabilisation of sand dunes can help to restore natural processes with benefits to Barry Links SAC/SSSI (PVA 07/09) and the Eden Estuary (Firth of Tay and Eden Estuary SAC / SPA; Eden Estuary SSSI). However, implementation of works could cause short duration disturbance to feeding and breeding birds and harbour seals. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
Coastal restoration actions may help to protect cultivated land from erosion and flooding but could lead to some loss of productive land, for example, if managed realignment allows the sea to flood cultivated land. The restoration and creation of intertidal areas may help to provide nurseries for fish. There is therefore a mixed effect on food provisioning.

Cultural services
The potential effects of coastal restoration action on cultural services are generally positive. By improving the coastal environment, recreation, wildlife experience and cultural amenity may benefit. However, coastal recreation areas such as golf courses could be adversely affected if managed realignment leads to flooding of recreational land. Additionally, implementation of works could restrict access to coastal areas which could cause local negative effects of short to medium duration.

The historic environment (e.g. listed buildings, scheduled monuments) is likely to benefit due to reduced risk of flooding.

A11.4.7 Coastal defences

Coastal defences under consideration for this LPD include walls, embankments, temporary barriers, revetments, groynes and tidal gates and barriers. These actions are being considered for four PVAs. Detached breakwaters and artificial reefs are also being considered for two PVAs.

The ecosystems most likely to be affected are urban, and coastal and marine. All SEA topics could be affected. The potential effects of the actions are described in the text below and summarised by SEA topic in table A11.8.

Table A11.8 Coastal defences: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	- - Negative effects on protected coastal habitats and the species they support through increased erosion and disruption of natural processes	Feasibility studies should consider how to avoid or minimise potential negative effects such increased erosion. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies should consider medium and long duration effects on recreation and accessibility to the coast. Short duration effects should be considered in design studies. Discussion with stakeholders recommended at both stages.
Soil	No significant effects	
Water	No significant effects	
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Further modelling required at feasibility and design stages to better understand erosion risks. Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	Feasibility and design stages should include consultation with communities to avoid or minimise negative effects on urban and coastal landscapes.

Commentary on potential significant effects

Regulating and maintaining services
By attenuating waves and surge, coastal defences can help to reduce flood risk. Some defences can also reduce erosion at the site of the defence. However, these actions can lead to the loss of natural habitat and interfere with coastal processes, altering rates of erosion and deposition elsewhere. Some of the soft substrates around Montrose (07/04), Carnoustie (07/09) and the outer Firth of Tay are relatively susceptible to erosion so effects here could be particularly significant. However, there are structures in place that help to protect from erosion and so the magnitude and direction of potential effects therefore also depends on the current condition of the coastline.

Loss of natural habitat can lead to reduced water quality by reducing the ability of the environment to filter, capture and recycle nutrients / pollutants. The effect on carbon storage is mixed: loss of natural habitat to sequester carbon will have negative effects; however, some actions might provide suitable substrate for kelp which can act as a carbon store.

The effects on protected sites are potentially significantly negative: coastal defences could impact on saltmarsh and sand dunes and coastal processes at a number of protected sites (e.g. Montrose Basin SPA / SSSI and Rickle Craig and Scurdie Ness SSSI (PVA 07/04); Barry Links SAC / SSSI (PVA 07/09), a number of sites around the Tay Estuary (PVAs 07/13 and 07/14). Protected species (birds, harbour seals, Atlantic salmon) could also be negative affected by actions – through short duration disturbance during construction and through longer duration effects such as loss of habitat. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
Coastal defences can have mixed effects on marine food provision: whilst there can be loss of natural habitat which can reduce productivity, other edible species may benefit (for example, a change from soft sediment feeding fish to lobster and crab fishery).

Cultural services
The effects of coastal defences on recreation and opportunity to experience nature and wildlife may be reduced through loss of natural habitat and access. However, there may also be benefits as access may be improved and disturbance to wildlife may be reduced.

There are potential negative effects on urban and coastal landscape. However, sensitively designed defences may help to improve amenity.

There are some coastal listed buildings and scheduled monuments that may benefit from reduced flood risk but the setting may be negatively affected by the defences. Further assessment is required at more detailed stages of planning based on the precise nature and location of the defence.

Table A11.9 Shortlisted actions for the Tay Estuary and Montrose Basin: Summary of potential effects on ecosystem services

Source of flooding	All		River					Coastal	
Ecosystem service	Non-structural actions		Run off reduction	River and floodplain restoration	Storage, conveyance, control	River defences		Coastal restoration	Coastal defences
Carbon storage	**0**		**+**	**+**	**-**	**-**		**+**	**+/-**
Local climate regulation	**0**		**0**	**0**	**0**	**0**		**0**	**0**
Water quality regulation	**0**		**+ +**	**+ +**	**+/-**	**-**		**+**	**-**
Pollination	**0**		**+**	**+**	**-**	**0**		**0**	**0**
Biological control of pests and disease	**0**		**+/-**	**+/-**	**-**	**0**		N/A	N/A
Wave/ surge attenuation	**0**		N/A	N/A	N/A	N/A		**+ +**	**+ +**
Water flow regulation	**0**		**+ +**	**+ +**	**+ +**	**+ +**		N/A	N/A
Erosion protection	**0**		**+ +**	**+ +**	**+/-**	**+/-**		**+ +**	**+/-**
Nutrition: food provision	**0**		**+/-**	**+/-**	**+/-**	**-**		**+/-**	**+/-**
Drinking water supply	**0**		**+**	**+**	**0**	**0**		**0**	**0**
Biotic materials: timber, biofuels	**0**		**+/-**	**+/-**	**+/-**	**0**		**0**	**0**
Recreation (physical interaction)	**0**		**+**	**+/-**	**+/-**	**+/-**		**+/-**	**+/-**
Accessible nature/wildlife experience	**0**		**+**	**+**	**-**	**+/-**		**+**	**+/-**
Spiritual and cultural amenity (landscape)	**0**		**+**	**+**	**-**	**-**		**+**	**-**

KEY					
	+ +	**Significant positive** Effects are widespread across the LPD; and/or Effects are likely to improve an ecosystem that is in less than good condition	**-**	**Negative** A noticeable negative effect that does not meet the description below
	+	**Positive** A noticeable positive effect that does not meet the description above	**- -**	**Significant negative** Effects are widespread across the LPD; and/or Effects are likely to cause an adverse effect on an ecosystem that is in less than good condition
	0	**No or negligible effects**	**+/-**	**Mixed:** The effect is likely to be a combination of positive and negative effects, particularly where effects are considered on sub-issues, areas or criteria

Map acknowledgments

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including *inter alia*, the following organisations:

Ordnance Survey
Flood maps are based upon Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office © Crown Copyright. Any unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. SEPA Licence number 100016991 (2015).

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology © NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2015), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright © The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC.

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

Appendix 12: Environmental assessment of the Flood Risk Management Strategy for the Tay

This appendix presents the current state of the environment and the assessment of significant environmental effects for the Flood Risk Management Strategy for the Tay Local Plan District (LPD). The purpose of this is to:

- Identify relevant information on the current state of the environment for the Tay LPD. This information supplements the description of the current state of Scotland's environment (section 3 of the main Environmental Report).
- Report the significant environmental effects of the actions proposed to manage flood risk in the Tay LPD.
- Identify mitigation of significant negative effects and opportunities to deliver wider benefits.
- Recommend further assessment at more detailed planning stages e.g. feasibility studies or design stages.

The overall assessment for all 14 Flood Risk Management Strategies is summarised in section 5 of the main Environmental Report.

A12.1 The Tay Local Plan District

The Tay LPD (figure A12) has an area of 6,061km^2 with a population of approximately 160,000 and includes Perth, Forfar, Blairgowrie, Crieff, Auchterarder, Aberfeldy and Pitlochry.

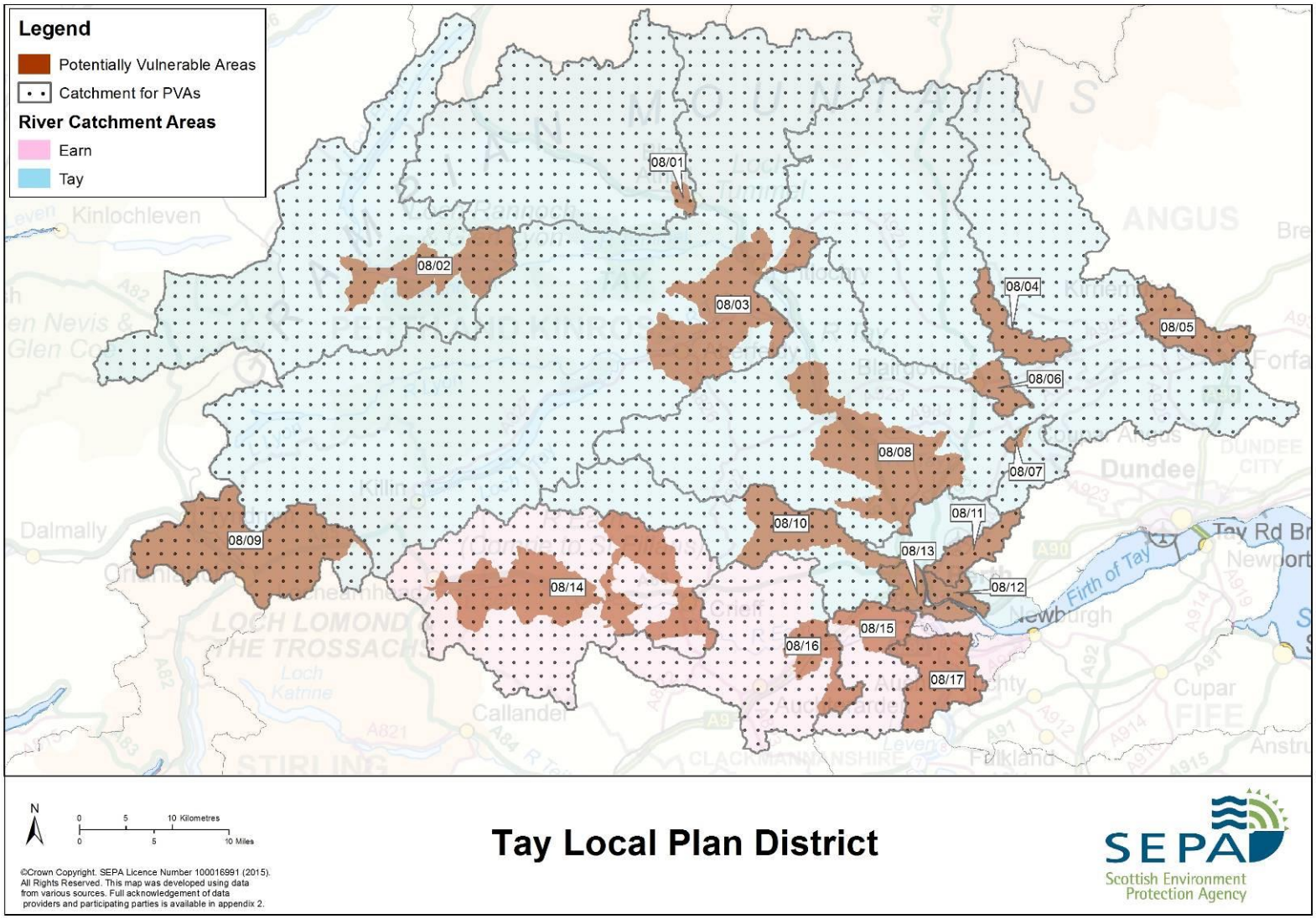
The LPD contains the River Tay and River Earn catchments. The River Tay is the longest river in Scotland (190km) and has the largest catchment covering an area of around 5,000km^2. More water flows through the River Tay than any other river in the UK. The largest lochs in the Tay catchment include Loch Ericht, Loch Rannoch and Loch Tay. The Tay Local Plan District includes a 74km stretch of the inner Firth of Tay, where the River Tay and the River Earn meet the Firth of Tay.

The main source of flooding in the Tay LPD is river flooding (81% of Annual Average Damages[1]), followed by surface water flooding (15% of Annual Average Damages) with the remaining damages caused by coastal flooding (4% of Annual Average Damages). The interaction between coastal flooding and river flooding on the River Tay and River Earn is an important factor for flooding in this area.

There are 17 Potentially Vulnerable Areas (PVAs) within the LPD; 13 of these are in the River Tay catchment and four are in the River Earn catchment. A range of non-structural and structural actions are being considered to manage flooding. Structural actions are being considered to manage river flooding in nine PVAs (table A12.1).

[1] An indicative estimate of the direct economic costs of flooding impacts to residential properties, non-residential properties and agriculture

Figure A12: Tay LPD and PVAs[2]



[2] Including candidate PVAs

Table A12.1 Shortlisted actions in the Tay LPD

Action	Shortlisted for the following PVAs																
	08/01	08/02	08/03	08/04	08/05	08/06	08/07	08/08	08/09	08/10	08/11	08/12	08/13	08/14	08/15	08/16	08/17
Run off reduction			●				●	●		●				●			
River and floodplain restoration			●		●		●	●		●	●			●			●
Storage conveyance and control			●	●	●		●	●		●	●			●			
River defences			●		●		●	●		●	●			●			●

A12.2 Environmental and policy context for the Tay LPD

Section 2.2 and Appendix 3 of the main Environmental Report identify the relationships between the Flood Risk Management Strategies and other plans, programmes and strategies.

A12.3 Additional relevant information on the current state of the environment for the Tay LPD

This sub section identifies relevant information on the current state of the environment for the Tay LPD. This information supplements the description of the current state of Scotland's environment (section 3 of the main Environmental Report).

A12.3.1 Ecosystems and condition

The Highland boundary fault cuts across the LPD dividing the landscape. To the west of the boundary fault the area is upland in nature, characterised by forestry (conifer plantations cover 11% of the area), rough grassland, heather and montane habitat. Upland heath is the predominant ecosystem covering 37% of the LPD. The lowland area is largely cultivated land ecosystem (arable, horticulture and improved grassland) covering 22% of the LPD. Semi-natural grassland makes up 19% of the LPD: this is mostly rough and acid grassland, although a small amount (0.1% of LPD) of calcareous grassland makes a notable contribution (65%) to the Scottish resource. Three percent of the area is freshwater: there are many lochs, and the River Tay itself is the Scotland's largest catchment and longest river. Many of the lochs and rivers in the River Tay catchment are managed to produce hydropower.

Table A3.2 lists the extent of different ecosystems within the Tay LPD, and provides an assessment of ecosystem condition.

Table A3.2 Ecosystems within the LPD

Ecosystem	Area (% of LPD in 2007)	Condition of ecosystem
Woodland - native	3	The Tay LPD is home to several large semi-natural woodlands contributing 6.9% to Scotland's total. The area of broadleaved woodland is set to increase from 6% to 13% by 2050 (Tay Forest Strategy). Woodland features in SSSIs are in mixed condition. Upland native mixed woodland is in general decline and in unfavourable condition in Cairngorms (native pinewood), Blackwood of Rannoch, Innishewan Wood, Glenartney Juniper Wood, and Coille Chriche SSSIs. Woodland expansion is proposed in three forest habitat network plans.
Woodland - conifer plantation	11	There is a large area of commercial forestry in the Tay Forest Park. Commercial forestry will be sustained in the Tay LPD (TayPlan, Tay Forest Strategy).
Cultivated land	22	Cultivated land is located in the eastern part of the LPD and along river valleys. The Tay diffuse pollution priority catchment encompasses the whole of the River Tay catchment. This indicates that there is potential degradation and erosion of soils.
Semi-natural grassland	19	Upland acid grassland is widespread in the western/northern part of the LPD. Calcareous grasslands are identified as nationally important (0.1% LPD but 65% of Scottish resource), and are included in the Tayside Local Biodiversity Plan. Most of the grassland falls within the Tay diffuse pollution priority catchment. Vascular plants/grassland features in some SSSIs are in less than good condition.
Wetlands (fen, marsh, and swamp; bog)	5	Approximately half of the wetlands in this LPD area are found outwith designated sites and the condition is unknown. Rannoch Moor SSSI contains blanket bog that is considered in favourable condition.
Upland heath	37	Upland heath is located within the mountainous north and west of the area. Several of the large montane SSSIs are in unfavourable condition.
Freshwater lochs and rivers	2	Of the 194 WFD river water bodies in this LPD, the majority are in good condition (18% are at less than good status for water quality and 11% are at less than good status for the condition of beds and banks). Of the 26 WFD loch water bodies in this LPD, 31% are failing to meet good overall status. Nearly all of LPD area falls within a diffuse pollution priority catchment and a Nitrate Vulnerable Zone. Diffuse pollution is considered a key pressure impacting on freshwaters.
Coastal & marine	<0.5*	(The condition has not been examined as there are no coastal structural actions proposed for this LPD)
Urban	1	Access to greenspace is generally good. In the largest urban settlement, Perth, residents have nearby access to good quality greenspace (North and South Inch parks, Kinoull woodland).

*The majority of the coastal and marine ecosystem extends beyond the terrestrial LPD boundary so is not captured in this figure

There are 23 Special Areas of Conservation (SACs), 11 Special Protected Areas (SPAs) and 126 Sites of Special Scientific Interest (SSSIs) in this LPD. All of these designated sites (except one geological SSSI) are within PVAs and their source catchments.

Upland montane habitat is a key ecosystem within designated sites, and several of the large SSSIs are in unfavourable condition (e.g. Carn Gorm and Meall Garbh, Meall Ghaordie, Caenlochan).

Woodland features in SSSIs are in mixed condition, although upland native mixed woodland could be considered in general decline – those SSSIs in unfavourable condition include: Cairngorms (native pinewood), Blackwood of Rannoch, Innishewan Wood, Glenartney Juniper Wood and Coille Chriche wood.

The River Tay is an SAC in favourable maintained condition for all protected features (Lamprey species, Atlantic salmon, otter, and lochs).

Opportunities to contribute to site management objectives include increasing upland and riparian woodland, and natural flood management actions which help reduce erosion, sedimentation and diffuse pollution pressures.

A12.3.2 Ecosystem services

This sub section summarises the major ecosystem services in the Tay LPD.

Regulating and maintaining services

- Carbon storage and sequestration is provided by woodlands and wetlands.
- The large areas of semi natural grassland and upland heath help to filter and maintain good water quality. This is particularly important for drinking water supply and freshwater fisheries.
- Pollination is considered an important service given the proximity of arable and soft fruit farming.

Provisioning services

- Tayside is an important agricultural area: there are high grade agricultural soils to the east of the Highland Boundary. Arable, horticulture and livestock dominate the area.
- Irrigation for agriculture (potatoes, soft fruit) is a significant service.
- Salmon and trout angling is a notable ecosystem service in the Tay LPD (particularly the River Tay and its tributaries). Seven rivers/lochs support finfish farming.
- There are 90 drinking water protection areas in the Tay LPD and 65 separate water bodies provide a source of drinking water.
- Commercial forestry and timber are a key ecosystem service (several areas identified for woodland expansion, two sawmills in the area).
- Hydroelectricity generation is key service in the area, with 57 water bodies providing hydroelectric power (these are located within the western half of the LPD).

Cultural services

- The area provides a wide range of recreational opportunities - angling is a significant activity in the area (especially in the River Tay) and many areas are important for kayaking/sailing/boating.
- Woodland and forestry recreation is an important cultural service. Resources ranges from local woodlands around towns (e.g. Kinnoull Hill, Hermitage) to large forests (e.g. Tay Forest Park) with activities include mountain biking, walking and running.
- Much of the LPD is considered important habitat for iconic wildlife. Bird watching and wildlife tourism is important to this area.
- Landscape is particularly notable. The LPD contains five National Scenic Areas (Loch Rannoch and Glen Lyon, Loch Tummel, River Earn, River Tay) and the western edge of Ben Nevis and Glen Coe National Scenic Area. There are large swathes of wild land in the western and northern areas of the LPD including: Ben Lawers, Lyon-Lochay, Breadalbane-Schiehallion, Rannoch-Nevis, and Cairngorms.

- The area is rich in historic sites, including scheduled ancient monuments, listed buildings, and gardens and designed landscapes.

A12.4 Environmental assessment of the Flood Risk Management Strategy for Tay LPD

This sub section provides an assessment of the potential environmental effects of the flood risk management actions under consideration for the PVAs within this LPD. The effects on SEA topics and on ecosystem services are reported under each group of actions. Table A12.7 compares the effects of different groups of actions on ecosystem services.

A12.4.1 Non-structural actions

A range of non-structural actions are being considered for the LPD such as property level protection, relocation of properties / infrastructure away from flood risk areas and flood warning schemes. These actions help to reduce the impacts of flooding and therefore are likely to have significant positive effects on the SEA objectives for human health and material assets. These effects have been assessed nationally rather than at an LPD level and the results are presented in section 4 of the main Environmental Report.

As these actions help to reduce the impacts of flooding rather than the probability of flooding, they are likely to have no or negligible effects on ecosystems and ecosystem services.

A12.4.2 Run off reduction actions

Actions to reduce run off include woodland and gully woodland planting, upland drain blocking, land management, creation or restoration of wetlands and ponds, and shelter belts. These actions are being considered in four PVAs in the Tay River catchment (located across the catchment) and for one PVA in the Earn catchment (upper catchment). All SEA topics and ecosystems could be affected by these actions: either directly (where an action impacts on the ecosystem in which the action is located) or indirectly (e.g. where the freshwater ecosystem benefits from arising land use change and management). The potential effects of the actions are described in the text below and summarised by SEA topic in table A12.3.

Table A12.3 Run off reduction: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	+ + Benefits to connectivity and health of freshwater and wetland biodiversity. Improved habitat diversity in cultivated land and grassland ecosystems	Opportunity to improve habitat diversity and address diffuse pollution pressures on aquatic and wetland habitats across the LPD. Feasibility studies should consider locating actions in cultivated land and grassland ecosystems where diffuse pollution pressures have been identified. Consultation with relevant organisations (e.g. SNH) recommended at feasibility and design stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Opportunity to reduce drinking water treatment costs with improved water quality.
Soil	+ + Benefits to safeguarding carbon rich soils	Opportunity to reduce erosion and safeguard carbon rich soils. Wetland creation has the potential to increase the extent and quality of carbon rich soils especially in cultivated land. Consultation with land managers recommended.

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Water	+ + Benefits by enhancing water quality and reducing sedimentation	Significant opportunity to address diffuse pollution pressures on the water environment by targeting run-off reduction actions, particularly in cultivated land, grasslands and upland habitats.
Climatic factors	+ + Benefits to carbon storage through wetland and woodland creation	Opportunity to improve carbon storage across LPD through wetland and woodland creation actions.
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	

Commentary on potential significant effects

Regulating and maintaining services
Run off reduction actions help to slow and store water by intercepting rainfall (e.g. woodlands) and/or increasing the extent to which the land can hold any water reaching the ground (both by slowing down the flow of runoff and increasing the permeability of soils). This in turn can help to regulate the flow of water by reducing the amount of water reaching rivers and slowing or reducing flood flows: this helps to protect people and properties from flooding.

All run off reduction actions enhance water quality regulation, water flow regulation and erosion protection by increasing filtration of nutrients and sediments, stabilising soils and helping to reduce diffuse pollution pressure and impacts on receiving water bodies. These benefits are particularly important in cultivated land and grassland ecosystems where diffuse pollution pressures have been identified.

Improving habitat diversity and connectivity, especially woodland planting and wetland creation will increase carbon storage potential across the LPD.

Wetland extent is limited and condition is unknown across the LPD; therefore, creation of wetlands would significantly benefit this ecosystem and associated services – carbon capture, water quality, flow regulation and erosion control. (Although wetlands also have the potential to release carbon dioxide into the atmosphere, the net benefit to carbon storage is more likely to be positive when restoring wetlands.)

Any water quality benefits and erosion protection will help to maintain the low nutrient and low sediment load that is essential for some protected species e.g. salmon in the Tay and Earn catchments. Protected wetlands are also likely to benefit. Upland native woodland may also benefit with woodland creation and management. However, there is a potential negative effect of woodland planting in upland heath because of the risk of loss or fragmentation of rare dwarf shrub heath, and potential negative effect of wetland restoration in bog woodland habitat as changes in water levels can affect regeneration of the woodland. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The effects of run off reduction actions on food provision are likely to be mixed. The actions may enhance the productivity of cultivated land and semi natural grassland by protecting soils from erosion and loss of nutrients, and through providing a more diverse habitat for pollinators and biological control of pests and disease. However, some areas of productive land may be lost and there is potential to increase the prevalence of some livestock pests.

By protecting water quality and reducing sedimentation, freshwater fisheries such as salmon and sea trout, are likely to benefit. These effects may also help improve and maintain drinking water supply.

Run off reduction actions help to regulate river flows by reducing peaks of extreme high or low flows: overall this effect is considered negligible on hydroelectricity generation.

Cultural services
There are likely to be significant positive effects from run off reduction actions on recreation and wildlife watching due to improved habitat diversity, which also increases the diversity of the landscape. These increase opportunities for recreation especially in upland heath ecosystem.

The historic environment has potential to benefit from these actions: firstly, through the reduction of flood risk to historic buildings and, secondly through the protection of wetland archaeology as a result of creating and restoring wetlands. Woodland planting, however, can disturb buried archaeology. The structure and setting of historic sites could be affected but this will need to be assessed at more detailed levels of flood risk management planning.

A12.4.3 River and floodplain restoration actions

Actions to restore river and floodplains include floodplain reconnection, riparian and floodplain woodland creation, large woody debris/boulders, and washland creation. Sediment management actions such as bank restoration are also included in this assessment. These types of actions are being considered throughout the LPD (in seven PVAs in the Tay catchment and two PVAs in the Earn catchment).

All SEA topics and a wide range of ecosystems may be affected: upland heath, woodlands, cultivated land, semi-natural grassland, wetlands, freshwater rivers and lochs and urban areas. The potential effects of the actions are described in the text below and summarised by SEA topic in table A12.4.

Table A12.4 River and floodplain restoration: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	+ + Benefits to connectivity and health of freshwater and wetland biodiversity. + + Improved habitat diversity in cultivated land and grassland ecosystems.	Floodplain and riparian woodland creation may positively contribute to the Tay Forest habitat network plans. Opportunity to significantly improve habitat connectivity and biodiversity by taking forward actions in cultivated land. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health + + Benefits from protecting and improving drinking water quality	There is an opportunity to reduce drinking water treatment costs with improved water quality. Feasibility studies should consider medium and long duration effects on recreation, such as changes to river flow. Design studies should consider short duration effects on quality and access to recreation.
Soil	+ + Benefits to safeguarding and increasing extent of carbon rich soils	Feasibility and design stages should consider potential loss of productive soils, particularly cultivated land. Consultation with land managers recommended at both stages.

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Water	+ + Benefits by enhancing water quality and reducing sedimentation and erosion	In addition to regulating flows, significant opportunity to address diffuse pollution pressures (erosion protection, reduced nutrient input and sedimentation) on the water environment by targeting river/floodplain restoration actions, particularly in cultivated land, grasslands and upland habitats.
Climatic factors	+ + Benefits to carbon storage through floodplain reconnection, washland and woodland creation	Opportunity to improve carbon storage through wetland and woodland creation actions.
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	uncertain	
Landscape	+ + Benefits to landscape diversity	Opportunity to improve landscape diversity especially in cultivated land and grassland habitats.

Commentary on potential significant effects

Regulating and maintaining services
River and floodplain restoration actions slow down in-channel flow by increasing the sinuosity of the river and help reconnect the river with the floodplain, increasing the amount of water stored on land. Floodplain planting can also slow down the flow of run off and increase the permeability of soils, while river bank restoration can reduce bank erosion and sediment deposition in the river. The effect of all of these actions is to help regulate the flow of water by slowing and/or reducing flood flows: this helps to protect people and properties from flooding.

The restoration and creation of habitat (woodlands, washlands, woody debris etc) within the river and floodplain, and reduced erosion of the river bed and banks can help to filter nutrients and reduce sediments. Wetland vegetation (in this case, vegetation on the floodplain) is particularly effective at storing nutrients. Given the diffuse pollution pressures in this LPD, restoration actions have the potential to lead to significant benefits for water quality as well as water flow regulation.

Other potential positive effects include improvements to pollination (as pollinating insects may benefit from greater food and shelter in a more diverse habitat), local climate regulation (through improved wetland condition) and disease and biological control.

The creation or restoration of woodlands and wetlands (floodplains) also has the potential to increase the capture and storage of carbon, although the net benefit may be less where floodplain restoration requires the removal of trees. As stated above, although wetlands have the potential to release carbon dioxide into the atmosphere, the net benefit to carbon storage is more likely to be positive when restoring this ecosystem.

Water quality, flow regulation and erosion protection improvements may help to maintain and improve condition of aquatic designated sites such as the River Tay SAC. Protected wetlands are also likely to benefit. Floodplain and riparian woodland creation may benefit native woodland protected sites and will positively contribute to the Tay Forest habitat network plans, which specifically mention need to improve connectivity of woodlands along river corridors. Restoration works, however, could lead to short duration increases in sediment load and could disturb or remove habitat: therefore the timing and mechanism of any in-river or bank works should be considered to avoid or minimise any negative effects. However, it is difficult to assess these effects at the strategic level: the effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The potential effects of river and floodplain restoration actions on food provision are likely to be mixed. As with run off reduction actions, these actions may enhance the productivity of cultivated land and semi natural grassland by protecting soils from erosion and loss of nutrient, increasing shelter for livestock and improvements to pollination. There may, however, be some loss of cultivated land and semi natural grassland. This impact is widespread across all PVAs proposed for these actions (except PVAs 08/14 and 08/03) as cultivated land and grasslands are dominant ecosystems.

Reducing diffuse pollution and sedimentation and improving water quality may result in a significant positive benefit to freshwater fisheries.

These actions may have a positive effect on drinking water as restoration actions will help to protect water quality, and may help stabilise supply throughout the year.

The potential effects on provision of biotic materials are mixed. Potential loss of cultivated land reduces opportunities for producing biofuels, however, the creation of woodland may provide timber.

Cultural services
Floodplain and river restoration actions are likely to improve landscape diversity and interest. The potential effects on recreation and wildlife watching are generally likely to be positive as the actions should improve habitat diversity and biodiversity. However, changes to the bed and banks of rivers may affect quality and access for kayaking and angling. Installing / implementing actions may also impede access to the river and its banks for recreation although these effects would be of short duration.

The historic environment has potential to benefit from these actions: firstly, through the reduction of flood risk to historic buildings and, secondly through the protection of wetland archaeology as a result of creating and restoring wetlands. Woodland planting, however, can disturb buried archaeology. The structure and setting of historic sites could be affected but this will need to be assessed at more detailed levels of flood risk management planning.

A12.4.4 Storage, conveyance and control

These actions include storage actions (on and offline flood storage), conveyance actions (channel modifications, removal of hydraulic constrictions, addition or removal of culverts weirs, bridges, pumping stations) and control actions (sluice gates, weir). Flood storage actions are being considered for four PVAs in the Tay catchment, and one PVA in the Earn catchment. Conveyance actions are being considered for seven PVAs in the Tay; control actions are shortlisted for one PVA. With the exception of PVA 08/14, these are located in the middle to lower reaches of the Tay catchment.

Whilst actions can be located in all ecosystems, the dominant land types likely to be affected by these actions are grassland, cultivated land and native woodland. All SEA topics could be affected.

The effects are dependent on the type of defence (for example, defences that are set back from the river are likely to have a smaller impact) and the degree to which the river banks have already been modified: however, the type and location of defences are not known at this strategic level of planning. The potential effects of the actions are described in the text below and summarised by SEA topic in table A12.5.

Table A12.5 Storage, conveyance and control: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	- - Loss or damage to floodplain, riparian habitat and wetlands, leading to reduced habitat connectivity and biodiversity - - Negative effects on freshwater fish, wet woodlands, habitat connectivity	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or damage to wetlands, riparian woodlands, disturbance of sediment, or barriers to fish passage. Opportunities to help maintain or improve ecosystem connectivity and resilience should be examined. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH, Fisheries Trusts) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies should consider medium and long duration effects on recreation, such as changes to river flow. Design studies should consider short duration effects on quality and access to recreation. Discussion with stakeholders recommended at both stages.
Soil	- - Disconnection of floodplain, loss or damage to carbon rich soils found in wetlands and riparian woodlands - - Erosion of carbon rich soils downstream of the structure	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or damage to wetlands, and riparian woodlands. Feasibility and design stages should consider potential loss of productive soils, particularly cultivated land. Consultation with land managers required.
Water	- - Loss of river habitats and changes to channel morphology could affect the status of rivers. + + Removal of existing structures could improve the status of rivers	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or damage to rivers especially those already less than good status due to habitat loss, disturbance of sediment or barriers to fish passage.
Climatic factors	- - Reduction in carbon sequestration due to loss or damage to wetlands	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or damage to wetlands.
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	Feasibility and design stages should include consultation with communities and SNH to avoid or minimise negative effects on landscape.

Commentary on potential significant effects

Regulating and maintaining services
Storage, conveyance and control actions are engineered actions that alter the storage and flow of water. These actions can deliver positive effects through regulating the flow of water and thus reducing flood risk to people and property.

These actions can lead to disruption to natural processes and loss of habitat. These may have a significant negative effect on water quality and carbon storage, particularly impacting on grassland,

native woodland and freshwater ecosystems. However, removal of structures can also restore habitats to a more natural state and improve water quality so overall effects of these actions on water quality are mixed.

The impacts on erosion control are considered mixed as the land immediately adjacent to the structure is likely to benefit from flood protection but erosion may be exacerbated downstream of the structure. Increased erosion can increase sediment and nutrient load of water, with potentially significant negative effects on protected species such as salmon and lamprey.

The effects on protected sites are dependent on the location and design of the action and will be assessed through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning. Any negative impacts on water quality, carbon storage and erosion control need to be considered in terms of the likely impact on condition of designated sites, both aquatic designated sites, and condition of terrestrial ecosystems particularly grasslands and native woodlands. Any loss or damage to riparian vegetation may have locally noticeable effects such as reduction in local climate regulation, pollination and pest and disease control.

Provisioning services
The effects on terrestrial food provision and production of biofuels are mixed: the actions may help to reduce flooding to some areas of cultivated land or semi natural grassland but other areas may suffer increased flooding (or erosion). These effects could lead to longer duration change in land use. Effects are dependent on both the type of action and its location.

Freshwater fisheries may suffer negative effects through loss of habitat and increased sedimentation. However, there are potential benefits to salmon as the modification or removal of existing structures may improve passage to fish.

Implications for hydroelectricity are likely to be minor, but depend on the type of action proposed and need to be assessed at more detailed levels of flood risk management planning.

Cultural services
Storage, conveyance and control actions have potentially negative effects on cultural services. Loss of natural habitat and river processes would have a negative effect on biodiversity, reducing opportunities to watch wildlife and interact with nature, and impacting on recreation such as angling. Changes to patterns of river flow can also affect sports such as kayaking. However, access for some activities could be improved with sensitive scheme design.

Loss of habitat and reduced landscape value arising from these actions may impact on land designated for landscape/scenic value and wild land, especially those in PVAs 08/03 and 08/14. In urban areas, storage, conveyance and control actions may have potentially negative effects by affecting the views of rivers.

The historic environment may benefit through a reduction in flood risk, but there is also potential for negative effects: the disconnection of the floodplain could damage wetlands and the archaeology preserved within it. The historic environment may be negatively affected altering the setting of historic sites or through damage to sites when the action is implemented. Further assessment is required at more detailed levels of flood risk management planning.

A12.4.5 River defences

River defences may include walls, embankments or demountable/ temporary defences. These defences are being considered in eight PVAs that are located throughout the LPD.

The actions are most likely to be located in or adjacent to rivers (freshwater lochs and rivers ecosystem) or set back from the river in the urban environment (urban ecosystem). All SEA topics could be affected. The potential effects of the actions are described in the text below and summarised by SEA topic in table A12.6.

Table A12.6 River defences: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	- - Negative effects on freshwater fish and habitat through increased sediment load - - Loss or damage to riparian/flood plain habitat, leading to reduced habitat connectivity and biodiversity	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or disturbance of sediment. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies should consider medium and long duration effects on recreation, such as changes to river flow. Design studies should consider short duration effects on quality and access to recreation. Discussion with stakeholders recommended at both stages.
Soil	No significant effects	
Water	- - Loss of river habitats and changes to channel morphology could affect the status of rivers	Feasibility studies should consider how to avoid or minimise potential negative effects on water quality and river habitat, including nutrient inputs, sedimentation and direct loss or damage to river habitats.
Climatic factors	- - Loss of floodplain habitat especially woodlands/wetlands which act as a carbon store	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or damage to floodplain wetlands.
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	Uncertain	Feasibility and design stages should include consultation with communities to avoid or minimise negative effects on urban landscape.

Commentary on potential significant effects

Regulating and maintaining services
River defences can deliver benefits by regulating water flow, reducing erosion at the site of the structure and reducing flood risk. The actions, however, can interfere with natural process: the defences can cause some or all of the floodplain to be disconnected from the river, which can lead to loss of natural habitat to capture, filter and recycle nutrients or pollutants. This can lead to a reduction in water quality and a loss of carbon storage. Erosion may also increase upstream or downstream of a defence due to changes in river processes. Any potential reduction in water quality is considered to be significant in the Tay LPD as much of the LPD is already under pressure from diffuse pollution.

A potential decline in water quality and increase in sediment load can also have negative effects on freshwater species and fisheries. The type and location of each defence is not currently known. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
River defences have potential negative effects on freshwater food production due to the loss of in-river and riparian habitat. However, this is dependent on the type of defence (for example, defences that are set back from the river are likely to have a smaller impact) and the degree to which the river banks have already been modified.

Cultural services
River defences may have mixed effects on recreation and opportunities to access nature and experience wildlife. Loss of natural habitat and biodiversity and changes to river flow can reduce the quality of the environment for recreation and wildlife watching. However, depending on their design, some defences can improve access for some types of recreation.

Within the urban landscape, river defences have potentially negative effects through disrupting the setting and view of the river and floodplain.

Historic buildings and monuments may benefit through reduced flood risk, but the defences may alter the setting of the site. Historic sites may also be affected, either for a short or long duration, by construction of the defences; however, this cannot be assessed at this level of planning as more information is required about the precise nature and location of the defences.

Table A12.7 Shortlisted actions for the Tay LPD: Summary of potential effects on ecosystem services

Source of flooding	All		River			
Ecosystem service	Non-structural actions		Run off reduction	River and floodplain restoration	Storage, conveyance, control	River defences
Carbon storage	**0**		**+ +**	**+ +**	**- -**	**- -**
Local climate regulation	**0**		**0**	**+**	**-**	**0**
Water quality regulation	**0**		**+ +**	**+ +**	**+/-**	**- -**
Pollination	**0**		**+**	**+**	**-**	**0**
Biological control of pests and disease	**0**		**0**	**+**	**-**	**0**
Wave/ surge attenuation	**0**		N/A	N/A	N/A	N/A
Water flow regulation	**0**		**+ +**	**+ +**	**+ +**	**+ +**
Erosion protection	**0**		**+ +**	**+ +**	**+/-**	**+/-**
Nutrition: food provision	**0**		**+/-**	**+/-**	**+/-**	**-**
Drinking water supply	**0**		**+**	**+**	**0**	**0**
Biotic materials: timber, biofuels	**0**		**+/-**	**+/-**	**+/-**	**0**
Recreation (physical interaction)	**0**		**+**	**+/-**	**+/-**	**+/-**
Accessible nature/wildlife experience	**0**		**+**	**+**	**-**	**+/-**
Spiritual and cultural amenity (landscape)	**0**		**+**	**+ +**	**-**	**-**

KEY					
	+ +	**Significant positive** Effects are widespread across the LPD; and/or Effects are likely to improve an ecosystem that is in less than good condition	**-**	**Negative** A noticeable negative effect that does not meet the description below
	+	**Positive** A noticeable positive effect that does not meet the description above	**- -**	**Significant negative** Effects are widespread across the LPD; and/or Effects are likely to cause an adverse effect on an ecosystem that is in less than good condition
	0	**No or negligible effects**	**+/-**	**Mixed:** The effect is likely to be a combination of positive and negative effects, particularly where effects are considered on sub-issues, areas or criteria

Map acknowledgments

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including *inter alia*, the following organisations:

Ordnance Survey
Flood maps are based upon Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office © Crown Copyright. Any unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. SEPA Licence number 100016991 (2015).

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology © NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2015), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright © The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC.

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

Appendix 13: Environmental assessment of the Flood Risk Management Strategy for the Forth

This appendix presents the current state of the environment and the assessment of significant environmental effects for the Flood Risk Management Strategy for the Forth Local Plan District (LPD). The purpose of this is to:

- Identify relevant information on the current state of the environment for the Forth. This information supplements the description of the current state of Scotland's environment (section 3 of the main Environmental Report).
- Report the significant environmental effects of the actions proposed to manage flood risk in the Forth.
- Identify mitigation of significant negative effects and opportunities to deliver wider benefits.
- Recommend further assessment at more detailed planning stages e.g. feasibility studies or design stages.

The overall assessment for all 14 Flood Risk Management Strategies is summarised in section 5 of the main Environmental Report.

A13.1 The Forth Local Plan District

The Forth LPD (figure A13) has an area of 1,609km^2 with a population of approximately 130,000. It includes Stirling, Alloa, Bridge of Allan, Dunblane, Alva, Menstrie and Tillicoultry. The main urban areas are centred around the inner Firth of Forth in the east of the Local Plan District, while further inland the catchment is more rural in nature.

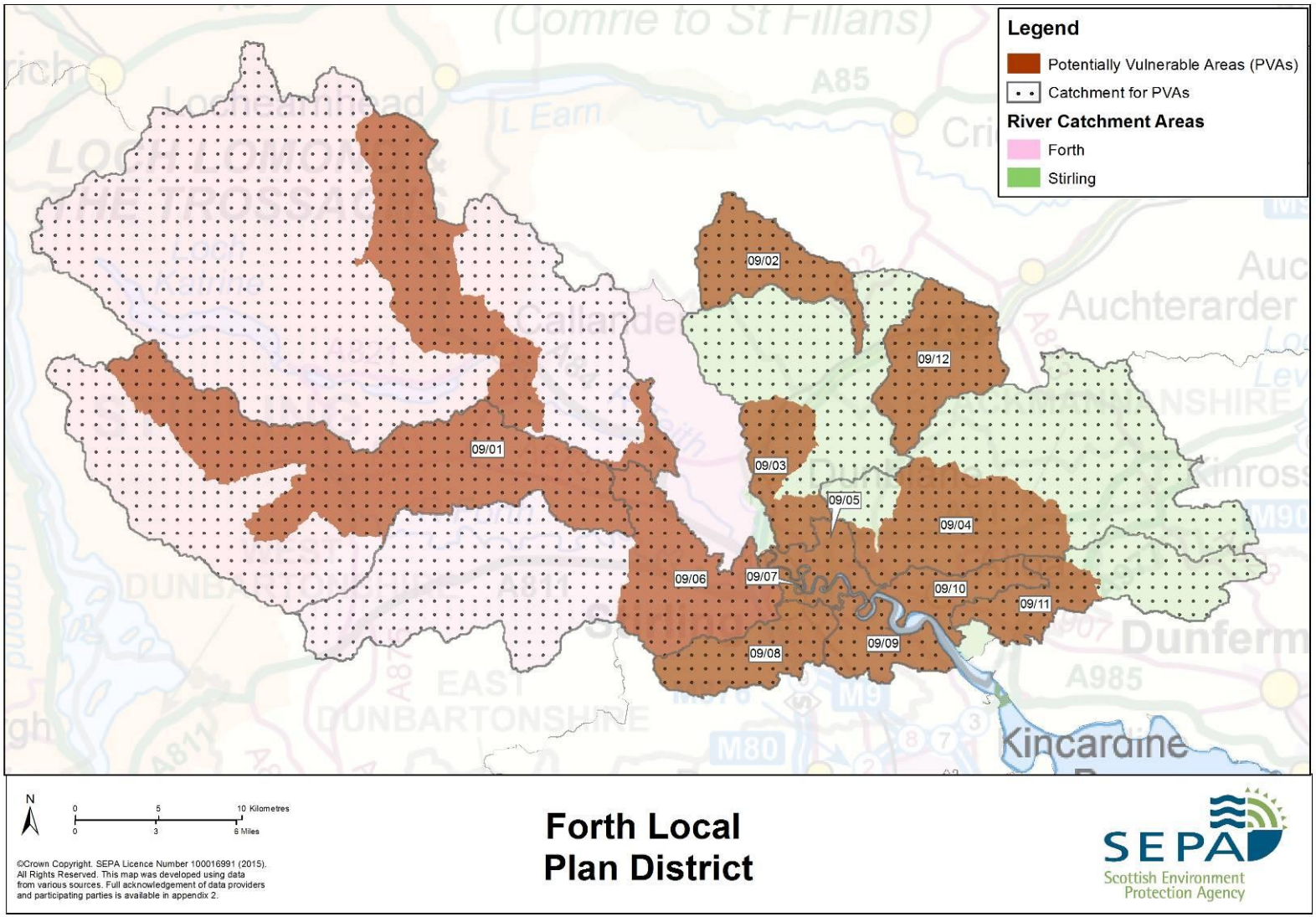
The largest river catchment is the River Forth along with its tributary the River Teith. Other watercourses include the River Devon and Allan Water. The largest lochs include Loch Katrine, Loch Lubnaig and Loch Venachar, all located in the catchment of the River Teith. The Forth Local Plan District includes a 74km stretch of coastline in the inner Firth of Forth where the River Forth, River Devon and Allan Water meet the Firth of Forth.

The main source of flooding in the LPD is river flooding (62% of Annual Average Damages[1]), followed by surface water flooding (35% of Annual Average Damages) with the remaining damages caused by coastal flooding (3% of Annual Average Damages). There are eleven Potentially Vulnerable Areas (PVAs) and one candidate PVA (09/12c).

A range of non-structural and structural actions are being considered to manage flooding in this LPD. Structural actions are being considered to manage river flooding in seven PVAs. No structural actions are being considered to manage coastal flood risk (table A13.1).

[1] An indicative estimate of the direct economic costs of flooding impacts to residential properties, non-residential properties and agriculture

Figure A13: Forth LPD and PVAs[2]



[2] Including candidate PVAs

Table A13.1 Shortlisted actions in the Forth LPD

Action	PVAs											
	09/01	09/02	09/03	09/04	09/05	09/06	09/07	09/08	09/09	09/10	09/11	09/12c
Run off reduction	●			●	●	●	●			●		●
River and floodplain restoration	●		●	●	●	●	●			●		●
Storage conveyance and control	●			●	●		●					●
River defences	●		●	●	●		●			●		●

A13.2 Environmental and policy context for the Forth LPD

Section 2.2 and Appendix 3 of the main Environmental Report identify the relationships between the Flood Risk Management Strategies and other plans, programmes and strategies.

A13.3 Additional relevant information on the current state of the environment for the Forth LPD

This sub section identifies relevant information on the current state of the environment for the Forth LPD. This information supplements the description of the current state of Scotland's environment (section 3 of the main Environmental Report).

A13.3.1 Ecosystems and condition

The predominant ecosystems in the Forth LPD are semi natural grassland and cultivated land, which cover 28% and 25% of the LPD area respectively. There are also large areas upland heath and conifer plantation, both of which cover 16% of land. There are smaller areas of native woodland, wetlands and urban ecosystems. The freshwater ecosystem includes rivers and lochs and covers approximately 2% of the LPD. The coastal and marine ecosystem in the estuarine area includes saltmarsh and mudflats.

Table A13.2 lists the extent of different ecosystems within the Forth LPD, and provides an assessment of ecosystem condition.

Table A13.2 Ecosystems within the LPD

Ecosystem	Area (% of LPD in 2007)	Condition of ecosystem
Woodland - native	5	In many protected sites, woodland features are in unfavourable condition. However, expansion and regeneration of native woodlands is a rural priority in this area. Nationally, the Native woodland survey in 2013 found that 46% of native woodlands were in good condition.
Woodland - conifer plantation	16	There are large areas of plantation in the upper catchments, particularly the Loch Ard Forest, Achray Forest and Strathyre Forest. Forestry can impact on water quality (e.g. the Duchray Water (upstream of PVA 09/01) and Lake of Menteith SSSI (PVAs 09/01 and 09/06). The condition of forestry otherwise in this LPD is unknown.
Cultivated land	25	There are some rural diffuse pollution pressures in this LPD, with agriculture being a contributing factor (although there are no diffuse pollution priority catchments). This indicates that there is potential degradation and erosion of soils.
Semi-natural grassland	28	There are very few protected grassland features in this LPD so there is no local information on condition. Nationally, outside of SSSIs, 41% of species rich lowland grassland is in favourable condition.
Wetlands (fen, marsh, and swamp; bog)	4	There are a number of relatively large wetland areas in this LPD. The condition of wetlands in protected sites is mixed. Pressures include scrub encroachment and build up of vegetative litter. Opportunities include drain blocking and maintaining water levels.
Upland heath	16	Some upland heath features in protected sites are in unfavourable condition. Pressures are often related to grazing.
Freshwater lochs and rivers	2	Rivers and lochs are in mixed condition. Of 11 WFD loch water bodies, 73% are at less than good overall status. Of 56 WFD river water bodies, 16% are at less than good status for water quality and 11% at less than good status for condition of beds and banks. Freshwater features in protected sites are in mixed condition. There are some water quality pressures in this LPD, including pressures from agriculture, forestry, fish farming and habitat loss.
Coastal & marine	<0.5*	There is one WFD coastal/transitional water body which is at less than good status for the condition of its coastline. Estuarine habitats (reed beds, saltmarsh, saline lagoons) are generally in good condition. Pressures include water quality (particularly from industry and agriculture), habitat loss and coastal squeeze.
Urban	2	Over two thirds (68%) of adults in Scotland have access to useable greenspace within a five-minute walk from their home (not including their own garden).

*The coastal and marine ecosystem extends beyond the terrestrial LPD boundary so is not captured in this figure

There are 5 Special Areas of Conservation (SACs), 2 Special Protected Areas (SPAs) and 54 Sites of Special Scientific Interest (SSSIs). Some of the larger sites described below.

- Protected woodland features are found in a number of designated sites, for example, the Trossachs Woods SAC (PVAs 09/06 and 09/01) contains oak woodland in unfavourable condition. Pressures are related to woodland management e.g. presence of non native species. The site is part of the Great Trossachs Forest, which contains some of the finest remaining upland wood pasture in the UK and is part of a significant regeneration project.

- There are a number of protected sites that include wetland features. Of particular note are Flanders Moss SAC and SSSI (PVAs 09/01 and 09/06): these sites contain one of the largest lowland raised bogs in Britain and one of the most intact bogs in Europe. The bog features are in unfavourable condition; pressures include encroachment by trees and shrubs. There are opportunities to help restore the bogs by increasing the water table, for example, by blocking ditches. Shelforkie Moss SAC (PVAs 09/03 and 09/12c) contains bog features in mixed condition.

- Ben More - Stob Binnein SSSI (PVA 09/01) and Ben Lomond SSSI (PVA 09/06) contain upland heath features which are in unfavourable condition. Pressures are largely related to grazing.

- River Teith SAC flows through a number of PVAs (PVAs 09/01, 09/05, 09/06, 09/07). It is designated for three lamprey species (all at favourable condition) and Atlantic salmon (unfavourable recovering).

- The Lake of Monteith SSSI (PVAs 09/01 and 09/06) contains a mesotrophic loch that is in unfavourable declining condition with water quality pressures from forestry, fish farming and agriculture.

- The Firth of Forth SSSI (PVAs 09/09 and 09/10) is designated, amongst other features, for saltmarsh, transition grasslands (reedbeds) and saline lagoons. Saltmarsh is thought to be in mainly in favourable condition (despite the outcomes of the most recent site monitoring survey). The transition grasslands and saline lagoons are in favourable condition. The habitats support a large number of non-breeding birds, which are designated as part of the SSSI and also as part of the Firth of Forth SPA. Pressures on the site include culvert operations (which affect fresh/saline water ingress/egress), loss of intertidal area, coastal squeeze, pollution (largely from farming and industry) and disturbance to birds.

A13.3.2 Ecosystem services

This sub section summarises the major ecosystem services in the Forth LPD.

Regulating and maintaining services

- Carbon storage and sequestration is provided by woodlands and wetlands. Carbon rich soils are found in the upper catchments in the north and the west of the LPD.
- The large areas of wetlands, semi natural grassland and upland heath help to filter and maintain good water quality. These three ecosystems and native woodland ecosystems also help to regulate the flow of water.
- The coastal ecosystems are estuarine: reedbeds, saltmarsh and saline lagoons. Most of the coastline has a low susceptibility to erosion, although the coastline around Dunmore and the mouth of the Black Devon River is more susceptible to coastal erosion. Structures that reduce the risk of erosion may be found along the coastline.

Provisioning services

- Agricultural production is predominantly beef cattle and cereal crops (in the lowlands) and hill-sheep farming (in the uplands). Production of soft fruit and vegetables is limited.
- Relatively small numbers of salmon and sea trout are caught and retained in this LPD.

There are a small number of fish farms / hatcheries in the freshwater ecosystem.
- There are number of large-scale commercial forestry plantations located largely around the upland areas of Stirling and towards the western part of Clackmannanshire.
- Hydroelectricity production, including small-scale micro generation schemes, is important in a number of river stretches including the River Teith.
- Water resources are important within this catchment with the lochs and reservoirs serving important functions in the supply of drinking water (e.g. Loch Katrine plays a vital role in providing supply for Glasgow). Rivers and lochs upstream and within of PVAs 09/01 and 09/04, and upstream of 09/06 are designated as Drinking Water Protected Areas

Cultural services
- The area provides a wide range of recreational opportunities, including angling, kayaking, walking, running, sailing, and swimming. It provides habitat for iconic wildlife, and bird watching is important to this area. There is one National Nature Reserve (Flanders Moss; upstream of 09/06).
- There are protected landscapes in form of the Trossachs and Loch Lomond National Scenic Area (upstream of PVA 09/01). The Loch Lomond and Trossachs National Park overlaps with much of PVA 09/01 and its catchment.
- There is an area of wild land (Ben More- Ben Ledi) in PVA 09/01 and its catchment. Areas of wild land have a distinct and special character, which is increasingly rare to find. Many people derive psychological and spiritual benefits from their existence, and they provide increasingly important havens for Scotland's wildlife.
- The area is rich in historic sites, including scheduled monuments, battlefields, listed buildings, and some gardens and designed landscapes.

A13.4 Environmental assessment of the Flood Risk Management Strategy for the Forth LPD

This sub section provides an assessment of the potential environmental effects of the flood risk management actions under consideration for the PVAs within this LPD. The effects on SEA topics and on ecosystem services are reported under each group of actions. Table A13.7 compares the effects of different groups of actions on ecosystem services.

A13.4.1 Non-structural actions

A range of non-structural actions are being considered for the LPD such as property level protection, relocation of properties / infrastructure away from flood risk areas and flood warning schemes. These actions help to reduce the impacts of flooding and therefore are likely to have significant positive effects on the SEA objectives for human health and material assets. These effects have been assessed nationally rather than at an LPD level and the results are presented in section 4 of the main Environmental Report.

As these actions help to reduce the impacts of flooding rather than the probability of flooding, they are likely to have no or negligible effects on ecosystems and ecosystem services.

A13.4.2 Run off reduction actions

Actions to reduce run off include woodland and gully woodland planting, upland drain blocking, land management, creation or restoration of wetlands and ponds, and shelter belts. These actions are being considered for seven PVAs.

All SEA topics and ecosystems may be affected by these actions: either directly (where an action impacts on the ecosystem in which the action is located) or indirectly (e.g. where the freshwater ecosystem benefits from arising land use change and management). The potential effects of the actions are described in the text below and summarised by SEA topic in table A13.3.

Table A13.3 Run off reduction: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	+ + Benefits to connectivity and health of wetland and native woodland ecosystems + + Benefits to salmon through improved water quality	Feasibility studies should consider opportunities to contribute to other drivers for restoration of wetlands and native woodlands, and improvements to salmonid populations. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH, Forestry Commission, National Park Authority) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	
Soil	+ + Benefits to safeguarding carbon rich soils (wetlands)	Design stages should consider protecting livestock from potential exposure to pests. Consultation with land managers recommended.
Water	+ + Benefits by enhancing water quality and reducing sedimentation	Actions should be coordinated with any morphology or diffuse pollution priority catchments proposed in the second river basin management plans.
Climatic factors	+ + Benefits to carbon storage through wetland enhancement	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	Consultation with relevant organisations (e.g. SNH, National Park Authority) recommended as part of any further studies.

Commentary on potential significant effects

Regulating and maintaining services
Run off reduction actions help to slow and store water by intercepting rainfall (e.g. woodlands) and/or increasing the extent to which the land can hold any water reaching the ground (both by slowing down the flow of run off and increasing the permeability of soils). This in turn can help to regulate the flow of water by reducing the amount of water reaching rivers and slowing or reducing flood flows: this helps to protect people and properties from flooding.

These actions can lead to improvements in water quality by helping to protect soils from erosion (thus reducing the sediment reaching rivers) and increasing infiltration of nutrients into soils. Of particular note are potential significant benefits to these services where actions are located in cultivated land or conifer forestry plantations (due to diffuse pollution pressures in this LPD) and in wetlands (where actions may help to restore and creation of wetlands).

The creation or restoration of woodlands and wetlands (including peatlands through upland drain blocking) has the potential to increase the capture and storage of carbon. In wetlands, the benefits may be significant as they are likely to improve the current condition and capacity to store carbon. (Although wetlands also have the potential to release carbon dioxide into the atmosphere, the net benefit to carbon storage is more likely to be positive when restoring wetlands.)

Increased habitat diversity and connectivity can provide benefits to pollination and biological

control of pests and diseases. However, an increase in the wetness of cultivated land and semi-natural grassland ecosystems may increase the prevalence of some livestock pests.

Water quality improvements and erosion protection may have potentially significant benefits to protected freshwater ecosystem sites/features that are in unfavourable condition e.g. salmon in the River Teith SAC (PVAs 09/01, 09/05, 09/06, 09/07); the mesotrophic loch in the Lake of Menteith SSSI (PVAs 09/01 and 09/06). Protected bog features may benefit through maintaining or increasing water levels e.g. Flanders Moss SAC / SSSI (PVAs 09/01 and 09/06) and Shelforkie Moss SAC (PVAs 09/12c). The Firth of Forth SSSI may also benefit as actions may help to reduce diffuse pollution which is a pressure on this site. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The potential effects of run off reduction actions on food provision are mixed. The actions may enhance the productivity of cultivated land and semi natural grassland by protecting soils from erosion and loss of nutrients (and, as identified above, through providing a more diverse habitat for pollinators and biological control of pests and disease). However, some areas of productive land may be lost and there is potential to increase the prevalence of some livestock pests.

The potential effects on timber production are also mixed. Actions that block drains or create wetlands within conifer plantations may lead to loss of timber productivity. However, woodland creation may provide a small local supply of timber.

Cultural services
The effects on recreation, wildlife watching and landscape are likely to be positive, as the actions should improve habitat diversity and biodiversity. In particular, actions that create or help to restore native woodland can help to improve habitat connectivity and contribute to native woodland regeneration priorities in this LPD.

Protected landscapes and wild land are unlikely to be adversely affected by these actions.

The historic environment has potential to benefit from these actions: firstly, through the reduction of flood risk to historic buildings and, secondly through the protection of wetland archaeology as a result of creating and restoring wetlands. Woodland planting, however, can disturb buried archaeology. The structure and setting of historic sites could be affected but this will need to be assessed at more detailed levels of flood risk management planning.

A13.4.3 River and floodplain restoration actions

Actions to restore river and floodplains include woodland creation, reach restoration, large woody debris / boulders and creation of washlands. Sediment management actions such as bank restoration and management of channel instabilities are also included in this assessment. Actions are being considered for 8 PVAs.

All SEA topics and a wide range of ecosystems may be affected: woodlands, cultivated land and semi natural grassland, wetlands, freshwater rivers and lochs and urban. The potential effects of the actions are described in the text below and summarised by SEA topic in table A13.4.

Table A13.4 River and floodplain restoration: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	+ + Benefits to connectivity and health of wetland ecosystems + + Benefits to salmon through improved water quality	Feasibility studies should consider opportunities to contribute to other drivers for restoration of wetlands and native woodlands, and improvements to salmonid populations. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies should consider medium and long duration effects on recreation, such as changes to river flow. Design studies should consider short duration effects on quality and access to recreation. Discussion with stakeholders recommended at both stages.
Soil	+ + Benefits to safeguarding carbon rich soils	Feasibility and design stages should consider potential loss of productive soils, particularly cultivated land. Consultation with land managers recommended.
Water	+ + Benefits by enhancing water quality and reducing sedimentation	Actions should be coordinated with any morphology or diffuse pollution priority catchments proposed in the second river basin management plans.
Climatic factors	+ + Benefits to carbon storage through wetland enhancement. However, any loss of woodland could reduce these benefits	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	Consultation with relevant organisations (e.g. SNH, National Park Authority) recommended as part of any further studies.

Commentary on potential significant effects

Regulating and maintaining services
River and floodplain restoration actions slow down in-channel flow by increasing the sinuosity of the river and help reconnect the river with the floodplain, increasing the amount of water stored on land. Floodplain planting can also slow down the flow of run off and increase the permeability of soils, while river bank restoration can reduce bank erosion and sediment deposition in the river. The effect of all of these actions is to help regulate the flow of water by slowing and/or reducing flood flows: this helps to protect people and properties from flooding.

The restoration and creation of habitat (woodlands, washlands, woody debris etc) within the river and floodplain, and reduced erosion of the river bed and banks can help to filter nutrients and reduce sediments. Wetland vegetation (in this case, vegetation on the floodplain) is particularly effective at storing nutrients. The water quality may significantly benefit where actions are located in ecosystems that are potential sources of rural diffuse pollution (for example, cultivated land and conifer plantations) and also where restoration reconnects and enhances connectivity between the river and floodplain wetlands (as wetlands ecosystem may be in less than good condition).

The creation or restoration of woodlands and wetlands (floodplains) also has the potential to increase the capture and storage of carbon. If floodplain restoration requires the removal of trees, the effects on carbon storage could be negative. Therefore, the net effects may be positive or negative.

Other potential positive effects include improvements to pollination (as pollinating insects may benefit from greater food and shelter in a more diverse habitat).

Water quality improvements and erosion protection may have potentially significant benefits to protected freshwater ecosystem sites/features that are in unfavourable condition e.g. salmon in the River Teith SAC (PVAs 09/01, 09/05, 09/06, 09/07); the mesotrophic loch in the Lake of Menteith SSSI (PVAs 09/01 and 09/06). Protected bog features may benefit through maintaining or increasing water levels e.g. Flanders Moss SAC / SSSI (PVAs 09/01 and 09/06). The Firth of Forth SSSI may also benefit as actions may help to reduce diffuse pollution which is a pressure on this site. However, restoration works could lead to short duration increases in sediment load and could disturb breeding birds or spawning fish, therefore the timing and implementation of actions needs to be carefully planned. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The potential effects on food provision are mixed: the actions may lead to the loss of cultivated land and semi natural grassland, although there are some potential benefits in semi-natural grassland through increased shelter for livestock.

Restoration actions may provide benefits to drinking water supply by helping to remove nutrients and pollutants.

The potential effects on provision of biotic materials are also mixed. Potential loss of cultivated land reduces opportunities for producing biofuels, however the creation of woodland may provide timber.

Cultural services
The potential effects on recreation, wildlife watching and landscape are positive, as the actions should improve habitat diversity and biodiversity. In particular, actions that create or help to restore native woodland can help to improve habitat connectivity and contribute to native woodland regeneration priorities in this LPD. However, changes to the bed and banks of rivers may affect quality and access of kayaking or angling. Installing / implementing actions may also impede access to the river and its banks for recreation although these effects would be of short duration.

Protected landscapes and wild land are unlikely to be adversely affected by these actions.

The historic environment has potential to benefit from these actions: firstly, through the reduction of flood risk to historic buildings and, secondly through the protection of wetland archaeology as a result of creating and restoring wetlands. Woodland planting, however, can disturb buried archaeology. The structure and setting of historic sites could be affected but this will need to be assessed at more detailed levels of flood risk management planning.

A13.4.4 Storage conveyance and control

Storage, conveyance and control actions include online and offline flood storage, addition or removal of control structure (e.g. weirs, sluice gates or flap values), and managing conveyance of water (e.g. adding or removing culverts or other hydraulic constrictions, altering bridges). Online/ offline storage is being considered for four PVAs; addition or removal of control structures is being consider for one PVA and managing conveyance is being considered for one PVA.

The actions could be located in most ecosystems, except upland heath and coastal and marine ecosystems. All SEA topics could be affected. The potential effects of the actions are described in the text below and summarised by SEA topic in table A13.5.

Table A13.5 Storage, conveyance and control: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	- - Loss or damage to wetlands, leading to reduced habitat connectivity and biodiversity - - Negative effects on salmon through increased sediment load	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or damage to wetlands, disturbance of sediment, or barriers to fish passage. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH, Fisheries Trusts) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies should consider medium and long duration effects on recreation, such as changes to river flow. Design studies should consider short duration effects on quality and access to recreation. Discussion with stakeholders recommended at both stages.
Soil	No significant effects	Feasibility and design stages should consider potential loss of productive soils, particularly cultivated land. Consultation with land managers recommended.
Water	- - Loss of riparian habitat could exacerbate pressure from diffuse pollution	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or damage to rivers, especially those already less than good due to habitat loss or disturbance of sediment.
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	Feasibility and design stages should include consultation with communities, SNH, and the National Park Authority to avoid or minimise negative effects on landscape.

Commentary on potential significant effects

Regulating and maintaining services
Storage, conveyance and control actions are engineered actions that alter the storage and flow of water. These actions can deliver positive effects through regulating the flow of water and thus reducing flood risk to people and property.

These actions can lead to disruption to natural processes and loss of habitat. These may have a negative effect on water quality and carbon storage. Negative effects could be significant if actions damage habitat at the edge of forestry or cultivated land that is helping to filter nutrients and protect from sediment loss.

Loss of natural habitat, particularly wetlands, may have locally noticeable negative effects on pollination, pest and disease control, local climate regulation and carbon storage.

The ecosystem adjacent to the structure may benefit through protection from erosion – this may have locally noticeable benefits in urban areas and in cultivated land and semi natural grassland. However, erosion can be exacerbated downstream of the structure, with potentially significant negative effects on cultivated land and freshwater ecosystems as these ecosystems are already under pressure as a result of sedimentation.

Any adverse effects on water quality and erosion protection may be potentially significant to Atlantic salmon, which are protected in the River Teith SAC (PVAs 09/01, 09/05, 09/06, 09/07) and in unfavourable condition. Implementation of actions could also lead to short duration increases in sediment load and could disturb spawning fish, therefore the timing and implementation of actions needs to be carefully planned. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The effects on terrestrial food provision and production of biofuels are mixed: the actions may help to reduce flooding to some areas of cultivated land or semi natural grassland but other areas may suffer increased flooding (or erosion). These effects could lead to longer duration change in land use.

Cultural services
Storage, conveyance and control actions have potentially negative effects on cultural services. Loss of natural habitat and negative effects on biodiversity can impact opportunities to watch wildlife and interact with nature, and recreation such as angling. Changes to patterns of river flow can also affect sports such as kayaking. Any actions located in native woodland could reduce habitat connectivity and undermine native woodland regeneration priorities in this LPD. However, access for some activities could be improved with sensitive scheme design.

There are protected landscapes and wild land in the upper catchment that could experience negative change from storage actions upstream of PVA 09/01. In urban areas, storage, conveyance and control actions may have potentially negative effects by affecting the views of rivers.

The historic environment may benefit through a reduction in flood risk but there is also potential for negative effects: the disconnection of the floodplain could damage wetlands and the archaeology preserved within it. The historic environment may be negatively affected altering the setting of historic sites or through damage to sites when the action is implemented. Further assessment is required at more detailed levels of flood risk management planning.

A13.4.5 River defences

River defences may include walls, embankments or demountable / temporary defences. These are being considered for seven PVAs.

The actions are most likely to be located in or adjacent to rivers (freshwater lochs and rivers ecosystem) or set back from the river in the urban environment (urban ecosystem). All SEA topics could be affected.

The effects are dependent on the type of defence (for example, defences that are set back from the river are likely to have a smaller impact) and the degree to which the river banks have already been modified; however, the type and location of defences are not known at this strategic level of planning. The potential effects of the actions are described in the text below and summarised by SEA topic in table A13.6.

Table A13.6 River defences: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	- - Negative effects on salmon through increased sediment load	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or disturbance of sediment. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies should consider medium and long duration effects on recreation, such as changes to river flow. Design studies should consider short duration effects on quality and access to recreation. Discussion with stakeholders recommended at both stages.
Soil	No significant effects	
Water	No significant effects	
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	Feasibility and design stages should include consultation with communities and the National Park Authority to avoid or minimise negative effects on urban landscape.

Commentary on potential significant effects

Regulating and maintaining services
River defences can deliver benefits by regulating water flow, reducing erosion at the site of the structure, and reducing flood risk. The actions, however, can interfere with natural process: the defences cause some or all of the floodplain to be disconnected from the river, which can lead to loss of natural habitat to capture, filter and recycle nutrients or pollutants. This can lead to a reduction in water quality and a loss of carbon storage. Erosion may also increase upstream or downstream of a defence due to changes in river processes.

A potential decline in water quality and increase in sediment load can have potentially negative effects on freshwater species such as Atlantic salmon– these effects may be significant as this species is in unfavourable condition in the River Teith SAC (PVAs 09/01, 09/05, 09/07). Implementation of actions could also lead to short duration increases in sediment load with potential negative effects on fish, therefore the timing and implementation of actions needs to be carefully planned. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The potential effects of river defences on provisioning services in this LPD are negligible.

Cultural services
River defences may have mixed effects on recreation and opportunities to access nature and experience wildlife. Loss of natural habitat and biodiversity, and changes to river flow, can reduce the quality of the environment for recreation and wildlife watching. However, depending on their design, some defences can improve access for some types of recreation.

Within the urban landscape, river defences have potentially negative effects through disrupting the setting and view of the river and floodplain.

Historic buildings and monuments may benefit through reduced flood risk, but the defences may alter the setting of the site. Historic sites may also be affected, either for a short or long duration, by the construction of the defences – however, this cannot be assessed at this level of planning as more information is required about the precise nature and location of the defence.

Table A13.7 Shortlisted actions for the Forth: Summary of potential effects on ecosystem services

Source of flooding	All		River			
Ecosystem service	Non-structural actions		Run off reduction	River and floodplain restoration	Storage, conveyance, control	River defences
Carbon storage	**0**		**+ +**	**+/-**	**-**	**-**
Local climate regulation	**0**		**0**	**0**	**-**	**0**
Water quality regulation	**0**		**+ +**	**+ +**	**--**	**-**
Pollination	**0**		**+/-**	**+**	**-**	**0**
Biological control of pests and disease	**0**		**+**	**0**	**-**	**0**
Wave/ surge attenuation	**0**		N/A	N/A	N/A	N/A
Water flow regulation	**0**		**+ +**	**+ +**	**+ +**	**+ +**
Erosion protection	**0**		**+ +**	**+ +**	**+/-**	**+/-**
Nutrition: food provision	**0**		**+/-**	**+/-**	**+/-**	**0**
Drinking water supply	**0**		**+**	**+**	**0**	**0**
Biotic materials: timber, biofuels	**0**		**+/-**	**+/-**	**+/-**	**0**
Recreation (physical interaction)	**0**		**+**	**+/-**	**+/-**	**+/-**
Accessible nature/wildlife experience	**0**		**+**	**+**	**-**	**+/-**
Spiritual and cultural amenity (landscape)	**0**		**+**	**+**	**-**	**-**

KEY					
	+ +	**Significant positive** Effects are widespread across the LPD; and/or Effects are likely to improve an ecosystem that is in less than good condition	**-**	**Negative** A noticeable negative effect that does not meet the description below
	+	**Positive** A noticeable positive effect that does not meet the description above	**- -**	**Significant negative** Effects are widespread across the LPD; and/or Effects are likely to cause an adverse effect on an ecosystem that is in less than good condition
	0	**No or negligible effects**	**+/-**	**Mixed:** The effect is likely to be a combination of positive and negative effects, particularly where effects are considered on sub-issues, areas or criteria

Map acknowledgments

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including *inter alia*, the following organisations:

Ordnance Survey
Flood maps are based upon Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office © Crown Copyright. Any unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. SEPA Licence number 100016991 (2015).

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology © NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2015), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright © The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC.

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

Appendix 14: Environmental assessment of the Flood Risk Management Strategy for the Forth Estuary

This appendix presents the current state of the environment and the assessment of significant environmental effects for the Flood Risk Management Strategy for the Forth Estuary Local Plan District (LPD). The purpose of this is to:

- Identify relevant information on the current state of the environment for the Forth Estuary LPD. This information supplements the description of the current state of Scotland's environment (section 3 of the main Environmental Report).
- Report the significant environmental effects of the actions proposed to manage flood risk in the Forth Estuary.
- Identify mitigation of significant negative effects and opportunities to deliver wider benefits.
- Recommend further assessment at more detailed planning stages e.g. feasibility studies or design stages.

The overall assessment for all 14 Flood Risk Management Strategies is summarised in section 5 of the main Environmental Report.

A14.1 The Forth Estuary Local Plan District

The Forth Estuary LPD (figure A14) has an area of 3,256km^2 with a population of approximately 1.4 million and includes Edinburgh, Livingston, Cumbernauld, Falkirk, Dunfermline, Kirkcaldy and Glenrothes.

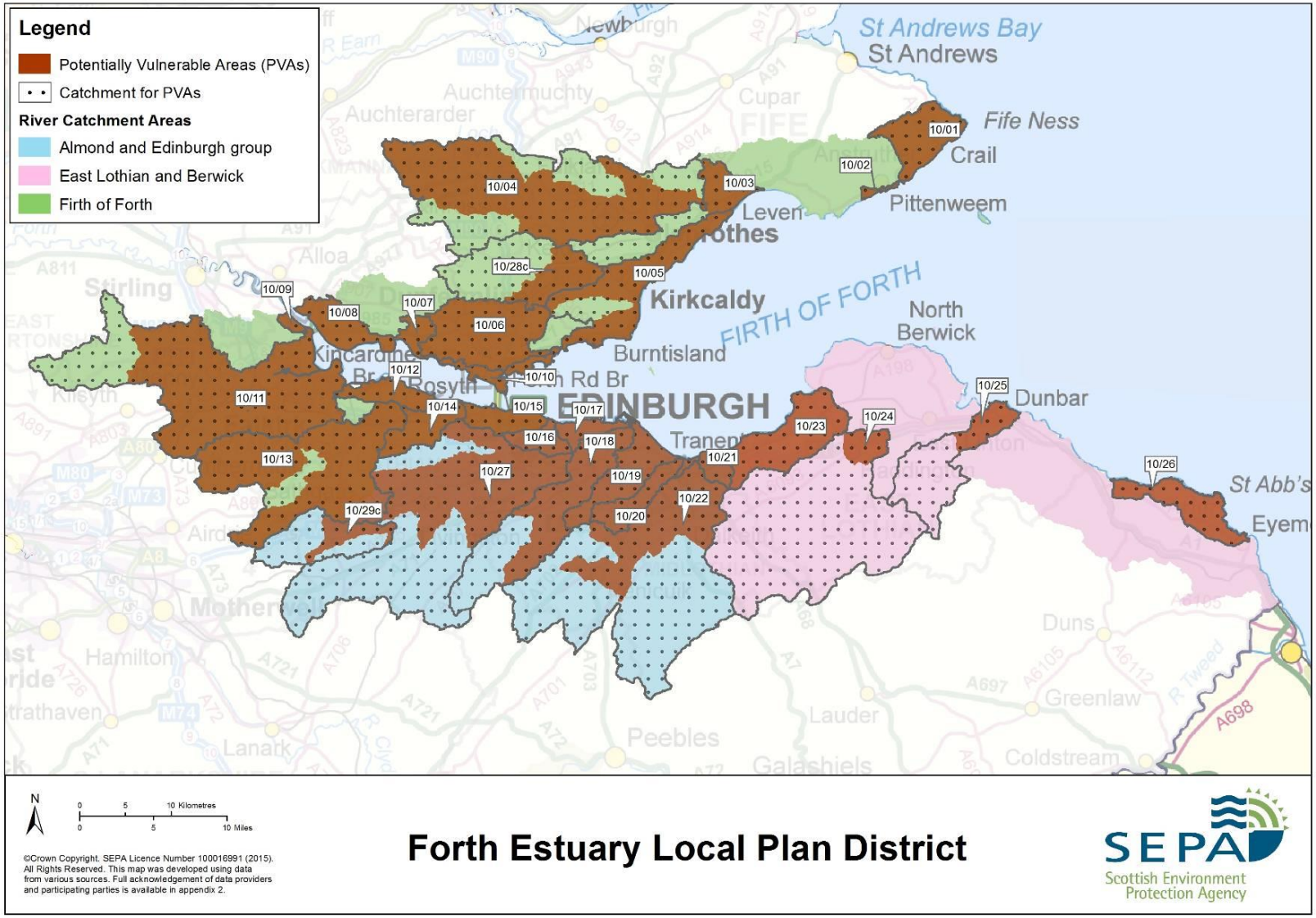
The main river catchments areas are Firth of Forth (including the River Leven, River Carron and River Avon), the Almond and Edinburgh group (including the River Almond, Water of Leith and the River Esk) and the East Lothian and Berwickshire group (including the River Tyne and the Eye Water). The LPD has 375km of coastline that includes the Firth of Forth and the Berwickshire coast. The Firth of Forth is the largest estuary on the east coast of Scotland and extends 95km from Stirling in the west, where the River Forth flows into estuary, to Fife Ness in the East where it meets the North Sea. The Forth Estuary LPD includes part of the Scotland central belt and is relatively urbanised.

The main source of flooding in the LPD is river flooding (53% of Annual Average Damages[1]), followed by surface water flooding (35% of Annual Average Damages) with the remaining damages caused by coastal flooding (12% of Annual Average Damages). There are 27 Potentially Vulnerable Areas (PVAs) and two candidate PVAs.

A range of non-structural and structural actions are being considered to manage flooding in this LPD. Structural actions are being considered to manage river flooding in 20 PVAs and to manage coastal flooding in 11 PVAs (table A14.1).

[1] An indicative estimate of the direct economic costs of flooding impacts to residential properties, non-residential properties and agriculture

Figure A14: Forth Estuary LPD and PVAs[2]



[2] Including candidate PVAs

Table A14.1: Shortlisted actions in Forth Estuary LPD

Action	Shortlisted for the following PVAs
Run off reduction	10/04, 10/05, 10/06, 10/07, 10/11, 10/13, 10/22, 10/24, 10/25, 10/17, 10/28 and 10/29c
River and floodplain restoration	10/01, 10/03, 10/04, 10/05, 10/06, 10/07, 10/08, 10/11, 10/13, 10/18, 10/19, 10/20, 10/21, 10/22, 10/23, 10/24, 10/25, 10/27, 10/28 and 10/29c
Storage conveyance and control	10/01, 10/03, 10/04, 10/05, 10/06, 10/07, 10/08, 10/13, 10/18, 10/20, 10/23, 10/24, 10/25, 10/27, 10/28 and 10/29c
River defences	10/01, 10/03, 10/04, 10/05, 10/06, 10/11, 10/13, 10/18, 10/19, 10/20, 10/21, 10/22, 10/23, 10/24, 10/25, 10/27, 10/28 and 10/29c
Coastal restoration	10/05, 10/07, 10/08, 10/09, 10/10, 10/11, 10/21, 10/23, 10/25 and 10/26.
Coastal defences	10/05, 10/07, 10/08, 10/09, 10/10, 10/11, 10/21, 10/23, 10/25 and 10/26.

A14.2 Environmental and policy context for the Forth Estuary LPD

Section 2.2 and Appendix 3 of the main Environmental Report identify the relationships between the Flood Risk Management Strategies and other plans, programmes and strategies.

A14.3 Additional relevant information on the current state of the environment for the Forth Estuary LPD

This sub section identifies relevant information on the current state of the environment for the Forth Estuary LPD. This information supplements the description of the current state of Scotland's environment (section 3 of the main Environmental Report).

A14.3.1 Ecosystems and condition

The predominant terrestrial ecosystem in the Forth Estuary LPD is cultivated land, which covers 56% of the area; the next largest is semi natural grassland covering 11% of the area. A significant amount (10%) is also urban, including Edinburgh, the capital of Scotland. Coastal ecosystem types are variable; the natural substrate is mainly soft with sand dune systems, mud flats and saltmarsh present. However, there are also many hard coastal protection structures present.

Table A14.2 lists the extent of different ecosystems within the Forth Estuary LPD, and provides an assessment of ecosystem condition.

Table A14.2 Ecosystems within the LPD

Ecosystem	Area (% of LPD in 2007)	Condition of ecosystem
Woodland - native	6	Nationally the area of native woodland cover has increased since the 2007 due to native woodland expansion. The Native Woodland Survey for Scotland 2013 found that 46% of native woodlands were in good condition.
Woodland - conifer plantation	7	There are some conifer plantations in the Forth Estuary but there is no information on the condition.
Cultivated land	56	Rural diffuse pollution is a pressure on the water environment in this LPD (including in one diffuse pollution priority catchments, the Eyewater). This indicates there is potential degradation and erosion of soils.

Ecosystem	Area (% of LPD in 2007)	Condition of ecosystem
Semi-natural grassland	11	Nationally, this ecosystem is thought to be in moderate condition. The larger areas of semi- natural grassland are located around the Pentlands and surrounding Kinross.
Wetlands (fen, marsh, and swamp; bog)	2	There are small areas of wetlands scattered throughout the Forth Estuary LPD. Most of the protected sites with wetlands are not in good condition and show signs of drying out.
Upland heath	7	The majority of upland heath is located in the Pentlands to the south of Edinburgh. Nationally, upland habitats are generally in good condition and improving.
Freshwater lochs and rivers	1	There are 143 WFD river water bodies in this LPD. The condition of these is variable, with 50% at less than good status for water quality and 29% at less than good status due to the condition of beds and banks. There are 12 WFD loch water bodies in this LPD: only two of these are at less than good overall status. There are rural and urban diffuse pollution pressures in this LPD (including in one diffuse pollution priority catchment) and the eastern areas of the LPD are designated as Nitrate Vulnerable Zones (Strathmore/Fife and the Lothians/Borders). These indicate that freshwater ecosystems may be under pressure from excess nitrates and phosphorus.
Coastal & marine	<0.5*	In this LPD, the physical condition of the coastal and estuarine water bodies are at good WFD status or better for all except two water bodies. Bathing waters all achieved mandatory passes or better in 2013. Many coastal habitats are fragmented due to coastal squeeze and historical land reclamation. Within protected sites, coastal ecosystems are in mixed condition.
Urban	10	Access to greenspace in Scotland's urban environment is generally good. Over two thirds (68%) of adults in Scotland have access to useable greenspace within a five-minute walk from their home (not including their own garden).

*The majority of the coastal and marine ecosystem extends beyond the terrestrial LPD boundary so is not captured in this figure

There are eight Special Areas of Conservation (SACs), eight Special Protected Areas (SPAs) and 104 Sites of Special Scientific Interest (SSSIs). The sites with greatest relevance to flood risk management are described below.

The Forth islands and much of the Firth of Forth coastline are designated as SPAs for birds (aggregations of breeding and non-breeding birds), some of which are in declining condition and some in favourable condition. The Firth of Forth is also a SSSI designated for saltmarsh and sand dunes, which are in unfavourable declining condition. This is likely to be exacerbated with coastal squeeze and sea level rise. The saltmarsh in Fifeness SSSI, adjacent to PVA 10/01, is in favourable condition.

Loch Leven SSSI (PVA 10/04) is designated for birds, beetles, vascular plants, eutrophic loch and wetlands (hydromorphological mire range). This is also a National Nature Reserve. Loch Leven is the largest naturally eutrophic (nutrient-rich) loch in the British Isles. There is a need to reduce

phosphorus inputs from agricultural land and discharges from septic tanks. Bishop Hill SSSI (PVA 10/04) is designated for upland assemblage; it is in unfavourable condition due in part to overgrazing.

Dalkeith Oakwoods SSSI (PVA 10/22) is designated for broad-leaved, mixed and yew woodland, which is in unfavourable condition due to lack of regeneration. This is one of only two remaining ancient park woodlands in Scotland.

Within PVA 10/13 are:

- Linlithgow Loch SSSI, which is in unfavourable condition due to enrichment from agricultural and urban land uses in the catchment;
- Lochcote Marsh SSSI is designated for basin mire; it is in favourable condition;
- Carriber Glen SSSI is designated for upland mixed ash woodland, which is in unfavourable condition due to non-native species and grazing;
- Darnrig Moss SSSI is designated for raised bog. It is in unfavourable condition but is part of a programme of ditch blocking, bank re-profiling etc to enhance the natural bog vegetation.

Slamannan Plateau SSSI covers both PVA 10/13 and 10/11 and is in favourable condition for Taiga bean goose. The site also supports other species of geese. Any proposals for forestry near these areas could have a negative impact on these species as they prefer clear lines of sight.

In PVA 10/11, Denny Muir SSSI is in unfavourable condition for blanket bog and grassland and favourable declining condition for basin fen, and Howierig Muir SSSI is in unfavourable condition for raised bog. Objectives for these SSSIs include increasing 'wetness' by investigating drainage and blocking ditches where appropriate.

In the catchment of PVA 10/25 Rammer Cleugh is a SSSI that includes two woods of sessile oak in unfavourable recovering condition. Site management objectives include further planting and tree regeneration.

A14.3.2 Ecosystem services

This sub section summarises the major ecosystem services in the Forth Estuary LPD.

Regulating and maintaining services

- Carbon storage and sequestration is provided by woodlands and wetlands.
- The topsoils generally have a moderate organic content. Much of the agricultural land is suitable for cereals, horticulture or other crops, particularly Fifeness and the areas south of the Forth Estuary.
- The coastal ecosystems are predominantly sand, shingle, dunes and saltmarshes, which help to attenuate waves and surge. Much of the estuary is naturally susceptible to coastal erosion as much of the land is reclaimed. However, there many structures in place to help manage this risk.

Provisioning services

- The Forth Estuary LPD is an important agricultural area. A large amount of the Forth Estuary is used for cereals, other crops and horticulture, particularly south of the Forth Estuary. There are also large areas for grassland based farming and rough grazing in the upland areas.
- There is an active finfish and shellfish farming area adjacent to PVA 10/26, where structural actions to reduce the risk of coastal flooding are being considered. Shellfish farming is also important along the coast from Fifeness to Leven, where PVAs 10/01 and 10/03 are located. However, there are no structural actions being considered to reduce the risk of coastal flooding in these PVAs. There are also some inland fish farming sites in PVA 10/04 where structural actions are being considered to reduce the risk of river flooding.

- There is a very small amount of salmon and sea trout caught and retained in the Forth Estuary (less than 1% of the national catch).
- There is some woodland and commercial forestry with three major sawmills located within the LPD. It is located within the Scottish Lowlands Forestry District and a small part of the Tay Forestry District. Most of the low lying land in the Forth Estuary has very good flexibility for the growth and management of tree crops.
- There are a number of drinking water protected areas within the upstream catchments of PVAs (PVAs 10/18, 10/22, 10/04). There are structural actions being considered to reduce the risk of river flooding in all of these catchments. However, as the drinking water protected areas are located at the top of the catchments, it is unlikely they would be affected by any actions.

Cultural services

- The area provides a wide range of recreational opportunities, including angling, wildfowling, kayaking, walking, sailing, swimming, surfing, windsurfing and diving.
- Many of the river catchments provide habitat for iconic wildlife, as does the south coast of the Forth Estuary and the inner estuary. There are three National Nature Reserves: Blawhorn Moss is in the upper catchment of PVA 10/13; St Abbs Head is adjacent to PVA 10/26; Loch Leven is located in the middle of PVA 10/04.
- The area is rich in historic sites, including scheduled monuments, gardens and designed landscapes and two UNESCO World Heritage Sites: Edinburgh in PVA 10/18 and the Antonine Wall in PVAs 10/11 and 10/12.

A14.4 Environmental assessment of the Flood Risk Management Strategy for Forth Estuary

This sub section provides an assessment of the potential environmental effects of the flood risk management actions under consideration for the PVAs within this LPD. The effects on SEA topics and on ecosystem services are reported under each group of actions. Table A14.9 compares the effects of different groups of actions on ecosystem services.

A14.4.1 Non-structural actions

A range of non-structural actions are being considered for the LPD such as property level protection, relocation of properties / infrastructure away from flood risk areas and flood warning schemes. These actions help to reduce the impacts of flooding and therefore are likely to have significant positive effects on the SEA objectives for human health and material assets. These effects have been assessed nationally rather than at an LPD level and the results are presented in section 4 of the main Environmental Report.

As these actions help to reduce the impacts of flooding rather than the probability of flooding, they are likely to have no or negligible effects on ecosystems and ecosystem services.

A14.4.2 Run off reduction actions

Actions to reduce run off include woodland planting, upland drain blocking, land management including soil and bare earth improvements and changing agricultural field drainage and creation or restoration of woodlands and ponds. These actions are being considered for 12 PVAs.

All SEA topics and ecosystems may be affected by these actions: either directly (where an action impacts on the ecosystem in which the action is located) or indirectly (e.g. where the freshwater ecosystem benefits from arising land use change and management). The potential effects of the actions are described in the text below and summarised by SEA topic in table A14.3.

Table A14.3 Run off reduction: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	+ + Benefits to connectivity and health of wetland ecosystems and woodlands	Feasibility studies should consider opportunities to contribute to other drivers for restoration of wetlands, woodlands, rivers and lochs. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Care should be taken if woodland creation is being considered near the Slamannan Plateau as this could negatively impact on geese. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	
Soil	+ + Benefits to safeguarding carbon rich soils	Design stages should consider protecting livestock from potential exposure to pests. Consultation with land managers recommended.
Water	+ + Benefits by enhancing water quality and reducing sedimentation	Actions should be coordinated with any morphology or diffuse pollution priority catchments proposed in the second river basin management plans.
Climatic factors	+ + Benefits to carbon storage through wetland enhancement and forestry creation	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects
Landscape	No significant effects	

Commentary on potential significant effects

Regulating and maintaining services
Run off reduction actions help to slow and store water by intercepting rainfall (e.g. woodlands) and/or increasing the extent to which the land can hold any water reaching the ground (both by slowing down the flow of run off and increasing the permeability of soils). This in turn can help to regulate the flow of water by reducing the amount of water reaching rivers and slowing or reducing flood flows: this helps to protect people and properties from flooding.

These actions can lead to improvements in water quality by helping to protect soils from erosion (thus reducing the sediment reaching rivers) and increasing infiltration of nutrients into soils. Wetland vegetation is particularly effective at storing nutrients: as this ecosystem may be under pressure from drying out in many parts of this LPD, there are potentially significant benefits to water quality and erosion protection through the restoration and creation of wetlands. Land management actions such as changing agricultural field drainage could lead to significant benefits to some of the loch and river water bodies which are under pressure from rural diffuse pollution.

The creation or restoration of woodlands and wetlands (including peatlands through upland drain blocking) has the potential to increase the capture and storage of carbon. (Although wetlands also have the potential to release carbon dioxide into the atmosphere, the net benefit to carbon storage is more likely to be positive when restoring wetlands.)

Increased habitat diversity and connectivity can provide benefits to pollination and biological control of pests and diseases. However, an increase in the wetness of cultivated land and semi-natural grassland ecosystems may increase the prevalence of some livestock pests.

There are many protected areas for woodlands and wetlands that could also benefit from these types of actions, depending on where they are located. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The effects of run off reduction actions on food provision are likely to be mixed. The actions may enhance the productivity of cultivated land and semi natural grassland by protecting soils from erosion and loss of nutrients, and through providing a more diverse habitat for pollinators and biological control of pests and disease. However, some areas of productive land may be lost and there is potential to increase the prevalence of some livestock pests.

Actions that block drains or create wetlands within conifer plantations may lead to loss of timber productivity; however, it is more likely that these actions would be located in other ecosystems.

Cultural services
The effects on recreation, wildlife watching and landscape are likely to be positive as the actions should improve habitat diversity and biodiversity.

The historic environment has potential to benefit from these actions: firstly, through the reduction of flood risk to historic buildings and, secondly through the protection of wetland archaeology as a result of creating and restoring wetlands. Woodland planting, however, can disturb buried archaeology. The structure and setting of historic sites could be affected but this will need to be assessed at more detailed levels of flood risk management planning.

A14.4.3 River and floodplain restoration actions

Actions to restore river and floodplains include woodland creation, reach restoration, large woody debris / boulders and creation of washlands. Sediment management actions such as bank restoration are also included in this assessment. These types of actions are being considered for 20 PVAs.

All SEA topics and a wide range of ecosystems may be affected: woodlands, cultivated land and semi natural grassland, wetlands, freshwater rivers and lochs and urban. The potential effects of the actions are described in the text below and summarised by SEA topic in table A14.4.

Table A14.4 River and floodplain restoration: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	+ + Benefits to connectivity and health of wetland ecosystems	Feasibility studies should consider opportunities to contribute to other drivers for restoration of wetlands and woodlands. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies should consider medium and long duration effects on recreation, such as changes to river flow. Design studies should consider short duration effects on quality and access to recreation. Discussion with stakeholders recommended at both stages.

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Soil	+ + Benefits to safeguarding carbon rich soils	Feasibility and design stages should consider potential loss of productive soils, particularly cultivated land. Consultation with land managers recommended.
Water	+ + Benefits by enhancing water quality and reducing sedimentation	Actions should be coordinated with any morphology or diffuse pollution priority catchments proposed in the second river basin management plans.
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	

Commentary on potential significant effects

Regulating and maintaining services
River and floodplain restoration actions slow down in-channel flow by increasing the sinuosity of the river and help reconnect the river with the floodplain, increasing the amount of water stored on land. Floodplain planting can also slow down the flow of run off and increase the permeability of soils, while river bank restoration can reduce bank erosion and sediment deposition in the river. The effect of all of these actions is to help regulate the flow of water by slowing and/or reducing flood flows: this helps to protect people and properties from flooding.

The restoration and creation of habitat (woodlands, washlands, woody debris etc) within the river and floodplain and reduced erosion of the river bed and banks can help to filter nutrients and reduce sediments. Wetland vegetation (in this case, vegetation on the floodplain) is particularly effective at storing nutrients. Where restoration reconnects the river with floodplain wetlands, there are potentially significant positive effects on water quality as wetlands ecosystem may be in less than good condition.

The creation or restoration of woodlands and floodplain wetlands also has the potential to increase the capture and storage of carbon, although the net benefit may be less where floodplain restoration requires the removal of trees. As stated above, although wetlands have the potential to release carbon dioxide into the atmosphere, the net benefit to carbon storage is more likely to be positive when restoring this ecosystem.

Other potential positive effects include improvements to pollination (as pollinating insects may benefit from greater food and shelter in a more diverse habitat) and disease and biological control.

Water quality improvements and erosion protection will help to maintain the protected lochs such as Loch Leven. Protected wetlands are also likely to benefit. However, restoration works could lead to short duration increases in sediment load and could disturb breeding birds, therefore the timing and implementation of actions needs to be carefully planned. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The potential effects on food provisioning are mixed. The actions may lead to the loss of cultivated land and semi natural grassland, although there are some potential benefits in semi-natural grassland through increased shelter for livestock.

The effects on provision of biotic materials are also mixed. Potential loss of cultivated land reduces opportunities for producing biofuels, however, the creation of woodland may provide timber.

Restoration actions may provide benefits to drinking water supply by helping to remove nutrients and pollutants. However, this will depend on the location of actions proposed as most of the drinking water protected areas are located near the top of the catchments.

Cultural services
The potential effects on recreation, wildlife watching and landscape are positive, as the actions should improve habitat diversity and biodiversity. Changes to the bed and banks of rivers, however, may affect quality and access of kayaking. Installing / implementing actions may also impede access to the river and its banks for recreation although these effects would be of short duration.

The historic environment has potential to benefit from these actions: firstly, through the reduction of flood risk to historic buildings and, secondly through the protection of wetland archaeology as a result of creating and restoring wetlands. Woodland planting, however, can disturb buried archaeology. The structure and setting of historic sites could be affected but this will need to be assessed at more detailed levels of flood risk management planning. Particular care should be taken to ensure actions do not negatively impact on the Antonine Wall or Edinburgh World Heritage Sites.

A14.4.4 Storage conveyance and control

Storage conveyance and control actions include on and offline flood storage, channel modifications, relief or diversion channels, and addition / modification / removal of weirs, bridges, pumping stations, culverts, sluice gates and trash screens. These types of actions are being considered for 16 PVAs.

The actions could be located in most ecosystems, except upland heath and coastal and marine ecosystems. All SEA topics could be affected. The potential effects of the actions are described in the text below and summarised by SEA topic in table A14.5.

Table A14.5 Storage, conveyance and control: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	- - Loss or damage to wetlands, leading to reduced habitat connectivity and biodiversity + + Reducing barriers to fish passage through alteration or removal of existing structures	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or damage to wetlands and disturbance of sediment. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH, Fisheries Trusts) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies should consider medium and long duration effects on recreation, such as changes to river flow. Design studies should consider short duration effects on quality and access to recreation. Discussion with stakeholders recommended at both stages.

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Soil	- - Loss or damage to carbon rich soils found in wetlands due to habitat loss - - Erosion of carbon rich soils downstream of the structure	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or damage to wetlands. Feasibility and design stages should consider potential loss of productive soils, particularly cultivated land. Consultation with land managers recommended.
Water	- - Actions could impact negatively on morphology and sediment dynamics + + Actions could impact positively on morphology, sediment dynamics and fish passage	Actions should be coordinated with any morphology or diffuse pollution priority catchments proposed in the second river basin management plans.
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	Feasibility and design stages should include consultation with communities and SNH to avoid or minimise negative effects on landscape.

Commentary on potential significant effects

Regulating and maintaining services
Storage, conveyance and control actions are engineered actions that alter the storage and flow of water. These actions can deliver positive effects through regulating the flow of water and thus reducing flood risk to people and property.

These actions can lead to disruption to natural processes and loss of habitat. These may have a negative effect on water quality and carbon storage, and potentially significantly so on wetland ecosystems which may be in unfavourable condition. The removal of existing structures, however, can also restore habitats to a more natural state and improve water quality. Overall, these actions could have significantly positive or significantly negative effects on water quality depending on the type of action proposed and existing condition of the ecosystem.

The ecosystem adjacent to the structure may benefit through protection from erosion – this may have locally noticeable benefits in urban areas and in cultivated land and semi natural grassland. However, erosion can be exacerbated downstream of the structure.

Loss of natural habitat may have locally noticeable negative effects on pollination and pest and disease control and local climate regulation.

Actions that could alter the functioning of protected wetlands with potentially negative effects on protected sites. Implementation of actions could also lead to short duration increases in sediment load and could disturb birds, therefore the timing and implementation of actions needs to be carefully planned. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning

Provisioning services
The effects on terrestrial food provision and production of biofuels are mixed: the actions may help to reduce flooding to some areas of cultivated land or semi natural grassland; however, other areas may suffer increased flooding (or erosion). These effects could lead to longer duration change in land use.

Freshwater fishery production may have locally noticeable beneficial effects where alteration or removal of existing structures reduces barriers to fish passage.

Cultural services
Storage, conveyance and control actions have potentially negative effects on cultural services. Loss of natural habitat and negative effects on biodiversity can impact opportunities to watch wildlife and interact with nature. Changes to patterns of river flow can also affect sports such as kayaking. However, access for some activities could be improved with sensitive scheme design and opportunities for recreation such as angling could be improved if actions lead to improvements to fish passage.

The historic environment may benefit through a reduction in flood risk, but there is also potential for negative effects: the disconnection of the floodplain could damage wetlands and the archaeology preserved within it. The historic environment may be negatively affected altering the setting of historic sites or through damage to sites when the action is implemented. Further assessment is required at more detailed levels of flood risk management planning.

A14.4.5 River defences

River defences may include walls, embankments or demountable / temporary defences. These are being considered for 18 PVAs.

The actions are most likely to be located adjacent to rivers or set back from the river or loch. All SEA topics could be affected.

The effects are dependent on the type of defence (for example, defences that are set back from the river are likely to have a smaller impact) and the degree to which the river banks have already been modified: however, the type and location of defences are not known at this strategic level of planning. The potential effects of the actions are described in the text below and summarised by SEA topic in table A14.6.

Table A14.6 River defences: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	- - Negative effects on ecology through increased sediment load and potential decline in water quality	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or disturbance of sediment. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies should consider medium and long duration effects on recreation, such as changes to river flow. Design studies should consider short duration effects on quality and access to recreation. Discussion with stakeholders recommended at both stages.
Soil	No significant effects	
Water	+ + - - Actions could impact positively or negatively on morphology and sediment dynamics	Actions should be coordinated with any morphology priority catchments proposed in the second river basin management plans.
Climatic factors	No significant effects	

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	+ + Benefits from restoring coastal landscapes	Feasibility and design stages should include consultation with communities to avoid or minimise negative effects on urban landscape.

Commentary on potential significant effects

Regulating and maintaining services
River defences can deliver benefits by regulating water flow, reducing erosion at the site of the structure, and reducing flood risk. The actions, however, can interfere with natural process: the defences cause some or all of the floodplain to be disconnected from the river, which can lead to loss of natural habitat to capture, filter and recycle nutrients or pollutants. This can lead to a reduction in water quality and a loss of carbon storage. Erosion may also increase upstream or downstream of a defence due to changes in river processes. However, where river banks have already been modified, installing new river defences provides an opportunity to improve river morphology and sediment dynamics.

A potential decline in water quality and increase in sediment load could have negative effects on protected areas such as Loch Leven. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
River defences have potential negative effects on freshwater food production due to the loss of in river and riparian habitat. However, this is dependent on the type of defence (for example, defences that are set back from the river are likely to have a smaller impact) and the degree to which the river banks have already been modified.

Cultural services
River defences may have mixed effects on recreation and opportunities to access nature and experience wildlife. Loss of natural habitat and biodiversity, and changes to river flow, can reduce the quality of the environment for recreation and wildlife watching. However, depending on their design, some defences can improve access for some types of recreation.

Within the urban landscape, river defences have potentially negative effects through disrupting the setting and view of the river and floodplain.

Historic buildings and monuments may benefit through reduced flood risk, but the defences may alter the setting of the site. Historic sites may also be affected, either for a short or long duration, by construction of the defences – however, this cannot be assessed at this level of planning as more information is required about the precise nature and location of the defence.

A14.4.6 Coastal restoration

Coastal restoration includes actions to help attenuate waves or surge, such as beach recharge schemes, shingle reprofiling, and restoration of sand dunes and coastal vegetated shingle, and restoration of intertidal areas. Actions are being considered for 10 PVAs.

The ecosystems most likely to be affected are coastal and marine ecosystems, but also semi natural grassland and cultivated land. All SEA topics could be affected. The potential effects of the actions are described in the text below and summarised by SEA topic in table A14.7

Table A14.7 Coastal restoration: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	+ + Benefits from restoring coastal habitats (saltmarsh, sand dunes)	Feasibility studies should consider opportunities to help protect and restore protected coastal habitats. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects, for example, on breeding or feeding birds, and on marine species through short duration potential sediment disturbance. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies and design studies should consider short and medium duration effects on coastal access. Discussion with stakeholders recommended at both stages.
Soil	+ + Benefits from protecting coastal soils from erosion - - Potential loss of productive agricultural land	Feasibility and design stages should consider potential loss of productive soils, particularly cultivated land. Consultation with land managers recommended.
Water	No significant effects	
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption
Cultural heritage	+ + Benefits from protecting coastal historic environment from coastal erosion	
Landscape	No significant effects	

Commentary on potential significant effects

Regulating and maintaining services
Coastal restoration actions help to provide space to attenuate waves and coastal surge through the creation and restoration of natural habitats. They can also help make soft coastal sediment less susceptible to erosion – this effect could deliver significant benefits to the Forth Estuary LPD where coastal habitats are showing signs of erosion in places. Through attenuating waves and surge and protecting from erosion, coastal restoration actions have the potential to reduce flood risk.

The restoration of natural habitats may help to provide carbon storage.

Protected habitats and species may benefit from restoration actions, through the restoration of saltmarsh, mudflats and dunes. However, implementation of works could cause disturbance to feeding and breeding birds. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
Coastal restoration actions may help to protect cultivated land and semi natural grassland from erosion and flooding. However, they may also result in a reduction in terrestrial food production if agricultural land is converted or restored to coastal or intertidal habitats. The restoration and creation of intertidal areas may help to provide nurseries for fish. There is therefore a mixed effect on food provisioning.

Cultural services
The potential effects of coastal restoration actions on cultural services are generally positive. By improving the coastal environment, recreation, and wildlife experience are all likely to benefit. However, implementation of works could restrict access to coastal areas which could cause short to medium duration local negative effects.

There are potentially significant positive effects on coastal landscapes if actions help to improve the extent and condition of coastal habitats, for example, in areas where land has previously been reclaimed from the sea.

The historic environment is likely to benefit due to reduced risk of flooding and perhaps significantly due to the potential protection from coastal erosion.

A14.4.7 Coastal defences

Coastal defences under consideration for this LPD include walls, embankments and temporary defences. These actions are being considered for 10 PVA. Tidal gates and barriers are being considered for one PVA and revetments for two PVAs.

The ecosystems most likely to be affected are urban, coastal and marine. All SEA topics could be affected. The potential effects of the actions are described in the text below and summarised by SEA topic in table A14.8.

Table A14.8 Coastal defences: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	- - Negative effects on protected coastal habitats through increased erosion and disruption of natural processes	Feasibility studies should consider how to avoid or minimise potential negative effects such increased erosion. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies should consider medium and long duration effects on recreation. Design studies should consider short duration effects on quality and access to recreation. Discussion with stakeholders recommended at both stages.
Soil	No significant effects	
Water	No significant effects	
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure - - Property and infrastructure may experience an increased erosion risk outside of the area of protection	Further modelling required at feasibility and design stages to better understand erosion risks. Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	Feasibility and design stages should include consultation with communities to avoid or minimise negative effects on urban and coastal landscapes.

Commentary on potential significant effects

Regulating and maintaining services
By regulating the flow of water, coastal defences can help to reduce flood risk. Some defences also help to attenuate waves and can reduce erosion at the site of the defence. However, these actions can lead to the loss of natural habitat, interfere with coastal processes and potentially increase the risk of erosion elsewhere along the coast. Any actions proposed could therefore have significantly positive or negative effects on the erosion risk within the LDP.

Loss of natural habitat can lead to reduced water quality by reducing the ability of the environment to filter, capture and recycle nutrients / pollutants. The effects on carbon storage are mixed: loss of natural habitat to sequester carbon will have negative effects; however, some actions might provide suitable substrate for kelp which can act as a carbon store. Any actions that move existing embankments further back from the sea could create space for habitats such as saltmarsh that store carbon.

Management of coastal protected sites (some of which are currently in unfavourable condition) aims to preserve the natural dynamic processes of this area. Changes to natural coastal processes may alter the movement of gravel, shingle and sands, leading to potentially significant negative effects. Many of the PVAs are also adjacent to the Firth of Forth SSSI which is designated for saltmarsh and sand dunes. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
Coastal defences can have mixed effects on marine food provision: whilst there can be loss of natural habitat which can reduce productivity, sometimes other edible species can benefit (for example, a change from soft sediment feeding fish to lobster and crab fishery). The Forth Estuary LPD is also an important agricultural area, with large areas used for cereals, other crops and horticulture. Existing structures could protect land reclaimed for agriculture from coastal flooding as could any proposed coastal defences.

Cultural services
The effects of coastal defences on recreation and on opportunities to experience nature and wildlife may be reduced through loss of natural habitat and access. Conversely, with sensitive scheme design, there may also be benefits as access may be improved and disturbance to wildlife may be reduced. Any effects on the current recreational opportunities such as beaches, sailing, angling and diving should also be considered at more detailed stages of planning.

There are potential negative effects on urban and coastal landscapes. However, in areas where the shoreline is already modified, sensitively designed defences may help to improve amenity.

There are some coastal listed buildings in the PVAs: these may benefit from reduced flood risk but the setting may be negatively affected by the defences. Further assessment is required at more detailed planning about the precise nature and location of the defences.

Table A14.9 Shortlisted actions for the Forth Estuary: Summary of potential effects on ecosystem services

Source of flooding	All		River					Coastal	
Ecosystem service	Non-structural actions		Run off reduction	River and floodplain restoration	Storage, conveyance, control	River defences		Coastal restoration	Coastal defences
Carbon storage	**0**		**+ +**	**+/-**	**-**	**-**		**+**	**+/-**
Local climate regulation	**0**		**0**	**0**	**-**	**0**		**0**	**0**
Water quality regulation	**0**		**+ +**	**+ +**	**+/-**	**+/-**		**+**	**+/-**
Pollination	**0**		**+**	**+**	**-**	**0**		**0**	**0**
Biological control of pests and disease	**0**		**0**	**0**	**-**	**0**		N/A	N/A
Wave/ surge attenuation	**0**		N/A	N/A	N/A	N/A		**+ +**	**+ +**
Water flow regulation	**0**		**+ +**	**+ +**	**+ +**	**+ +**		N/A	N/A
Erosion protection	**0**		**+ +**	**+ +**	**+/-**	**+/-**		**+**	**+/-**
Nutrition: food provision	**0**		**+/-**	**+/-**	**+/-**	**-**		**+/-**	**+/-**
Drinking water supply	**0**		**+**	**+**	**0**	**0**		**0**	**0**
Biotic materials: timber, biofuels	**0**		**+/-**	**+/-**	**+/-**	**0**		**0**	**0**
Recreation (physical interaction)	**0**		**+**	**+/-**	**+/-**	**+/-**		**+/-**	**+/-**
Accessible nature/wildlife experience	**0**		**+**	**+**	**-**	**+/-**		**+**	**+/-**
Spiritual and cultural amenity (landscape)	**0**		**+**	**+**	**-**	**-**		**++**	**+/-**

KEY				
	+ +	**Significant positive** Effects are widespread across the LPD; and/or Effects are likely to improve an ecosystem that is in less than good condition	**-**	**Negative** A noticeable negative effect that does not meet the description below
	+	**Positive** A noticeable positive effect that does not meet the description above	**- -**	**Significant negative** Effects are widespread across the LPD; and/or Effects are likely to cause an adverse effect on an ecosystem that is in less than good condition
	0	**No or negligible effects**	**+/-**	**Mixed:** The effect is likely to be a combination of positive and negative effects, particularly where effects are considered on sub-issues, areas or criteria

Map acknowledgments

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including *inter alia*, the following organisations:

Ordnance Survey
Flood maps are based upon Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office © Crown Copyright. Any unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. SEPA Licence number 100016991 (2015).

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology © NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2015), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright © The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC.

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

Appendix 15: Environmental assessment of the Flood Risk Management Strategy for Clyde and Loch Lomond

This appendix presents the current state of the environment and the assessment of significant environmental effects for the Flood Risk Management Strategy for the Clyde and Loch Lomond Local Plan District (LPD). The purpose of this is to:

- Identify relevant information on the current state of the environment for Clyde and Loch Lomond. This information supplements the description of the current state of Scotland's environment (section 3 of the main Environmental Report).
- Report the significant environmental effects of the actions proposed to manage flood risk in the Clyde and Loch Lomond LPD.
- Identify mitigation of significant negative effects and opportunities to deliver wider benefits.
- Recommend further assessment at more detailed planning stages e.g. feasibility studies or design stages.

The overall assessment for all 14 Flood Risk Management Strategies is summarised in section 5 of the main Environmental Report.

A15.1 The Clyde and Loch Lomond Local Plan District

The Clyde and Loch Lomond LPD (figure A15) has a total area of approximately 4,800 km^2 and a population of over 1.9 million people. It extends from Loch Lomond in the north to Leadhills in the south and includes part of the Loch Lomond and the Trossachs National Park. The main population centres within the district are Airdrie/Coatbridge, Cambuslang, Milngavie, Cumbernauld, Dumbarton, East Kilbride, Greenock, Motherwell/Wishaw, Hamilton, Paisley, Rutherglen and Glasgow City.

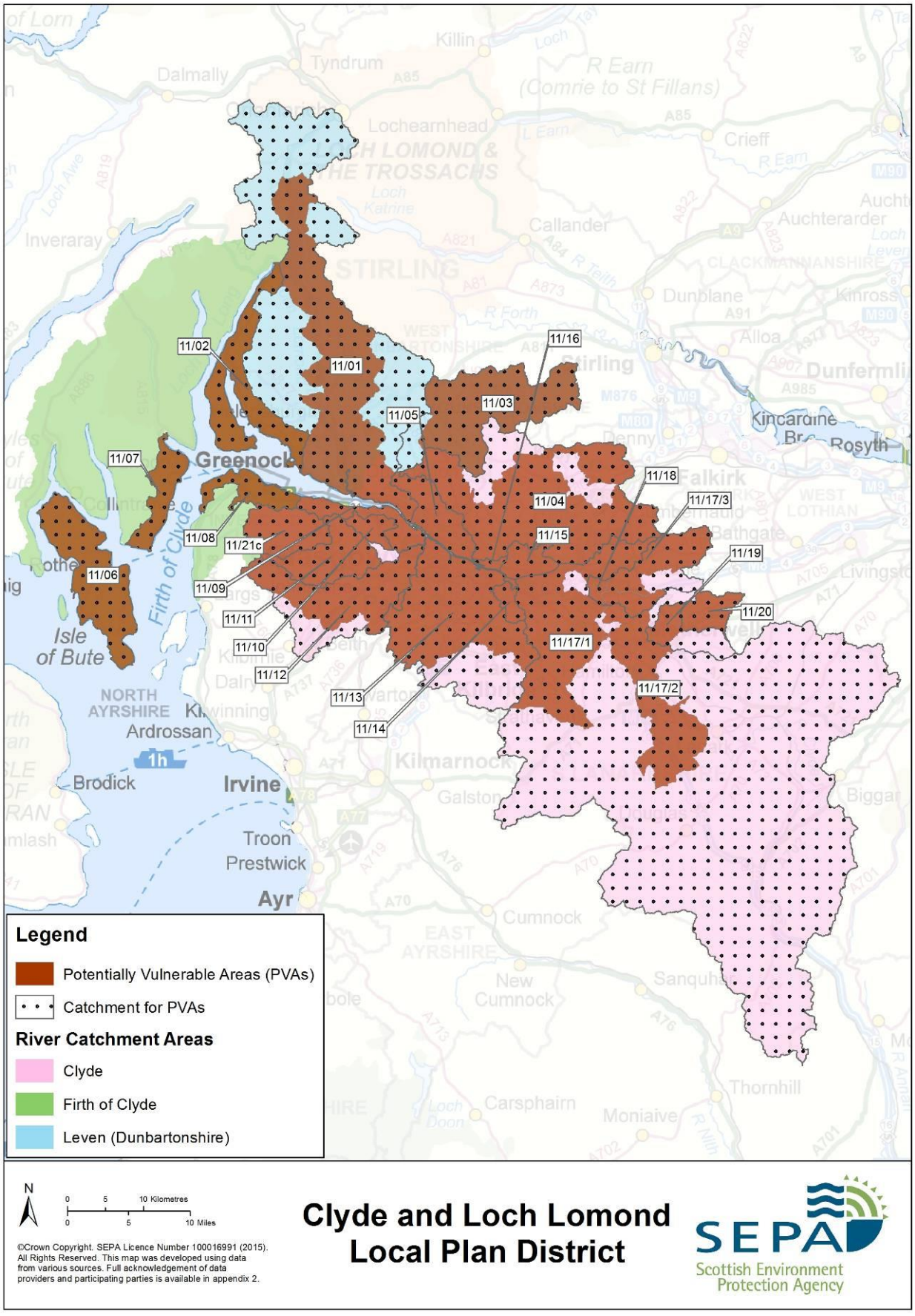
There are three river catchment areas that make up this LPD: the Clyde, the Leven (Dunbartonshire) and the Firth of Clyde.

The main source of flooding in the LPD is river flooding (43% of Annual Average Damages[1]). Coastal and surface water flooding provides almost equal contributions to flooding damages within the LPD (30% and 27% of Annual Average Damages respectively). There are 22 Potentially Vulnerable Areas (PVAs) within the LPD and one candidate PVA covering Crossford, Hazelbank and Kirkfieldbank.

A range of non-structural and structural actions are being considered to manage flooding in this LPD. Structural actions are being considered to manage river flooding in 15 PVAs and to manage coastal flooding in nine PVAs. Sustainable urban drainage systems (SUDS) are being considered to help manage river flooding or interactions between river flooding and surface water flooding in eight PVAs (table A15.1).

[1] An indicative estimate of the direct economic costs of flooding impacts to residential properties, non-residential properties and agriculture

Figure A15: Clyde and Loch Lomond LPD and PVAs[2]



[2] Including candidate PVAs

Table A15.1: Shortlisted actions in Clyde and Loch Lomond LPD

Action	Shortlisted for the following PVAs
Run off reduction	11/01, 11/04, 11/05, 11/06, 11/07, 11/08, 11/09, 11/10, 11/11, 11/12, 11/13, 11/14, 11/17/1, 11/17/2, 11/21c
River and floodplain restoration	11/01, 11/04, 11/05, 11/06, 11/07, 11/08, 11/11, 11/12, 11/13, 11/14, 11/17/1, 11/21c
Storage conveyance and control	11/01, 11/04, 11/05, 11/06, 11/07, 11/08, 11/10, 11/11, 11/12, 11/13, 11/14, 11/17/1, 11/17/2, 11/21c
River defences	11/01, 11/04, 11/05, 11/07, 11/08, 11/10, 11/11, 11/12, 11/13, 11/14, 11/17/1, 11/17/2
Sustainable Urban Drainage Systems	11/04, 11/05, 11/07, 11/08, 11/12, 11/13, 11/14, 11/17/1
Coastal restoration	11/01, 11/09, 11/13, 11/14, 11/16
Coastal defences	11/01, 11/02, 11/08, 11/09, 11/13, 11/16

A15.2 Environmental and policy context for the Clyde and Loch Lomond LPD

Section 2.2 and Appendix 3 of the main Environmental Report identify the relationships between the Flood Risk Management Strategies and other plans, programmes and strategies.

A15.3 Additional relevant information on the current state of the environment for the Clyde and Loch Lomond LPD

This sub section identifies relevant information on the current state of the environment for the Clyde and Loch Lomond LPD. This information supplements the description of the current state of Scotland's environment (section 3 of the main Environmental Report).

A15.3.1 Ecosystems and condition

The predominant ecosystems within the LPD are cultivated land (mainly improved grassland), which covers 27% of the district, and semi-natural grassland (mainly acid grassland), which covers 21% of the district. Other common ecosystems are coniferous plantation woodland (13% of the district) and native woodlands (8% of the district). The urban/suburban ecosystem covers 9% of the district – this is nearly a third (31%) of all of Scotland's urban and suburban area.

The freshwater ecosystem covers 2% of the LPD by area and includes the river Clyde and Loch Lomond. The coastal and marine ecosystem is made up predominantly of hard flood defences and shoreline reinforcements (particularly in the Inner Firth of Clyde) and rocky shoreline. There are also large intertidal mudflats, sandflats and saltmarsh in the Clyde estuary.

Table A15.2 lists the extent of different ecosystems within the LPD, and provides an assessment of ecosystem condition.

Table A15.2. Ecosystems within the LPD

Ecosystem	Area (% of LPD in 2007)	Condition of ecosystem
Woodland - native	8	Native woodland is scattered across the lowlands, loch sides and riparian areas of the district (e.g. Loch Lomond) and also near the coastline on the Outer Firth of Clyde. 15% of Scotland's native woodland area can be found in this LPD. The condition of native woodland in this LPD is not fully known, although the condition of woodland features in protected sites is mixed. Pressures include grazing and non-native species. Nationally, the native woodlands survey 2013 found that 46% of woodlands were in good condition.
Woodland - conifer plantation	13	Large areas of conifer plantation can be found on the Cowal peninsula (to the west of the Firth of Clyde). There are also some areas in the upper catchments of the Clyde and the Leven. Condition is unknown.
Cultivated land	27	Improved grasslands (used for grazing) are found mainly in the lowland areas of the district, on the periphery of the Greater Glasgow area, reaching north to West Dunbartonshire and south to South Lanarkshire. There are no diffuse pollution priority catchments. There is, however, some indication that cultivated land is contributing to diffuse pollution in some areas (e.g. PVA 11/12 Castle Semple and Barr Lochs SSSI).
Semi-natural grassland	21	Acid grassland is found in the north west of the LPD on the slopes of the upland areas of Cowal and the Loch Lomond and the Trossachs National Park, and in the south east of the district on the slopes of the Lowther Hills. There are no protected sites that contain large areas of semi natural grassland so local information on condition is not available.
Wetlands (fen, marsh, and swamp; bog)	4	Larger wetlands are found mainly in the upper edges of the catchments. Monitoring of protected sites indicate that some raised bog is in unfavourable condition in this LPD (Waukenwee Moss SAC / SSSI; Blantyre Muir SSSI (PVA 11/17/1)).
Upland heath	15	Recent improvements mean that, nationally, most features now at favourable condition and are improving. Most actions are likely to take place in or close to urban areas so effects on upland heath are likely to be limited. Creation of scrub in the Renfreshire Heights SPA/SSSI could help to provide habitat for Hen Harrier Prey.
Freshwater lochs and rivers	2	The condition of freshwater rivers and lochs is mixed. Of 157 WFD river water bodies, 28% are at less than good status for water quality and 16% at less than good status for the condition of beds and banks. Of 20 WFD loch water bodies, 75% are at less than good overall status. There are no diffuse pollution or nitrate vulnerable zones, although there are a number of catchments where diffuse pollution has been identified as a pressure (e.g. PVAs 11/01, 11/03, 11/17 – 11/20).

Ecosystem	Area (% of LPD in 2007)	Condition of ecosystem
Coastal & marine	<0.5*	The remaining coastal habitat is mainly rocky coast although there are some large intertidal mudflats and sand flats in the Clyde Estuary. Saltmarshes in the Inner Clyde SSSI are in favourable condition. Much of the Inner Firth of Clyde is highly developed, with hard flood defences and hard shoreline reinforcements. Of 12 WFD coastal and transitional water bodies, 25% are at less than good status for the physical condition of the coastline. There is also one heavily modified water body, which is at poor ecological potential. Water quality in the Clyde estuary is compromised by discharges of industrial effluent and treated sewage although effluent treatment has improved resulting in returning populations of residential and migratory fish. The quality of bathing and shellfish waters in the Firth of Clyde is affected by inputs of bacteria from diffuse sources, which increase during periods of high rainfall.
Urban	9	Access to greenspace in Scotland's urban environment is generally good. Over two thirds (68%) of adults in Scotland have access to useable greenspace within a five-minute walk from their home (not including their own garden).

*The majority of the coastal and marine ecosystem extends beyond the terrestrial LPD boundary so is not captured in this figure

There are 13 Special Areas of Conservation (SACs), seven Special Protected Areas (SPAs) and 138 Sites of Special Scientific Interest (SSSIs) in this LPD; for example:

- The Renfrewshire Heights SPA/SSSI (predominantly wetland and upland heath) is designated for hen harriers, which are in unfavourable declining condition. Actions such as upland drain blocking and scrub creation in the upper catchments of PVAs 11/11, 11/12, and 11/21c could help to create habitat for hen harrier prey (and thus deliver benefits to hen harriers).
- There are many protected sites within or adjacent to Loch Lomond containing native woodland, wetland and freshwater river and loch ecosystems. For example, the river Endrick Mouth and Islands SSSI contains one of the best examples of a floodplain wetland in Scotland (hydrological mire range: in favourable condition) and it is vulnerable to changes in water levels. Sites in Loch Lomond could be affected by actions to manage flood risk from the river Leven (PVA 11/01[3]).
- Waukenwee Moss SAC / SSSI (PVA 11/17/1), where some parts of the raised bog are in unfavourable recovering condition. Pressures include artificial drainage and overgrazing.
- Blantyre Muir SSSI (PVA 11/17/1), where the raised bog is in unfavourable condition. Pressures include artificial drainage.
- Castle Semple and Barr Lochs SSSI (PVA 11/12) contains a eutrophic loch which is in unfavourable condition due to the presence of non-native species. Sediment and phosphorus run off from upstream may be encouraging the growth of non-native species, so actions that reduce run off and capture sediment may benefit this site.
- Central Lochs Bute SSSI (PVA11/06) is designated for greylag goose. The site also contains an ancient crannog (in Loch Ascog) and the only Scottish population of violet crystalwort. The water levels are controlled by dams and sluices.

[3] There are no structural actions under consideration for PVA 11/03

- The Inner Clyde SSSI contains coastal and marine ecosystems and is designated for saltmarsh and a number of species of non-breeding birds. The Inner Clyde SAC is designated for non-breeding redshank. All features are all in favourable condition. The sites could be threatened by actions (particularly in PVAs 11/01, 11/09 and 11/08) that involve changes to grazing regimes, coastal protection or flood prevention works, or removal of intertidal or subtidal sediments (e.g. dredging).

The location of flood risk and likely location of actions mean that some protected sites, although they fall within a PVA or PVA catchment, are not likely to be affected e.g. North End of Bute SSSI as actions for PVA 11/06 are likely to be located closer to the area of flood risk in Rothesay. The Upper Loch Fyne and Loch Goil Marine Protected Area is unlikely to be affected by any FRM actions.

A15.3.2 Ecosystem services

This sub section summarises the major ecosystem services in this LPD.

Regulating and maintaining services

- Carbon storage and sequestration is provided by woodlands, upland heath and wetlands.
- Native woodlands, semi natural grassland, upland heath and wetlands help to filter and maintain good water quality. These ecosystems also help to regulate the flow of water.
- The coastal ecosystems are predominantly rocky coast and modified coastline (hard flood defences and hard shoreline reinforcements), so the coastline has generally low susceptibility to erosion. There are some areas of salt marsh, which help to attenuate waves and surge and provide important habitat for birds and other species.

Provisioning services

- Large areas of cultivated land (mainly improved grassland) are used mainly for grassland based farming, with only small areas used for crops and cereals. Semi natural grasslands in the upper Clyde catchment and the Cowal peninsula are used for rough grazing.
- Commercial fishing takes places in the Firth of Clyde and the rivers and bays provide a small catch of wild salmon and sea trout. There are finfish and shellfish farming sites around the Cowal Peninsula (notably Loch Striven, north of the Isle of Bute (PVA 11/06)). Freshwater fish farming can be found on the Isle of Bute, south of Rothesay (PVA 11/06). There are also freshwater fish farms in PVAs 11/01 and just outside of PVA 11/17/2 – these farms are unlikely to be affected as any actions are likely to be located downstream of these farms.
- There are woodland plantations on the Cowal Peninsula (PVA 11/07), around Loch Lomond (PVA 11/01), and at the upper reaches of the Clyde catchment.
- There are a number of rivers and lochs that are important sources of drinking water: these overlap with PVAs 11/01 (Carmen Reservoir), 11/04, 11/05, 11/06, 11/07, 11/11, 11/12 and 11/21c.
- Hydroelectricity is generated in PVAs 11/03, 11/13, 11/17/1 and 11/17/2.

Cultural services

- The Firth of Clyde and the sea lochs provide a wide range of recreational opportunities, including angling, sailing and diving. Freshwater rivers and lochs are popular for kayaking, sailing, boating and angling. The terrestrial ecosystems are used for a wide rage of recreation including, walking, cycling and running.
- The LPD provides habitat for iconic wildlife in upland areas (PVAs 11/03, 11/11, 11/12, 11/21c). There are two National Nature Reserves: Clyde Valley Woodlands (PVAs 11/17/1 and 11/17/2) and Loch Lomond (PVA 11/01).
- Landscape is important. PVAs 11/01 and the tip of 11/02 are part of the Loch Lomond and Trossachs National Park. There are also two National Scenic Areas: Loch Lomond (PVA 11/01) and Kyle of Bute (PVA 11/06).
- The upper areas of PVAs 11/12 and 110/1 contain areas of wild land: these areas have a distinct and special character, which is increasingly rare to find. Many people derive psychological and spiritual benefits from their existence, and they provide increasingly

important havens for Scotland's wildlife.

- The LPD contains a large number of listed buildings and some scheduled monuments and gardens and designed landscapes. The Antonine Wall UNESCO World Heritage Site runs through PVAs 11/01, 11/05 and 11/04; New Lanark UNESCO World Heritage Site is located just outside of PVA 11/17/2.

A15.4 Environmental assessment of the Flood Risk Management Strategy for Clyde and Loch Lomond LPD

This sub section provides an assessment of the potential environmental effects of the flood risk management actions under consideration for the PVAs within this LPD. The effects on SEA topics and on ecosystem services are reported under each group of actions. Table A15.10 compares the effects of different groups of actions on ecosystem services.

A15.4.1 Non-structural actions

A range of non-structural actions are being considered for the LPD such as property level protection, relocation of properties / infrastructure away from flood risk areas and flood warning schemes. These actions help to reduce the impacts of flooding and therefore are likely to have significant positive effects on the SEA objectives for human health and material assets. These effects have been assessed nationally rather than at an LPD level and the results are presented in section 4 of the main Environmental Report.

As these actions help to reduce the impacts of flooding rather than the probability of flooding, they are likely to have no or negligible effects on ecosystems and ecosystem services.

A15.4.2 Run off reduction actions

Actions to reduce run off may include woodland and gully woodland planting, upland drain blocking, land management, creation or restoration of wetlands and ponds, and shelter belts. Run off reduction actions are being considered for 15 PVAs.

All SEA topics and ecosystems could be affected by these actions: either directly (where an action impacts on the ecosystem in which the action is located) or indirectly (e.g. where the freshwater ecosystem benefits from arising land use change and management). The potential effects of the actions are described in the text below and summarised by SEA topic in table A15.3.

Table A15.3 Run off reduction: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	+ + Benefits to connectivity and health of wetland ecosystems	Feasibility studies should consider opportunities to contribute to other drivers for restoration of wetlands and woodlands, and supporting designated site objectives. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	
Soil	+ + Benefits to restoring and safeguarding carbon rich soils	Design stages should consider protecting livestock from potential exposure to pests. Consultation with land managers recommended.

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Water	+ + Benefits by enhancing water quality and reducing sedimentation	
Climatic factors	+ + Benefits to carbon storage through wetland enhancement	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Feasibility studies should consult with Forestry Commission Scotland to assess potential effects on timber production in PVA 11/06. Design stages should consider how to minimise waste and energy consumption
Cultural heritage	Uncertain	Feasibility and design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects, particularly for the Antonine Wall UNESCO World Heritage Site.
Landscape	No significant effects	

Commentary on potential significant effects

Regulating and maintaining services
Run off reduction actions help to slow and store water by intercepting rainfall (e.g. woodlands) and/or increasing the extent to which the land can hold any water reaching the ground (both by slowing down the flow of run off and increasing the permeability of soils). This in turn can help to regulate the flow of water by reducing the amount of water reaching rivers and slowing or reducing flood flows: this helps to protect people and properties from flooding.

These actions can lead to improvements in water quality by helping to protect soils from erosion (thus reducing the sediment reaching rivers) and increasing infiltration of nutrients into soils. Wetland vegetation is particularly effective at storing nutrients: there are therefore potentially significant benefits to these services through the restoration and creation of wetlands as this ecosystem is under pressure from drainage in some parts of the LPD. Water quality benefits may also be significant if the actions are located in cultivated land as water quality is currently under pressure from rural diffuse pollution in a number of catchments.

The creation or restoration of woodlands and wetlands (including peatlands through upland drain blocking) has the potential to increase the capture and storage of carbon. In wetlands, the benefits may be significant as the actions are likely to improve the current condition and extent of this ecosystem. (Although wetlands also have the potential to release carbon dioxide into the atmosphere, the net benefit to carbon storage is more likely to be positive when restoring wetlands.)

Increased habitat diversity and connectivity can provide benefits to pollination and biological control of pests and diseases. However, an increase in the wetness of cultivated land and semi-natural grassland ecosystems may increase the prevalence of some livestock pests.

Enhancing and restoring wetlands may lead to benefits to protected sites: for example, raised bog Waukenwee Moss SAC / SSSI and Blantyre Muir SSSI (PVA 11/17/1) could benefit from actions that reduce run off. Other actions in PVA 11/17/1 could affect the Clyde Valley Woodlands SAC and a number of SSSIs. Reduced diffuse pollution could benefit Castle Semple and Barr Lochs SSSI (PVA 11/12). Hen Harriers in the Renfrewshire Heights SPA/SSSI may benefit if run off reduction actions in PVA 11/12 help to restore wetlands and create scrub that can provide habitat for prey. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The effects of run off reduction actions on food provision are mixed. The actions may enhance the productivity of cultivated land and semi natural grassland by protecting soils from erosion and loss of nutrients, and through providing a more diverse habitat for pollinators and biological control of pests and disease. However, some areas of productive land may be lost and there is potential to increase the prevalence of some livestock pests.

Run off reduction actions may also help to protect drinking water quality (as there are a number of rivers and lochs that are drinking water protected areas in this LPD). Hydroelectricity generation is unlikely to be affected.

Actions that block drains or create wetlands within conifer plantations may lead to loss of timber productivity: for example, run off reduction actions in PVA 11/07 may be located conifer plantations and discussion with the Forestry Commission Scotland is recommended should this action be selected. In general, however, actions are unlikely to be located within conifer plantations.

Cultural services
The effects on cultural services (recreation, accessibility to wildlife, landscape) are likely to be positive, as the actions should improve habitat diversity and biodiversity. Areas of wild land, National Nature Reserves, National Scenic Areas and the Loch Lomond and Trossachs National Park are unlikely to be affected – for example, run off reduction actions in PVA 11/01 are likely to be located below the Leven barrage.

The historic environment has potential to benefit from these actions: firstly, through the reduction of flood risk to historic buildings and, secondly through the protection of wetland archaeology as a result of creating and restoring wetlands. Woodland planting, however, can disturb buried archaeology. The structure and setting of historic sites could also be affected. Further assessment is required at more detailed levels of flood risk management planning once information in the location and type of action is available. In particular, actions in PVA 11/04 could be located close to the Antonine Wall UNESCO World Heritage Site so consultation with Historic Scotland is recommended.

A15.4.3 River and floodplain restoration actions

Actions to restore river and floodplains may include woodland creation, reach restoration, large woody debris/ boulders and creation of washlands. Most restoration actions in this LPD are likely to be small scale. Sediment management actions such as bank restoration are also included in this assessment. These types of actions are being considered for 12 PVAs.

All SEA topics and a wide range of ecosystems may be affected but particularly cultivated land, semi natural grassland, native woodlands, wetlands, freshwater rivers and lochs, and urban ecosystems. The potential effects of the actions are described in the text below and summarised by SEA topic in table A15.4.

Table A15.4 River and floodplain restoration: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	+ + Benefits to connectivity and health of wetland ecosystems	Feasibility studies should consider opportunities to contribute to other drivers for restoration of wetlands and woodlands. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies should consider medium and long duration effects on recreation, particularly in public parks. Design studies should consider short duration effects on quality and access to recreation. Discussion with stakeholders recommended at both stages.
Soil	+ + Benefits from restoring carbon rich soils	Feasibility and design stages should consider potential loss of productive soils, particularly cultivated land. Consultation with land managers recommended.
Water	+ + Benefits by enhancing water quality and reducing sedimentation	
Climatic factors	+ + Benefits to carbon storage through wetland enhancement. However, loss of woodland could reduce these benefits	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	

Commentary on potential significant effects

Regulating and maintaining services
River and floodplain restoration actions slow down in-channel flow by increasing the sinuosity of the river and help reconnect the river with the floodplain, increasing the amount of water stored on land. Floodplain planting can also slow down the flow of run off and increase the permeability of soils, while river bank restoration can reduce bank erosion and sediment deposition in the river. The effect of all of these actions is to help regulate the flow of water by slowing and/or reducing flood flows: this helps to protect people and properties from flooding.

The restoration and creation of habitat (woodlands, washlands, woody debris etc) within the river and floodplain and reduced erosion of the river bed and banks can help to filter nutrients and reduce sediments. Wetland vegetation (in this case, vegetation on the floodplain) is particularly effective at storing nutrients. Where restoration reconnects the river with floodplain wetlands, there are potentially significant positive effects on water quality as wetlands ecosystem may be in less than good condition. There are also potentially significant positive effects on water quality if actions are located in or adjacent to cultivated land (through reducing diffuse pollution).

The creation or restoration of woodlands and wetlands (floodplains) has the potential to increase the capture and storage of carbon, although the net benefit may be less where floodplain restoration requires the removal of trees. As stated above, although wetlands have the potential to release carbon dioxide into the atmosphere, the net benefit to carbon storage is more likely to be positive when restoring this ecosystem.

Other potential positive effects include improvements to pollination (as pollinating insects may benefit from greater food and shelter in a more diverse habitat) and disease and biological control.

Without further detail on the location, scale, and type of action, it is difficult to assess the likely effects on protected sites and species. Actions in PVA 11/17/1 could affect the Clyde Valley Woodlands SAC and a number of SSSIs. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The effects on food provision are likely to be mixed. The actions may lead to the loss of cultivated land and semi natural grassland, although there are some potential benefits in semi-natural grassland through increased shelter for livestock. Benefits to freshwater food provisioning are likely to be negligible.

There are potential positive effects on provision of biotic materials as the creation of woodland may provide timber.

Restoration actions may provide benefits to drinking water supply by helping to remove nutrients and pollutants.

Cultural services
The potential effects on recreation, wildlife watching and landscape are positive, as the actions should improve habitat diversity and biodiversity. However, some actions may use parkland which could make the land unsuitable for some types of recreation either temporarily (during a flood event) or for a medium to long duration (through changing the wetness of the land). Installing / implementing actions may also impede access to the river and its banks for recreation although these effects would be of short duration.

Actions are likely to take place close to urban areas; areas of wild land, National Nature Reserves, National Scenic Areas and the Loch Lomond and the Trossachs National Park are unlikely to be affected. For example, restoration actions in PVA 11/01 are likely to be located below the Leven barrage.

The historic environment has potential to benefit from these actions: firstly, through the reduction of flood risk to historic buildings and, secondly through the protection of wetland archaeology as a result of creating and restoring wetlands. Woodland planting, however, can disturb buried archaeology. The structure and setting of historic sites could be affected but this will need to be assessed at more detailed levels of flood risk management planning.

A15.4.4 Storage conveyance and control

Storage, conveyance and control actions include on and offline flood storage, channel modifications, modification of weirs, bridges, and culverts. Note that many of the actions under consideration involve modifying existing artificial structures such as weirs, culverts and reservoirs. These types of actions are being considered for 14 PVAs, sometimes at multiple locations within a PVA.

The actions are most likely to be located in freshwater, urban, cultivated land, semi natural grasslands and native woodland ecosystems. More rarely, actions could be located in conifer plantations. In some instances, the actions look to use existing lochs, wetlands, parks and playing fields for storage. All SEA topics could be affected. The potential effects of the actions are described in the text below and summarised by SEA topic in table A15.5.

Table A15.5 Storage, conveyance and control: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	- - Loss or damage to loch ecosystems	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or damage to loch ecosystems. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH, Fisheries Trusts) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies should consider medium and long duration effects on recreation, such as changes in use of and access to parkland and sports fields and impacts on navigation. Design studies should consider short duration effects. Discussion with stakeholders required at both stages. Actions that seek to utilise drinking water assets should be developed in collaboration with Scottish Water.
Soil	No significant effects	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or damage to wetlands. Feasibility and design stages should consider potential loss of productive soils, particularly cultivated land. Consultation with land managers required.
Water	- - Degradation of water quality and erosion in freshwater rivers and lochs	Feasibility and design studies should examine how to eliminate or minimise any adverse effects on water quality and erosion.
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects. Particular attention should be given to actions in PVA 11/04 that fall close to the Antonine Wall.
Landscape	No significant effects	Feasibility and design stages should include consultation with communities, SNH, and the National Park Authority to avoid or minimise negative effects on landscape.

Commentary on potential significant effects

Regulating and maintaining services
Storage, conveyance and control actions are engineered actions that alter the storage and flow of water. These actions can deliver positive effects through regulating the flow of water and thus reducing flood risk to people and property.

These actions can lead to disruption to natural processes and loss of habitat. These may have a negative effect on water quality and carbon storage. Given that 75% of lochs in this LPD are at less than good status for WFD (e.g. Strathclyde Loch, Loch Fad, Castle Semple and Barr Lochs, Loch Lomond), these negative effects could be significant. However, the removal of structures can

also restore habitats to a more natural state and improve water quality and so much depends on the location and design of the actions.

The potential effects of these actions on erosion protection are mixed. Some ecosystems may, in part, benefit: for example urban or cultivated land adjacent to the structure may experience an increase in protection from erosion. However, erosion can be exacerbated upstream and or downstream of actions with potentially significant negative effects on any rivers or lochs that may already be under pressure: note this depends on the type, location and operation of the action.

Loss of natural habitat may lead to locally noticeable negative effects on pollination and pest and disease control.

A number of lochs are being considered for their potential to help store flood water and in some cases, these lochs also contain designated environmental sites that could be affected e.g. Castle Semple and Barr Lochs SSSI (PVA 11/12); Central Lochs, Bute SSSI (PVA 11/06); sites in Loch Lomond such as river Endrick Mouth and Islands SSSI (PVA 11/01). There are some potential negative effects such as changes in water levels and erosion, although the effects are uncertain without more detail on the type, location and operation of actions. Actions in PVA 11/17/1 could affect the Clyde Valley Woodlands SAC and a number of SSSIs. The effects on protected sites will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The effects on terrestrial food provision are mixed: the actions may help to reduce flooding to some areas of cultivated land or semi natural grassland; however, other areas may suffer increased flooding (or erosion). These effects could lead to longer duration change in land use.

There are several drinking water protected areas in this LPD, and some actions under consideration involve modifying or working with drinking water assets (e.g. reservoirs, barrages). Therefore this is a potential for both positive and negative effects on drinking water supply.

Cultural services
Storage, conveyance and control actions have potentially negative effects on cultural services. Loss of natural habitat and negative effects on biodiversity can impact opportunities to watch wildlife and interact with nature, and recreation such as angling. Some actions may use parkland and sports fields which could may the land unsuitable for some types of recreation either temporarily (during a flood event) or for a medium to long duration (through changing accessibility, topography or area). Changes to river flow and water levels could affect navigation, although the direction of effects cannot be predicted at this strategic level of planning. Access for some activities could be improved with sensitive scheme design.

Actions are likely to take place close to urban areas and so areas of wild land are unlikely to be affected. Any changes to the operation of the Leven Barrage (PVA 11/01) could alter the water levels in Loch Lomond, with potential negative effects on the Loch Lomond and Trossachs National Park, Loch Lomond National Scenic Area and Loch Lomond National Nature Reserve. In urban areas, storage, conveyance and control actions may have potentially negative effects by affecting the views of rivers. In all case, the effects are dependent on the location, type and operation of any structures which is not known at this stage in the planning process.

The historic environment may benefit through a reduction in flood risk, but there is also potential for negative effects: the disconnection of the floodplain could damage wetlands and the archaeology preserved within it. The historic environment may be negatively affected altering the setting of historic sites or through damage to sites when the action is implemented. Further assessment is required at more detailed levels of flood risk management planning. In particular, actions in PVA 11/04 could be located close to the Antonine Wall UNESCO World Heritage Site so consultation with Historic Scotland is recommended.

A15.4.5 River defences

River defences may include walls, embankments or demountable / temporary defences. These are being considered for twelve PVAs. Some actions involve the enhancement of existing flood defences. The actions are most likely to be located in or adjacent to rivers (freshwater lochs and rivers ecosystem) or set back from the river in the urban environment (urban ecosystem). All SEA topics could be affected.

The effects are dependent on the type of defences (for example, defences that are set back from the river are likely to have a smaller impact) and the degree to which the river banks have already been modified: however, the type and location of defences are not known at this stage in the planning process. The potential effects of the actions are described in the text below and summarised by SEA topic in table A15.6.

Table A15.6 River defences: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	No significant effects	Feasibility studies should consider how to avoid or minimise potential negative effects on protected sites. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise any negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies should consider medium and long duration effects on recreation and accessibility to nature. Design studies should consider short duration effects on quality and access to recreation. Discussion with stakeholders recommended at both stages.
Soil	No significant effects	
Water	- - Degradation of water quality in freshwater rivers and lochs	Feasibility and design studies should examine how to eliminate or minimise any adverse effects on water quality and erosion.
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects, Particular attention should be given to actions in PVA 11/04 that fall close to the Antonine Wall.
Landscape	No significant effects	Feasibility and design stages should include consultation with communities to avoid or minimise negative effects on urban landscape.

Commentary on potential significant effects

Regulating and maintaining services

River defences can deliver benefits by regulating water flow, reducing erosion at the site of the structure and reducing flood risk. The actions, however, can interfere with natural process: the defences could cause some or all of the floodplain to be disconnected from the river, which can lead to loss of natural habitat to capture, filter and recycle nutrients or pollutants. This can lead to a reduction in water quality. Erosion may also increase upstream or downstream of a defence due to changes in river processes. As a number of river and loch water bodies in this LPD are at less than good WFD status, potential negative effects on water quality may be significant.

Actions in the following PVAs could affect protected sites: PVA 11/4 (Mugdock Wood SSSI), PVA 11/17/1 (Clyde Valley Woodland SAC, NNR and a number of SSSIs) and PVA 11/12 (Castle Semple and Barr Lochs SSSI). However, without more detail on the location and type of action, it is difficult to identify potential effects at this state in the flood risk management planning process. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
There are no or negligible potential effects of the actions on provisioning services.

Cultural services
River defences may have mixed effects on recreation and opportunities to access nature and experience wildlife. Loss of natural habitat and biodiversity can reduce the quality of the environment for recreation and wildlife watching. However, depending on their design, some defences can improve access for some types of recreation.

Actions are likely to take place close to urban areas so areas of wild land, National Scenic Areas and the Loch Lomond and Trossachs National Park are unlikely to be affected. Within the urban landscape, river defences have potentially negative effects through disrupting the setting and view of the river and floodplain.

Historic buildings and monuments may benefit through reduced flood risk, but the defences may alter the setting of the site. Historic sites may also be affected, either for a short or long duration, by construction of the defences. In particular, actions in PVA 11/04 could be located close to the Antonine Wall UNESCO World Heritage Site so consultation with Historic Scotland is recommended. However, the actions are difficult to assess at this level of planning as more information is required about the precise nature and location of the defence.

A15.4.6 Sustainable urban drainage systems (SUDS)

Sustainable urban drainage systems (SUDS) are being considered for eight PVAs to manage surface water flooding and/or river flooding in the urban environment, for example, by reducing urban run off. Some of these actions may be progressed through surface water management planning.

All SEA topics could be affected. The ecosystems most likely to be affected are the urban freshwater ecosystems (although there could also be indirect impacts on the coastal and marine ecosystem). The potential effects of the actions are described in the text below and summarised by SEA topic in table A15.7.

Table A15.7 SUDS: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	No significant effects	Feasibility and design studies should consider opportunities to improve local biodiversity.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility and design studies should consider opportunities provide green space in urban areas. Discussion with affected communities recommended at both stages.
Soil	No significant effects	
Water	+ + Positive effects from reducing urban diffuse pollution of the water environment	Feasibility and design studies should examine how to eliminate or minimise any adverse effects on water quality and erosion.
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	Feasibility and design stages should include consultation with communities to seek opportunity to improve urban landscapes

Commentary on potential significant effects

Regulating and maintaining
SUDS help to reduce the rate and volume of run off from the urban environment, which helps to manage water as close to the source as possible. This can reduce surface water flooding (from run off) and can help to reduce river flooding by reducing peak flood flows. This helps to protect people and properties from flooding.

The actions can help adapt to climate change: for example, ponds can provide local cooling effects which can be beneficial in a densely populated urban environment.

SUDS have the potential to lead to improvements in water quality by helping to filter pollutants that might run off from the urban environment (e.g. from roads or industrial estates). SUDS can also help to reduce spills from combined –sewer overflows, with potential benefits for freshwater and coastal/marine ecosystems Given the urban diffuse pollution pressures on the water environment, the actions have potential to deliver significant benefits of water quality.

Wildlife in rivers and estuaries may benefit from improvements to water quality. For example, the actions could benefit the Inner Clyde SPA/SSSI by helping to minimise any harmful water pollutants that could run off from the urban environment. Effects will be assessed through Habitats Regulations Appraisal and through further more detailed levels of flood risk management planning.

Provisioning
SUDS actions are likely to have no or negligible effects of food provisioning.

Cultural services
SUDS have potentially positive effects on recreation and opportunities to watch wildlife as they can provide natural habitat such as wetlands in the urban ecosystem. Coastal bathing waters may also benefit through improved water quality. The quality of urban landscape may be enhanced. There are thus potential benefits for human health through improving the living environment of communities and enhanced urban greenspace.

The historic environment may benefit through a reduction in flood risk but there is also potential for negative effects on the undiscovered urban archaeology during construction of SUDS. The direction and magnitude of potential effects will need to be assessed during more detailed flood risk management planning.

A15.4.7 Coastal restoration

Coastal restoration actions, which can help to attenuate waves or estuarine surge, are being considered for five PVAs.

The ecosystems most likely to be affected are coastal and marine ecosystems and cultivated land. All SEA topics could be affected. The potential effects of the actions are described in the text below and summarised by SEA topic in table A15.8

Table A15.8 Coastal restoration: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	No significant effects	Feasibility studies should consider opportunities to help protect and restore protected coastal habitats, notable the Inner Clyde SSSI / SPA. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects, for example, on breeding or feeding birds. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies and design studies should consider the short and longer duration effects on coastal access. Discussion with stakeholders recommended at both stages.
Soil	No significant effects	Feasibility and design stages should consider potential loss of productive soils (cultivated land). Consultation with land managers recommended.
Water	+ + Benefits to water quality through improving coastal morphology	
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	
Landscape	No significant effects	

Commentary on potential significant effects

Regulating and maintaining services
Coastal restoration actions help to provide space to attenuate waves and coastal surge through the creation and restoration of natural habitats. Through attenuating waves and surge, coastal restoration actions have the potential to reduce flood risk. These natural habitats can hep to protect from erosion, although most of the coastline has low susceptibility to erosion.

Much of the Inner Firth of Clyde is highly developed, with hard flood defences and hard shoreline reinforcements. As 25% of coastal and estuarine water bodies in this LPD are at less than good status for the condition of the coastline, coastal restoration actions could have significant positive effects on water quality. The restoration of natural habitats may also provide carbon storage and help to adapt to future climate change.

The Inner Clyde SSSI and SPA could benefit from restoration actions that could create space for salt marsh regeneration, by halting or reversing coastal squeeze. However, implementation of works could cause disturbance to feeding and breeding birds. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The restoration and creation of intertidal areas may help to provide nurseries for fish, but could lead to some loss of productive land. There is therefore a mixed effect on food provisioning.

Cultural services
The potential effects of coastal restoration action on cultural services are generally positive. By improving the coastal environment, recreation, wildlife experience and cultural amenity may benefit. However, restoration could restrict or alter access to coastal areas which could cause local negative effects of short or long duration.

The historic environment is likely to benefit due to reduced risk of flooding. Historic sites may also be affected, either for a short or long duration, by the actions. However, the effects are difficult to assess at this level of planning as more information is required about the precise nature and location of the action.

A15.4.8 Coastal defences

Coastal defences, which include walls, embankments, temporary barriers, revetments, and tidal gates and barriers, are being considered for seven PVAs[4]. Some actions involve the enhancement of maintenance of existing defences.

The ecosystems most likely to be affected are urban, and coastal and marine. All SEA topics could be affected. The potential effects of the actions are described in the text below and summarised by SEA topic in table A15.9.

Table A15.9 Coastal defences: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	- - Negative effects on fish passage	Feasibility studies should consider how to avoid or minimise potential negative effects on coastal habitats and the species they support including migratory species. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies should consider medium and long duration effects on recreation and accessibility to coastal areas. Design studies should consider short duration effects on quality and access. Discussion with stakeholders recommended at both stages.
Soil	No significant effects	
Water	+ + - - Positive and adverse effects could be significant depending on location and type of action and existing state of coastline	Feasibility and design studies should examine how to eliminate or minimise any adverse effects on water quality and erosion.
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Further modelling required at feasibility and design stages to better understand any erosion risks. Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.

[4] In PVA 11/14, direct defences are also under consideration to jointly address river and coastal flooding. The action has been assessed under river defences because it would be located in the freshwater ecosystem rather than the coastal and marine ecosystem.

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Landscape	No significant effects	Feasibility and design stages should include consultation with communities to seek opportunity to improve urban and coastal landscapes and avoid or minimise negative effects.

Commentary on potential significant effects

Regulating and maintaining services
By attenuating waves and surge, coastal defences can help to reduce flood risk.

By removing natural habitat, coastal defences can have negative environmental effects but the effects will depend largely on the current state of the shoreline and the details of the proposed actions. In this LPD, there are long lengths of hard coastal defences and shoreline protection, with 25% of coastal and transitional water bodies at less than good status for then condition of the coastline. New defences on undeveloped shoreline or tidal barriers could have potentially significant negative effects on water quality and erosion; conversely, changes to existing defences could deliver potentially significant positive effects, for example, by moving back defences from the shoreline. The effects of coastal defence actions on water quality and erosion are therefore mixed.

The Inner Clyde SPA and SSSI could be affected by coastal defences: the salt marsh that helps to support the site is in favourable condition but is under threat from coastal squeeze so hard coastal defences may exacerbate pressure on this habitat. Tidal barriers could impacts on upstream protected sites if the barriers impede fish passage: for example, in the Endrick Water SAC salmon are in unfavourable condition so any negative effects could be potentially significant. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
Coastal defences can have mixed effects on marine food provision: whilst there can be loss of natural intertidal habitat which can reduce productivity, sometimes other edible species can benefit (for example, a change from soft sediment feeding fish to lobster and crab fishery).

Cultural services
The effects of coastal defences on recreation and opportunities to experience nature and wildlife may be reduced through loss of natural habitat and access. However, there may also be benefits as access may be improved and disturbance to wildlife may be reduced.

There are potential negative effects on urban and coastal landscapes. However, in areas where the shoreline is already modified, sensitively designed defences may help to improve amenity.

There are a number of historic and cultural heritage sites that may benefit from reduced flood risk but the setting may be negatively affected by the defences. Further assessment is required at more detailed planning about the precise nature and location of the defence.

Table A15.10 Shortlisted actions for Clyde and Loch Lomond: Summary of potential effects on ecosystem services

Source of flooding	All		River					River / Surface Water		Coastal	
Ecosystem service	Non-structural actions		Run off reduction	River and floodplain restoration	Storage, conveyance, control	River defences		SUDS		Coastal restoration	Coastal defences
Carbon storage	**0**		**+ +**	**+/-**	**-**	**0**		**0**		**+**	**0**
Local climate regulation	**0**		**0**	**0**	**-**	**0**		**+**		**0**	**0**
Water quality regulation	**0**		**+ +**	**+ +**	**--**	**--**		**+ +**		**+ +**	**+/-**
Pollination	**0**		**+**	**+**	**-**	**0**		**0**		**0**	**0**
Biological control of pests and disease	**0**		**+/-**	**0**	**-**	**0**		**0**		N/A	N/A
Wave/ surge attenuation	**0**		N/A	N/A	N/A	N/A		N/A		**+ +**	**+ +**
Water flow regulation	**0**		**+ +**	**+ +**	**+ +**	**+ +**		**+ +**		N/A	N/A
Erosion protection	**0**		**+ +**	**+ +**	**+/-**	**+/-**		**0**		**+**	**+/-**
Nutrition: food provision	**0**		**+/-**	**+/-**	**+/-**	**0**		**0**		**+/-**	**+/-**
Drinking water supply	**0**		**+**	**+**	**+/-**	**0**		**0**		**0**	**0**
Biotic materials: timber, biofuels	**0**		**+/-**	**+**	**+/-**	**0**		**0**		**0**	**0**
Recreation (physical interaction)	**0**		**+**	**+/-**	**+/-**	**+/-**		**+**		**+/-**	**+/-**
Accessible nature/wildlife experience	**0**		**+**	**+**	**-**	**+/-**		**+**		**+**	**+/-**
Spiritual and cultural amenity (landscape)	**0**		**+**	**+**	**-**	**-**		**+**		**+**	**+/-**

KEY					
	+ +	**Significant positive** Effects are widespread across the LPD; and/or Effects are likely to improve an ecosystem that is in less than good condition	**-**	**Negative** A noticeable negative effect that does not meet the description below
	+	**Positive** A noticeable positive effect that does not meet the description above	**- -**	**Significant negative** Effects are widespread across the LPD; and/or Effects are likely to cause an adverse effect on an ecosystem that is in less than good condition
	0	**No or negligible effects**	**+/-**	**Mixed:** The effect is likely to be a combination of positive and negative effects, particularly where effects are considered on sub-issues, areas or criteria

Map acknowledgments

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including *inter alia*, the following organisations:

Ordnance Survey
Flood maps are based upon Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office © Crown Copyright. Any unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. SEPA Licence number 100016991 (2015).

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology © NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2015), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright © The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC.

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

Appendix 16: Environmental assessment of the Flood Risk Management Strategy for Ayrshire

This appendix presents the current state of the environment and the assessment of significant environmental effects for the Flood Risk Management Strategy for Ayrshire Local Plan District (LPD). The purpose of this is to:

- Identify relevant information on the current state of the environment for Ayrshire. This information supplements the description of the current state of Scotland's environment (section 3 of the main Environmental Report).
- Report the significant environmental effects of the actions proposed to manage flood risk in Ayrshire.
- Identify mitigation of significant negative effects and opportunities to deliver wider benefits.
- Recommend further assessment at more detailed planning stages e.g. feasibility studies or design stages.

The overall assessment for all 14 Flood Risk Management Strategies is summarised in section 5 of the main Environmental Report.

A16.1 The Ayrshire Local Plan District

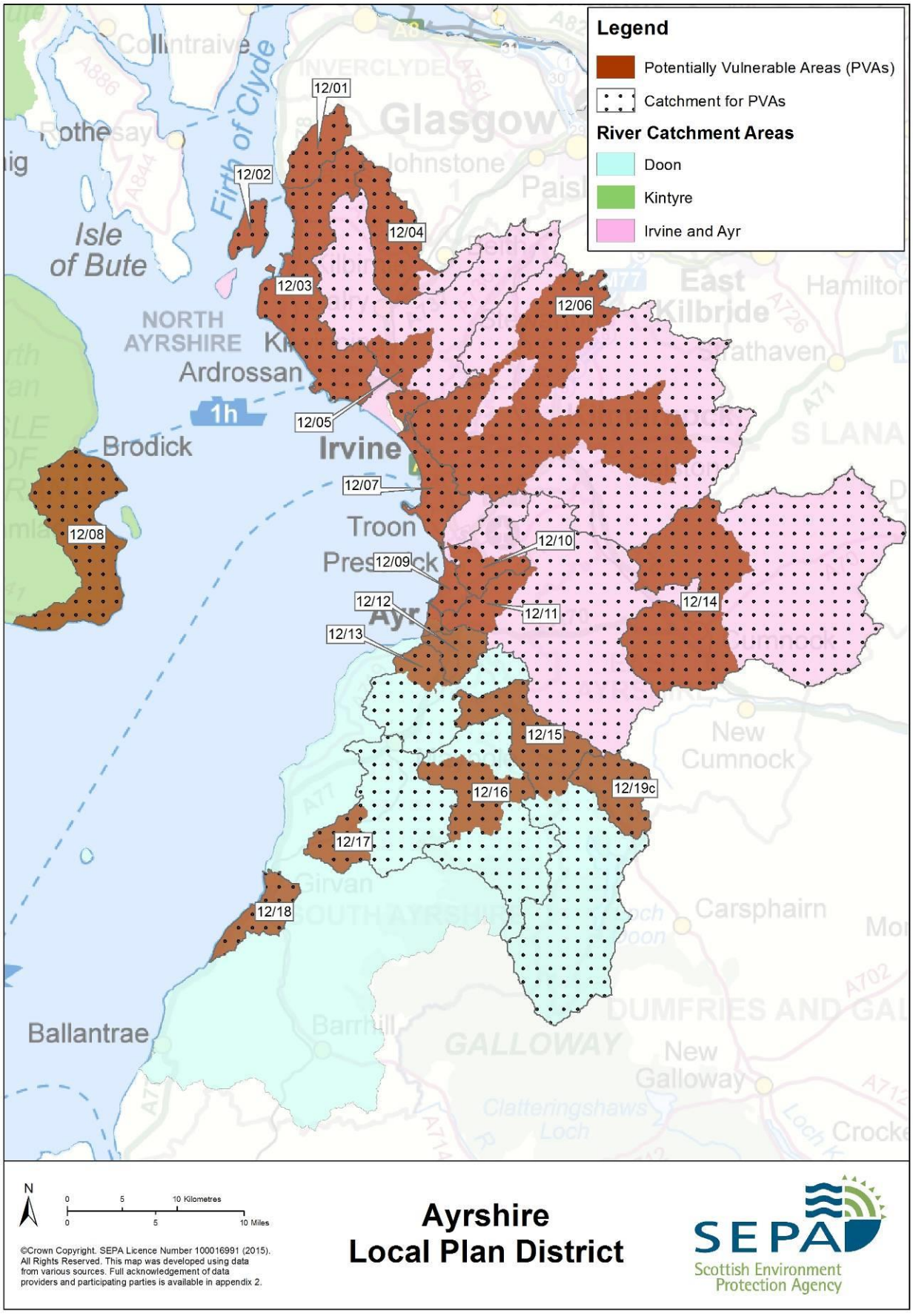
The Ayrshire Local Plan District (LPD) (figure A16) extends from Largs in the north to Ballantrae in the south and includes the Isle of Arran. The LPD has a total area of 3,100 km^2 and a population of approximately 370,000 people. The main population centres within the LPD district are Kilmarnock, Irvine and Ayr.

The main source of flooding in the LPD is river flooding (73% of Annual Average Damages[1]), followed by surface water flooding (almost 20% of Annual Average Damages) and coastal flooding (less than 8% of Annual Average Damages). There are 18 Potentially Vulnerable Areas (PVAs) within the LPD which are located across the area, and one candidate PVA (Dalmellington (12/19c)).

A range of non-structural and structural actions are being considered to manage flooding in this LPD. Structural actions are being considered to manage river flooding in 12 PVAs and to manage coastal flooding in six PVAs. Sustainable urban drainage systems (SUDS) are being considered to help manage river flooding or interactions between river flooding and surface water flooding in five PVAs (table A16.1).

[1] An indicative estimate of the direct economic costs of flooding impacts to residential properties, non-residential properties and agriculture

Figure A16: Ayrshire LPD and PVAs[2]



[2] Including candidate PVAs

Table A16.1: Shortlisted actions in Ayrshire LPD

Action	Shortlisted for the following PVAs
Run off reduction	12/01,12/02,12/03,12/04,12/05,12/06, 12/08, 12/14, 12/15, 12/18, 12/19c
River and floodplain restoration	12/03, 12/04, 12/05, 12/08, 12/10, 12/14, 12/15, 12/18
Storage conveyance and control	12/01, 12/02, 12/03, 12/05, 12/08, 12/10, 12/14, 12/15, 12/18, 12/19c
River defences	12/03, 12/04, 12/05, 12/06, 12/08, 12/14, 12/15, 12/19c
Sustainable Urban Drainage Systems	12/03, 12/05, 12/06, 12/07, 12/09
Coastal restoration	12/03, 12/07, 12/08, 12/09, 12/18
Coastal defences	12/02, 12/03, 12/07, 12/08, 12/09

A16.2 Environmental and policy context for the Ayrshire LPD

Section 2.2 and Appendix 3 of the main Environmental Report identify the relationships between the Flood Risk Management Strategies and other plans, programmes and strategies.

A16.3 Additional relevant information on the current state of the environment for Ayrshire LPD

This sub section identifies relevant information on the current state of the environment for the Ayrshire LPD. This information supplements the description of the current state of Scotland's environment (section 3 of the main Environmental Report).

A16.3.1 Ecosystems and condition

The predominant ecosystem in Ayrshire is cultivated land which covers 39% of the area. The upland ecosystems fringe the north, east and south of Ayrshire, and are the main ecosystem on the PVA catchment on the Isle of Arran. The upland area comprises plantation woodlands, blanket bogs, heaths and grasslands. It covers a further 40% of the area. Only 3% of the area is urban and these areas are found mainly along the river valleys and coast.

Table A16.2 lists the extent of different ecosystems within the LPD and provided an assessment of ecosystem condition.

Table A16.2: Ecosystems within the LPD

Ecosystem	Area (% of LPD in 2007)	Condition of ecosystem
Woodland - native	5	Native woodland is very fragmented and the remnants tend to follow steeper riverside gorges, coastal cliffs and around lochs. Some of these woodlands are designated for example River Ayr Gorge, Martnaham Loch. These woodlands are in unfavourable condition due to poor regeneration and structure. This is recognized as a problem for native woodlands throughout the area.

Ecosystem	Area (% of LPD in 2007)	Condition of ecosystem
Woodland - conifer plantation	15	The most significant areas of plantation woodland are in the Carrick Hills, and East Ayrshire. These plantations fringe the upper reaches of PVA catchments for River Doon (12/15, 12/19c) and River Irvine (12/06) They are being restructured to improve their diversity and to remove planting from peatlands. Overall woodland cover is declining.
Cultivated land	39	Rural diffuse pollution is a widespread pressure on the water environment in this LPD. This indicates that there is potential erosion and degradation of soils.
Semi-natural grassland	18	The most extensive areas are in the upland areas and adjacent to the coast; elsewhere, it is highly fragmented within dairy farmland. Some of the most extensive upland areas are designated as protected sites e.g. Muirkirk and Lowther Uplands SSSI/SPA, Merrick Hills SAC. Mostly this is in favourable condition although some areas are overgrazed.
Wetlands (fen, marsh, and swamp; bog)	6	The most extensive areas are blanket bogs which are in upland areas, some of which are designated. Within designated sites in the Muirkirk Uplands, they are mostly in favourable condition, but Aird's Moss SAC is unfavourable due to drainage and overgrazing. Drainage and overgrazing may also affect condition outside of designated sites. Most of the designated wetland sites are small isolated raised bogs surrounded by cultivated land; their condition is mixed.
Upland heath	12	Upland heath is less extensive than semi-natural grasslands and is found in the upland areas adjacent to forestry plantations. It is fragmented except within designated sites such as the Muirkirk and Lowther Uplands SPA/SSSIs and Arran Moors SPA where it is considered to be in favourable condition.
Freshwater lochs and rivers	1	Of 102 river water bodies, 39% are at less than good status for water quality and 11% are at less than good status for the condition of beds and banks. There are widespread rural diffuse pollution pressures in this LPD. Targeted action in diffuse pollution priority catchments in the River Garnock, River Ayr and River Doon has helped tackle problem areas. Some lochs are in poor condition as reflected in eutrophication of designated sites e.g. Martnaham Loch and Woodlands SSSI.
Coastal & marine	<0.5*	Most of the coastal area is good status except for Irvine Bay, which is less than good status due to loss and damage to habitats. There are several geological SSSIs along the hard coast that are sensitive to coastal engineering works. Sand dunes are extensive features along the soft coastal areas - many of these are designated and are in unfavourable condition e.g. Western Gailes.
Urban	3	Local plans recognize the area is part of the Central Scotland Green Network and identify areas within towns to extend the existing green network. This includes woodland planting for land around the urban fringe. The provision of green space is variable across urban areas in the LPD.

*The majority of the coastal and marine ecosystem extends beyond the terrestrial LPD boundary so is not captured in this figure

There are a small number of environmental sites of European and national importance in this LPD with 6 Special Areas of Conservation (SACs), 3 Special Protected Areas (SPAs), and 52 Sites of Special Scientific Interest (SSSIs) within the PVA catchments.

The largest areas of designated sites are found in the upper catchments that fringe the north east and south of the LPD. They contain large areas of blanket bog e.g. Aird's Moss, Muirkirk Uplands, and upland heath and acid grasslands (e.g. North Lowther Uplands, Merrick Kells, Muirkirk Uplands and Arran Moors). There are three upland SPAs designated for hen harriers as the main feature.

In the lowland areas there are small isolated wetlands that are mostly lowland raised bogs e.g. Cockinhead Moss, Dykeneuk Moss, Dalmellington Moss, Gleann Dubh. There are also small woodland sites associated with steep sided valleys and gorges next to rivers and lochs e.g. Loch Doon, River Ayr Gorge, Portencross Woods, Dundonald Woods and Ness Glen. The coast has designated sites for sand dunes e.g. South Annan Sands and Troon golf links and foreshore.

There are small areas of protected intertidal habitats e.g. Bogside Flats at Irvine. There 17 geological SSSIs that can be affected by coastal engineering especially at the coast e.g. Girvan to Ballantrae Bay. Within this LPD, there is the South Arran Marine Protected Area which includes Lamlash Bay (PVA 12/08). Kames Bay (PVA 12/02) is designated a SSSI and it is a key study site for marine biology.

The condition of features in protected sites in this LPD is mostly favourable. However, there are pressures on protected sites that are relevant for the Flood Risk Management Strategy. Loch Doon SSSI is unfavourable for arctic char due to fluctuating water levels. (Arctic Char are a salmonid fish found in lochs. Scotland is a stronghold and this is one of 5 sites in Scotland designated for the species.) Airds Moss SAC is affected by historic drainage. Western Gailes is unfavourable due to strand management and canalisation of burns. There are features that are currently favourable that could be affected by river works e.g. River Ayr Gorge SSSI is designated for *Fleutiauxellus maritimus* which is a scarce species of click beetle that lives in river shingle and could be threatened by river engineering and flow regulation.

A16.3.2 Ecosystem services

This sub section summarises the major ecosystem services in this LPD.

Regulating and maintaining services

- Carbon storage and sequestration is provided by woodlands, wetlands and carbon rich soils. Overall Ayrshire is not a key area for carbon storage except where there are mosses and the upland areas on Arran, Renfrewshire Heights and Muirkirk uplands. There are only very small areas of native woodland to store carbon and plantation woodlands act a more short term stores of carbon (PVAs catchments 12/01, 12/04, 12/06, 12/14, 12/15, 12/16, 12/17 and 12/19c).
- The extensive sand-dunes on the Ayrshire coast reduce the effect of offshore wind on the beaches, golf courses and other coastal recreational areas, and provide local climate regulation.
- The links golf courses and sand dunes provide a network supporting pollinating insects for arable land in the coastal strip. The Irvine to Girvan Nectar project is promoting enhancement of this service on golf courses (PVAs 12/07, 12/09, 12/13).
- Headlands provide natural protection to reduce waves. There are extensive sand dunes between Barassie and Ayr and around Irvine Bay. There is long term retreat of dunes along this coast - Seamill, Ardrossan, Saltcoats to Ayr and Turnberry to Irvine frontage. Coastal engineering has reduced the sediment sources and increased local erosion of the dunes reducing their effectiveness.
- Intensive farming and land management practices have affected the natural ability of ecosystems to regulate water quality. Actions are targeting ditch blocking on blanket bogs, riparian restoration, and soil management to address these issues in the River Ayr, Irvine

and Garnock catchments. Along the North Ayrshire strip there is work with golf courses linked to the Nectar project.

Provisioning services

- Ayrshire is predominately agricultural producing dairy and beef. It has the second largest number of dairy cattle in Scotland[3]. Upland grassland areas are used for lamb production and the more free draining soils close to the coast are used for arable.
- Commercial fishing takes place north of West Kilbride (PVA 12/01 and PVA12/03), off the Girvan coast (PVA 12/18), and off Arran and Ardrossan coasts. Small numbers of salmon and sea trout are caught and retained in this LPD. There is some fish farming in the sea and rivers.
- Forestry is a significant activity in the Carrick Forest (catchments of PVAs 12/15 and 12/19c) and Isle of Arran (PVA 12/08). Ayrshire has a large resident timber processing industry - ranging from large paper mills to the small family run sawmills. These businesses not only add important value to the raw material grown in Ayrshire but also support more than 2000 jobs.
- There are 33 drinking water protected catchments. The key areas are in the upland areas of PVA catchments for 12/01, 12/03 and 12/04.

Cultural services

- The area south of Ayr is part of the Galloway and South Ayrshire Biosphere Reserve. (Biospheres are places with world-class environments that are designated by the United Nations to promote and demonstrate a balanced relationship between people and nature.) It is internationally promoted for nature based tourism and other outdoor activities such as walking and biking. The coastal towns are centres for sailing, beach based tourism and golf, with international recognition for the links golf courses. The Ayrshire Coastal path follows most of the coast. There is kayaking on Loch Doon, on Ayr downstream of Greenock Water, Water of Girvan, and River Doon. Recreational fishing is widespread. There are recreational dive sites around Lamlash Bay, West Kilbride, and Ayr Bay.
- Riverside areas in towns are often corridors of green space through the urban areas with local routes for walking and cycling. For example green space is identified for the North Ayrshire Local Plan along most of the riverside in Irvine and Kilwinning. Some of the green space areas are relatively natural providing key corridors for wildlife and provide areas for people to view nature close to where they live.
- The area is known for its industrial heritage such as the iron industry in the Doon Valley. There is a key site at Girvan Mains which is a Roman camp, crop marks and enclosure (PVA 12/18). There are several castles with gardens e.g. Skeldon House (PVA12/15) and Glen Garnock Castle (PVA 12/04)

A16.4 Environmental assessment of the Flood Risk Management Strategy for Ayrshire

This sub section provides an assessment of the potential environmental effects of the flood risk management actions being considered for this LPD. The effects on SEA topics and on ecosystem services are reported under each group of actions. Table A16.10 compares the effects of different groups of actions on ecosystem services.

A16.4.1 Non-structural actions

A range of non-structural actions are being considered for the LPD such as property level protection, relocation of properties / infrastructure away from flood risk areas and flood warning schemes. These actions help to reduce the impacts of flooding and therefore are likely to have significant positive effects on the SEA objectives for human health and material assets. These effects have been assessed nationally rather than at an LPD level and the results are presented in section 4 of the main Environmental Report.

[3] http://www.scotland.gov.uk/Publications/2007/03/14162921/14.

As these actions help to reduce the impacts of flooding rather than the probability of flooding, they are likely to have no or negligible effects on ecosystems and ecosystem services.

A16.4.2 Run off reduction actions

Actions to reduce run off include woodland and gully woodland planting, upland drain blocking, land management, creation or restoration of wetlands and ponds, and shelter belts. These actions are being considered for eleven PVAs.

All SEA topics could be affected by these actions. The actions are most likely to be located in cultivated land in this LPD, but also in blanket bog, upland heath and semi-natural grasslands especially in the Renfrewshire Heights (PVAs 12/01 12/02 and 12/03, 12/04) and plantation woodland in PVA 12/08 on Arran. There is potential for indirect effects from changes in flows and sediment inputs on river and loch ecosystems in the PVAs where the actions are applied. The potential effects of actions are described in the text below and summarised by SEA topic in table A16.3

TableA16.3 Run off reduction: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	+ + Benefits from increased diversity and restoration of upland ecosystems, and improvements to cultivated and river ecosystems	Feasibility studies should consider opportunities to contribute to other drivers, especially diffuse pollution priority catchments and Rivers Trusts work to help Salmon. Landscape scale projects initiated via the Central Scotland Green Network may also provide opportunities to realise these actions on the ground. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	
Soil	+ + Benefits to safeguarding carbon rich soils + + Benefits to reducing soil and nutrient loss from cultivated land	Opportunities to work with diffuse pollution priority catchment officers at feasibility stage and design stage to build on existing projects and relationship with land owners/managers. Design stages should consider protecting livestock from potential exposure to pests. Consultation with land managers recommended.
Water	+ + Benefits by enhancing water quality and reducing sedimentation	Opportunities to work with diffuse pollution priority catchment officers and Rivers Trusts at feasibility stage and design stage to build on existing projects and relationship with land owners.
Climatic factors	+ + Benefits to carbon storage through wetland enhancement and woodland planting	Opportunities to enhance carbon storage and sequestration in upland catchments at feasibility stages.
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects
Landscape	No significant effects	

Commentary on potential significant effects

Regulating and maintaining services
Run off reduction actions help to slow and store water by intercepting rainfall (e.g. woodlands) and/or increasing the extent to which the land can hold any water reaching the ground (both by slowing down the flow of run off and increasing the permeability of soils). This in turn can help to regulate the flow of water by reducing the amount of water reaching rivers and slowing or reducing flood flows: this helps to protect people and properties from flooding.

These actions can lead to improvements in water quality by helping to protect soils from erosion (thus reducing the sediment reaching rivers) and increasing infiltration of nutrients into soils. Wetland vegetation is particularly effective at storing nutrients. There is potential for significant positive benefits to water quality regulation if actions support the aims of river basin management planning to reduce diffuse pollution (for example, existing projects to block drains on blanket bogs to deliver improvements to the Dipple Burn on the River Ayr and Kingswell Burn on the River Irvine).

There is potential for significant positive benefits by increasing carbon storage and sequestration through drain blocking of blanket bog. The greatest benefits are likely to arise by targeting blanket bogs which are in poor condition due to drying out and erosion. In this area this is more likely to be outside protected sites (PVAs 12/01, 12/03, 12/08 and 12/19c). Also there are some potential positive benefits to carbon storage in most ecosystems from an increase in storage in woodland and wetland soils.

Increased habitat diversity and connectivity can provide benefits to pollination especially on cultivated land. However, an increase in the wetness of cultivated land and semi-natural grassland ecosystems may increase the prevalence of some livestock pests.

There is potential for some positive benefits to protected sites. Renfrewshire Heights SSSI/SPA could benefit from increased diversification of upland habitats provided that actions are sensitive to existing conservation management objectives (PVA 12/01). There are similar potential benefits in the Arran Moors SSSI/SPA and Gleann Dubh SSSI (PVA 12/08). The reduction of sediments through actions on cultivated land could have a positive benefit on Ayr Gorge SSSI by reducing sedimentation of shingle used by the scarce click beetle (PVA 12/14). The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The effects of run off reduction actions on food provision are mixed. The actions may enhance the productivity of cultivated land and semi natural grassland by protecting soils from erosion and loss of nutrients; however, some actions could result in loss of productive land for crops such as silage.

Currently salmon rivers Ayr, Irvine and Girvan are relatively low in productivity compared with other Scottish rivers. These actions combined with other river restoration actions have potential to make a significant difference. The Rivers Trusts have been working with riparian landowners to help deliver existing projects to improve the rivers for breeding salmon. Therefore liaison with Rivers Trusts is recommended at the feasibility stage.

Run off reduction actions may help to protect drinking water supply (e.g. water colour, sediment) if actions are located in the upland catchments (e.g. PVAs 12/01, 12/03) where there are drinking water protected areas.

Actions that block drains or create wetlands within conifer plantations on the Isle of Arran (PVA 12/08) may lead to loss of timber productivity; however, it is more likely that these actions would be located in other ecosystems or could be combined with the open space requirements for forestry plantations. Liaison with forest managers is recommended at the feasibility stage.

Cultural services
The effects on cultural services (recreation, accessibility to wildlife, landscape) are likely to be positive, as the actions should improve habitat diversity and biodiversity. There is potential for a positive benefit to recreation through improved flow regulation that makes river flows better for activities such as kayaking. Improved water quality can enhance recreational fishing.

There are likely to be very limited effects on identified cultural heritage sites. Glen Garnock Castle (12/04) and Kelburn Castle (12/03) are within areas of potential for run off actions. The actions need to be in-keeping with the management of these sites.

A16.4.3 River and floodplain restoration actions

Actions to restore rivers and floodplains may include woodland creation, reach restoration, large woody debris / boulders, and creation of washlands. Sediment management actions such as bank restoration are also included in this assessment. These types of actions are being considered for nine PVAs: the majority of actions are for sediment management but there are three PVAs where river and floodplain restoration potential is identified.

All SEA topics could be affected. The main ecosystems affected are river, coastal and cultivated land. The potential effects of the actions are described in the text below and summarised by SEA topic in table A16.4.

Table A16.4 River and floodplain restoration: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	+ + Benefits to connectivity and health of river ecosystems	Feasibility studies should consider opportunities to contribute to other drivers for restoration of rivers. Further studies of sediment movement are needed to fully understand the implications at the feasibility and design stages. Consultation with relevant organisations (e.g. SNH, Rivers Trusts and Diffuse Pollution Priority Catchment Officers recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies should consider medium and long duration effects on recreation, such as changes to river flow and seasonal flooding. Design studies should consider short duration effects on quality and access to recreation. Discussion with stakeholders recommended at both stages.
Soil	No significant effects	
Water	+ + Benefits by enhancing water quality and reducing sedimentation	Feasibility studies should consider opportunities to contribute to other drivers for restoration of rivers. Further studies of sediment movement are needed to fully understand the implications at the feasibility and design stages. Consultation with relevant organisations (e.g. SNH, Rivers Trusts and Diffuse Pollution Priority Catchment Officers) recommended at both stages.
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Cultural heritage	No significant effects	Further investigation and liaison with relevant authorities is recommended as part of feasibility studies. Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	

Commentary on potential significant effects

Regulating and maintaining services
River and floodplain restoration actions slow down in-channel flow by increasing the sinuosity of the river and help reconnect the river with the floodplain, increasing the amount of water stored on land. Floodplain planting can also slow down the flow of run off and increase the permeability of soils, while river bank restoration can reduce bank erosion and sediment deposition in the river. The effect of all of these actions is to help regulate the flow of water by slowing and/or reducing flood flows: this helps to protect people and properties from flooding.

The restoration and creation of habitat (woodlands, washlands, woody debris etc) within the river and floodplain, and reduced erosion of the river bed and banks can help to filter nutrients and reduce sediments. Wetland vegetation (in this case, vegetation on the floodplain) is particularly effective at storing nutrients. There are potential significant positive benefits to water quality due to buffering rivers from agricultural land in diffuse pollution catchments. However, implementation of in-stream actions could release (for a short duration) fine sediment, which could have a temporary negative effect on water quality. Further feasibility studies are needed to fully understand the implications at the feasibility and design stages.

The creation or restoration of woodlands and wetlands (floodplains) also has the potential to increase the capture and storage of carbon, although the net benefit may be less if floodplain restoration requires the removal of trees.

Actions can increase availability of habitat for fish when river levels are high and provide refuge areas during flood event depending on design. They can also provide nursery areas for fish (again, depending on design). However, actions may also lead to the (short duration) release of fine sediment which can adversely affect spawning gravels. Further studies are needed to fully understand the implications at the feasibility and design stages.

The potential effects on protected sites are mixed. The rare click beetle in River Ayr Gorge SSSI could be sensitive to changes in shingle distribution and release of fine sediments from work upstream. Further investigation is needed to assess effects in more detail in PVA 12/14. One potential river and floodplain restoration site is part of Bogside SSSI (PVA 12/06). There is potential to positively benefit this site by extending the area of floodplain habitats. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The potential effects on food production are mixed. In this LPD, restoration actions are unlikely to be located in highly productive land. Instead, the actions are more likely to be located in small areas in narrow floodplains between meanders. The in-stream actions have the potential to significantly improve habitat for fish including salmon. However, some actions could release fine sediments that could affect spawning gravels downstream.

There is potential to link up fragmented areas of native woodland along rivers in PVA 12/14. This could result in a small increase in wood fuel and hard wood timber if native woodland is planted.

Cultural services
The effects on recreation, wildlife watching and landscape are generally likely to be positive, as the actions should improve habitat diversity and biodiversity. However, changes to the bed and banks of rivers may affect quality and access of kayaking. There could be an increase in diversity to recreational areas, but also reduced seasonal access where the floodplain is reconnected to the river and allowed to flood at times of high flows (for example, camping and golfing in PVA 12/18). . There are likely to be benefits to recreational fishing from improved fish habitat except in cases where fine sediments are released from sites upstream which adversely affect spawning gravels.

The historic environment has potential to benefit from these actions: firstly, through the reduction of flood risk to historic buildings and, secondly through the protection of wetland archaeology as a result of creating and restoring wetlands. Woodland planting, however, can disturb buried archaeology, and some floodplain archaeology could be adversely affected by floodwater. For example, the archaeology site (a Roman camp) at Girvan Mains could be potentially affected by floodplain and river restoration (PVA 12/18). Further investigation and liaison with relevant authorities is needed as part of feasibility studies.

A16.4.4 Storage conveyance and control

Storage, conveyance and control actions include online storage (e.g. increase storage in existing reservoirs), offline flood storage, increasing the size of existing culverts, removal of weirs and screens, and modifying discharge structures from reservoirs. These actions are being proposed for ten PVAs.

Cultivated land, semi-natural grasslands urban and freshwater are the main ecosystems affected by these actions. All SEA topics could be affected. The potential effects of the actions are described in the text below and summarised by SEA topic in table A16.5.

Table A16.5 Storage, conveyance and control: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	+ + Removal of barriers to fish migration - - Negative effects on protected site features including Arctic Char and scarce click beetle from changes to flow and fluctuating water levels.	Feasibility studies should consider how to avoid or minimise potential negative effects on protected species and such as loss or damage to riparian and in-stream habitats Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH, Rivers Trusts) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health - - Negative effects on hydro-electricity production	Feasibility studies should consider effects on water supply and hydroelectricity from using reservoirs for flood storage. Medium and long duration effects on recreation, such river flow. Design studies should consider short duration effects on quality and access to recreation. Discussion with stakeholders recommended at both stages.
Soil	No significant effects	
Water	+ + Removal of barriers to fish migration provides an opportunity to improve condition of water courses	See above.
Climatic factors	No significant effects	

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	

Commentary on potential significant effects

Regulating and maintaining services
Storage, conveyance and control actions are engineered actions that alter the storage and flow of water. These actions can deliver positive effects through regulating the flow of water and thus reducing flood risk to people and property. However, in this LPD, there are potential adverse effects on other uses requiring flow regulation, for example, holding water levels at a lower height in Loch Doon to allow flood storage could affect hydroelectricity production.

These actions can lead to disruption to natural processes and loss of habitat. These may have a negative effect on water quality.

The potential effects of these actions on erosion protection are mixed. Some ecosystems may, in part, benefit: for example, urban or cultivated land adjacent to the structure may experience an increase in protection from erosion. However, erosion can be exacerbated upstream and/or downstream of action.

There are potential adverse effects on protected sites, for example:
- In Loch Doon SSSI, the Arctic Char may be vulnerable to fluctuating water levels which could be exacerbated if the Loch is used for flood storage.
- The scarce click beetle in the River Ayr Gorge SSSI (PVA 12/14) could be sensitive to changes in shingle distribution caused by changes to flow from release of water from the storage areas. There could be opportunities to reduce sedimentation of the shingle with an increase in sediment stored in the floodplain upstream.
- There may be adverse effects on existing features at Bogside SSSI (PVA 12/06) from deep prolonged flooding if the area is used for offline storage.

The effects on protected sites will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The effects on terrestrial food provision are mixed: the actions may help to reduce flooding to some areas of cultivated land or semi natural grassland; however, other areas may suffer increased flooding (or erosion). These effects could lead to longer duration change in land use.

Modifications to culverts, removal of weirs and screens provide opportunity to remove barriers to fish migration. This could improve production of salmon when combined with other river restoration actions.

Cultural services
Storage, conveyance and control actions have potentially negative effects on cultural services. Loss of natural habitat and negative effects on biodiversity can impact on opportunities to watch wildlife and interact with nature, and recreation. Changes to patterns of river flow can also affect sports such as kayaking. However, the quality or access for some activities could be improved with sensitive scheme design. There are possible adverse effects on recreational use of land in urban areas if recreation areas are used for offline storage areas.

No specific cultural heritage issues were identified although further investigation is recommended at the feasibility stage when more information on location is available.

A16.4.5 River defences

River defences may include walls, embankments or demountable / temporary defences. These are being considered for eight PVAs that are located throughout the LPD.

The actions are most likely to be located in or adjacent to rivers (freshwater lochs and rivers ecosystem) or set back from the river in the urban environment (urban ecosystem) or adjacent to suburban areas where there is a mixture cultivated land and semi-natural grassland. Some of these areas are recreational green space. All SEA topics could be affected.

The effects are dependent on the types of defences (for example, defences that are set back from the river are likely to have a smaller impact) and the degree to which the river banks have already been modified: however, the exact types and location of defences are not known at this stage in the planning process. The potential effects of the actions are described in the text below and summarised by SEA topic in table A16.6.

Table A16.6 River defences: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	- - Negative effects on protected site features (such as the scarce click beetle) from changes to flow, erosion and sediment	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or disturbance of sediment. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies should consider medium and long duration effects on recreation, such as changes to river flow. Design studies should consider short duration effects on quality and access to recreation. Discussion with stakeholders recommended at both stages.
Soil	No significant effects	
Water	- - Negative effects from increased erosion that in combination with other pressures could affect river condition	Further studies of sediment movement are needed to fully understand the implications at the feasibility and design stages.
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	? Effects uncertain	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	- - Impact on landscape in green space areas	Feasibility and design stages should include consultation with communities to avoid or minimise negative effects on urban landscape.

Commentary on potential significant effects

Regulating and maintaining services

River defences can deliver benefits by regulating water flow, reducing erosion at the site of the structure and reducing flood risk. The actions, however, can interfere with natural process: a defence could cause some or all of the floodplain to be disconnected from the river, which can lead to loss of natural habitat to capture, filter and recycle nutrients or pollutants. This can lead to a reduction in water quality. Erosion may also increase upstream or downstream of a defence due to changes in river processes. As there are catchments with diffuse pollution pressures in this LPD, potential negative effects on water quality may be significant.

A decline in water quality and increase in sediment load can have potentially negative effects on freshwater species such as salmon.

Actions could affect protected sites, for example:
- The scarce click beetle in River Ayr Gorge SSSI (PVA 12/14) could be sensitive to changes in shingle distribution and release of fine sediments from work upstream.
- There is potential for the defences to cause erosion and change to features in Bogside SSSI PVA 12/06.
- Dalmellington Moss SSSI and Scottish Wildlife Trust reserve is downstream from possible river defences in PVA 12/19c. Whilst this site as a raised bog is hydrologically separate from the river, it could be affected if flow regimes to the river and floodplain change.

The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
River defences may have potentially negative effects on freshwater food production from salmon due to the loss of in-river and riparian habitat and sedimentation. This would act in combination with other existing pressures on breeding salmon such as rural diffuse pollution.

Cultural services
River defences may have mixed effects on recreation and on opportunities to access nature and experience wildlife. Loss of natural habitat and biodiversity and changes to river flow can reduce the quality of the environment, particularly in the urban area. However, depending on their design, some defences can improve access for some types of recreation provided disturbance to wildlife is minimised as part of the design.

Within the urban landscape, river defences have potentially negative effects through disrupting the setting and view of the river and floodplain.

There are potential effects on the settings of Seagate Castle in Irvine (PVA 12/06) Craigengillan Estate in Dalmellington (12/19c) and Kelburn Castle in Largs (PVA12/03). If these actions are taken forward, further investigation and liaison with relevant authorities is recommended as part of feasibility studies to ascertain whether there are any significant effects.

A16.4.6 Sustainable urban drainage systems (SUDS)

Sustainable urban drainage systems (SUDS) are being considered for five PVAs to manage surface water flooding and/or river flooding to the urban environment, for example, by reducing urban run off. Some of these actions may be progressed through surface water management planning.

All SEA topics could be affected. The ecosystems most likely to be affected are the urban freshwater ecosystems (although there could also be indirect impacts on the coastal and marine ecosystem). The potential effects of the actions are described in the text below and summarised by SEA topic in table A16.7.

Table A16.7 SUDS: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	No significant effects	Feasibility and design studies should consider opportunities to improve local biodiversity.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility and design studies should consider opportunities provide green space in urban areas. Discussion with affected communities recommended at both stages.
Soil	No significant effects	

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Water	+ + Positive effects from reducing urban diffuse pollution of the water environment	Feasibility and design studies should examine how to eliminate or minimise any adverse effects on water quality and erosion.
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	Feasibility and design stages should include consultation with communities to seek opportunity to improve urban landscapes.

Commentary on potential significant effects

Regulating and maintaining
SUDS help to reduce the rate and volume of run off from the urban environment, which helps to manage water as close to the source as possible. This can reduce surface water flooding (from run off) and can help to reduce river flooding by reducing peak flood flows. This helps to protect people and properties from flooding.

The actions can help adapt to climate change; for example, ponds can provide local cooling effects which can be beneficial in a densely populated urban environment.

SUDS have the potential to lead to improvements in water quality by helping to filter pollutants that might run off from the urban environment (e.g. from roads or industrial estates). SUDS can also help to reduce spills from combined sewer overflows, with potential benefits for freshwater and coastal/marine ecosystems. Given the urban diffuse pollution pressures on the water environment, the actions have potential to deliver significant benefits to water quality.

Wildlife in rivers and estuaries may benefit from improvements to water quality. For example, the actions may help the intertidal mudflat at Bogside Flats SSSI (PVAs 12/05, 12/06 and 12/07) remain free from pollution. Effects will be assessed through Habitats Regulations Appraisal and through further more detailed levels of flood risk management planning.

Provisioning
SUDS actions are likely to have no or negligible effects of food provisioning.

Cultural services
SUDS have potentially positive effects on recreation and opportunities to watch wildlife as they can provide natural habitat such as wetlands in the urban ecosystem. Coastal bathing waters may also benefit through improved water quality. The quality of urban landscape may be enhanced. There are thus potential benefits for human health through improving the living environment of communities and enhanced urban greenspace.

The historic environment may benefit through a reduction in flood risk but there is also potential for negative effects on undiscovered urban archaeology during construction of SUDS. The direction and magnitude of potential effects will need to be assessed during more detailed flood risk management planning.

A16.4.7 Coastal restoration

Coastal restoration includes actions to help attenuate waves, such as beach recharge schemes, shingle reprofiling and restoration of sand dunes. These actions are being considered for four PVAs in a number of locations. The creation and restoration of intertidal areas is also being considered to help attenuate coastal surge in two PVAs.

The ecosystems most likely to be affected are coastal and marine ecosystems and cultivated land. All SEA topics could be affected. The potential effects of the actions are described in the text below and summarised by SEA topic in table A16.8.

Table A16.8 Coastal restoration: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	No significant effects (although effects on protected sites are uncertain at this stage)	Feasibility studies should include studies to understand effects on sediment distribution on coastal and marine ecosystems. Consultation with relevant organisations (e.g. SNH) recommended at feasibility stage for possible effects on protected sites. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies and design studies should consider the effects on coastal access. Discussion with stakeholders recommended at both stages.
Soil	No significant effects	
Water	No significant effects	
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	
Landscape	No significant effects	

Commentary on potential significant effects

Regulating and maintaining services

Coastal restoration actions help to provide space to attenuate waves and coastal surge through the creation and restoration of natural habitats. Through attenuating waves and surge, coastal restoration actions have the potential to reduce flood risk.

Restored areas of intertidal habitat for surge attenuation have higher rates of carbon sequestration. However areas available are small scale so this is unlikely to be a significant benefit in this LPD.

Protected habitats and species are unlikely to be affected, although further assessment is recommended at feasibility and design stages to examine whether actions such as beach recharge schemes have any wider effects on sediment supply to sand dunes such as those at Wester Gailes SSSI and Troon Golf Course and Foreshore SSSI.

Provisioning services

There are potentially mixed effects on provisioning services. There are some localised opportunities with the tidal rivers to restore inter-tidal habitat as part of surge attenuation actions, which could improve nursery areas for commercial fisheries. However, beach re-charge could affect sediment sources for offshore sand banks with potential adverse effects on scallop fisheries.

Cultural services
By improving the coastal environment, recreation, wildlife experience and cultural amenity are all likely to benefit. However, implementation of works could restrict access to coastal areas which could cause short to medium duration local negative effects.

The historic environment is likely to benefit due to reduced risk of flooding and perhaps significantly due to the potential protection from coastal erosion. No specific assets were identified that could be adversely affected at this stage. However, the effects are difficult to assess at this level of planning as more information is required about the precise nature and location of the actions.

A16.4.8 Coastal defences

Coastal defences under consideration for this LPD include walls, embankments, temporary barriers, revetments, and tidal gates and barriers. Coastal management actions include revetments, groynes breakwaters, artificial reefs and detached breakwaters. There are five PVAs where direct defences and coastal management actions are being considered.

The ecosystems most likely to be affected are coastal and urban. All SEA topics could be affected. The potential effects of the actions are described in the text below and summarised by SEA topic in table A16.9.

Table A16.9 Coastal defences: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	- - Negative effects on protected coastal and marine habitats through increased erosion and disruption of natural processes	Feasibility studies should consider how to avoid or minimise potential negative effects such increased erosion. Modelling of effects on coastal processes recommended, particularly to understand how multiple coastal actions within a coastal cell may interact. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH and Marine Scotland) recommended at all stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Further modelling of coastal processes recommended at feasibility and design stages (see above). Feasibility studies should consider medium and long duration effects on recreation and accessibility to coastal areas. Design studies should consider short duration effects on quality and access to recreation. Discussion with stakeholders required at both stages.
Soil	No significant effects	
Water	No significant effects	
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure - - Property and infrastructure may experience an increased erosion risk outside of the area of protection	Further modelling of coastal processes recommended at feasibility and design stages (see above). Design stages should consider how to minimise waste and energy consumption.

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	- - Negative effects on seascape and coastal landscape from artificial structures.	Feasibility and design stages should include consultation with communities to avoid or minimise negative effects on urban and coastal landscapes.

Commentary on potential significant effects

Regulating and maintaining services
By attenuating waves and surge, coastal defences can help to reduce flood risk.

By removing natural habitat, coastal defences can have negative environmental effects and alter natural coastal processes of erosion and deposition. This can lead to erosion of dunes and beaches elsewhere (and, potential increases in flood risk to other coastal areas if defences are not correctly designed). This is particularly relevant for areas where there is long shore drift (e.g. PVAs 12/03, 12/07 and 12/09).

Where coastal defences lead to loss of natural habitat, there are potential negative effects on carbon storage. However, actions such as offshore reefs can provide areas for kelp to colonize that could help increase carbon storage.

Protected sites that could be affected by coastal defences include:
- Sand dune sites at Wester Gailes SSSI and Troon Golf course and Foreshore SSSI: changes to costal processes could benefit these sites by reducing erosion and increasing sediment supply, or result in an adverse effect through increased erosion and a reduction in sediment supply. The actions require consideration of the effect on coastal processes within the coastal cell to understand their effects in combination with each other.
- Any defences at Millport frontage could affect local coastal processes within the Kames Bay and adversely affect the Kames Bay SSSI. This is a long term marine research area. The Ardrossan to Saltcoats SSSI is notified for its geology and is sensitive to coastal engineering works.
- Any actions at Lamlash Bay would be within South Arran Marine Protected Area. Further assessment of potential effects is recommended at feasibility stage, as well as consultation with Marine Scotland.

Provisioning services
There is a mixed effect on provisioning services. Coastal management actions could affect sediment sources for offshore sand banks with potential adverse effects on scallop fisheries. Actions such as offshore reefs could have a positive effect on other local fisheries such as shell fish and crabs and lobsters.

Cultural services
The effects of coastal defences on recreation and opportunity to experience nature and wildlife are mixed depending on the actions and their effect on coastal processes. The offshore actions could increase opportunities for diving and angling, and protecting beaches from wave action. In other locations there could be erosion of beaches and sand dunes that protect golf courses behind these natural defences.

There is potential for a significant adverse effect on landscape from these actions if defences interfere with seascape and sea views.

The historic environment is likely to benefit due to reduced risk of flooding and perhaps significantly due to the potential protection from coastal erosion. No specific assets were identified that could be adversely affected at this stage. Further assessment is required at more detailed planning about the precise nature and location of the defence.

Table A16.10 Shortlisted actions for Ayrshire: Summary of potential effects on ecosystem services

Source of flooding	All		River					River / Surface Water		Coastal	
Ecosystem service	Non-structural actions		Run off reduction	River and floodplain restoration	Storage, conveyance, control	River defences		SUDS		Coastal restoration	Coastal defences
Carbon storage	**0**		**+ +**	**+**	**0**	**0**		**0**		**+**	**+/-**
Local climate regulation	**0**		**0**	**0**	**0**	**0**		**+**		**0**	**0**
Water quality regulation	**0**		**+ +**	**+/-**	**+/-**	**--**		**+ +**		**+**	**0**
Pollination	**0**		**+**	**0**	**0**	**0**		**0**		**0**	**0**
Biological control of pests and disease	**0**		**0**	**0**	**0**	**0**		**0**		N/A	N/A
Wave/ surge attenuation	**0**		N/A	N/A	N/A	N/A		N/A		**+ +**	**+ +**
Water flow regulation	**0**		**+ +**	**+ +**	**+ +**	**+ +**		**+ +**		N/A	N/A
Erosion protection	**0**		**+ +**	**+ +**	**+/-**	**+/-**		**0**		**+**	**--**
Nutrition: food provision	**0**		**+/-**	**+/-**	**+/-**	**-**		**0**		**+/-**	**+/-**
Drinking water supply	**0**		**+**	**0**	**0**	**0**		**0**		**0**	**0**
Biotic materials: timber, biofuels	**0**		**+**	**+**	**0**	**0**		**0**		**0**	**0**
Recreation (physical interaction)	**0**		**+**	**+/-**	**+/-**	**+/-**		**+**		**+/-**	**+/-**
Accessible nature/wildlife experience	**0**		**+**	**+**	**-**	**+/-**		**+**		**+**	**+/-**
Spiritual and cultural amenity (landscape)	**0**		**+**	**+**	**0**	**-**		**+**		**+**	**--**

KEY					
	+ +	**Significant positive** Effects are widespread across the LPD; and/or Effects are likely to improve an ecosystem that is in less than good condition	**-**	**Negative** A noticeable negative effect that does not meet the description below
	+	**Positive** A noticeable positive effect that does not meet the description above	**- -**	**Significant negative** Effects are widespread across the LPD; and/or Effects are likely to cause an adverse effect on an ecosystem that is in less than good condition
	0	**No or negligible effects**	**+/-**	**Mixed:** The effect is likely to be a combination of positive and negative effects, particularly where effects are considered on sub-issues, areas or criteria

Map acknowledgments

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including *inter alia*, the following organisations:

Ordnance Survey
Flood maps are based upon Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office © Crown Copyright. Any unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. SEPA Licence number 100016991 (2015).

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology © NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2015), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright © The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC.

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

Appendix 17: Environmental assessment of the Flood Risk Management Strategy for Tweed

This appendix presents the current state of the environment and the assessment of significant environmental effects for the Flood Risk Management Strategy for Tweed Local Plan District (LPD). The purpose of this is to:

- Identify relevant information on the current state of the environment for the Tweed. This information supplements the description of the current state of Scotland's environment (section 3 of the main Environmental Report).
- Report the significant environmental effects of the actions proposed to manage flood risk in the Tweed.
- Identify mitigation of significant negative effects and opportunities to deliver wider benefits.
- Recommend further assessment at more detailed planning stages e.g. feasibility studies or design stages.

The overall assessment for all 14 Flood Risk Management Strategies is summarised in section 5 of the main Environmental Report.

A17.1 The Tweed Local Plan District

The Tweed Local Plan District (LPD) (figure A17) contains the Scottish part of the River Tweed catchment and covers a total area of approximately 4,341km^2. The area extends from Biggar in the west, down to Coldstream in the east and contains a population of approximately 120,000. The main tributaries of the River Tweed include the Biggar Water, Lyne Water, Eddleston Water, Ettrick Water, Gala Water, Leader Water, Whiteadder Water, Blackadder Water and River Teviot. The Tweed LPD also includes the Scottish part of the Bowmont Water.

Tweed is a cross-border catchment, with the lowermost 7km of the main stem, the River Till (including its tributary the Bowmont Water), and the Whiteadder Water straddling the Scottish/English border. Because the lowermost section of Tweed is located in England, including the mouth at Berwick-upon-Tweed, the Tweed LPD does not contain any coastline. Actions in the Scottish areas of Tweed may have the potential to affect downstream areas in England, including the coastal area into which Tweed drains. This is discussed further in section A17.4. In the event that actions are deemed to have the potential to affect the English side of the border, this will be discussed further with the Environment Agency and other relevant responsible authorities.

The main source of flooding in the LPD is river flooding (80% of Annual Average Damages[1]) with the remaining (20%) caused by surface water flooding. There are 13 Potentially Vulnerable Areas (PVAs) within the LPD spread across the LPD area. The source catchments for the PVAs (the areas that drain to the PVA) cover most of the LPD.

A range of non-structural and structural actions are being considered to manage flooding in this LPD. Structural actions are being considered to manage river flooding in seven PVAs (table A17.1).

[1] An indicative estimate of the direct economic costs of flooding impacts to residential properties, non-residential properties and agriculture

Figure A17: Tweed LPD and PVAs

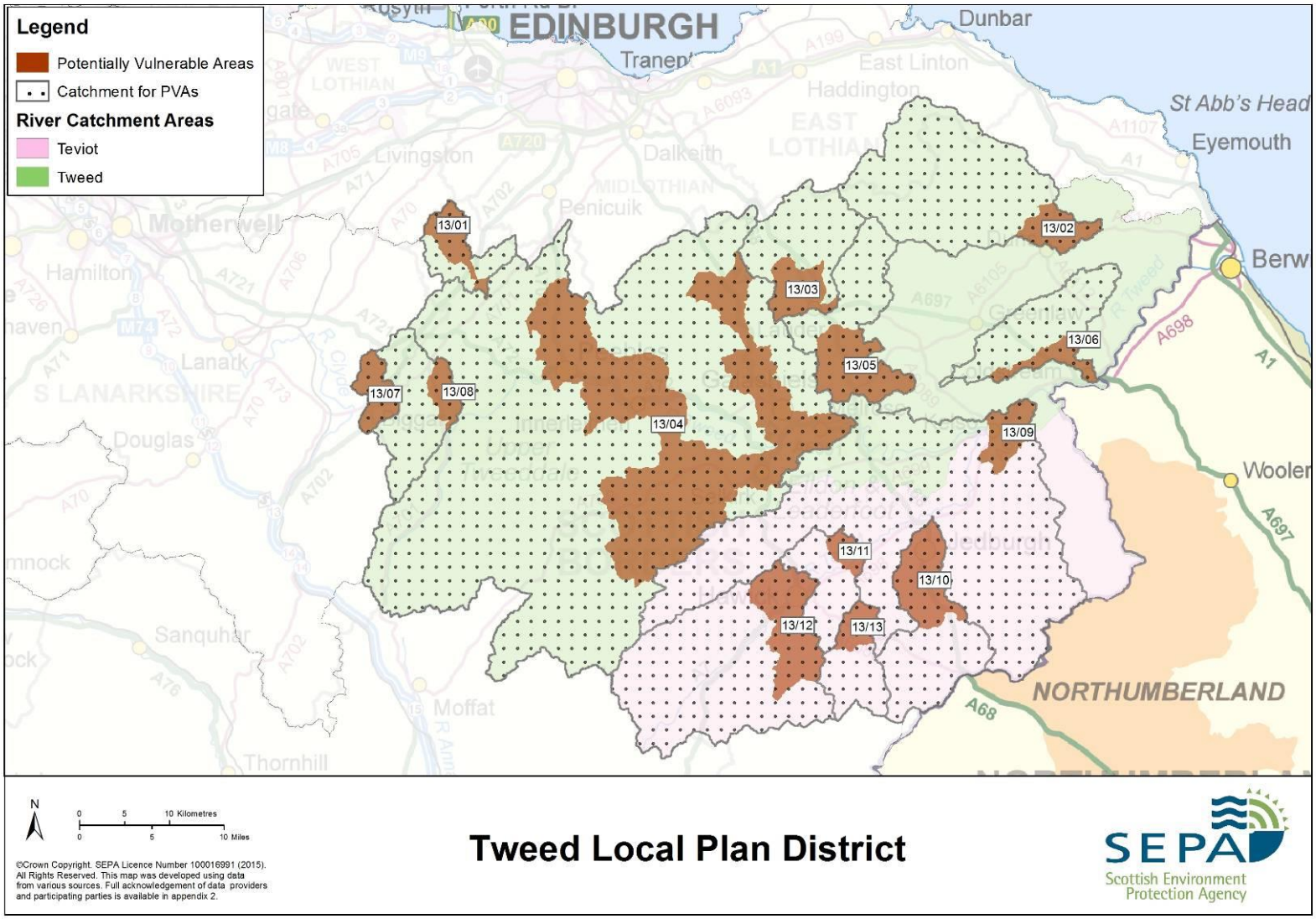


Table A17.1: Shortlisted actions in Tweed LPD

Action	Shortlisted for the following PVAs												
	13/01	13/02	13/03	13/04	13/05	13/06	13/07	13/08	13/09	13/10	13/11	13/12	13/13
Run off reduction				●	●		●	●		●		●	●
River and floodplain restoration				●	●		●	●		●		●	●
Storage conveyance and control				●	●		●	●		●		●	
River defences				●	●		●	●		●		●	●

A17.2 Environmental and policy context for the Tweed LPD

Section 2.2 and Appendix 3 of the main Environmental Report identify the relationships between the Flood Risk Management Strategies and other plans, programmes and strategies.

A17.3 Additional relevant information on the current state of the environment for the Tweed LPD

This sub section identifies relevant information on the current state of the environment for the Tweed LPD. This information supplements the description of the current state of Scotland's environment (section 3 of the main Environmental Report).

A17.3.1 Ecosystems and condition

The predominant ecosystem in Tweed is cultivated land, which covers 37% of the area and account for 9% of the national total. Other common ecosystems are semi natural grassland (27%), conifer plantation (15%) and upland heath (14%). Table A17.2 shows the ecosystems present within this LPD.

Table A17.2. Ecosystems within the LPD

Ecosystem	Area (% of LPD in 2007)	Condition of ecosystem
Woodland - native	4	Native woodlands are poorly represented and fragmented in the area as a result of a long history of sheep grazing and border warfare. In 2007, only 1% of the area's woodland was designated as an area of semi-natural woodland but this has since increased as new native woodlands have been created or put into positive management. The Native Woodland Survey of Scotland reports that around 76% the woodland in this area is in moderate to good overall health for biodiversity.
Woodland - conifer plantation	15	Nationally, the area of forest plantation is increasing. There is no information on the condition.
Cultivated land	37	Rural diffuse pollution is a pressure on the water environment in this LPD. This indicates that there is potential erosion and degradation of soils.

Ecosystem	Area (% of LPD in 2007)	Condition of ecosystem
Semi-natural grassland	27	Nationally, this ecosystem is thought to be in moderate condition. There is no information on the condition of this ecosystem in this LPD.
Wetlands (fen, marsh, and swamp; bog)	1	Nationally, within protected sites, condition is generally good. However, in this LPD, a large number of protected sites are classed as being in unfavourable condition, particularly basin fens and raised bogs. The Tweed is notable for its large number of basin mires (over 200 identified).
Upland heath	14	Nationally, upland habitats are generally in good condition and improving. There is no information on the overall condition of this ecosystem in this LPD.
Freshwater lochs and rivers	0.5	There are 154 river water bodies in this LPD. The condition of these river water bodies is generally good, with 15% at less than good status for water quality and 12% at less than good status due to the physical condition of the river beds and banks. The condition of lochs is also good in this LPD. None of the six loch water bodies are at less than good overall status. There are rural diffuse pollution pressures in this LPD. A large part of the eastern and south east areas of this LPD are designated as a Nitrate Vulnerable Zone. This indicates that ground and surface waters may be under pressure from excess nitrates and phosphorus.
Urban	1	Access to greenspace in Scotland's urban environment is generally good and this is particularly true of the urban areas within this LPD. Over two thirds (68%) of adults in Scotland have access to useable greenspace within a five-minute walk from their home (not including their own garden).

There are seven Special Areas of Conservation (SACs), four Special Protected Areas (SPAs) and 82 Sites of Special Scientific Interest (SSSIs) in this LPD.

The largest area of designated sites is found in the upper catchment due mainly to the extent of the Moorfoot Hills SSSI/SAC and Tweedsmuir Hills SSSI. These sites contain large areas of upland heath (including intact blanket bog), as well as wetlands and semi-natural grassland. The main stem of the river and its major tributaries of Whiteadder, Teviot, Ettrick, and Gala are designated as both a SAC (for Atlantic salmon, otter, lamprey and water crowfoot) and a SSSI. The catchment of Tweed also drains to the Berwick and North Northumberland Coast SAC (not located within this LPD). Many of the Border Mires and Mosses enjoy SSSI status with the Whitlaw Moss complex designated as a National Nature Reserve.

The condition of features in protected sites in this LPD is mixed. Relevant pressures include high intensity grazing and land management for grouse shooting (e.g. Moorfoot Hills SAC which is the largest area of intact blanket bog in south east Scotland), diffuse pollution, acidification, eutrophication, river-works and bankside management, genetic pollution and disease, abstraction and impoundment management (e.g. River Tweed SAC which is currently unfavourable for Atlantic salmon, lamprey, and water crowfoot), scrub encroachment from woodland and land drainage (e.g.

Threepwood Moss SAC which is the considered to be one of the best areas within the UK for active raised bogs). The Whitlaw and Branxholme SAC, which is considered to be one of the best areas within the UK for transition mires and quaking bogs, alkaline fens and slender green feather moss, is also under pressure from agricultural activities.

Opportunities to contribute to site management objectives include the damming of drains, removal of scrub and introduction of low intensity grazing to increase water levels within bogs, as well as good muirburn practice to encourage regeneration of heather moorland. The meeting of site objectives is also being assisted by the many land and river restoration initiatives (such as those managed by Tweed Forum) and management plans in place in Tweed, including the Tweed Catchment Management Plan and Tweed River Basin Management Plan.

A17.3.2 Ecosystem services

This sub section summarises the major ecosystem services in the Tweed LPD.

Regulating and maintaining services

- Carbon storage and sequestration in Tweed will not be as great as in some other areas of the country (e.g. compared with the Highlands where there are large areas of peatlands) but will still be considerable in the upland areas of the catchment.
- Areas of wetlands, semi natural grassland and upland heath help to filter and maintain the good water quality in Tweed. This is particularly important to the Tweed fishery and the economy that this supports.
- Water supply reservoirs in the headwaters of several Tweed tributaries (e.g. Whiteadder and Megget) allow river flow to be enhanced particularly during the drier summer months. Ecosystems such as woodlands, wetlands, semi natural grassland and upland heath in Tweed help to regulate the overland flow of water.

Provisioning services

- Tweed is an important agricultural area. The upland areas, predominantly in the west of the LPD, contain predominantly rough grazing. Further down the catchment, grassland farming is more common. The lowland areas of Tweed in the east of the LPD contain large areas of fertile land committed to arable farming.
- The Tweed District provides the largest numbers of wild salmon and sea trout caught and retained in Scotland. There are no active fish farming sites in Tweed (or coastal environment in to which Tweed drains).
- There is significant woodland cover in the upper catchment, with large areas of commercial forestry plantation.
- There are a number of rivers that are important sources of drinking water, including the Ettrick Water, Allan Water, Yarrow Water, Lyne water, West Water, Herriot Water, Caddon Water and the main stem of the Tweed west of Galashiels. There are also a number of reservoirs within the headwaters of Tweed.

Cultural services

- The area provides a wide range of recreational opportunities, including angling, walking, riding, cycling, and canoeing. The catchment is particularly notable for the number of walking and cycling routes that it contains, including the Southern Upland Way.
- There are protected landscapes in the form of one National Nature Reserve (Whitlaw Moss) and two National Scenic Areas (Eildon and Leaderfoot, and Upper Tweeddale). Wild land exists at Talla Hart fell in the headlands of the catchment. This area has a distinct and special character, with little overt human influence on the landscape.
- The area is also rich in historic sites, including scheduled monuments, listed buildings (such as stately homes and castles), battlefields and gardens.

A17.4 Environmental assessment of the Flood Risk Management Strategy for Tweed

This sub section provides an assessment of the potential environmental effects of the flood risk management actions under consideration for the PVAs within this LPD. The effects on SEA topics and on ecosystem services are reported under each group of actions. Table A17.7 compares the effects of different groups of actions on ecosystem services.

A17.4.1 Non-structural actions

A range of non-structural actions are being considered for the LPD such as property level protection, relocation of properties / infrastructure away from flood risk areas and flood warning schemes. These actions help to reduce the impacts of flooding and therefore are likely to have significant positive effects on the SEA objectives for human health and material assets. These effects have been assessed nationally rather than at an LPD level and the results are presented in section 4 of the main Environmental Report.

As these actions help to reduce the impacts of flooding rather than the probability of flooding, they are likely to have no or negligible effects on ecosystems and ecosystem services.

A17.4.2 Run off reduction actions

Actions to reduce run off include woodland planting, upland drain blocking, land management actions such as soils and bare earth improvements, and the creation or restoration of wetlands and ponds. These actions are being considered for seven PVAs. These PVAs and their source catchments are predominantly located in the middle to upper catchment of Tweed. Consequently there is little potential for actions to affect the other side of the border in England, such as the Berwick and North Northumberland Coast SAC.

All SEA topics and ecosystems may be affected by these actions: either directly (where an action impacts on the ecosystem in which the action is located) or indirectly (e.g. where the freshwater ecosystem benefits from arising land use change and management). The potential effects of the actions are described in the text below and summarised by SEA topic in table A17.3.

Table A17.3 Run off reduction: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	+ + Benefits to connectivity and health of wetland and woodland ecosystems	Feasibility studies should consider opportunities to contribute to other drivers for restoration of wetlands and woodlands, including improvements to protected habitats and species. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits to flood risk reduction and protection of human health	Feasibility studies should consider opportunities to benefit recreation.
Soil	+ + Benefits to safeguarding carbon rich soils and reduction in soil erosion.	Design stages should consider how best to protect livestock from potential exposure to pests.
Water	+ + Benefits to water quality and sedimentation	
Climatic factors	No significant effects	

Material assets	+ + Benefits to flood risk reduction and protection of properties and infrastructure	Design stages should consider how to minimise waste generation and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise potential for negative effects.
Landscape	No significant effects	

Commentary on potential significant effects

Regulating and maintaining services
Run off reduction actions help to slow and store water by intercepting rainfall (e.g. woodlands) and/or increasing the extent to which the land can hold any water reaching the ground (both by slowing down the flow of run off and increasing the permeability of soils). This in turn can help to reduce the amount of water reaching rivers and slow or reduce flood flows, helping to protect people and properties from flooding.

These actions can also lead to improvements in water quality by helping to protect soils from erosion (thus reducing the sediment reaching rivers) and increasing infiltration of nutrients into soils. Wetland vegetation is particularly effective at storing nutrients. Any benefits to water quality and soil erosion will help to maintain the low nutrient and low sediment load that is essential for the protected aquatic species in the Tweed catchment such as salmonids.

The creation or restoration of woodlands and wetlands (including peatlands through upland drain blocking) also has the potential to increase the capture and storage of carbon. Although wetlands also have the potential to release carbon dioxide into the atmosphere, the net benefit to carbon storage is more likely to be positive when restoring wetlands. Upland drain blocking and the restoration of wetlands may also help to improve the connectivity and condition of the many protected wetlands within Tweed (including bogs and mires).

Increased habitat diversity and connectivity can provide benefits to pollination and biological control of pests and diseases. However, an increase in the wetness of cultivated land and semi-natural grassland ecosystems may increase the prevalence of some livestock pests.

There is a potential negative effect of woodland planting on upland heath and wetlands due to scrub encroachment. There is also a potential negative effect of wetland restoration on bog woodland habitat as changes in water levels can affect regeneration of the woodland. The potential for these effects will be assessed further through Habitats Regulations Appraisal and during more detailed flood risk management planning.

Provisioning services
The potential effects of run off reduction actions on food provision are mixed. These actions may enhance the productivity of cultivated land and semi natural grassland by protecting soils from erosion and loss of nutrients (and, as identified above, through providing better biological control of pests and disease). However, some areas of productive land may be lost where these actions are implemented and livestock may be impacted by an increase in livestock pests. Since these actions are being promoted in PVA catchments largely out with fertile areas of the Tweed, the potential for loss of highly productive land is minimal. Freshwater fisheries may benefit through improved water quality and reduced sedimentation.

Actions may provide benefits to drinking water supply by helping to remove nutrients.

Actions that block drains or create wetlands within conifer plantations may lead to loss of timber productivity. However, it is unlikely that these actions would be located in these ecosystems.

Cultural services

The effects on recreation, wildlife watching and landscape are likely to be positive, as the actions should improve habitat diversity and biodiversity.

The historic environment also has the potential to benefit from these actions: firstly, through the reduction of flood risk to historic buildings and secondly, through the protection of wetland archaeology as a result of creating and restoring wetlands. Conversely, woodland planting can disturb buried archaeology. The structure and setting of historic sites could also be affected but this will need to be assessed during more detailed flood risk management planning.

A17.4.3 River and floodplain restoration actions

Actions to restore rivers and floodplains include floodplain reconnection, floodplain woodland restoration, reach restoration, and creation of washlands. Sediment management actions such as bank restoration are also included in this assessment. At least one of these types of actions is being considered for seven PVAs. These PVAs and their catchments are located within the middle to upper catchment of Tweed. Consequently there is little potential for actions to affect the other side of the border in England.

All SEA topics and a wide range of ecosystems may be affected including woodlands, cultivated land, semi natural grassland, wetlands, freshwater rivers, and the urban ecosystem. The potential effects of the actions are described in the text below and summarised by SEA topic in table A17.4.

Table A17.4 River and floodplain restoration: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	+ + Benefits to connectivity and health of wetland ecosystems	Feasibility studies should consider opportunities to contribute to other drivers for restoration of wetlands and woodlands, including improvements to protected habitats and species. These studies should also consider potential negative effects on habitat, such as wader habitat. Design studies should aim to achieve sympathetic design, siting and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits to flood risk reduction and protection of human health	Feasibility studies should consider opportunities to benefit recreation. Design studies should consider short duration effects on quality and access to recreation.
Soil	+ + Benefits to safeguarding carbon rich soils	Feasibility studies should consider potential loss of fertile soils, particularly cultivated land. Design stages should consider how best to protect livestock from potential exposure to pests.
Water	+ + Benefits to water quality and sedimentation	
Climatic factors	No significant effects.	
Material assets	+ + Benefits to flood risk reduction and protection of properties and infrastructure.	Design stages should consider how to minimise waste generation and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise potential for negative effects.
Landscape	No significant effects	

Commentary on potential significant effects

Regulating and maintaining services
River and floodplain restoration actions slow down in-channel flow by increasing the sinuosity of the river and help reconnect the river with the floodplain, increasing the amount of water stored on land. Floodplain planting can also slow down the flow of runoff and increase the permeability of soils, while river bank restoration can reduce bank erosion and sediment deposition in the river. The effect of all of these actions is to regulate the flow of water by slowing and/or reducing flood flows: this helps to protect people and properties from flooding.

The creation or restoration of woodlands and floodplain wetlands also has the potential to increase the capture and storage of carbon, although the net benefit may be less where floodplain restoration requires the removal of trees. As stated above, although wetlands have the potential to release carbon dioxide into the atmosphere, the net benefit to carbon storage is more likely to be positive when restoring this ecosystem.

The restoration and creation of habitat (woodlands, washlands, woody debris etc) within the river and floodplain, and reduced erosion of the river bed and banks, can help to filter nutrients and reduce sediments. Wetland vegetation (in this case, vegetation on the floodplain) is particularly effective at storing nutrients. As there are rural diffuse pollution pressures in this LPD, there may be significant benefits to improved water quality from these actions.

Other potential positive effects include improvements to pollination (as pollinating insects may benefit from greater food and shelter in a more diverse habitat) and biological control of pests and diseases. However, as with runoff reduction actions, an increase in the wetness of cultivated land and semi-natural grassland ecosystems may increase the prevalence of some livestock pests.

Any benefits to water quality and soil erosion will help to maintain the low nutrient and low sediment load that is essential for the protected aquatic species in the Tweed catchment such as salmonids. Restoration of wetlands may also help to improve the connectivity and condition of the many protected wetlands within Tweed (including bogs and mires). However, restoration works could lead to short duration increases in sediment load and could disturb, or remove the habitat, of breeding birds (e.g. waders). Consequently the timing and implementation of actions needs to be carefully planned. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The effects of river and floodplain restoration actions on food provision are likely to be mixed. As with runoff reduction actions, these actions may enhance the productivity of cultivated land and semi natural grassland by protecting soils from erosion and loss of nutrients. They may also benefit meat production through better biological control of pests and through provision of shelter for livestock. Conversely, some areas of productive land may be lost where these actions are implemented and livestock may be impacted by an increase in livestock pests. However, since these actions are being promoted in PVA catchments largely out with fertile areas of the Tweed, the potential for loss of highly productive land is minimal.

By protecting water quality and reducing sedimentation, freshwater fisheries such as salmon and sea trout may benefit.

Restoration actions may provide benefits to drinking water supply by helping to remove nutrients and pollutants.

Cultural services
The potential effects of river and floodplain restoration actions on recreation, wildlife watching and the landscape are positive, since these actions should improve habitat diversity and biodiversity. Access to the river for activities such as fishing or kayaking may be improved or hampered

depending on the location and design of works. On the ground works may also impede access to the river although these effects would be of short duration.

Restoration actions are unlikely to take place in wild land due to its distance from flood risk receptors and therefore this habitat should not be affected.

The historic environment also has the potential to benefit from these actions: firstly, through the reduction of flood risk to historic buildings and secondly, through the protection of wetland archaeology as a result of creating and restoring wetlands. Conversely, woodland planting can disturb buried archaeology. The structure and setting of historic sites could also be affected but this will need to be assessed during more detailed flood risk management planning.

A17.4.4 Storage, conveyance and control actions

Storage, conveyance and control actions include on and offline flood storage, channel modifications, and addition or modification to weirs, bridges, or pumping stations. These types of actions are being considered for six PVAs (conveyance actions are being considered for four PVAs, flood storage for four PVAs and modifications to fluvial control structures for three PVAs). These PVAs and their catchments are predominantly located within the middle to upper catchment of Tweed. Consequently there is little potential for actions to affect the other side of the border in England.

A wide range of ecosystems may be affected including woodlands, semi natural grassland, wetlands, freshwater rivers, and the urban ecosystem. All SEA topics could be affected. The potential effects of the actions are described in the text below and summarised by SEA topic in table A17.5.

Table A17.5 Storage, conveyance and control: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	- - Loss or damage to ecosystems leading to reduced habitat connectivity and biodiversity - - Negative effects on protected habitats and species through increased sediment load	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or damage to wetlands, disturbance of sediment, or barriers to fish passage. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH, Fisheries Trusts) recommended at all stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits to flood risk reduction and protection of human health	Feasibility studies should consider medium and long duration effects on recreation. Design studies should consider short duration effects on quality of, and access to, recreation. Discussion with stakeholders recommended at all stages.
Soil	- - Loss or damage to carbon rich soils in ecosystems such as wetlands and riparian woodlands	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss of fertile land or damage to wetlands. Consultation with land managers recommended.
Water	- - Loss of river habitats and changes to channel morphology could affect the status of rivers	Feasibility studies should consider how to avoid or minimise potential negative effects on the morphology of rivers.
Climatic factors	No significant effects	

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Material assets	+ + Benefits to flood risk reduction and protection of properties and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	Feasibility and design stages should include consultation with communities and SNH to avoid or minimise negative effects on landscape.

Commentary on potential significant effects

Regulating and maintaining services
Storage, conveyance and control actions are engineered actions that alter the storage and/or flow of water. These actions can deliver positive effects through regulating the flow of water and thus reducing flood risk to people and property.

These actions can lead to disruption to natural processes and loss of habitat. This has potentially negative effects on water quality (due to loss of habitat to filter nutrients) and carbon storage, particularly if the actions affect wetlands that are already in unfavourable condition.

Any loss or damage to ecosystems may have local effects such as a reduction in pollination and pest and disease control.

The ecosystem adjacent to the structure may benefit from these actions through protection from erosion. However, erosion can be exacerbated downstream of a conveyance structure, with potentially significant negative effects on downstream ecosystems.

Increased erosion can increase sediment and nutrient load of water, with potentially significant negative effects on protected species such as salmonids. Implementation of actions could also lead to short duration increases in sediment load and could disturb spawning fish, therefore the timing and implementation of actions needs to be carefully planned. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning

Provisioning services
The effects on terrestrial food provision and production of biofuels are likely to be mixed. Actions may help to reduce flooding to some areas of cultivated land or semi natural grassland. However, other areas may suffer increased flooding (or erosion) and productive land may be lost (e.g. with online storage). Freshwater fisheries may suffer negative effects through loss of habitat and increased sedimentation.

Drinking water supply may be negatively affected if actions lead to loss or damage to wetlands (as wetlands can help to filter nutrients and pollutants thus reducing treatment costs).

Cultural services
Storage, conveyance and control actions have potentially negative effects on cultural services. Loss of natural habitat and negative effects on biodiversity can impact opportunities to watch wildlife and interact with nature, and undertake recreational activities such as angling. Changes to patterns of river flow can also affect sports such as kayaking. However, access for some activities could be improved with sensitive scheme design.

There are protected landscapes within the catchments of PVAs 13/04 and 13/08 that could experience negative effects from storage actions in the catchment. In urban areas, storage, conveyance and control actions may have potentially negative effects by affecting the views of rivers.

The historic environment may benefit through a reduction in flood risk, but there is also potential for negative effects. For example, disconnection of the floodplain could damage wetlands and the archaeology preserved within it. The historic environment may be negatively affected altering the setting of historic sites or through damage to sites when the action is implemented. Further assessment is required at more detailed levels of flood risk management planning.

A17.4.5 River defences

River defences may include walls, embankments or demountable / temporary defences. At least one of these types of actions is being considered for seven PVAs. These PVAs and their catchments are predominantly located within the middle to upper catchment of Tweed. Consequently there is little potential for actions to affect the other side of the border in England. The actions are most likely to be located in or adjacent to rivers (freshwater lochs and rivers ecosystem) or set back from the river in the urban environment (urban ecosystem). All SEA topics could be affected.

The effects are dependent on the types of defences (for example, defences that are set back from the river are likely to have a smaller impact) and the degree to which the river banks have already been modified: however, the exact types and locations of defences are not known at this stage in the planning process. The potential effects of the actions are described in the text below and summarised by SEA topic in table A17.6.

Table A17.6 River defences: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	- - Loss or damage to ecosystems (e.g. wetlands) leading to reduced habitat connectivity and biodiversity - - Negative effects on protected habitats and species through increased sediment load	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or disturbance of sediment. Design studies should aim to achieve sympathetic design, siting and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at all stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits to flood risk reduction and protection of human health	Feasibility studies should consider medium and long duration effects on recreation. Design studies should consider short duration effects on quality of, and access to recreation. Discussion with stakeholders recommended at all stages.
Soil	- - Loss or damage to carbon rich soils in ecosystems such as wetlands and riparian woodlands	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss of fertile land or damage to wetlands. Consultation with land managers recommended.
Water	- - Loss of river habitats and changes to channel morphology could affect the status of rivers	Feasibility studies should consider how to avoid or minimise potential negative on the morphology of rivers.
Climatic factors	No significant effects	
Material assets	+ + Benefits to flood risk reduction and protection of properties and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	Feasibility and design stages should include consultation with communities to avoid or minimise negative effects on urban landscape.

Commentary on potential significant effects

Regulating and maintaining services
River defences can deliver benefits by regulating water flow, reducing erosion at the site of the structure, and reducing flood risk. The actions, however, can also interfere with natural process. For example, river defences can cause some or all of the floodplain to be disconnected from the river, which can lead to loss of wetland habitat to capture, filter and recycle nutrients or pollutants. This can lead to a reduction in water quality and loss of carbon storage. Erosion may also increase upstream or downstream of a defence due to changes in river processes.

A potential decline in water quality and increase in sediment load can have potentially negative effects on freshwater species such as Atlantic salmon. Implementation of actions could also lead to short duration increases in sediment load with potential negative effects on fish: therefore the timing and implementation of actions needs to be carefully planned. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
River defences have potentially negative effects on freshwater food production due to the loss of in river and riparian habitat. However, this is dependent on the type of defence (for example, defences that are set back from the river are likely to have a smaller impact) and the degree to which the river banks have already been modified.

Cultural services
River defences may have mixed effects on recreation and opportunities to access nature and experience wildlife. Loss of natural habitat and biodiversity, and changes to river flow, can reduce the quality of the environment for recreation and wildlife watching. However, depending on their design, some defences can improve access for some types of recreation.

Within the urban landscape, river defences have potentially negative effects through disrupting the setting and view of the river and floodplain.

Historic buildings and monuments may benefit through reduced flood risk, but the defences may alter the setting of the site. Historic sites may also be affected, either for a short or long duration, by construction of the defences. However, this cannot be assessed at this stage of planning as more information is required about the precise nature and location of the defences.

Table A17.7 Shortlisted actions for Tweed: Summary of potential effects on ecosystem services

Source of flooding	All		River			
Ecosystem service	Non-structural actions		Run off reduction	River and floodplain restoration	Storage, conveyance, control	River defences
Carbon storage	0		+ +	+ +	- -	- -
Local climate regulation	0		0	0	0	0
Water quality regulation	0		+ +	+ +	- -	- -
Pollination	0		+	+	-	-
Biological control of pests and disease	0		+/-	+/-	-	0
Wave/ surge attenuation	0		N/A	N/A	N/A	N/A
Water flow regulation	0		+ +	+ +	+ +	++
Erosion protection	0		+ +	+ +	+/-	+/-
Nutrition: food provision	0		+/-	+/-	+/-	-
Drinking water supply	0		+	+	-	-
Biotic materials: timber, biofuels	0		+/-	+/-	+/-	+/-
Recreation (physical interaction)	0		+	+/-	+/-	+/-
Accessible nature/wildlife experience	0		+	+	-	+/-
Spiritual and cultural amenity (landscape)	0		+	+	-	-

KEY					
	+ +	**Significant positive** Effects are widespread across the LPD; and/or Effects are likely to improve an ecosystem that is in less than good condition	-	**Negative** A noticeable negative effect that does not meet the description below
	+	**Positive** A noticeable positive effect that does not meet the description above	- -	**Significant negative** Effects are widespread across the LPD; and/or Effects are likely to cause an adverse effect on an ecosystem that is in less than good condition
	0	**No or negligible effects**	+/-	**Mixed:** The effect is likely to be a combination of positive and negative effects, particularly where effects are considered on sub-issues, areas or criteria

Map acknowledgments

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including *inter alia*, the following organisations:

Ordnance Survey
Flood maps are based upon Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office © Crown Copyright. Any unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. SEPA Licence number 100016991 (2015).

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology © NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2015), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright © The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC.

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.

Appendix 18: Environmental assessment of the Flood Risk Management Strategy for Solway

This appendix presents the current state of the environment and the assessment of significant environmental effects for the Flood Risk Management Strategy for the Solway Local Plan District (LPD). The purpose of this is to:

- Identify relevant information on the current state of the environment for Solway LPD. This information supplements the description of the current state of Scotland's environment (section 3 of the main Environmental Report).
- Report the significant environmental effects of the actions proposed to manage flood risk in Solway.
- Identify mitigation of significant negative effects and opportunities to deliver wider benefits.
- Recommend further assessment at more detailed planning stages e.g. feasibility studies or design stages.

The overall assessment for all 14 Flood Risk Management Strategies is summarised in section 5 of the main Environmental Report.

A18.1 The Solway Local Plan District

The Solway Local Plan District (LPD) (figure A18) has a total area of approximately 7,000km^2 and a population of approximately 160,000 people. It extends from Drummore and Portpatrick in the west, to beyond Langholm and Newcastleton in the east. The main population centres within the district are Dumfries, Stranraer, Annan and Moffat.

There are five river catchment groups that make up this LPD: the Esk (Dumfriesshire), the Annan, the Nith, the Dee (Galloway) and the Cree.

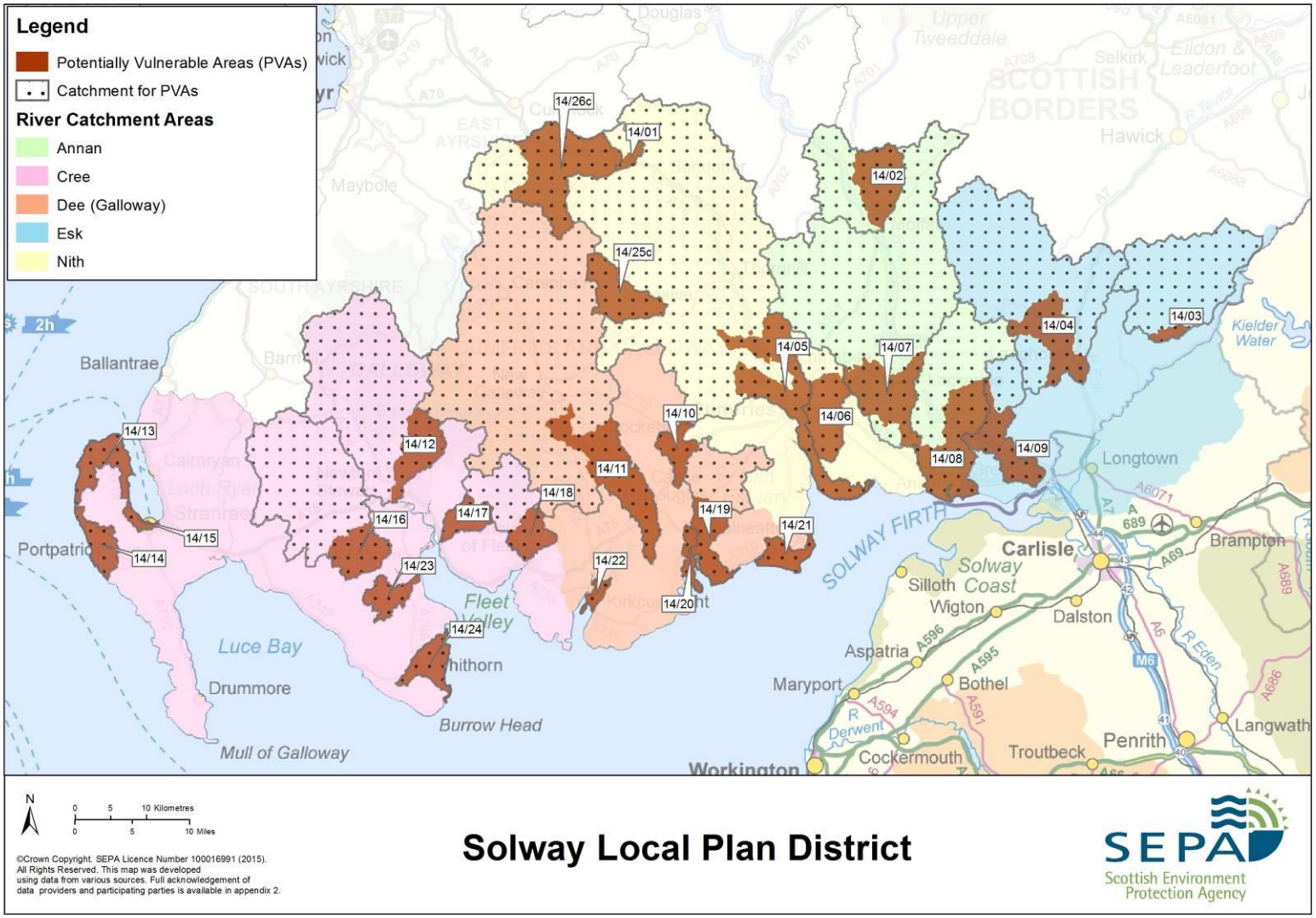
The main source of flooding is river flooding (68% of Annual Average Damages[1]). Coastal and surface water flooding provide almost equal contributions to flooding damages within the LPD (17% and 16% of Annual Average Damages respectively). There are 24 Potentially Vulnerable Areas (PVAs) within the district, and two candidate PVAs covering Moniaive and New Cumnock.

Solway includes catchments that straddle the Scotland-England border, namely the River Sark, and River Esk and the Solway estuary. Actions in the Scottish areas of these catchments may have the potential to affect downstream areas in England, including the coastal area into which they drain. This is discussed further in section A18.4. In the event that actions are deemed to have the potential to affect the English side of the border, this will be discussed further with the Environment Agency and other relevant responsible authorities.

A range of non-structural and structural actions are being considered to manage flooding in this LPD. Structural actions are being considered to manage river flooding in 12 PVAs and to manage coastal flooding in five PVAs (table A18.1).

[1] An indicative estimate of the direct economic costs of flooding impacts to residential properties, non-residential properties and agriculture

Figure A18: Solway LPD and PVAs[2]



[2] Including candidate PVAs

Table A18.1 Shortlisted actions in Solway LPD

Action	Shortlisted for the following PVAs
Run off reduction	14/02, 14/03, 14/04, 14/05, 14/08, 14/11, 14/12, 14/15, 14/17, 14/19, 14/26c
River and floodplain restoration	14/02, 14/03, 14/04, 14/05, 14/08, 14/11, 14/19, 14/26c
Storage conveyance and control	14/01, 14/02, 14/03, 14/04, 14/08, 14/11, 14/12, 14/15, 14/19, 14/26c
River defences	14/01, 14/02, 14/03, 14/04, 14/05, 14/08, 14/12, 14/19, 14/26c
Coastal restoration	14/08
Coastal defences	14/08, 14/19, 14/21, 14/22, 14/24

A18.2 Environmental and policy context for Solway LPD

Section 2.2 and Appendix 3 of the main Environmental Report identify the relationships between the Flood Risk Management Strategies and other plans, programmes and strategies.

A18.3 Additional relevant information on the current state of the environment for Solway LPD

This sub section identifies relevant information on the current state of the environment for Solway LPD. This information supplements the description of the current state of Scotland's environment (section 3 of the main Environmental Report).

A18.3.1 Ecosystems and condition

The predominant terrestrial ecosystem in Solway is cultivated land, which covers 34% of the area. Other common ecosystems include conifer plantations covering 24% of the area and semi natural grassland covering 22% of the area. Cultivated land is generally located in the south, with forestry generally located in the north of the LPD. Less than 1% of the area is urban.

Within the coastal ecosystem is a variety of habitat, including large areas of saltmarsh (e.g. mouth of the river Cree to Baldoon Sands; mouth of the river Nith around Blackshaw Bank) and large sand dune systems (e.g. Luce sands within Luce Bay; Mersehead sands at Southerness Point). There is also some shingle ecosystems (e.g. to the east of Luce Bay and Wigtown Bay).

Table A18.2 lists the extent of different ecosystems within the LPD and provides an assessment of ecosystem condition.

Table A18.2 Ecosystems within the LPD

Ecosystem	Area (% of LPD in 2007)	Condition of ecosystem
Woodland - native	5	There are not many areas of native woodland in Solway. This area contributes to 13% of all native woodland in Scotland. The area of native woodland cover has increased since 2007 due to native woodland expansion programmes.

Ecosystem	Area (% of LPD in 2007)	Condition of ecosystem
Woodland - conifer plantation	24	A significant amount of the Solway LPD comprises of conifer plantations, including Galloway Forest Park. It is located within the south of the Galloway Forestry Strategy and east of the Dumfries and Borders Forestry Strategy.
Cultivated land	34	Cultivated land is generally located in the south of the LPD. Rural diffuse pollution is a pressure on the water environment in this LPD (including in two diffuse pollution priority catchments: Galloway Coastal and Stewartry Coastal). This indicates there is potential degradation and erosion of soils.
Semi-natural grassland	22	This ecosystem is generally located to the north of the LPD adjacent to woodland and upland heath. Nationally, this ecosystem is thought to be in moderate condition.
Wetlands (fen, marsh, and swamp; bog)	4	Wetlands are generally in unfavourable condition within protected sites in this LPD, although many are recovering.
Upland heath	11	The condition of upland assemblage in protected areas within this LPD is mixed.
Freshwater lochs and rivers	< 1	There are 224 river water bodies in this LPD. The condition of river water bodies is variable, with 46% at less than good status for water quality and 42% at less than good status due to the condition of beds and banks. Loch water bodies are generally in poor condition: 17 out of 18 lochs are at less than good overall status. There are rural diffuse pollution pressures in this LPD (including in two diffuse pollution priority catchments); wider Lower Nithsdale is also a Nitrate Vulnerable Zone. This indicates that ground and surface waters may be under pressure from excess nitrates and phosphorus.
Coastal & marine	0.5*	In this LPD, the physical condition of the coastline is at good status or better for all water bodies except one. However, much of the saltmarsh and sand dune habitats are in unfavourable condition. The bathing waters all achieved mandatory passes or better in 2013.
Urban	<1	Access to greenspace in Scotland's urban environment is generally good. Over two thirds (68%) of adults in Scotland have access to useable greenspace within a five-minute walk from their home (not including their own garden).

*The majority of the coastal and marine ecosystem extends beyond the terrestrial LPD boundary so is not captured in this figure

There are many environmental sites of European and national importance in this LPD: 18 Special Areas of Conservation (SACs), seven Special Protected Areas (SPAs) and 101 Sites of Special Scientific Interest (SSSIs), for example:

Coastal

Luce Bay and Sands is a SAC for sand dunes that are in unfavourable declining condition. This is located in the bay adjacent to PVA 14/24 where structural actions are being considered to reduce the risk of coastal flooding. The Cree Estuary, located along the coastline from PVA 14/24 is also designated as a SSSI for saltmarsh in unfavourable condition and mudflats and pink footed geese (favourable condition). The Borgue Coast SSSI, opposite PVA 14/24 is designated for sand dunes

(in unfavourable declining condition).

The Solway Firth SAC covers a large area of the Solway Firth including the coastline on both the Scottish and English banks of the Firth. It is designated for subtidal sandbanks and shingle vegetation, both in favourable maintained condition, and dune grassland, which is in unfavourable condition. This is also a SSSI for various bird species (mixed condition), sand dunes and saltmarsh (unfavourable condition). This is adjacent to PVAs 14/08 and 14/21 where structural actions are being considered to reduce the risk of coastal flooding.

River
Cairnsmore of Fleet SSSI (also a National Nature Reserve) is within and upstream of PVA 14/17 where actions to reduce run off and store water are being considered. This is designated for blanket bog (unfavourable recovering condition) and upland assemblage (favourable condition).

Merrick Kells SSSI (also an SAC) is upstream of PVA 14/12 where actions to reduce run off and store water are being considered. This is designated for blanket bog (unfavourable recovering condition) and upland assemblage (favourable maintained condition). To maintain the wetness of bogs, actions such as blocking of drainage ditches are encouraged. Tree planting, however, may have negative effects on bogs by reducing water levels.

Within PVA 14/11, where actions to reduce run off, store water and restore the river / floodplain are being considered, there are three SSSIs and one SPA that are important sites for wetland birds (Loch Ken and River Dee Marshes SPA; Threave and Carlingwark Loch SSSI; River Dee (Parton to Crossmichael) SSSI; and Kenmure Holmes SSSI). These areas are also designated an SPA (Loch Ken and River Dee Marshes). Wetland habitat is important in all of these areas, with high water levels during the winter favoured to encourage the use of the area by waterfowl. Stable water levels during the nesting season benefit breeding birds and grassland management, whilst occasional flooding and subsequent drying out of pools is required for invertebrate management.

Further up the catchment of PVA 14/11 is Laughenghie and Airdie Hills SSSI. In areas identified as being of potential benefit to black grouse, consideration should be given to the protection of existing woodland and scrub cover and the further planting of small areas with suitable trees. Merrick Kells SSSI (also an SAC) is also located further upstream of this PVA.

In the catchments of PVA 14/03 and 14/04 is the Langholm – Newcastleton Hills SSSI (also an SPA) designated for upland assemblage. There has been some drying of peat and increased grass cover at this site. There is also a geological feature that should not be obscured by woodland planting.

Upstream of PVA 14/01, North Lowther Uplands SSSI (also an SPA) is in unfavourable condition for upland assemblage and breeding birds. Flood risk management actions that block drains could contribute to protecting and enhancing peat formation at this site. The maintenance of open ground habitats is also favoured, so tree planting may not be appropriate here.

A18.3.2 Ecosystem services

This sub section summarises the major ecosystem services in this LPD.

Regulating and maintaining services

- Carbon storage and sequestration is provided by extensive woodlands and some smaller areas of wetlands. There are large areas of carbon rich soils located in the Solway LPD, particularly in the northern areas.
- Pollination and biological control are likely to be locally important in the areas of this LPD where horticulture is important.
- The areas of wetlands, woodlands, semi natural grassland and upland heath help to filter and maintain good water quality.
- The coastal ecosystems are predominantly sand, shingle, dunes and saltmarshes, which help to attenuate waves and surge. There is very little hard coastline. Consequently,

significant lengths of coastline are naturally susceptible to erosion.

Provisioning services

- Most of Dumfries and Galloway is only suitable for rough grazing or grassland-based farming. However, there are some areas suitable for cereals, horticulture and other crops, particularly in the south around Stranraer, Whithorn, Dumfries and Annan.
- There is one active marine shellfish site in Loch Ryan, adjacent to PVA 14/15, but there are no actions being considered to reduce the risk of coastal flooding in this PVA. There are some freshwater finfish fisheries upstream of Dumfries. There are small numbers of wild salmon caught and retained, contributing to 6% of the total retained catch in Scotland. Catches of wild sea trout contribute 18% of the total retained catch in Scotland. Commercial marine fishing takes place in the Solway Firth and coastal and estuarine habitats will provide nurseries and habitat for commercially caught fish.
- There is significant woodland cover throughout the catchment, with large areas of commercial forestry plantation.
- There are 21 drinking water protected areas in the Solway LPD, including the Tarff Water near PVA 14/18, Old Water in the upstream catchment of PVA 14/05 and the Black Esk in the upstream catchment of PVA 14/04.

Cultural services

- The area provides a wide range of recreational opportunities, including angling, wildfowling, riding, kayaking, walking, sailing, swimming and diving. It provides habitat for iconic wildlife, bird watching and wildlife tourism. Conservation of the hen harrier is particularly important as is recreational fishing. The River Nith is regarded as one of Scotland's most productive rivers for both salmon and sea trout, with the Annan and Esk both highly regarded. There are also two National Cycle routes. The Galloway Forest Park is Britain's largest forest park and a hub for outdoor activities.
- Landscape is particularly important. There are protected landscapes in the form of three National Nature Reserves (Cairnsmore of Fleet near PVA 14/17, Caerlaverock and Kirkconnell Flow near PVA 14/05), three National Scenic Areas (Fleet Valley near PVA 14/18, East Stewartry Coastal near PVAs 14/19, 14/20 and 14/21, and Nith Estuary near PVAs 14/21, 14/04 and 14/06). On the English coast of the Solway Firth is the Solway Coast Area of Outstanding Natural Beauty.
- There are two areas of wild land: Tall-Hart Fell in the upper catchment of PVA 14/02 and Merrick in the upper catchment of PVA 14/12. These areas have a distinct and special character, which is increasingly rare to find. Many people derive psychological and spiritual benefits from their existence, and they provide increasingly important havens for Scotland's wildlife.
- The area is rich in historic sites, including scheduled monuments and gardens and designed landscapes.

A18.4 Environmental assessment of the Flood Risk Management Strategy for Solway LPD

This sub section provides an assessment of the potential environmental effects of the flood risk management actions being considered for this LPD. The effects on SEA topics and on ecosystem services are reported for each group of actions. Table A18.9 compares the effects of different groups of actions on ecosystem services.

A18.4.1 Non-structural actions

A range of non-structural actions are being considered for the LPD such as property level protection, relocation of properties / infrastructure away from flood risk areas and flood warning schemes. These actions help to reduce the impacts of flooding and therefore are likely to have significant positive effects on the SEA objectives for human health and material assets. These effects have been assessed nationally rather than at an LPD level and the results are presented in section 4 of the main Environmental Report.

As these actions help to reduce the impacts of flooding rather than the probability of flooding, they are likely to have no or negligible effects on ecosystems and ecosystem services.

A18.4.2 Run off reduction actions

Actions to reduce run off include woodland and gully woodland planting, upland drain blocking, land management, creation or restoration of wetlands and ponds, and shelter belts. These actions are being considered for 11 PVAs.

All SEA topics and all ecosystems may be affected by these actions: either directly (in terrestrial ecosystems) as the action is located in the ecosystem itself, or indirectly as the ecosystem (freshwater, urban, or coastal and marine ecosystems) is located downstream of the action. The potential effects of the actions are described in the text below and summarised by SEA topic in table A18.3.

Table A18.3 Run off reduction: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	+ + Benefits to connectivity and health of wetland ecosystems	Feasibility studies should consider opportunities to contribute to other drivers for restoration of wetlands and woodlands. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at all stages. The location of any woodland planting should be carefully assessed to ensure it does not reduce wetland and open habitats favoured by some protected species or adversely impact on archaeological sites. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	
Soil	+ + Benefits to safeguarding carbon rich soils	Design stages should consider protecting livestock from potential exposure to pests. Consultation with land managers recommended.
Water	+ + Benefits by enhancing water quality and reducing sedimentation	Actions to improve water quality should be coordinated with those being undertaken as part of diffuse pollution priority catchment improvements.
Climatic factors	+ + Benefits to carbon storage through wetland enhancement	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	

Commentary on potential significant effects

Regulating and maintaining services
Run off reduction actions help to slow and store water by intercepting rainfall (e.g. woodlands) and/or increasing the extent to which the land can hold any water reaching the ground (both by slowing down the flow of run off and increasing the permeability of soils). This in turn can help to regulate the flow of water by reducing the amount of water reaching rivers and slowing or reducing flood flows: this helps to protect people and properties from flooding.

These actions can lead to improvements in water quality by helping to protect soils from erosion (thus reducing the sediment reaching rivers) and increasing infiltration of nutrients into soils. These water quality benefits may be significant if the actions are located in cultivated land or forestry as water quality is currently under pressure from rural diffuse pollution in a number of catchments.

The creation or restoration of woodlands and wetlands (including peatlands through upland drain blocking) also has the potential to increase the capture and storage of carbon. In wetlands, the benefits may be significant as they are likely to improve the current condition as many wetlands are at risk from drying out. (Although wetlands also have the potential to release carbon dioxide into the atmosphere, the net benefit to carbon storage is more likely to be positive when restoring wetlands.)

Increased habitat diversity and connectivity can provide benefits to pollination and biological control of pests and diseases. However, an increase in the wetness of cultivated land and semi-natural grassland ecosystems may increase the prevalence of some livestock pests.

Protected wetlands are likely to benefit, although actions should aim not to alter the seasonal changes in water levels that support nesting and feeding birds. There are potential negative effects if woods are planted in upland bog areas as this may reduce the area of open habitat and impact negatively on protected bird species. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The effects of run off reduction actions on food provision are mixed. The actions may enhance the productivity of cultivated land and semi natural grassland by protecting soils from erosion and loss of nutrients and through providing a more diverse habitat for pollinators and biological control of pests and disease. However, some areas of productive land may be lost and there is potential to increase the prevalence of some livestock pests. Freshwater fisheries may benefit through improved water quality and reduced sedimentation.

Actions may provide benefits to drinking water supply by helping to remove nutrients.

Actions that block drains or create wetlands within conifer plantations may lead to loss of timber productivity; however, it is more likely that these actions would be located in other ecosystems.

Cultural services
The effects on recreation, wildlife watching and landscape are likely to be positive as the actions should improve habitat diversity and biodiversity. Recreational fishing is an important industry in this LPD. Any water quality benefits and erosion protection will help to maintain the low nutrient and low sediment load that is essential for some aquatic species such as salmonids.

The historic environment has potential to benefit from these actions: firstly, through the reduction of flood risk to historic buildings and, secondly, through the protection of wetland archaeology as a result of creating and restoring wetlands. Woodland planting, however, can disturb buried archaeology. The structure and setting of historic sites could be affected but this will need to be assessed at more detailed levels of flood risk management planning.

A18.4.3 River and floodplain restoration actions

Actions to restore river and floodplains include woodland creation, reach restoration and creation of washlands. Sediment management actions such as bank restoration are also included in this assessment. These types of actions are being considered for eight PVAs.

All SEA topics and a wide range of ecosystems may be affected but particularly cultivated land, semi natural grassland, native woodlands, wetlands, freshwater rivers and lochs, and urban ecosystems. The potential effects of the actions are described in the text below and summarised by SEA topic in table A18.4.

Table A18.4 River and floodplain restoration: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	+ + Benefits to connectivity and health of wetland ecosystems	Feasibility studies should consider opportunities to contribute to other drivers for restoration of wetlands and woodlands. Stable water levels during the nesting season are important to breeding birds. Design studies should aim to achieve sympathetic design, siting and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies should consider medium and long duration effects on recreation, such as changes to river flow. Design studies should consider short duration effects on quality and access to recreation. Discussion with stakeholders recommended at both stages.
Soil	+ + Benefits to safeguarding carbon rich soils	Feasibility and design stages should consider potential loss of productive soils, particularly cultivated land. Consultation with land managers recommended.
Water	+ + Benefits by enhancing water quality and reducing sedimentation	Actions to improve water quality should be coordinated with those being undertaken as part of diffuse pollution priority catchment improvements.
Climatic factors	+ + Benefits to carbon storage through wetland enhancement. However, loss of woodland could reduce these benefits	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	

Commentary on potential significant effects

Regulating and maintaining services

River and floodplain restoration actions slow down in-channel flow by increasing the sinuosity of the river and help reconnect the river with the floodplain, increasing the amount of water stored on land. Floodplain planting can also slow down the flow of run off and increase the permeability of soils, while river bank restoration can reduce bank erosion and sediment deposition in the river. The effect of all of these actions is to help regulate the flow of water by slowing and/or reducing

flood flows: this helps to protect people and properties from flooding.

The restoration and creation of habitat (woodlands, washlands, woody debris etc) within the river and in the floodplain and reduced erosion of the river bed and banks can help to filter nutrients and reduce sediments, leading to potential benefits to water quality. Wetland vegetation (in this case, vegetation on the floodplain) is particularly effective at storing nutrients. Where restoration reconnects the river with floodplain wetlands, there are potentially significant positive effects on water quality (as wetlands ecosystem may be in less than good condition and a large number of river water bodies are in less than good condition for water quality).

The creation or restoration of woodlands and floodplain wetlands also has the potential to increase the capture and storage of carbon, although the net benefit may be less where floodplain restoration requires the removal of trees. As stated above, although wetlands have the potential to release carbon dioxide into the atmosphere, the net benefit to carbon storage is more likely to be positive when restoring this ecosystem.

Other potential positive effects include improvements to pollination (as pollinating insects may benefit from greater food and shelter in a more diverse habitat) and biological control of disease and pests.

Protected wetlands may benefit depending on the location of the restoration actions. However, restoration works could lead to short duration increases in sediment load and could disturb breeding birds, therefore the timing and implementation of actions needs to be carefully planned. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The effects on food provision are likely to be mixed. The actions may lead to the loss of cultivated land and semi natural grassland, although there are some potential benefits in semi-natural grassland through increased shelter for livestock. By protecting water quality and reducing sedimentation, freshwater fisheries such as salmon and sea trout, may benefit.

The effects on the provision of biotic materials are also mixed. Potential loss of cultivated land reduces opportunities for producing biofuels; however the creation of woodland may provide timber.

Restoration actions may provide benefits to drinking water supply by helping to remove nutrients and pollutants.

Cultural services
The potential effects on recreation, wildlife watching and landscape are positive, as the actions should improve habitat diversity and biodiversity. Access to the river for activities such as fishing or kayaking may be improved or hampered depending on the location and design of works. On the ground works may also impede access to the river although these effects would be of short duration.

Actions are likely to take place close to urban areas so any effects on wild land are likely to be limited.

The historic environment has potential to benefit from these actions: firstly, through the reduction of flood risk to historic buildings and, secondly through the protection of wetland archaeology as a result of creating and restoring wetlands. Woodland planting, however, can disturb buried archaeology. The structure and setting of historic sites could be affected but this will need to be assessed at more detailed levels of flood risk management planning.

A18.4.4 Storage conveyance and control

Storage, conveyance and control actions include on and offline flood storage, channel modifications, addition or modification of weirs, bridges, pumping stations. These types of actions are being considered for a total of ten PVAs (conveyance actions are being considered for eight PVAs; flood storage is being considered for eight PVAs; and installation or modification of fluvial control structures is being considered for two PVAs).

The actions could be located in most ecosystems, except upland heath and coastal and marine ecosystems. All SEA topics could be affected. The potential effects of the actions are described in the text below and summarised by SEA topic in table A18.5.

Table A18.5 Storage, conveyance and control: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	- - Loss or damage to wetlands, leading to reduced habitat connectivity and biodiversity	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or damage to wetlands, disturbance of sediment and how to deliver potential improvements such as reduction in barriers to fish passage. Design studies should aim to achieve sympathetic design, siting and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH, Fisheries Trusts) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies should consider medium and long duration effects on recreation, such as changes to river flow. Design studies should consider short duration effects on quality and access to recreation. Discussion with stakeholders recommended at both stages.
Soil	- - Loss or damage to carbon rich soils found in wetlands due to habitat loss - - Erosion of carbon rich soils downstream of the structure	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or damage to wetlands. Feasibility and design stages should consider potential loss of productive soils, particularly cultivated land. Consultation with land managers recommended.
Water	- - Actions could impact negatively on morphology and sediment dynamics + + Actions could impact positively on morphology, sediment dynamics and fish passage	Actions should be coordinated with diffuse pollution priority catchments and any morphology priority catchments proposed in the second river basin management plans.
Climatic factors	- - Reduction in carbon sequestration due to loss or damage to wetlands	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or damage to wetlands.
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	Feasibility and design stages should include consultation with communities and SNH to avoid or minimise negative effects on landscape.

Commentary on potential significant effects

Regulating and maintaining services
Storage, conveyance and control actions are engineered actions that alter the storage and flow of water. These actions can deliver positive effects through regulating the flow of water and thus reducing flood risk to people and property.

These actions can lead to disruption to natural processes and loss of habitat. These may have a negative effect on water quality and carbon storage, particularly so if the actions affect wetlands which may already be in unfavourable condition.

The potential effects of these actions on erosion protection are mixed. Some ecosystems may, in part, benefit: for example urban areas, cultivated land, and semi natural grassland adjacent to the structure may experience an increase in protection from erosion. However, erosion can be exacerbated upstream and/or downstream of actions with potentially significant negative effects on wetlands that may already be in unfavourable condition. Increased erosion can increase sediment and nutrient load of water, with potentially significant negative effects on fish populations.

Any loss or damage to wetlands may have locally noticeable effects such as reduction in pollination, and pest and disease control.

Provisioning services
The effects on terrestrial food provision and production of biofuels are mixed. The actions may help to reduce flooding to some areas of cultivated land or semi natural grassland. However, other areas may suffer increased flooding (or erosion). These effects could lead to longer duration changes in land use. Freshwater production may suffer negative effects through loss of habitat and increased sedimentation. However, actions like removing culverts may reduce barriers to fish passage and improve habitats.

Drinking water supply may be negatively affected if actions lead to loss or damage to wetlands (as wetlands can help to filter nutrients and pollutants thus reducing treatment costs).

Cultural services
Storage, conveyance and control actions have potentially negative effects on cultural services. Loss of natural habitat and negative effects on biodiversity can impact opportunities to watch wildlife and interact with nature and reduce the quality of recreation such as angling. Changes to patterns of river flow can also affect sports such as kayaking. However, access for some activities could be improved with sensitive scheme design. Actions such as removing culverts may reduce barriers to fish passage and improve habitats, thus helping to improve recreational angling.

The historic environment may benefit through a reduction in flood risk, but there is also potential for negative effects: the disconnection of the floodplain from the river could damage wetlands and the archaeology preserved within it. The historic environment may be negatively affected by altering the setting of historic sites or through damage to sites when the action is implemented. Further assessment is required at more detailed levels of flood risk management planning.

A18.4.5 River defences

River defences may include walls, embankments or demountable / temporary defences. These are being considered for nine PVAs

The actions are most likely to be located in or adjacent to rivers (freshwater lochs and rivers ecosystem) or set back from the river in the urban environment (urban ecosystem). All SEA topics could be affected.

The effects are dependent on the type of defences (for example, defences that are set back from the river are likely to have a smaller impact) and the degree to which the river banks have already

been modified: however, the exact types and locations of defences are not known at this stage in the planning process. The potential effects of the actions are described in the text below and summarised by SEA topic in table A18.6.

Table A18.6 River defences: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	- - Negative effects on fish through increased sediment load	Feasibility studies should consider how to avoid or minimise potential negative effects such as loss or disturbance of sediment. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies should consider medium and long duration effects on recreation, such as changes to river flow. Design studies should consider short duration effects on quality and access to recreation. Discussion with stakeholders recommended at both stages.
Soil	No significant effects	
Water	- - Actions could impact negatively on morphology and sediment dynamics	Actions should be coordinated with diffuse pollution priority catchments and any morphology priority catchments proposed in the second river basin management plans.
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	No significant effects	Feasibility and design stages should include consultation with communities to avoid or minimise negative effects on urban landscape.

Commentary on potential significant effects

Regulating and maintaining services
River defences can deliver benefits by regulating water flow, reducing erosion at the site of the structure and reducing flood risk. The actions, however, can interfere with natural process: the defences can cause some or all of the floodplain to be disconnected from the river, which can lead to loss of natural habitat to capture, filter and recycle nutrients or pollutants. This can lead to a reduction in water quality and a loss of carbon storage. Erosion may also increase upstream or downstream of a defence due to changes in river processes. A potential decline in water quality and increase in sediment load can have potentially negative effects on freshwater species such as fish. (However, if river defences are set back from the river, the impact on the water environment can be reduced.)

Provisioning services
River defences have potentially negative effects on freshwater food production due to the loss of in river and riparian habitat. However, this is dependent on the type of defence (for example, defences that are set back from the river are likely to have a smaller impact) and the degree to which the river banks have already been modified.

Cultural services
River defences may have mixed effects on recreation and opportunities to access nature and experience wildlife. Loss of natural habitat and biodiversity, and changes to river flow, can reduce the quality of the environment for recreation and wildlife watching. However, depending on their design, some defences can improve access for some types of recreation.

Within the urban landscape, river defences have potentially negative effects through disrupting the setting and view of the river and floodplain.

Historic buildings and monuments may benefit through reduced flood risk, but the defences may alter the setting of sites. Historic sites may also be affected, either for a short or long duration, by construction of the defences – however, this cannot be assessed at this level of planning as more information is required about the precise nature and location of the defences.

A18.4.6 Coastal restoration

Coastal restoration actions help attenuate waves or surge. Actions include beach recharge schemes, shingle reprofiling, and restoration of sand dunes/ saltmarsh / coastal vegetated shingle. These actions are being considered for one PVA.

The ecosystems most likely to be affected are coastal and marine ecosystems, but also semi natural grassland and cultivated land. All SEA topics could be affected. The potential effects of the actions are described in the text below and summarised by SEA topic in table A18.7

Table A18.7 Coastal restoration: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	+ + Benefits from restoring coastal habitats (saltmarsh)	Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects, for example, on breeding or feeding birds, and on marine species through short duration potential sediment disturbance. Consultation with relevant organisations (e.g. SNH and Natural England) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies and design studies should consider short and medium duration effects on coastal access. Discussion with stakeholders recommended at both stages.
Soil	+ + Benefits from protecting coastal soils from erosion	Feasibility and design stages should consider potential loss of productive soils, particularly cultivated land. Consultation with land managers recommended.
Water	No significant effects	
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure	Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	
Landscape	No significant effects	

Commentary on potential significant effects

Regulating and maintaining services
Coastal restoration actions help to provide space to attenuate waves and coastal surge through the creation and restoration of natural habitats. Through attenuating waves and surge, coastal restoration actions have the potential to reduce flood risk.

The restoration of natural habitats may help to provide carbon storage and help adapt to future climate change.

The actions may be adjacent to the Upper Solway Flats and Marshes SSSI, designated for various features including saltmarsh. Restoration of the saltmarsh to help protect properties against flooding could have benefits for the species found in this SSSI. However, implementation of works could cause disturbance to feeding and breeding birds such as barnacle geese and wigeon. The SSSI is located within the larger SAC that spans the whole Solway Firth and is designated for similar features such as mudflats and sandbanks that would benefit from restoration actions. The effects will be assessed further through Habitats Regulations Appraisal and at more detailed levels of flood risk management planning.

Provisioning services
The restoration and creation of intertidal areas may help to provide nurseries for fish, but could lead to some loss of productive land (cultivated land and semi natural grassland). Conversely, some areas of productive land may benefit through reduced erosion and flooding. There is therefore a mixed effect on food provisioning.

Cultural services
The potential effects of coastal restoration actions on cultural services are generally positive. By improving the coastal environment, recreation, wildlife experience and cultural amenity are all likely to benefit.

The historic environment is likely to benefit due to reduced risk of flooding and perhaps significantly due to the potential protection from coastal erosion. The Annan Hill Roman camp is located near the coastline so potential effects on this site should be considered during more detailed flood risk management planning.

A18.4.7 Coastal defences

Coastal defences include actions such as walls, embankments, temporary barriers, revetments, and tidal gates and barriers. These actions are being considered for five PVAs.

The ecosystems most likely to be affected are urban, and coastal and marine. All SEA topics could be affected. The potential effects of the actions are described in the text below and summarised by SEA topic in table A18.8.

Table A18.8 Coastal defences: Summary of significant environmental effects, opportunities and mitigation

SEA topics	Potential significant effects	Opportunities, mitigation, recommendations
Biodiversity, flora and fauna	- - Negative effects on protected coastal habitats through increased erosion and disruption of natural processes	Feasibility studies should consider how to avoid or minimise potential negative effects such increased erosion. Design studies should aim to achieve sympathetic design, siting, and timing of works to avoid or minimise negative effects. Consultation with relevant organisations (e.g. SNH and Natural England) recommended at both stages. Habitat Regulations Appraisal will address negative effects on SACs and SPAs.
Population and human health	+ + Benefits from reducing flood risk and protecting human health	Feasibility studies should consider medium and long duration effects on changes to coastal processes that could affect flooding, erosion,

		access and recreation. Design studies should consider short duration effects on quality and access to recreation. Discussion with stakeholders recommend at both stages.
Soil	No significant effects	
Water	No significant effects	
Climatic factors	No significant effects	
Material assets	+ + Benefits from reducing flood risk and protecting property and infrastructure - - Property and infrastructure may experience an increased erosion risk outside of the area of protection	Further modelling required at feasibility and design stages to better understand erosion risks. Design stages should consider how to minimise waste and energy consumption.
Cultural heritage	No significant effects	Design stages should consult with relevant organisations (e.g. Historic Scotland) to help avoid or minimise negative effects.
Landscape	- - Soft coast habitats such as saltmarsh and sand dunes are a rare landscape in Scotland	Feasibility and design stages should include consultation with communities to avoid or minimise negative effects on urban and coastal landscapes.

Commentary on potential significant effects

Regulating and maintaining services
By attenuating waves and surge, coastal defences can help to reduce flood risk. Some defences can also reduce erosion at the site of the defence. However, these actions can lead to the loss of natural habitat and interfere with coastal processes, altering rates of erosion and deposition elsewhere. Many coastal defences could have potentially significant negative effects on the natural ability of coastal habitats to protect against erosion. This is particularly important in the Solway Firth, where there are many protected areas and rare saltmarsh habit.

Loss of natural habitat can lead to reduced water quality by reducing the ability of the environment to filter, capture and recycle nutrients / pollutants. The effect on carbon storage is mixed: loss of natural habitat to sequester carbon will have negative effects; however, some actions might provide suitable substrate for kelp which can act as a carbon store.

The management of coastal protected sites (some of which are in unfavourable condition) aims to preserve the natural dynamic processes found in this area. Any actions that alter natural coastal processes may affect the movement of gravel, shingle and sands, leading to potentially significant negative effects on protected sites. Actions also have the potential to affect the English side of the Solway Firth (both in terms of erosion risk and protected features located there). Further studies would need to be undertaken to better understand these effects.

Provisioning services
Coastal defences can have mixed effects on marine food provision: whilst there can be loss of natural habitat which can reduce productivity, other edible species may benefit (for example, a change from soft sediment feeding fish to lobster and crab fishery).

Cultural services
The effects of coastal defences on recreation and opportunities to experience nature and wildlife may be reduced through loss of natural habitat and biodiversity. However, with sensitive scheme design, there may also be benefits through improved access and reduced disturbance to wildlife.

There are potential negative effects on urban and coastal landscape, particularly where actions could degrade rare saltmarsh and sand dunes.

There are some coastal listed buildings along the coast that may benefit from reduced flood risk; however, the setting of the buildings may be negatively affected by the defences. Further assessment is required at more detailed stages of planning about the precise nature and location of the defences.

Table 18.9 Shortlisted actions for Solway: Summary of potential effects on ecosystem services

Source of flooding	All		River					Coastal	
Ecosystem service	Non-structural actions		Run off reduction	River and floodplain restoration	Storage, conveyance, control	River defences		Coastal restoration	Coastal defences
Carbon storage	**0**		**+ +**	**+/-**	**-**	**-**		**+**	**+/-**
Local climate regulation	**0**		**0**	**0**	**0**	**0**		**0**	**0**
Water quality regulation	**0**		**+ +**	**+ +**	**+/-**	**- -**		**+**	**-**
Pollination	**0**		**+**	**+**	**-**	**0**		**0**	**0**
Biological control of pests and disease	**0**		**+/-**	**+**	**-**	**0**		N/A	N/A
Wave/ surge attenuation	**0**		N/A	N/A	N/A	N/A		**+ +**	**+ +**
Water flow regulation	**0**		**+ +**	**+ +**	**+ +**	**+ +**		N/A	N/A
Erosion protection	**0**		**+**	**+**	**+/-**	**- -**		**+ +**	**+/-**
Nutrition: food provision	**0**		**+/-**	**+/-**	**+/-**	**-**		**+/-**	**+/-**
Drinking water supply	**0**		**+**	**+**	**0**	**0**		**0**	**0**
Biotic materials: timber, biofuels	**0**		**+/-**	**+/-**	**+/-**	**0**		**0**	**0**
Recreation (physical interaction)	**0**		**+**	**+/-**	**+/-**	**+/-**		**+/-**	**+/-**
Accessible nature/wildlife experience	**0**		**+**	**+**	**-**	**+/-**		**+**	**+/-**
Spiritual and cultural amenity (landscape)	**0**		**+**	**+**	**-**	**-**		**+**	**- -**

KEY					
	+ +	**Significant positive** Effects are widespread across the LPD; and/or Effects are likely to improve an ecosystem that is in less than good condition	**-**	**Negative** A noticeable negative effect that does not meet the description below
	+	**Positive** A noticeable positive effect that does not meet the description above	**- -**	**Significant negative** Effects are widespread across the LPD; and/or Effects are likely to cause an adverse effect on an ecosystem that is in less than good condition
	0	**No or negligible effects**	**+/-**	**Mixed:** The effect is likely to be a combination of positive and negative effects, particularly where effects are considered on sub-issues, areas or criteria

Map acknowledgments

SEPA gratefully acknowledges the cooperation and input that various parties have provided, including *inter alia*, the following organisations:

Ordnance Survey
Flood maps are based upon Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office © Crown Copyright. Any unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. SEPA Licence number 100016991 (2015).

The Centre for Ecology and Hydrology
Some features of these maps are based upon digital spatial data licensed from the Centre for Ecology and Hydrology © NERC (CEH) and third party licensors.

The Met Office
Data provided by The Met Office has been used under licence in some areas of flood risk information production. ©Crown Copyright (2015), the Met Office.

The James Hutton Institute
Data provided under licence from the James Hutton Institute has been applied in production of flood risk management information. Copyright © The James Hutton Institute and third party licensors.

British Geological Survey
Flood risk information has been derived from BGS digital data under licence. British Geological Survey ©NERC.

Local authorities
SEPA acknowledges the provision of flood models and other supporting data and information from local authorities in Scotland and their collaboration in the production of flood risk management information.

Scottish Water
SEPA acknowledges the inclusion of surface water flooding data generated by Scottish Water in preparation of flood risk information.