East Lothian Council

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- Potentially Vulnerable Areas (PVA) summaries
- Appraisal Brief
- Characterisation Reports

Authorised By	Monica Patterson
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Potentially Vulnerable Area: 10/21 - Musselburgh

Local Plan District	Local Authorities	Main Catchment
10 - Forth Estuary	City of Edinburgh, East Lothian	Edinburgh Coastal

Background

This Potentially Vulnerable Area (PVA) covers an area of 12km^2 and includes a small part of Edinburgh and Musselburgh (Figure 1). Within this PVA approximately 1,300 residential properties are at a medium likelihood of flooding from one or more sources. The total Annual Average Damages (AAD) from all sources of flooding are approximately £3.2 million (this includes damages to residential properties, non-residential properties, transport and agriculture). The majority of these damages are caused by river flooding (Figure 2).

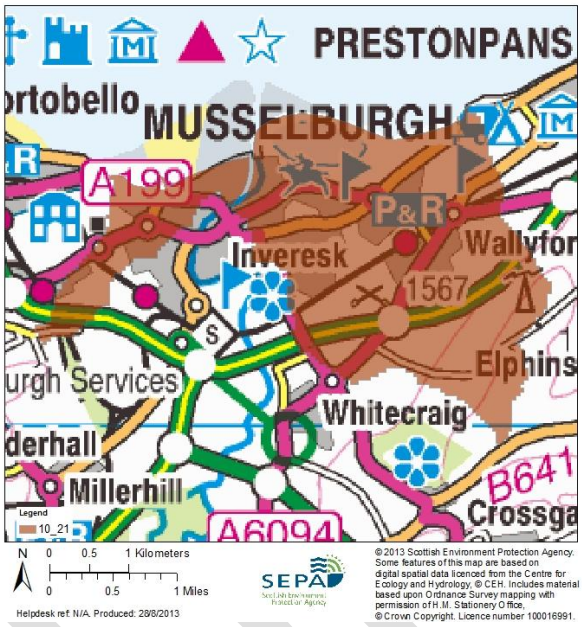

Figure 1: Musselburgh Potentially Vulnerable Area

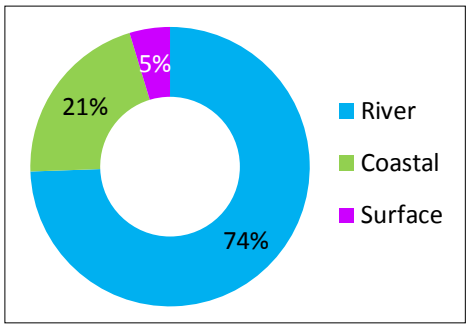

Figure 2: Annual Average Damages by flood source

Summary of impacts from all sources of flooding

Approximately 1,300 residential properties and 270 non-residential properties are at a medium likelihood of flooding from one or more sources. A summary of the impacts from all sources of flooding can be seen in Table 1 and a map showing the impacts from all sources at a medium likelihood of flooding can be seen in Figure 4.

The highest risk of river flooding is from the River Esk to Musselburgh.

The highest risk of coastal flooding is from the Firth of Forth to Musselburgh and Inveresk.

The highest risk of surface water flooding is in Wallyford and Pinkie Brae (Musselburgh).

The economic damages incurred for each return period can be seen in Figure 3. For this PVA the highest damages are to residential property followed by damages to non-residential properties.

In 2010 Scottish Water carried out a Flood Risk Assessment Study of 292 non infrastructure water and wastewater assets across Scotland that were within the 1 in 200 year flood extent. Of the assets assessed, no water assets and one wastewater asset were identified as being at risk of flooding within this PVA.

Table 1: Summary of flood impacts from all sources

	High likelihood	Medium likelihood	Low likelihood
No. of Residential Properties at risk	280	1,300	1,600
No. of Non-Residential Properties at risk	60	270	320
No. of People at risk	620	2,800	3,500
Community Facilities at risk	<10 Community Facilities • <10 Educational Buildings. • 1 Educational Building • 1 Care Home	<10 Community Facilities • <10 Educational Buildings. • <10 Care Homes	<10 Community Facilities • <10 Educational Buildings. • <10 Care Homes
Utilities at risk	<10 utilities • <10 Energy sites	10 utilities • ~10 Energy sites • <10 Scottish Water Assets	10 utilities • ~10 Energy sites • <10 Scottish Water Assets
Transport Links at risk (excluding minor roads)	7 Roads affected at 26 locations • 5 A Roads • 2 B Roads 1 Railway route affected at 6 locations • Berwick-upon-Tweed to Edinburgh	7 Roads affected at 83 locations • 5 A Roads • 2 B Roads 1 Railway route affected at 11 locations • Berwick-upon-Tweed to Edinburgh	8 Roads affected at 106 locations • 5 A Roads • 3 B Roads 1 Railway route affected at 11 locations • Berwick-upon-Tweed to Edinburgh
Designated Areas (km^2) at risk	0.3 km^2 • 1 SSSI • 1 SPA • 1 SAC	0.3 km^2 • 1 SSSI • 1 SPA • 1 SAC	0.3 km^2 • 1 SSSI • 1 SPA • 1 SAC
No. of Cultural Heritage Sites at risk	9	10	10
Agricultural Land at risk (km^2)	0.3 km^2	0.6 km^2	0.7 km^2

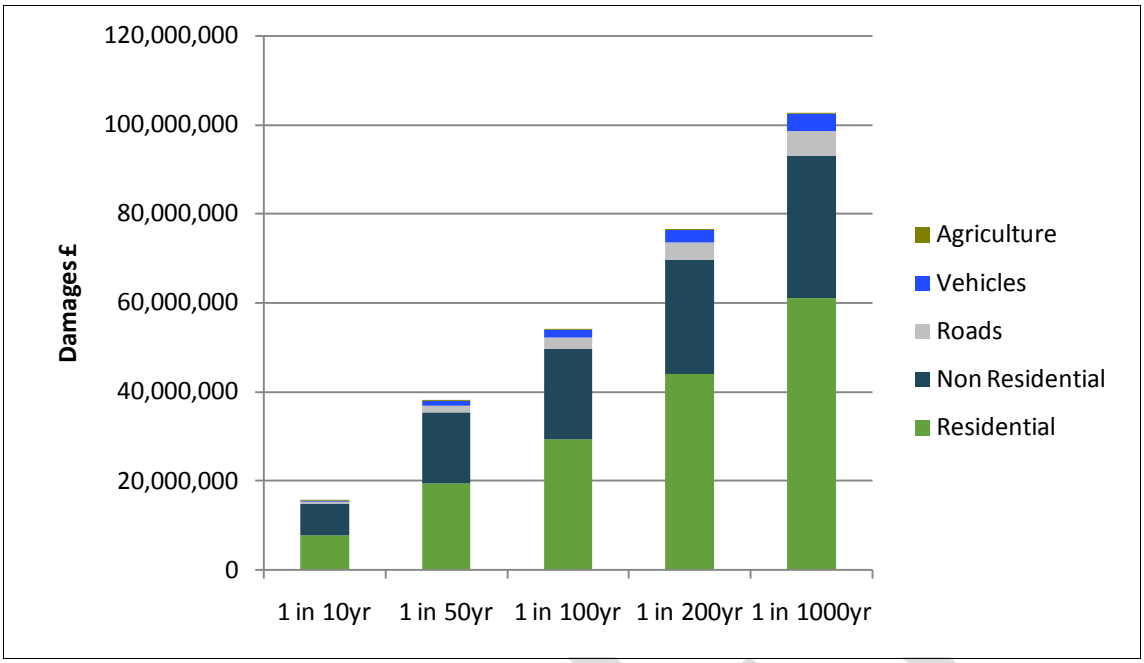

Figure 3: Damages by flood frequency from all sources

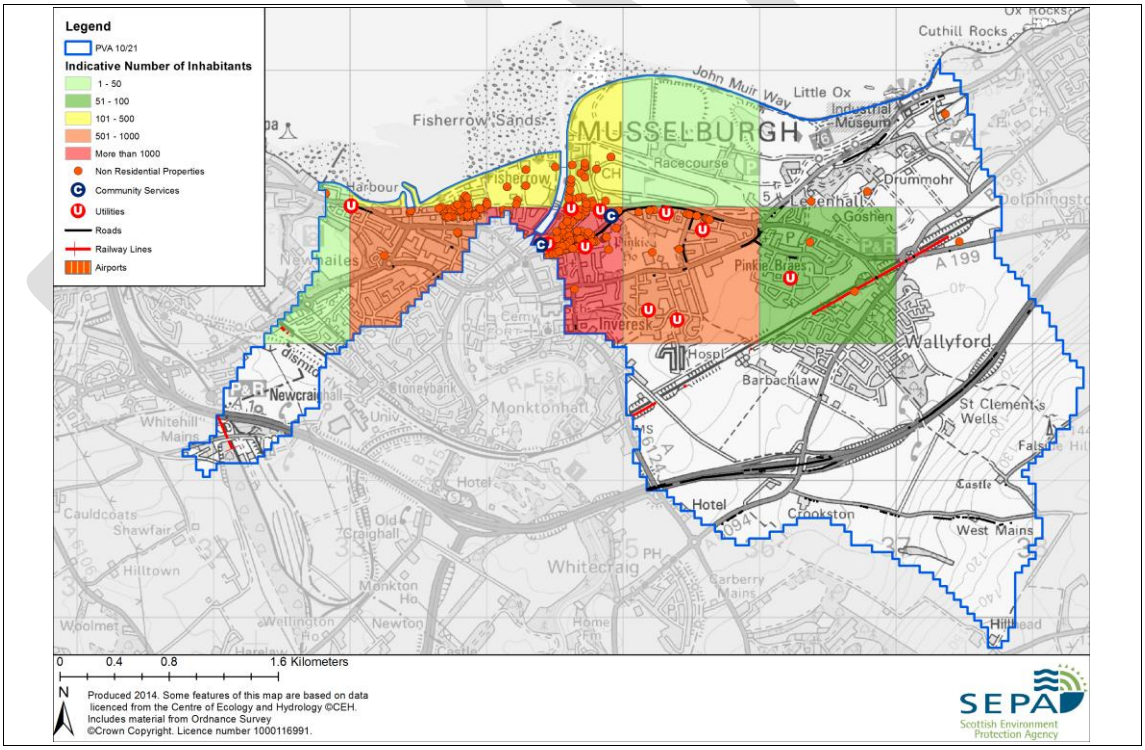

Figure 4: Impacts from all sources at a medium likelihood of flooding

Summary of existing local actions to manage risk

There are no formal flood protection/prevention schemes constructed under the Flood Prevention (Scotland) Act 1961 or the Flood Risk Management (Scotland) Act 2009 to reduce the risk of flooding.

Other measures may exist that were not constructed under the 1961 or the 2009 Acts but do reduce the impact of flooding, this may include other structures, natural features and natural flood management measures. These other measures can be seen in the river, coastal and surface water flooding report Appendixes.

There are 3 flood warning target areas within this PVA:

- Musselburgh - River flood warning, Esk
- Portobello Esplanade - Coastal flood warning, Firth of Forth
- Musselburgh Coastal - Coastal flood warning, Firth of Forth

SEPA and the local authorities work closely with many other organisations that have flooding related duties and interests such as the police, fire & rescue services, the Scottish Government and the Scottish Flood Forum. SEPA and the local authorities, often in partnership with these organisations, undertake various awareness raising campaigns that include community events, information leaflets, educational plays in schools, the use of social media and advertising.

In addition to the above, the following community groups that help with flood resilience are known to operate within this PVA:

- East Lothian Bio-diversity Group
- East Lothian Tenants and Residents Panel
- Musselburgh Waterfront Group
- Musselburgh and Inveresk Community Council

Numerous local community councils are also known to operate throughout the East Lothian Council district.

The following local incentives or subsidies have also been put in place in order to provide property owners with property level resilience/resistance measures:

- The City of Edinburgh Council owns 450m of temporary pallet barriers that can be utilised to protect properties from river flooding. In addition to this, the Council also owns 8,000 sandbags and there are a further 1,500 sandbags located in fire stations throughout the City which can be utilised by the public during flood events. The Council also operates Emergency Action Packs that are used to determine where people should be deployed during flood events. This includes drawings, maps and sandbag construction drawings
- East Lothian Council strategically deploy temporary flood barriers and sand bags when properties are threatened by flooding

History of flooding

The following river flood event has been identified as significant:

- 13 August 1948, River Esk: Evacuation required in Musselburgh after flooding occurred in Eskside West, Eskside East, Shorthope Street, Millhill and areas of the High Street

The following coastal flood event has been identified as significant:

- 30 March 2010: A tidal surge coinciding with the highest mean tides of the year caused extensive flooding along the East Coast of Scotland, with the Firth of Forth being one of the worst affected areas. Locations within this coastal area affected included Leith, Musselburgh, Prestonpans, Port Seton, Dunbar and North Berwick. Impacts included flooding of properties, damage to harbours, seawalls and roads with Edinburgh City Council estimating the costs to repair damages in the region of 650,000

In addition to the above, there is a history of groundwater flooding in Musselburgh, particularly around the Pinkie area.

Potentially Vulnerable Area: 10/22 - Lasswade, Penicuik, Dalkeith, Musselburgh

Local Plan District	Local Authorities	Main Catchment
10 - Forth Estuary	Midlothian, City of Edinburgh, East Lothian	River Esk (Lothian)

Background

This Potentially Vulnerable Area (PVA) covers an area of 97km^2 (Figure 1). Within this PVA approximately 300 residential properties are at a medium likelihood of flooding from one or more sources. The total Annual Average Damages (AAD) from all sources of flooding are approximately £1.7 million (this includes damages to residential properties, non-residential properties, transport and agriculture). The majority of these damages are caused by surface water flooding (Figure 2).

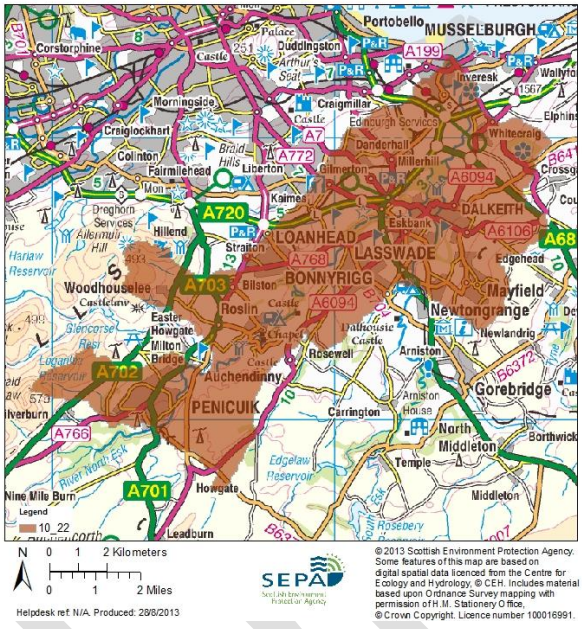

Figure 1: Potentially Vulnerable Area 10/22

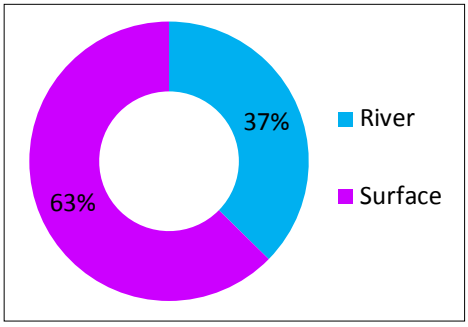

Figure 2: Annual Average Damages by flood source

Summary of impacts from all sources of flooding

Approximately 300 residential properties and 320 non-residential properties are at a medium likelihood of flooding from one or more sources. A summary of the impacts from all sources of flooding can be seen in Table 1 and a map showing the impacts from all sources at a medium likelihood of flooding can be seen in Figure 4.

The highest risk of river flooding is from the River Esk, the River South Esk, the River North Esk and the Loan Burn to Musselburgh, Dalkeith and Newbattle, Lasswade and Bonnyrigg and Penicuik.

The highest risk of coastal flooding is from the River Esk to Musselburgh and Inveresk (Musselburgh).

The highest risk of surface water flooding is in Dalkeith, Lasswade and Bonnyrigg.

The economic damages incurred for each return period can be seen in Figure 3. For this PVA the highest damages are to roads followed by damages to non-residential properties.

Table 1 – Summary of flood impacts from all sources

	High likelihood	Medium likelihood	Low likelihood
No. of Residential Properties at risk	60	300	470
No. of Non-Residential Properties at risk	140	320	370
No. of People at risk	130	660	1,000
Community Facilities at risk	<10 Community Facilities • <10 Educational Buildings.	<10 Community Facilities • <10 Educational Buildings. • <10 Child Day Care Centres.	<10 Community Facilities • <10 Educational Buildings. • <10 Child Day Care Centres • <10 Emergency Services Buildings.
Utilities at risk	10 utilities • 10 Energy sites	20 utilities • 20 Energy sites	30 utilities • ~30 Energy sites • <10 Scottish Water Assets
Transport Links at risk (excluding minor roads)	26 Roads affected at 286 locations • 15 A Roads • 11 B Roads 1 Railway route affected at 2 locations • Berwick-upon-Tweed to Edinburgh	26 Roads affected at 427 locations • 15 A Roads • 11 B Roads 1 Railway route affected at 5 locations • Berwick-upon-Tweed to Edinburgh	27 Roads affected at 497 locations • 15 A Roads • 12 B Roads 1 Railway route affected at 7 locations • Berwick-upon-Tweed to Edinburgh
Designated Areas (km^2) at risk	0.1 km^2 • 4 SSSI	0.1 km^2 • 4 SSSI	0.1 km^2 • 4 SSSI
No. of Cultural Heritage Sites at risk	27	29	29
Agricultural Land at risk (km^2)	0.8 km^2	1.1 km^2	1.2 km^2

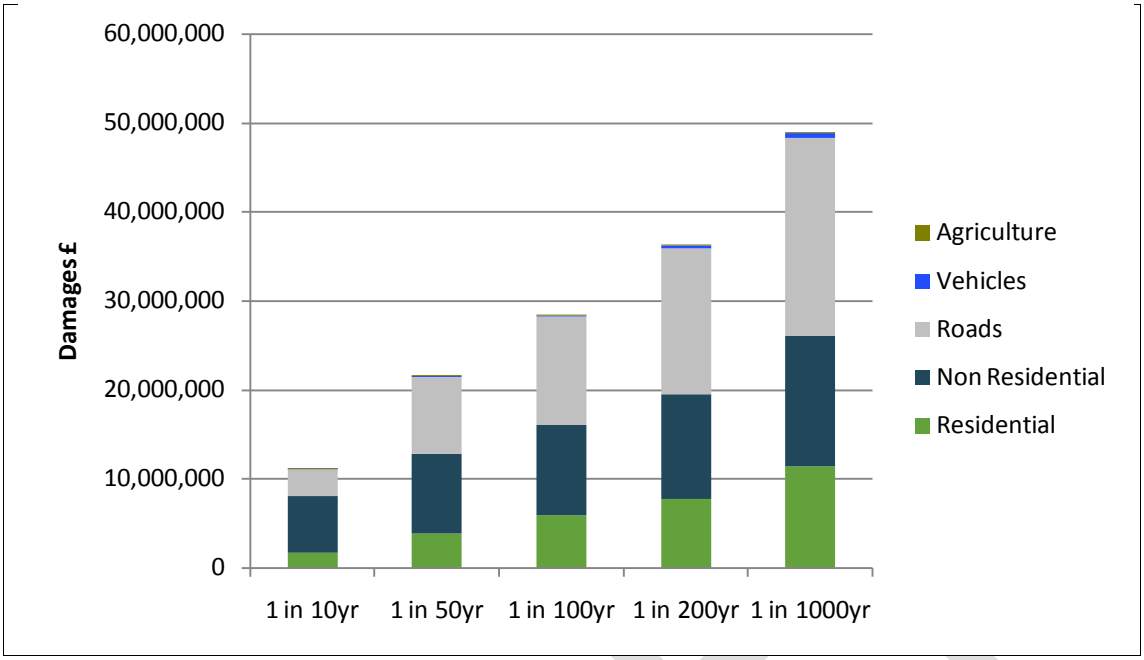

Figure 3: Damages by flood frequency from all sources

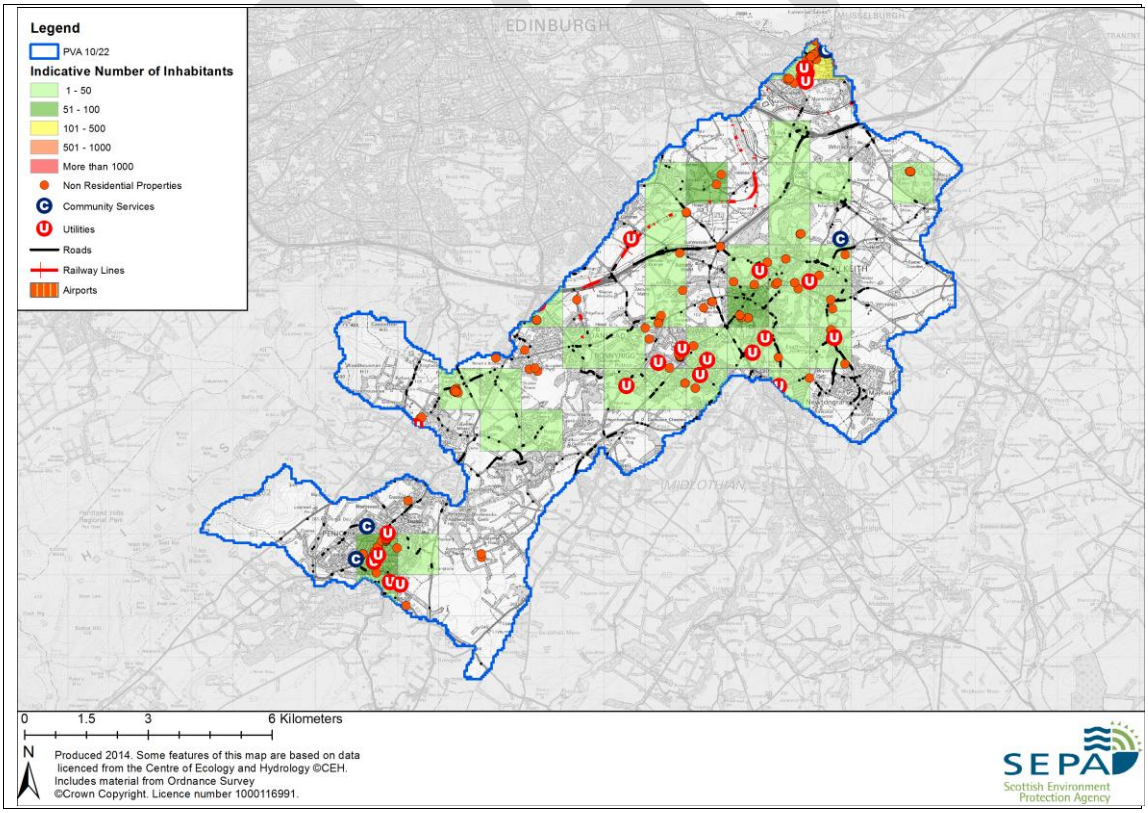

Figure 4: Impacts from all sources at a medium likelihood of flooding

Summary of existing local actions to manage risk

There are two formal flood protection/prevention schemes constructed under the Flood Prevention (Scotland) Act 1961 or the Flood Risk Management (Scotland) Act 2009 to reduce the risk of flooding.

- Rullion Road, Penicuik Flood Prevention Scheme 1994 Description: Construction of ditches to divert surface run-off from residential property
- C53 Polton Road Bridge Relief Culvert Flood Prevention

Other measures may exist that were not constructed under the 1961 or the 2009 Act's but do reduce the impact of flooding, this may include other structures, natural features and natural flood management measures. These other measures can be seen in the river, coastal and surface water flooding report Appendixes.

There are 2 flood warning target areas within this PVA:

- Musselburgh - River flood warning, Esk
- Musselburgh Coastal - Coastal flood warning, Firth of Forth

SEPA and the local authorities work closely with many other organisations that have flooding related duties and interests such as the police, fire & rescue services, the Scottish Government and the Scottish Flood Forum. SEPA and the local authorities, often in partnership with these organisations, undertake various awareness raising campaigns that include community events, information leaflets, educational plays in schools, the use of social media and advertising.

In addition to the above, the following community groups that help with flood resilience are known to operate within this catchment:

- East Lothian Bio-diversity Group
- East Lothian Tenants and Residents Panel
- Musselburgh Waterfront Group
- Musselburgh and Inveresk Community Council

Numerous local community councils are also known to operate throughout the East Lothian Council district.

The following local incentives or subsidies have also been put in place in order to provide property owners with property level resilience/resistance measures:

- East Lothian Council strategically deploy temporary flood barriers and sand bags when properties are threatened by flooding

Some local authorities have their own policies regarding property level protection. Contact your local authority or view their website for more information.

History of flooding

The following river flood events have been identified as significant:

- 6 October 1990, River Esk; Musselburgh was affected by flooding from the Esk

- 13 August 1948: Evacuation required in Musselburgh after flooding occurred in Eskside West, Eskside East, Shorthope Street, Millhill and areas of the High Street

No significant coastal or surface water events have been identified in this PVA.

Potentially Vulnerable Area: 10/23 - Cockenzie and Port Seton, Longniddry, Prestonpans

Local Plan District	Local Authorities	Main Catchment
10 - Forth Estuary	East Lothian	East Lothian Coastal

Background

This Potentially Vulnerable Area (PVA) covers an area of 65km^2 and includes Cockenzie and Port Seton, Prestonpans, Longniddry and Tranent (Figure 1). Within this PVA approximately 120 residential properties are at a medium likelihood of flooding from one or more sources. The total Annual Average Damages (AAD) from all sources of flooding are approximately £700,000 (this includes damages to residential properties, non-residential properties, transport and agriculture). The majority of these damages are caused by surface water flooding (Figure 2).

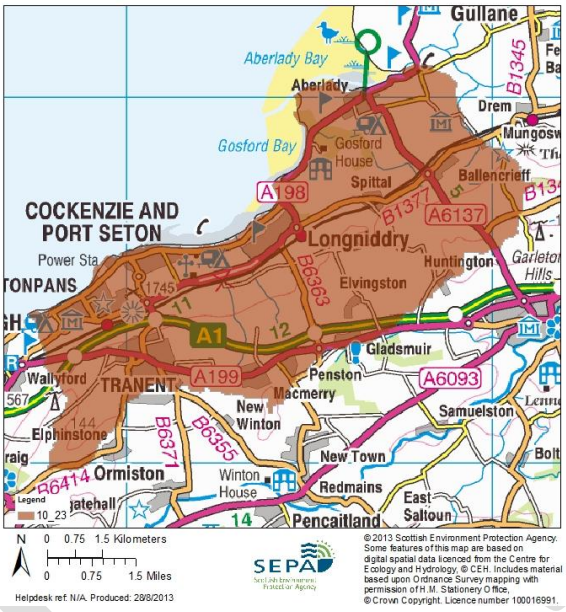

Figure 1: Potentially Vulnerable Area 10/23

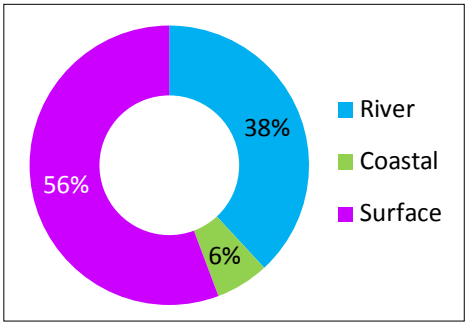

Figure 2: Annual Average Damages by flood source

Summary of impacts from all sources of flooding

Approximately 120 residential properties and 60 non-residential properties are at a medium likelihood of flooding from one or more sources. A summary of the impacts from all sources of flooding can be seen in Table 1 and a map showing the impacts from all sources at a medium likelihood of flooding can be seen in Figure 4.

The highest risk of river flooding is from Firth of Forth to Longniddry, Tranent and Cockenzie and Port Seton.

The highest risk of coastal flooding is from the Firth of Forth to Prestonpans, Cockenzie and Port Seton.

The highest risk of surface water flooding is in Tranent.

The economic damages incurred for each return period can be seen in Figure 3. For this PVA the highest damages are to roads followed by damages to residential properties.

In 2010 Scottish Water carried out a Flood Risk Assessment Study of 292 non infrastructure water and wastewater assets across Scotland that were within the 1 in 200 year flood extent. Of the assets assessed, no water assets and one wastewater assets were identified as being at risk of flooding within this PVA.

Table 1: Summary of flood risk from all sources

	High likelihood	Medium likelihood	Low likelihood
No. of Residential Properties at risk	50	120	180
No. of Non-Residential Properties at risk	30	60	70
No. of People at risk	110	260	400
Community Facilities at risk	None	None	None
Utilities at risk	<10 utilities • <10 Energy sites	10 utilities • ~10 Energy sites • <10 Scottish Water Assets	10 utilities • ~10 Energy sites • <10 Scottish Water Assets
Transport Links at risk (excluding minor roads)	11 Roads affected at 103 locations • 4 A Roads • 7 B Roads 1 Railway route affected at 23 locations • Berwick-upon-Tweed to Edinburgh	11 Roads affected at 158 locations • 4 A Roads • 7 B Roads 1 Railway route affected at 28 locations • Berwick-upon-Tweed to Edinburgh	11 Roads affected at 174 locations • 4 A Roads • 7 B Roads 1 Railway route affected at 29 locations • Berwick-upon-Tweed to Edinburgh
Designated Areas (km2) at risk	0.5km2 • 1 SSSI • 1 SPA • 1 SAC	0.5km2 • 1 SSSI • 1 SPA • 1 SAC	0.6km2 • 1 SSSI • 1 SPA • 1 SAC
No. of Cultural Heritage Sites at risk	15	19	19
Agricultural Land at risk (km2)	1.4km2	1.9km2	2.1km2

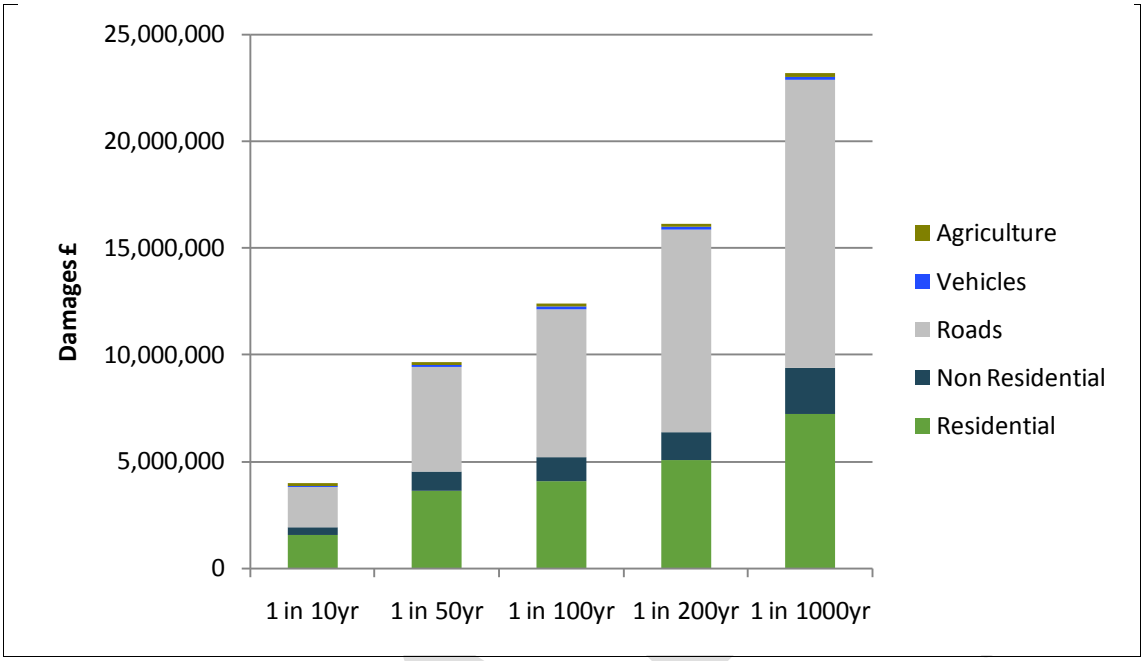

Figure 3: Damages by flood frequency from all sources

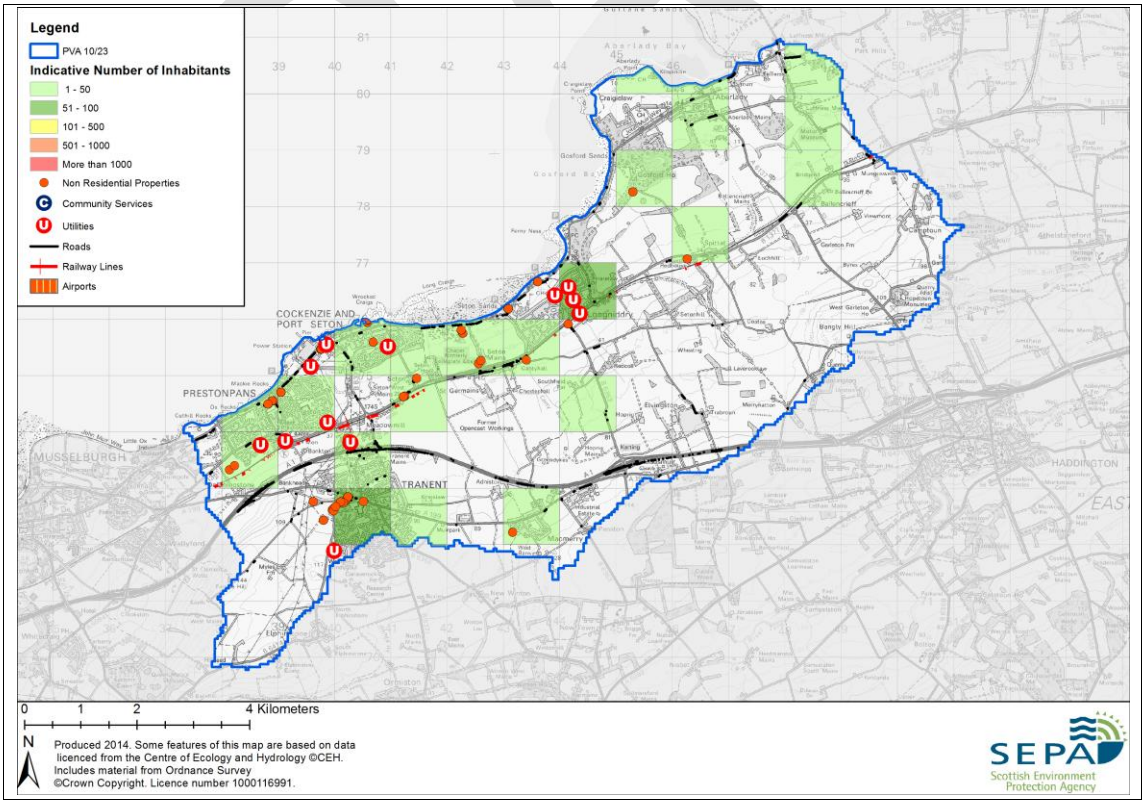

Figure 4: Impacts from all sources at a medium likelihood of flooding

Summary of existing local actions to manage risk

There are one formal flood protection/prevention schemes constructed under the Flood Prevention (Scotland) Act 1961 or the Flood Risk Management (Scotland) Act 2009 to reduce the risk of flooding.

- Prestonpans Flood Prevention Scheme 1972

Other measures may exist that were not constructed under the 1961 or the 2009 Acts but do reduce the impact of flooding, this may include other structures, natural features and natural flood management measures. These other measures can be seen in the river, coastal and surface water flooding report Appendixes.

There is one flood warning target area within this PVA:

- Prestonpans, Cockenzie and Port Seton - Coastal flood warning, Firth of Forth and Tay

SEPA and the local authorities work closely with many other organisations that have flooding related duties and interests such as the police, fire & rescue services, the Scottish Government and the Scottish Flood Forum. SEPA and the local authorities, often in partnership with these organisations, undertake various awareness raising campaigns that include community events, information leaflets, educational plays in schools, the use of social media and advertising.

In addition to the above, the following community groups that help with flood resilience are known to operate within this catchment:

- East Lothian Bio-diversity Group
- East Lothian Tenants and Residents Panel
- Coastal Regeneration Group for Port Seton and Cockenzie

Numerous local community councils are also known to operate throughout the East Lothian Council district.

The following local incentives or subsidies have also been put in place in order to provide property owners with property level resilience/resistance measures:

- East Lothian Council strategically deploy temporary flood barriers and sand bags when properties are threatened by flooding

History of flooding

The following coastal flood event has been identified as significant:

- 30 March 2010: A tidal surge coinciding with the highest mean tides of the year caused extensive flooding along the East Coast of Scotland, with the Firth of Forth being one of the worst affected areas. Locations within this coastal area affected included Leith, Musselburgh, Prestonpans, Port Seton, Dunbar and North Berwick. Impacts included flooding of properties, damage to harbours, seawalls and roads with Edinburgh City Council estimating the costs to repair

damages in the region of 650,000.

No significant river or surface water events have been identified in this PVA.

Potentially Vulnerable Area: 10/24 – Haddington

Local Plan District (LPD)	Local Authorities	Main Catchment
10 - Forth Estuary	East Lothian	River Tyne

Background

This Potentially Vulnerable Area (PVA) covers an area of 16km^2 and includes Haddington (Figure 1). Within this PVA approximately 230 residential properties are at a medium likelihood of flooding from one or more sources. The total Annual Average Damages (AAD) from all sources of flooding are approximately £700,000 (this includes damages to residential properties, non-residential properties, transport and agriculture). The majority of these damages are caused by river flooding (Figure 2).

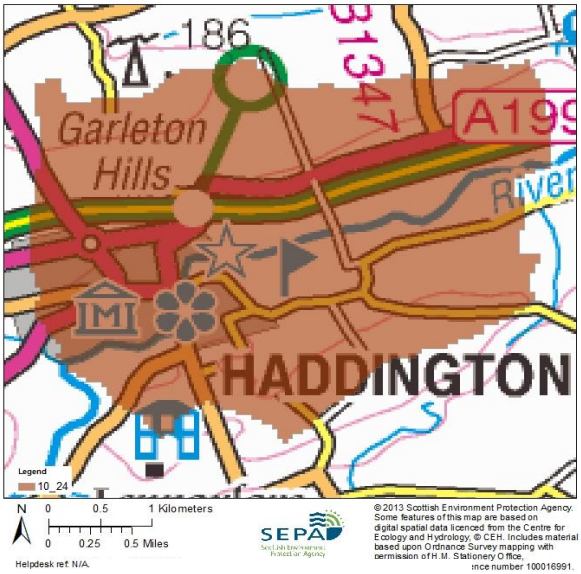

Figure 1: Haddington Potentially Vulnerable Area

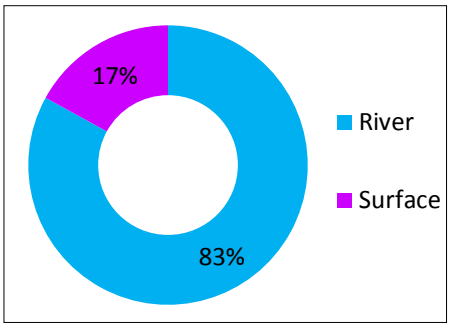

Figure 2: Annual Average Damages by flood source

Summary of impacts from all sources of flooding

Approximately 230 residential properties and 180 non-residential properties are at a medium likelihood of flooding from one or more sources. A summary of the impacts from all sources of flooding can be seen in Table 1 and a map showing the impacts from all sources a medium likelihood of flooding can be seen in Figure 4.

The highest risk of river flooding is from the River Tyne to Haddington and the highest risk of surface water flooding is also in Haddington.

The economic damages incurred for each return period can be seen in figure 3. For this PVA the highest damages are to residential property followed by damages to non-residential properties.

Table 1: Summary of flood impacts from all sources

	High likelihood	Medium likelihood	Low likelihood
No. of Residential Properties at risk	70	230	330
No. of Non-Residential Properties at risk	30	180	210
No. of People at risk	150	510	730
Community Facilities at risk	None	1 Community Facility • 1 Educational Building.	1 Community Facility • 1 Educational Building.
Utilities at risk	<10 utilities • <10 Energy sites	<10 utilities • <10 Energy sites • <10 Communications sites	<10 utilities • <10 Energy sites • <10 Communications sites
Transport Links at risk (excluding minor roads)	5 Roads affected at 25 locations • 4 A Roads • 1 B Road	6 Roads affected at 59 locations • 5 A Roads • 2 B Roads	6 Roads affected at 68 locations • 5 A Roads • 2 B Roads
Designated Areas (km^2) at risk	None	None	None
No. of Cultural Heritage Sites at risk	5	5	5
Agricultural Land at risk (km^2)	0.6 km^2	0.8 km^2	0.9 km^2

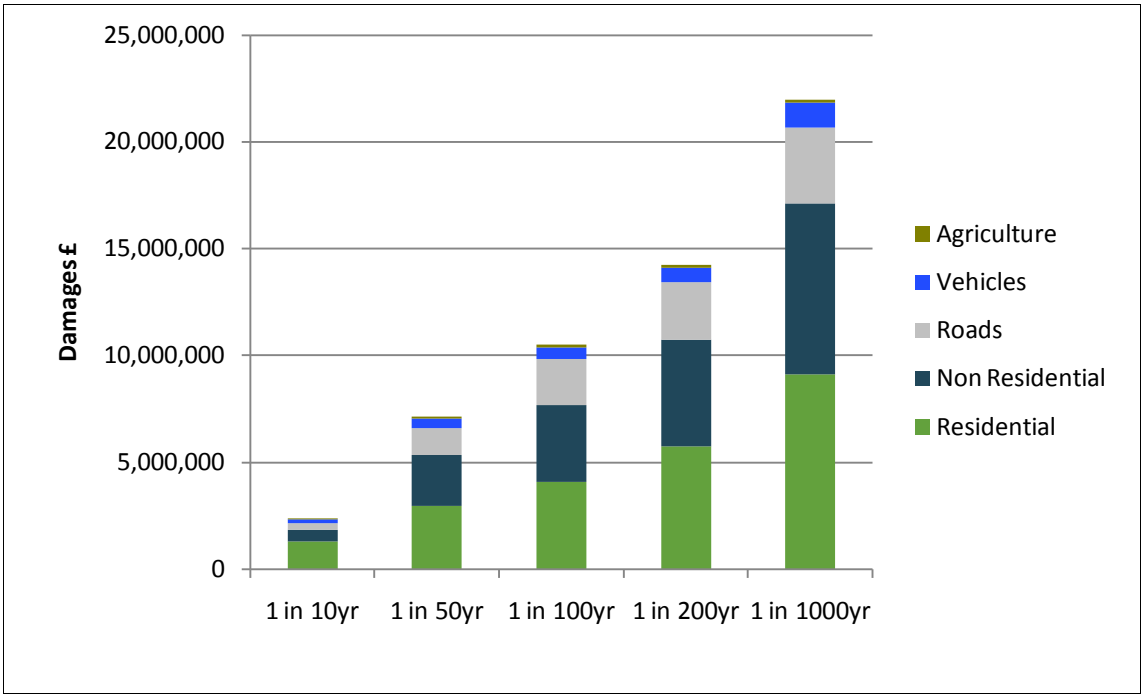

Figure 3: Damages by flood frequency from all sources

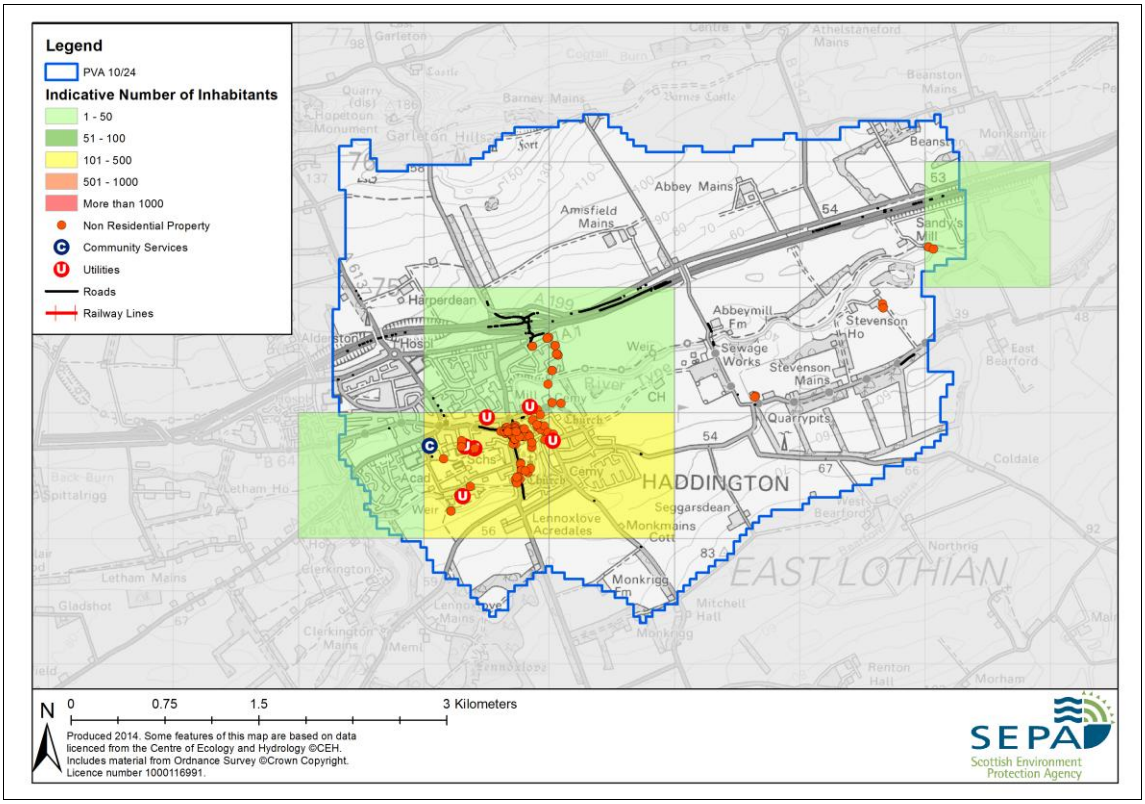

Figure 4: Impacts from all sources at a medium likelihood of flooding

Summary of existing local actions to manage risk

There are no formal flood protection/prevention schemes constructed under the Flood Prevention (Scotland) Act 1961 or the Flood Risk Management (Scotland) Act 2009 to reduce the risk of flooding.

Other measures may exist that were not constructed under the 1961 or the 2009 Acts but do reduce the impact of flooding, this may include other structures, natural features and natural flood management measures. These other measures can be seen in the river, coastal and surface water flooding report Technical Annexes.

There are 3 flood warning target areas within this PVA:

- Haddington (Red) - River flood warning, Tyne
- Haddington (Orange) - River flood warning, Tyne
- Haddington (Green) - River flood warning, Tyne

SEPA and the local authorities work closely with many other organisations that have flooding related duties and interests such as the police, fire & rescue services, the Scottish Government and the Scottish Flood Forum. SEPA and the local authorities, often in partnership with these organisations, undertake various awareness raising campaigns that include community events, information leaflets, educational plays in schools, the use of social media and advertising.

In addition to the above, the following community groups that help with flood resilience are known to operate within this catchment:

- East Lothian Bio-diversity Group
- East Lothian Tenants and Residents Panel

- Friends of the River Tyne

Numerous local community councils are also known to operate throughout the East Lothian Council district.

The following local incentives or subsidies have also been put in place in order to provide property owners with property level resilience/resistance measures:

- East Lothian Council strategically deploy temporary flood barriers and sand bags when properties are threatened by flooding

History of flooding

The following river flood events have been identified as significant.

- 7 July and 25 Sept 2012, Haddington; Property flooding, due to drains/watercourses backing up and unable to discharge into the River Tyne due to high levels. Wider property flooded avoided by actions East Lothian council.
- 12 August 1948, River Tyne, Eye Water and Whiteadder Water; The waters of the River Tyne rose 2 inches at Haddington above the bottom of the plate which commemorates a previous flood of October 1775, and flooded the High Street of the town to a depth of 57 inches. The flood event is known to have affected a large area with railway lines and road bridges damaged or destroyed and multiple buildings flooded
- 1926 & 1932, Haddington; Photographic evidence of large flood events in Haddington
- October 1775, Haddington; Large flood event in Haddington inundating most of the town

No significant surface water flood events have been identified in this PVA.

Potentially Vulnerable Area: 10/25 - Dunbar, West Barns

Local Plan District	Local Authorities	Main Catchment
10 - Forth Estuary	East Lothian	East Lothian Coastal

Background

This Potentially Vulnerable Area (PVA) covers an area of 19km^2 and includes Dunbar and West Barns (Figure 1). Within this PVA approximately 40 residential properties are at a medium likelihood of flooding from one or more sources. The total Annual Average Damages (AAD) from all sources of flooding are approximately £200,000 (this includes damages to residential properties, non-residential properties, transport and agriculture). The majority of these damages are caused by surface water flooding (Figure 2).

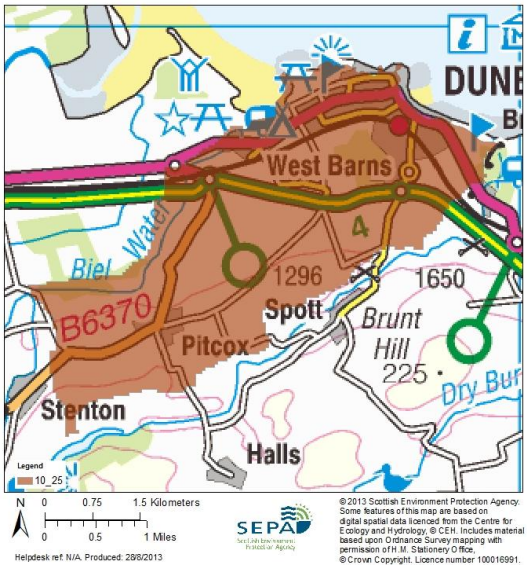

Figure 1: Dunbar, West Barns Potentially Vulnerable Area

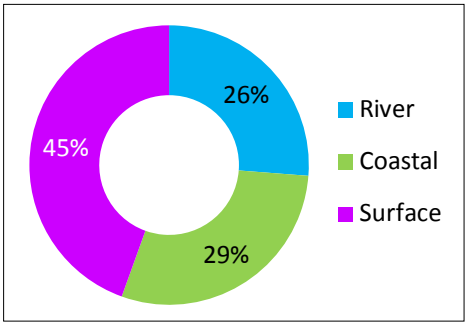

Figure 2: Annual Average Damages by flood source

Summary of impacts from all sources of flooding

Approximately 40 residential properties and 20 non-residential properties are at a medium likelihood of flooding from one or more sources. A summary of the impacts from all source of flooding can be seen in Table 1 and a map showing the impacts from all sources at a medium likelihood of flooding can be seen in Figure 4.

The highest risk of river flooding is from the Biel Water and Hedderwick Burn to Dunbar and West Barns and the highest risk of surface water flooding is also in Dunbar and West Barns.

The highest risk of coastal flooding is from the North Sea to Dunbar and West Barns.

The economic damages incurred for each return period can be seen in Figure 3. For this PVA the highest damages are to roads followed by damages to residential properties.

Table 1: Summary of flood risk from all sources

	High likelihood	Medium likelihood	Low likelihood
No. of Residential Properties at risk	10	40	60
No. of Non-Residential Properties at risk	10	20	20
No. of People at risk	20	90	130
Community Facilities at risk	None	None	None
Utilities at risk	<10 utilities • <10 Energy sites	<10 utilities • <10 Energy sites	<10 utilities • <10 Energy sites
Transport Links at risk (excluding minor roads)	4 Roads affected at 39 locations • 3 A Roads • 1 B Road 1 Railway route affected at 15 locations • Berwick-upon-Tweed to Edinburgh	4 Roads affected at 49 locations • 3 A Roads • 1 B Road 1 Railway route affected at 17 locations • Berwick-upon-Tweed to Edinburgh	4 Roads affected at 57 locations • 3 A Roads • 1 B Road 1 Railway route affected at 18 locations • Berwick-upon-Tweed to Edinburgh
Designated Areas (km^2) at risk	0.2 km^2 • 1 SSSI • 1 SPA • 1 SAC	0.2 km^2 • 1 SSSI • 1 SPA • 1 SAC	0.2 km^2 • 1 SSSI • 1 SPA • 1 SAC
No. of Cultural Heritage Sites at risk	9	9	9
Agricultural Land at risk (km^2)	0.3 km^2	0.4 km^2	0.5 km^2

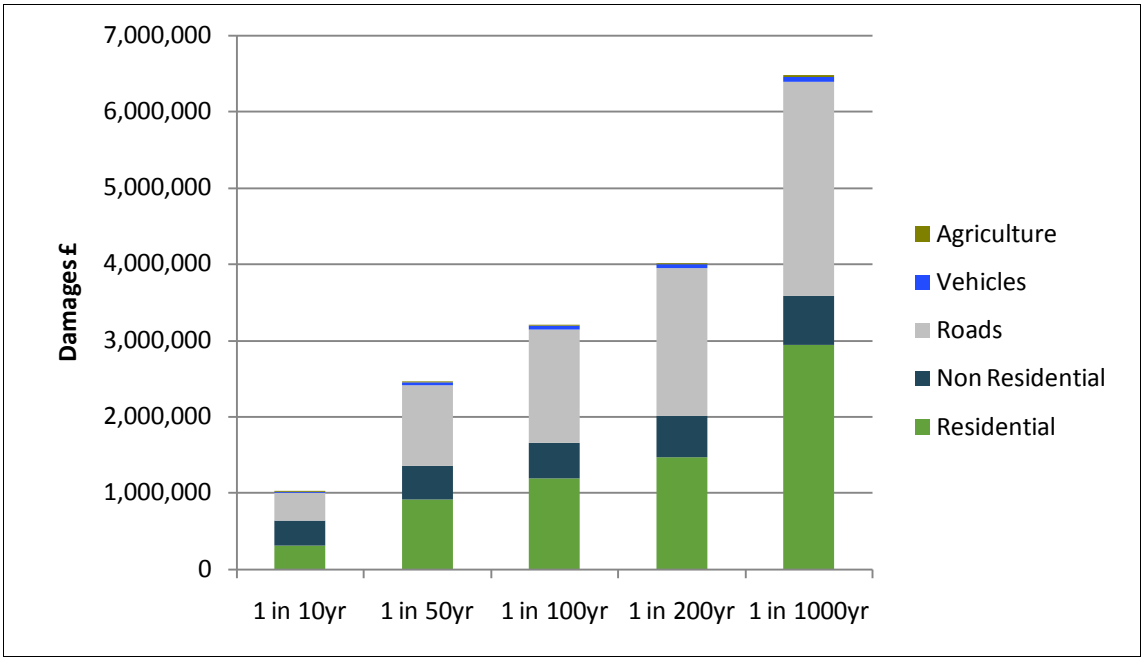

Figure 3: Damages by flood frequency from all sources

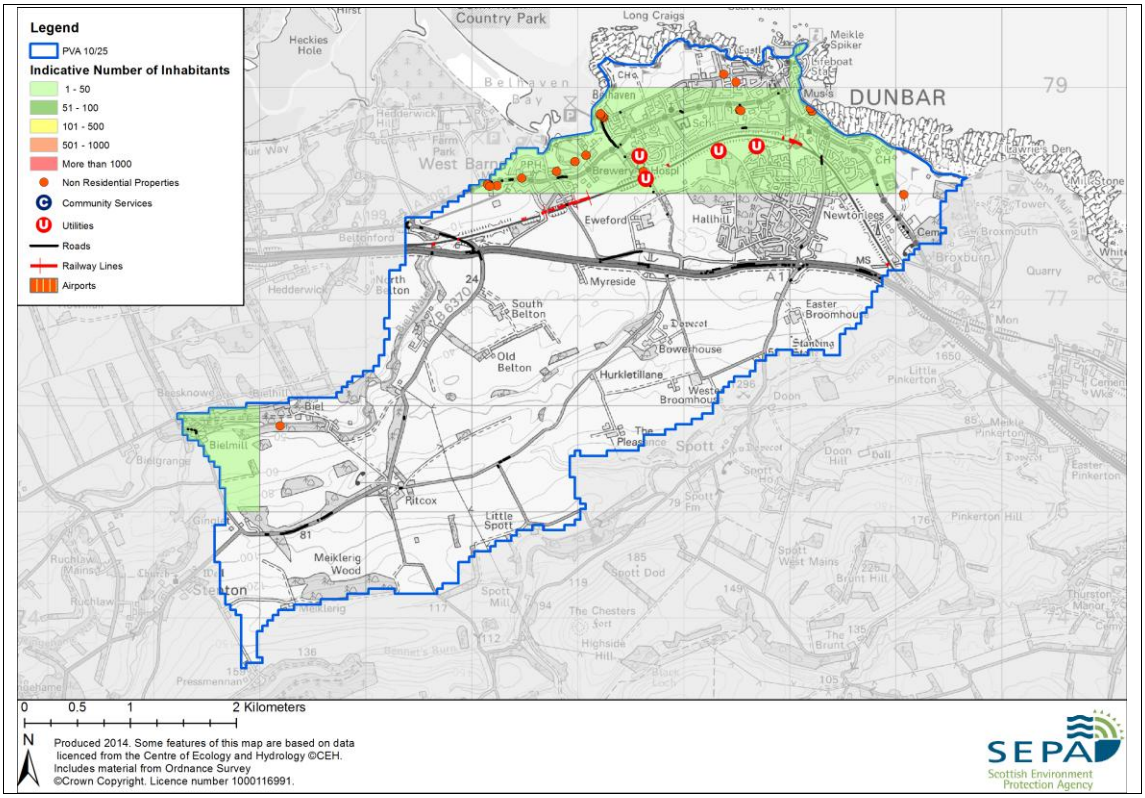

Figure 4: Impacts from all sources at a medium likelihood of flooding

Summary of existing local actions to manage risk

There are no formal flood protection/prevention schemes constructed under the Flood Prevention (Scotland) Act 1961 or the Flood Risk Management (Scotland) Act 2009 to reduce the risk of flooding.

Other measures may exist that were not constructed under the 1961 or the 2009 Acts but do reduce the impact of flooding, this may include other structures, natural features and natural flood management measures. These other measures can be seen in the river, coastal and surface water flooding report Appendixes.

There is one flood warning target area within this PVA:

- Dunbar including West Barns - Coastal flood warning, Firth of Forth

SEPA and the local authorities work closely with many other organisations that have flooding related duties and interests such as the police, fire & rescue services, the Scottish Government and the Scottish Flood Forum. SEPA and the local authorities, often in partnership with these organisations, undertake various awareness raising campaigns that include community events, information leaflets, educational plays in schools, the use of social media and advertising.

In addition to the above, the following community groups that help with flood resilience are known to operate within this catchment:

- East Lothian Bio-diversity Group
- East Lothian Tenants and Residents Panel
- Dunbar Shore and Harbour Neighbourhood Group

Numerous local community councils are also known to operate throughout the East Lothian Council district.

The following local incentives or subsidies have also been put in place in order to provide property owners with property level resilience/resistance measures:

- East Lothian Council strategically deploy temporary flood barriers and sand bags when properties are threatened by flooding

History of flooding

The following river flood events have been identified as significant:

- 22 October 2002: Belhaven Hospital flooded. Patients had to be evacuated after ward closed and the Generator room was shut down

The following coastal flood events have been identified as significant:

- 5 December 2012: A combination of wind and high tides caused large waves and coastal flooding along the East coast of Scotland, in the Forth Estuary LPD there was significant damage to North Berwick Harbour and damage to the communal slipway at Dunbar Harbour
- 30 March 2010: A tidal surge coinciding with the highest mean tides of the year caused extensive flooding along the East Coast of Scotland, with the Firth of Forth being one of the worst affected areas. Locations within this coastal area affected included Leith, Musselburgh, Prestonpans, Port Seton, Dunbar and

North Berwick. Impacts included flooding of properties, damage to harbours, seawalls and roads with Edinburgh City Council estimating the costs to repair damages in the region of 650,000

- August 1949: Storm surge caused flooding to Dunbar

No significant surface water events have been identified in this PVA.

Flood Risk Management (Scotland) Act
Pre-consultation update
June 2014

Purpose

This note provides information to support local authorities in preparing material for committee approval. It contains detail of the flood risk management planning process and the core content that will be available for public consultation between December 2014 and June 2015.

Further background information on flood risk management can be obtained from SEPA's website (www.sepa.org.uk/flooding) or from your FRM Regional Planning Manager.

Background

The Flood Risk Management (Scotland) Act 2009 established a new plan-led approach to flood risk management. Its primary aim is to reduce overall flood risk in the most sustainable manner. SEPA, in collaboration with partners, is producing Flood Risk Management Strategies (FRM Strategies) to set out the future direction and priorities for managing flooding. These strategic documents are supplemented with Local Flood Risk Management Plans (Local FRM Plans) produced by lead local authorities which describe the delivery and funding arrangements for the agreed priorities.

In 2011 SEPA consulted and identified 243 areas where the potential impacts of flooding justified further assessment and appraisal of flood risk management actions. These Potentially Vulnerable Areas form the basis on which local authorities, Scottish Water, SEPA and other responsible authorities are developing FRM Strategies and Local FRM Plans. The 243 Potentially Vulnerable Areas in Scotland have been grouped together for planning purposes within 14 Local Plan Districts. 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 Potentially Vulnerable Areas.

Public consultation

Flood risk management authorities have been working closely in partnership over the previous two years to produce the FRM Strategies and Local FRM Plans. A period of public consultation on the documents will run from December 2014 to June 2015. The final FRM Strategies and Local FRM Plans (due for publication in December 2015 and June 2016 respectively) will take account of views expressed through consultation and include further detail as to national priority and delivery.

Lead local authorities and SEPA are required to coordinate their consultation arrangements during the production of the FRM Strategies and Local FRM Plans. The consultation will be delivered through a phased approach beginning in December 2014 and closing in June 2015. Key elements of the documents to be consulted on are:

- Characterisation reports;
- Setting objectives;
- Identifying actions to reduce flood risk, and;
- Implementation arrangements.

Characterisation reports

It is important that the likelihood and potential impact of flooding is commonly understood by the organisations involved in coordinating the reduction of flood risk in Potentially Vulnerable Areas. To achieve this, SEPA has been working with local authorities and others to define the existing levels of flood risk. This information is summarised in characterisation reports.

The characterisation reports describe the location of each Local Plan District, the physical characteristics including the major rivers and coastal areas as well as the administrative boundaries. Information on historical floods, existing flood management activities, potential for natural flood management and the sensitivity of catchments and coastal areas to climate change is also included. The reports identify the flooding hazards and the risk they present to certain

receptors such as infrastructure, human health, community facilities and residential properties. Impacts have been monetised where practical and assessed for varying scales of flood events.

In summary, the characterisation reports define the flood risk problem in Potentially Vulnerable Areas and provide the evidence base against which future actions to reduce risk can be assessed and compared.

Setting objectives

Agreeing objectives will help develop a common vision for flood risk management. Under the FRM Act, Scottish Ministers, SEPA and responsible authorities have a general duty to work together using their flood risk related functions to help achieve the objectives set out in the FRM Strategies. Setting objectives is an important step towards identifying what actions should be taken to reduce the likelihood and impact of flooding.

SEPA is to set objectives for the management of flood risk within the Potentially Vulnerable Areas designated across Scotland. SEPA must then identify the most sustainable actions to achieve those objectives. Because of the range of issues involved no single body can be responsible for managing flood risk. SEPA's role is to bring together the best available information on flood risk – and on the potential mitigating actions – to help everybody involved coordinate their activity and reduce overall risk in the most sustainable manner. This will be done with the close cooperation of the bodies responsible for delivering those actions, including local authorities, SEPA, Scottish Water and others.

Objectives are agreed in two stages. Initial objectives for consultation are based on SEPA's national flood maps and the detailed knowledge and information provided by local authorities, all of which is summarised in the characterisation reports. Initial objectives are quite broad in nature with their purpose being to help identify the appropriate actions to manage flooding. After consultation, with the benefit of more detailed information on what is practical and feasible in terms of technical solutions and resources, these initial objectives will be refined to provide specific final objectives to manage flooding.

Some objectives are set across the whole Local Plan District. For example, there should be an objective set to avoid an increase in flood risk through the appropriate application of land use planning policies and the development control process of planning authorities. In addition, an objective should be set to reduce the overall flood risk, thereby ensuring that activities such as improved flood warning, awareness-raising with the public and general maintenance of flood prevention schemes can be included.

Most objectives will be set at the scale of the Potentially Vulnerable Area. Where significant flood risks have been identified within the Potentially Vulnerable Area, one or more objectives may be set to address the specific locations where the flood risk is concentrated.

The FRM Strategy objectives are set around the principles of Avoid, Reduce, and Accept & Maintain:

Objective	Definition	Where
AVOID	Action is needed to avoid flood risks increasing in future. Use existing or new land-use planning actions to avoid new risks from development and to limit the impacts of climate change.	Applies to all PVAs and LPDs.
REDUCE	The current or future level of flood risks are significant AND new action is required. This may involve new actions or the enhancement of existing actions. Flood risks in these areas may still increase after new action is taken as a result of climate change.	Applies to PVAs where flood risk is significant and new action is needed.
ACCEPT & MAINTAIN	Significant flood risks are being managed appropriately. This will require ongoing maintenance of watercourses and existing flood risk management actions (e.g. flood defences and flood warning). Flood risks in these areas may increase as a result of climate change.	Applies to PVAs where flood risks are being managed appropriately and no new action is needed.

Note:

- Where an initial objective has been set to reduce risk to a utility site, trunk road or railway line, discussions will take place with the asset owner to determine the site specific nature of the risk involved and any actions already in place. These discussions will inform the final objectives and associated actions.

- Initial objectives have not yet been set for significant flood risks to environmentally-designated or important cultural heritage sites. Flood risk to these sites will be discussed with the authority responsible for their protection and initial objectives may be added at the conclusion of these discussions.

Flood risk management actions

Once objectives to manage risk in the Potentially Vulnerable Areas have been agreed, a short list of possible actions needs to be identified. Starting from a long-list of possible actions that includes the full range of structural and non-structural interventions, a screening exercise will refine the list to ensure the most sustainable combination of actions is selected to manage the identified flood risk.

It is important that a range of actions to reduce flood risk are considered in the appraisal process. This will include actions which are likely to be common to all Potentially Vulnerable Areas but will also include actions specific to individual Potentially Vulnerable Areas such as those to tackle a particular source of flooding. Actions may be added to or refined by the Local Plan District Partnerships, Local Advisory Groups or through engagement with the wider community prior to screening and appraisal. It is important that existing actions to manage flood risk are included in the long-list, so that the benefit of continued investment in those actions can be considered.

Prioritisation of actions

Multi-criteria analysis will be carried out on the proposed actions to inform a prioritisation process. More details of this will follow in subsequent briefings.

Implementation arrangements

The Local FRM Plans will provide detail how actions will be delivered. Information on responsibilities, funding sources and timescales will be included.

SECTION 3:

MAIN CATCHMENTS AND COASTAL AREAS WITHIN FORTH ESTUARY LOCAL PLAN DISTRICT

CHAPTER 4.3: COASTAL FLOODING

The area of the Forth Estuary Local Plan District that is affected by coastal flooding[1] is shown in Figure 1. The district has 375km of coastline stretching from Fife Ness in the north to the Scottish Borders in the south. The coastline includes the Firth of Forth and areas of coast exposed to the North Sea. Several urban areas are situated along the coastline including Grangemouth, Bo'ness, Edinburgh, Musselburgh, North Berwick and Eyemouth. Altogether there are 22 Potentially Vulnerable Areas in this district that have a risk of coastal flooding(Figure 1).

The flood maps used to generate information for this report were developed using consistent methods for the whole of Scotland. There is inherent uncertainty in all flood modelling due to the assumptions and simplifications required to represent complex natural processes. In seeking to improve overall confidence this national approach was supplemented where possible with more detailed, local assessments. The resultant maps are suitable for identifying the flood risk to communities and helping to assess the right combination of actions required to address those risks. They are not suitable for defining the flood risk to individual properties or for the detailed design of actions, such as flood defences.

The information on coastal flooding in this report is based on SEPA modelling using still water level predictions. The method used simplifies the coastal processes and flooding mechanisms at work during a storm. The modelling does not take into account all structures that may reduce the risk of coastal flooding, nor does it take into account the impact of wave overtopping or the interaction between river and coastal flooding. As a result they may underestimate coastal flood risk in some areas. In locations with wide and flat floodplains, the modelling may overestimate flood risk because the volumes of water able to inundate an area over a tidal cycle are not taken into account.

4.3.1 Coastal Flooding Impacts

Within the Local Plan District approximately 1,700 residential properties and 340 non-residential properties are at a medium likelihood of coastal flooding. The total Annual Average Damages in the district are approximately £4.0 million. It is estimated that 97% of residential and non-residential properties at a medium likelihood of coastal flooding are location within the area.

[1] The term coastal flooding is used under the Flood Risk Management (Scotland) Act 2009, but in some areas it is also referred to as tidal flooding and covers areas such as estuaries and river channels that are influenced by tidal flows.

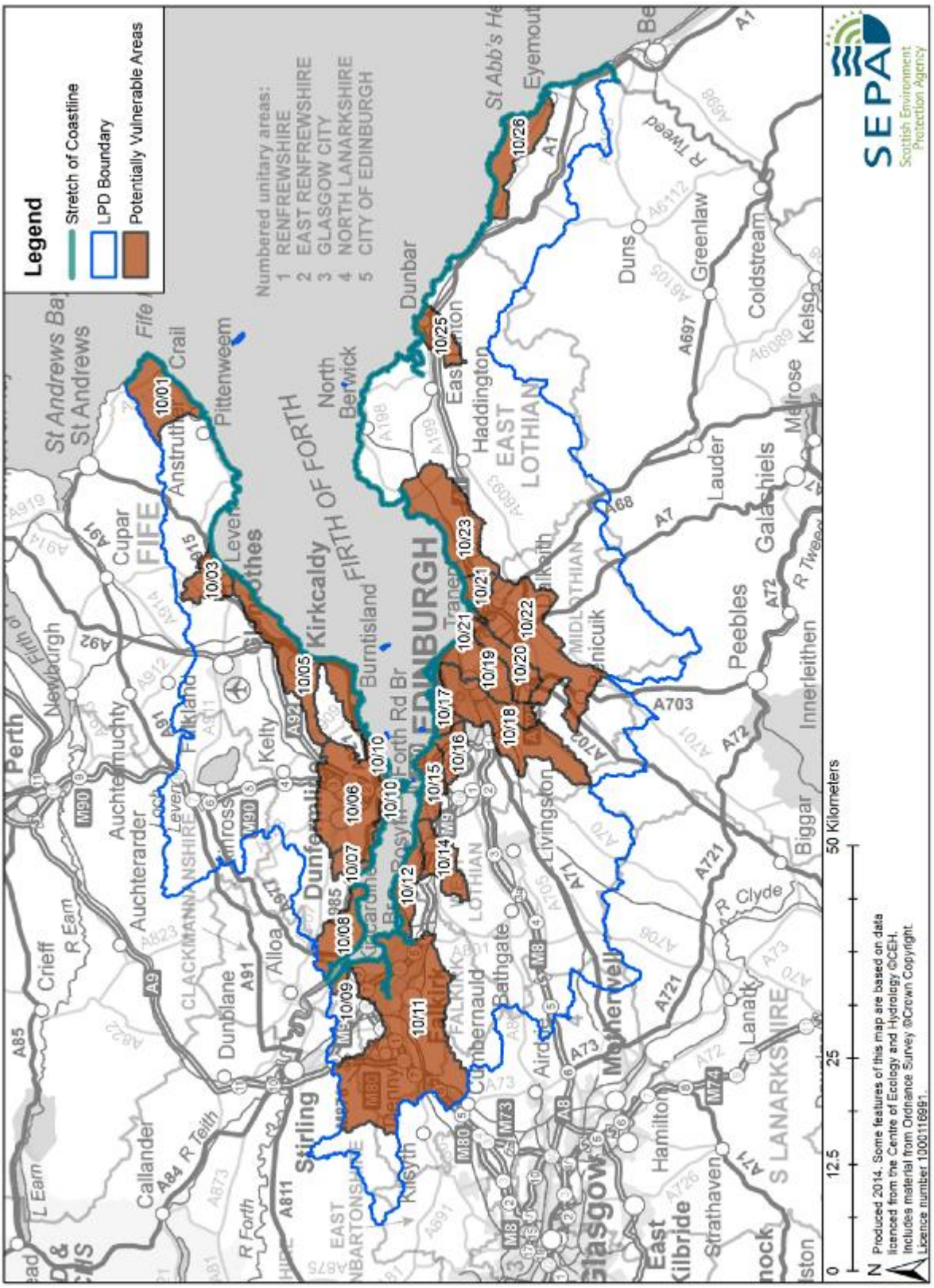

Figure 1: Forth Estuary Local Plan District coastal area and Potentially Vulnerable Areas with a risk of coastal flooding

Main urban centres and infrastructure at risk

The main urban areas with a risk of coastal flooding can be seen in Table 1. Table 1 shows the number of residential properties at risk and the total Annual Average Damages caused by coastal flooding, which includes damages to residential properties, non-residential properties, transport and agriculture. Figure 2 shows the distribution of residential properties at risk of coastal flooding throughout the district.

Table 1: Main urban centres with a risk of coastal flooding[2]

Locations	Number of residential properties at a medium likelihood of flooding	Total Annual Average Damages
Grangemouth	670	£520,000
Musselburgh	380	£660,000
Kincardine	150	£350,000
Culross	130	£320,000
Airth	110	£670,000
Eyemouth	60	£240,000
Edinburgh	30	£100,000
Inverkeithing-North Queensferry	20	£42,000
North Berwick	20	£13,000
South Queensferry	10	£20,000
Carron-Carronshore	<10	£110,000
Dunbar and West Barns	<10	£26,000
Anstruther-Pittenweem	<10	£22,000
Prestonpans, Cockenzie & Port	<10	£20,000
Limekilns	<10	£6,000
Bo'ness	<10	£2,000

Within the district utility assets, community facilities and transport routes have a medium likelihood of coastal flooding. The approximate numbers include:

- Utility Assets:
    - 40 energy production sites
    - <10 Radar sites
    - <10 Control Buildings
- Community Facilities:
    - <10 schools
- Transport Routes:
    - 18 Roads (13 A roads affected at 69 locations, 5 B roads affected at 30 locations)
    - 1 Railway route (Fife circle, Dalmeny to Winchburgh and Haymarket West Junctions, affected at 3 locations)

[2] Table 1 does not show properties at risk if they are protected by a formal Flood Protection / Prevention Scheme with a known standard of protection of 1 in 200 years.

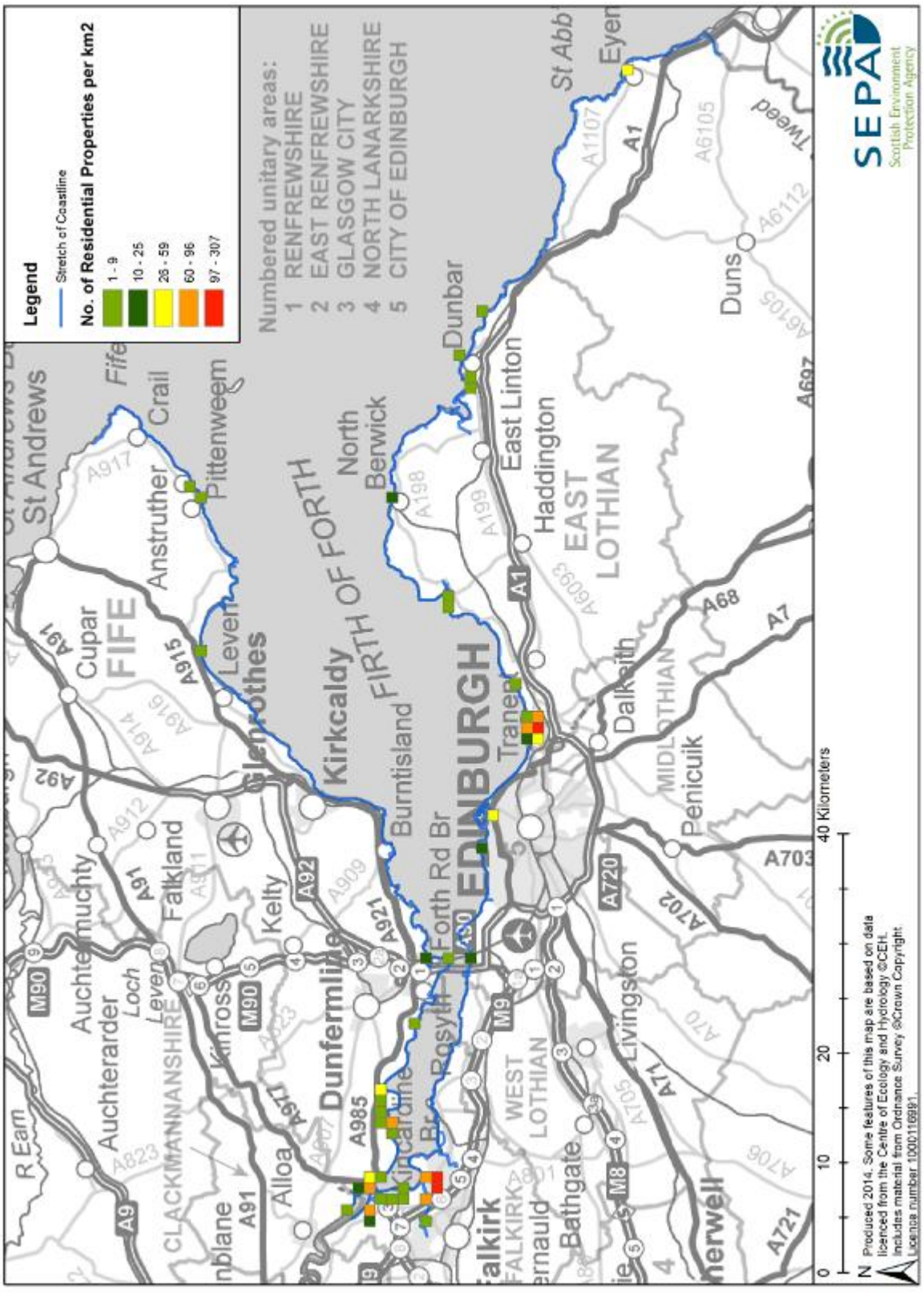

Figure 2: Residential properties with a medium likelihood of coastal flooding

History of coastal flooding

The following flooding events have been identified as having significant coastal influences by the local authorities and SEPA's historical flood database. This list is not exhaustive.

- 04 January 2014: A tidal surge combined with a storm surge affected coastal areas across the east of Scotland, particularly around the Forth Estuary
- 05 December 2013: A North Sea surge of 1.0m in height combined with a high spring tide of 5.4m caused flooding along the east coast. Eyemouth was affected withalmost all of Harbour Road inundated. Approximately 10 properties were flooded, which is less than may have been expected as a result of Council and property owner preventative action
- 15 December 2012: A combination of wind and high tides caused large waves and coastal flooding along the east coast of Scotland. There was significant damage to North Berwick Harbour and damage to the communal slipway at Dunbar Harbour
- 30 and 31 March 2010: A tidal surge coinciding with the highest mean tides of the year caused extensive flooding along the east coast of Scotland. the Firth of Forth was one of the worst affected areas, affecting Leith, Musselburgh, Prestonpans, Port Seton, Kirkcaldy, Dunbar, Eyemouth and North Berwick. Impacts included flooding of properties, damage to harbours, seawalls, Kirkcaldy Esplanade and roads. Edinburgh City Council estimating the cost to repair damages in the region of £650,000.
- 14 October 2010: Flooding from wave overtopping from the sea occurred at the Promenade, Musselburgh and the picnic areas at White Sands in Dunbar. Minor erosion to the coastal walkway at Prestonlinks, Prestonpans also occurred
- 22 October 2002: A storm caused combined fluvial and coastal flooding in Eyemouth. Impacts included flooding of properties in Harbour Road and the High Street. Sea levels at Eyemouth were at 3.128m
- 1978: A tidal flood event caused flooding of farmland to the west and east of Airth. damage to the seawall occurred at Blackness and flooding to Victoria Sawmills, Thomson and Balfour in Bo'ness. Flooding at Bothkennar resulted in a partial reconstruction of the bund on the Carron being necessary. This event also affected the Grangemouth laundry, Dalgrain Road and the Grangemouth old town area
- 01[8] March 1969: 2 boats sunk in Kirkcaldy harbour. Esplanade flooded under two feet of water. Transport services interrupted
- 30 September 1959: Grangemouth Docks flooded with highest tides on record at 4.47m
- 04 April 1958: 40 families evacuated in Kirkcaldy. Homes and businesses flooded, cars washed away and civil infrastructure damaged. Flooding affected other areas along the Fife coastline including Anstruther (Shore Street) and Pittenweem. Portobello promenade and nearby houses were also flooded during this event
- 01 October 1947: Waves up to 30 feet affected Kirkcaldy with properties and cars damaged from flood waters
- 17 October 1898: Newhaven Pier, Edinburgh washed away
- 28 November 1897: It was recorded that at North Berwick sailors drowned with many shipwrecks and damage to boats and roads
- 1881: the "Eyemouth Disaster", 191 fisherman died at Eyemouth
- 1877: Sea wall washed away between Portobello and Joppa

Economic activity

The total Annual Average Damages caused by coastal flooding in the Forth Estuary district are approximately £4.0 million. This consists of:

- 54% Residential properties (£1,650,000 direct damages, £500,000 indirect damages)
- 32% Non-residential properties (£1,300,000 direct damages)
- 3% Vehicles (£100,000 direct damages)
- 6% Emergency services (£250,000 indirect damages)
- 4% Roads (£170,000 direct damages)
- 1% Agriculture (£25,000 direct damages)

Out of the economic damages assessed the highest damages are to residential properties followed by damages to non-residential properties. Figure 3 shows the total Annual Average Damages throughout the Local Plan District.

High damages are seen around the Musselburgh area due to the large number of both residential and non-residential properties along the coastline.

High damages in Rosyth are identified largely due to the industrial units located in and around Rosyth Dockyard.

The greatest number of properties at risk is in Grangemouth. Industrial areas around Grangemouth, Kincardine and Culross also contribute to high damage values.

High damages can be seen in the Airth area due to the large number of residential properties along the coastline.

High damages in Eyemouth due to commercial properties around the harbour whilst local council and agency buildings also account for large proportions of the economic damages in the Eyemouth area.

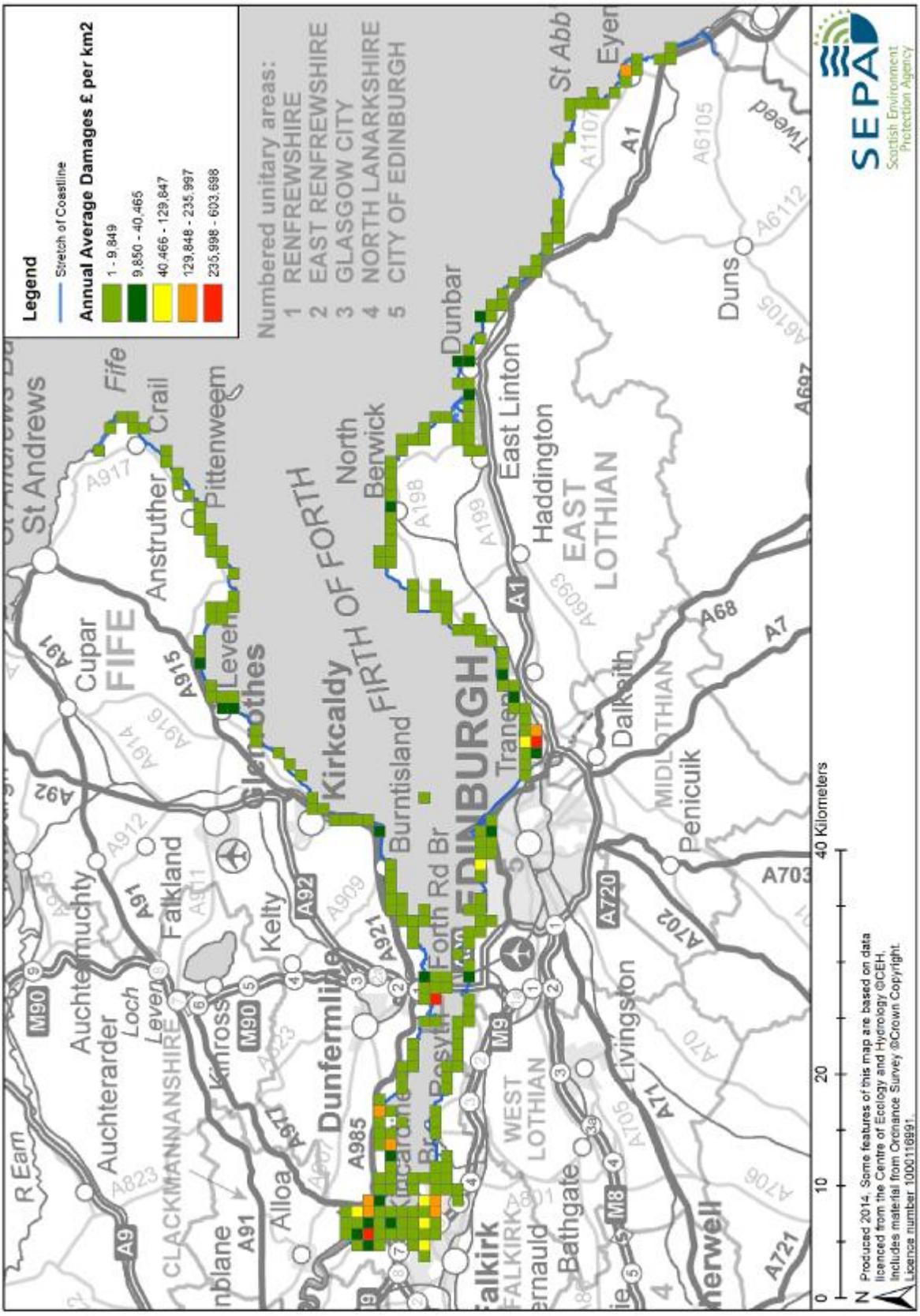

Figure 3: Annual Average Damages from coastal flooding

Areas of environmental and cultural importance at risk of flooding

Within the Local Plan District approximately 55 cultural heritage sites have a medium likelihood of coastal flooding. This includes 30 Scheduled Monuments, 20 Gardens and Designated Landscape sites, 4 Battlefield sites and 1 World Heritage Site.

Approximately 12 environmental sites have a medium likelihood of coastal flooding. This includes 1 Special Area of Conservation, 5 Special Protection Areas and 6 Sites of Special Scientific Interest.

4.3.2 Managing flood risk along the coastline

Many organisations work together to manage flood risk and individuals also have a responsibility for taking action to protect themselves and their property from flooding. Further information on the roles of different organisations in flood risk management and details on what individuals or businesses can do to prepare for flooding can be found in the leaflet Prepare for flooding - a guide for residents and businesses available on the SEPA website www.sepa.org.uk/flooding/flooding_publications.aspx .

Existing measures that are in place to manage coastal flood risk in the Local Plan District are described below.

Existing flood protection schemes

There are three formal flood protection/prevention schemes to reduce the risk of coastal flooding:

- Bo'ness: Coastal flood protection scheme, construction was completed in 2011 and has a standard of protection of 1 in 200 years
- Grangemouth: The Grange Burn flood protection scheme serves the area of Grangemouth. This is mainly a fluvial protection scheme but also has some coastal protection benefits. It commences at an overflow on the Grange Burn immediately downstream of the M9 Motorway and Beancross Road. It discharges to the River Avon immediately upstream of Wholeflats Road Bridge. It has an unknown standard of protection
- Prestonpans: The Prestonpans coastal flood protection scheme has a standard of protection of 1 in 200 years

Other actions exist that were not constructed under the Flood Prevention (Scotland) Act 1961 Act but do reduce the impact of coastal flooding. This may include other structures, natural features and natural flood management . These other actions can be seen in the Appendix in Table A1.

Existing coastal flood warning schemes

SEPA's Floodline service provides flood alerts and flood warnings throughout Scotland to the public and to organisations that have flooding related duties.

Flood alerts are issued over wide geographical areas (normally matching local authority boundaries). Information is used from the Met Office and SEPA to determine if flooding is possible within the flood alert area.

Where SEPA has a river or coastal flood monitoring system, flood warnings can be issued for a local target area that can more accurately predict the likelihood and timing of flooding.

There are 19 coastal flood warning target areas within the Forth Estuary district, as shown in Table 2 and Figure 4. Table 2 shows the total number of properties within a flood warning target area (not just those properties at risk of flooding), and the % of properties that have registered to receive flooding warnings directly from SEPA.

Table 2: Flood warning target areas

Flood Warning Target Area	Number of properties within FWTA	% of properties registered – January 2014
Anstruther to Elie	124	15
Blackness	24	8
Burntisland to Aberdour	26	15
Culross, Longannet ans Kincardine	615	9
Dunbar including West Barns	198	30
Eyemouth Coastal	88	20
Grangemouth	1,340	12
Granton and Leith	3,545	7
Kinghorn	50	6
Kirkcaldy	156	7
Leven and Methil	285	9
Lower Largo	38	39
Musselburgh Coastal	2,085	13
North Berwick	48	58
North Queensferry and Inverkeithing Bay	184	15
Portobello Esplanade	162	10
Prestonpans, Cockenzie and Port Seton	297	10
Rosyth, Limekilns and Charlestown	106	13
Torryburn and Newmills	29	10

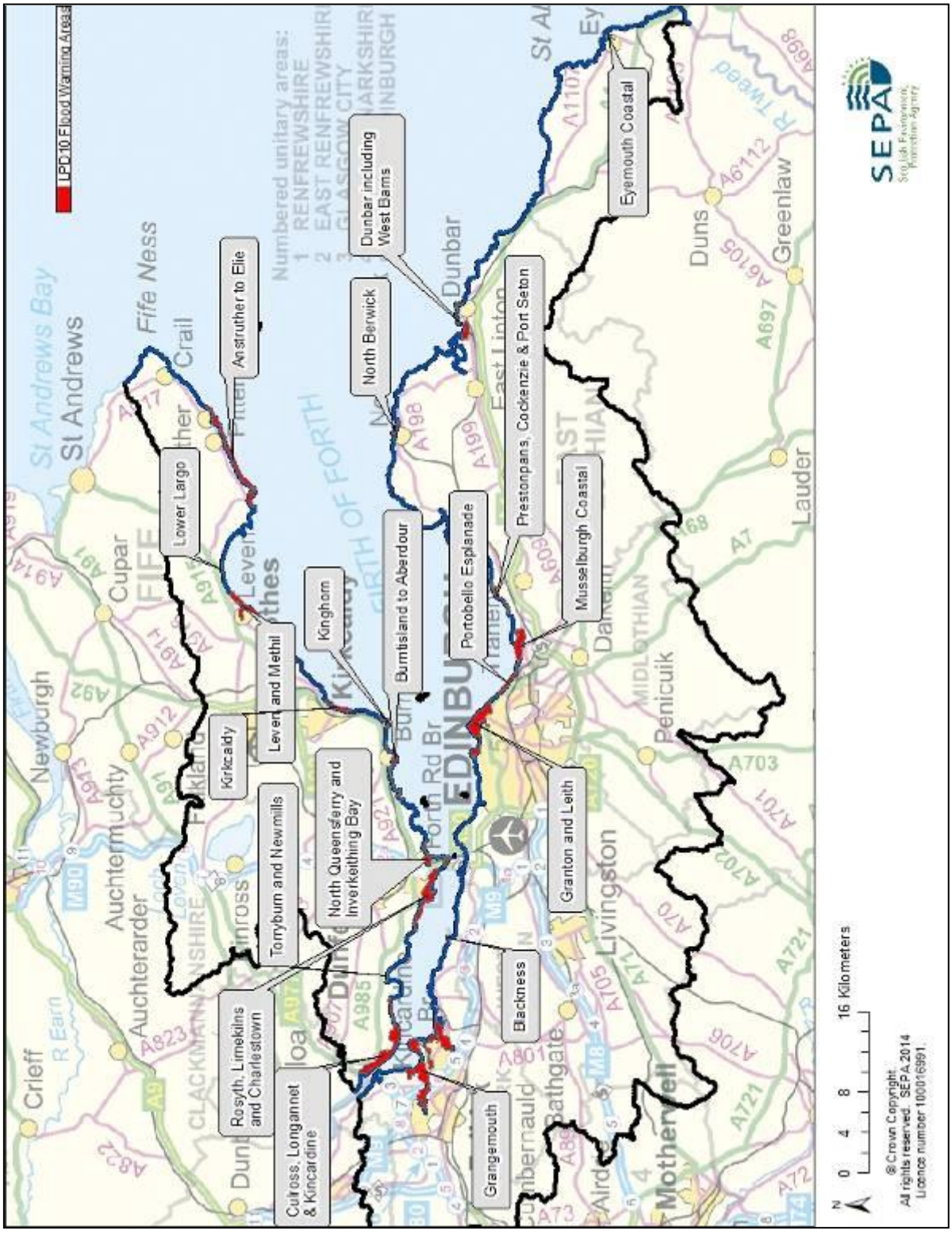

Figure 4: Flood warning target areas

Awareness raising campaigns and community flood action groups

SEPA and the local authorities work closely with many other organisations that have flooding related duties. These the police, fire & rescue services, the Scottish Government, Scottish Flood Forum and local coastal partnerships. SEPA and the local authorities, often in partnership with these organisations, undertake various awareness raising campaigns that include community events, information leaflets, educational plays in schools, the use of social media and advertising.

In addition the following community groups that help with flood resilience are known to operate within this Local Plan District:

- Burnmouth Resilient Community Group
- Coastal Regeneration Group for Port Seton and Cockenzie
- Cockburnpath Resilient Community Group
- Dunbar Shore and Harbour Neighbourhood Group
- East Lothian Bio-diversity Group and Local Community Councils
- Eyemouth Resilient Community Group
- Friends of the River Tyne
- Musselburgh Waterfront Group
- North Berwick Environment Group
- St Abbs Resilient Community Group

Property level resilience/resistance measures

Some local authorities have their own policies regarding property level protection. Contact your local authority or view their website for more information.

The following incentives or subsidies have been put in place to provide property owners with property level resilience/resistance measures:

- East Lothian Council strategically deploy temporary flood barriers and sand bags when properties are threatened by flooding
- Fife Council provide Aquasacs for use in emergencies and these area available from stores (flood pods) throughout FifeScottish Borders Council operates a subsidised flood protection products scheme for residential and non-residential property owners in flood risk areas. Scottish Borders Council has provided and maintains dedicated sandbag stores in areas of flood risk to ensure sandbags are available to the public in the event of a flood
- The City of Edinburgh Council store sandbags at key fire stations to be used in emergencies

Flood risk management studies

The following coastal flood risk management related studies have been identified in the Local Plan District:

- East Lothian Shoreline Management Plan (East Lothian Council)
- Fife Shoreline Management Plan (Fife Council)
- St Abb's Head to River Tyne Shoreline Management Plan (Posford Dvivier,1998)
- Portobello Beach,Review of past performance and options for improvement (HR Wallingford, 2002)
- Granton Waterfront, Wave and water level conditions report (HR Wallingford, 2002)
- Coastal defence survey, East Lothian Shoreline Management Plan (2002).

- Causes of beach lowering at Dunbar, Eastern Scotland, UK (Maritime Engineering 01/2006;59(MA4):157-166 (Pontee, 2006))
- Grangemouth (Sir Frederick Snow and Partners, 2006)
- Portobello seawall Standard of flood protection study (HR Wallingford, 2007)
- Eyemouth Seawall - Inspection, Testing and Options Report (Royal Haskoning,2009)
- Asset Management Plan (Edinburgh) (Jacobs, 2009)
- Grangemouth Flood Study (Halcrow Group Ltd, 2011 and 2012)
- SEPACoastal Flood Warning Improvement Project Phase 3: Firth of Forth and Tay (Royal Haskoning, 2012)
- Review of coastal flooding documents (City of Edinburgh Council, 2013)
- Eyemouth Overtopping and Flood Study (Royal Haskoning, 2013)

Although not specifically relating to coastal flooding, the following documentation may contain relevant information relating to coastal flood management:

- Water of Leith Flood Prevention Scheme modelling (model includes Fluvial and Coastal interface at Leith)
- Musselburgh Flood Study (Jacobs)

4.3.3 Climate Change and future flood risk

UK Climate Projections (UKCP09) predicts future climate change may lead to increased sea levels. The predicted magnitude of sea level rise due to climate change varies around the coastline based on UKCP09 2080 horizon projections. SEPA's coastal flooding has been modelled as a still water level projection, without wave action. Therefore there has been no consideration of the impacts of future climate on wave overtopping or storminess which could increase the number of people affected by coastal flooding.

For the UKCP09 high emissions scenario, the predicted average increase around the Forth Estuary Local Plan District ranges from 0.47-0.5m by 2080. Within the district it is estimated that the medium likelihood plus climate change scenario may increase the number of residential properties at risk of coastal flooding from approximately 1,700 to approximately 4,300. The number of non-residential properties may increase from approximately 340 to approximately 1,300.

The predicted average sea level increases, and the predicted increases in coastal flood risk around the coastal line are outlined below:

Mid Firth of Forth (North and south coast from Clackmannashire Bridge to North and South Queensferry)

The predicted average sea level increase is 0.47m by 2080.
The medium likelihood plus climate change scenario may increase the number of residential properties at risk of coastal flooding from approximately 1,100 to approximately 1,900 and the number of non-residential properties from approximately 150 to approximately 700. The Grangemouth area is likely to experience the biggest increase in coastal flooding under this scenario.

North Queensferry to Fife Ness (Outer Firth of Forth)

The predicted average sea level increase is 0.49m by 2080.
The medium likelihood plus climate change scenario may increase the number of residential properties at risk of coastal flooding from approximately 30 to approximately 140 and the number of non-residential properties from approximately 40 to approximately 170. The urban centres of Kirkcaldy and Buckhaven-Methil-Leven would also be affected by coastal flooding under this scenario.

South Queensferry to North Berwick (Outer Firth of Forth)

The predicted average sea level increase is 0.49m by 2080.
The medium likelihood plus climate change scenario may increase the number of residential properties at risk of coastal flooding from approximately 480 to approximately 2,200 and the number of non-residential properties from approximately 100 to approximately 440. The largest increases in properties at risk will be seen in Edinburgh and Musselburgh with the urban centre of Cockenzie and Port Seton also being affected by coastal flooding under this scenario.

North Berwick to english border

The predicted average sea level increase is 0.50m by 2080.
The medium likelihood plus climate change scenario may increase the number of residential properties at risk of coastal flooding from approximately 70 properties to approximately 130 properties and the number of non-residential properties from approximately 60 properties to approximately 80 properties.

4.3.4 Coastal processes

Wave energy is important to understanding coastal processes and the resulting risk of coastal flooding or erosion. Waves can be influenced by winds and storms as well as the shape of the shoreline. During a storm, the wind and low atmospheric pressure can temporarily increase the height of the sea (storm surge) above predicted tidal levels. Extreme sea levels can result when a storm surge coincides with high tides.

To identify objectives and sustainable actions to manage the risk of coastal flooding, it is important to understand coastal processes and how these may alter with climate change. It is expected that sea level will rise and there will be an increase in wave heights. The deposition and erosion of sediment can affect the risk of coastal flooding and the long term effectiveness of actions. Actions to manage coastal flooding in one area can also affect deposition and erosion in other areas, particularly where beaches are present. The power of waves also affects the maintenance costs and lifespan of proposed or existing actions that protect against the risk of coastal flooding.

The Forth Estuary Local Plan District has 375km of coastline stretching from Fife Ness in the north to the Scottish Borders in the south. The coastline includes the Firth of Forth and the coastline from North Berwick to the english border exposed to the North Sea.

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 Local Plan District includes the mid and outer Firth of Forth.

The main influences of coastal flooding in the Firth of Forth are storm surges and locally generated winds. Due to the sheltering effects of the estuary the Firth of Forth is less affected by swell waves but the influence of these increases towards the outer Firth of Forth.

The coast from around North Berwick to the scottish border is exposed to the North Sea. In this area storm surges, swell waves and locally generated waves all influence coastal flooding.

Sediments in the inner Firth of Forth are generally characterised by finer sediments and mud, creating habitats such as mudflats, salt marshes and reed beds. These habitats can be seen at Skinflats north of Grangemouth and the Alloa Inches. Over the last two hundred years, much of the mudflat areas of the inner and mid Firth of Forth have been drained and

lost to allow agricultural and industrial development. Toward the outer Firth of Forth the sediments in the estuary become coarser creating habitats such as sandy beaches and dunes, as can be seen at Gullane Bay and Aberlady Bay.

SEPA commissioned a strategic assessment to indicate where coastal erosion is an important factor when considering actions to reduce the risk of coastal flooding. The map showing natural susceptibility to coastal erosion can be viewed on SEPA's website (www.sepa.org.uk). This does not include existing coastal protection or flood protection structures which may reduce the risk of coastal erosion. It also does not indicate areas that will erode or the timescales over which erosion could occur. The findings of the assessment around the coastline are outlined below:

Mid Firth of Forth (North and south coast from Clackmannashire Bridge to North and South Queensferry)

Most of the coastline around the mid Firth of Forth has a medium and medium to high susceptibility to coastal erosion. Areas including to the west of Grangemouth, Bo'ness and Kincardine are particularly susceptible to coastal erosion. Although the areas around Grangemouth, Bo'ness and North Queensferry are shown to be naturally slightly more susceptible to coastal erosion, structures that may help manage coastal erosion are present along much of the coastline.

North Queensferry to Fife Ness (Outer Firth of Forth)

Most of the coastline along North Queensferry to Fife Ness has a low susceptibility to coastal erosion. However, Burntisland and Methil are considered to be more susceptible. Although the areas around Burntisland, Kirkcaldy and Methil (Figure 4) are shown to be naturally slightly more susceptible to coastal erosion, there are a number of structures that may help manage coastal erosion present that mostly coincide with the urban areas of Kirkcaldy, Burntisland, Inverkeithing, Methil, Buckhaven and Anstruther.

South Queensferry to North Berwick (Outer Firth of Forth)

Most of the coastline along South Queensferry to North Berwick has a medium susceptibility to coastal erosion.However, there are isolated areas, notably between Leith and Portobello that are more susceptible to coastal erosion. Although the area around Edinburgh is shown to be naturally slightly more susceptible to coastal erosion, structures that may help manage coastal erosion are present particularly between Cramond and Prestonpans.

North Berwick to English Border

Most of the coastline along North Berwick to the english border has a low to medium susceptibility to coastal erosion with areas including the coastline between Dunbar and Thorntonloch noted as being particularly susceptible to coastal erosion. Although the areas around Dunbar, St Abb's and Burnmouth are shown to be naturally more susceptible to coastal erosion, structures that may help manage coastal erosion are present in the West Barns area near Dunbar, at the Torness Nuclear Power Station, at St Abb's and at Burnmouth.

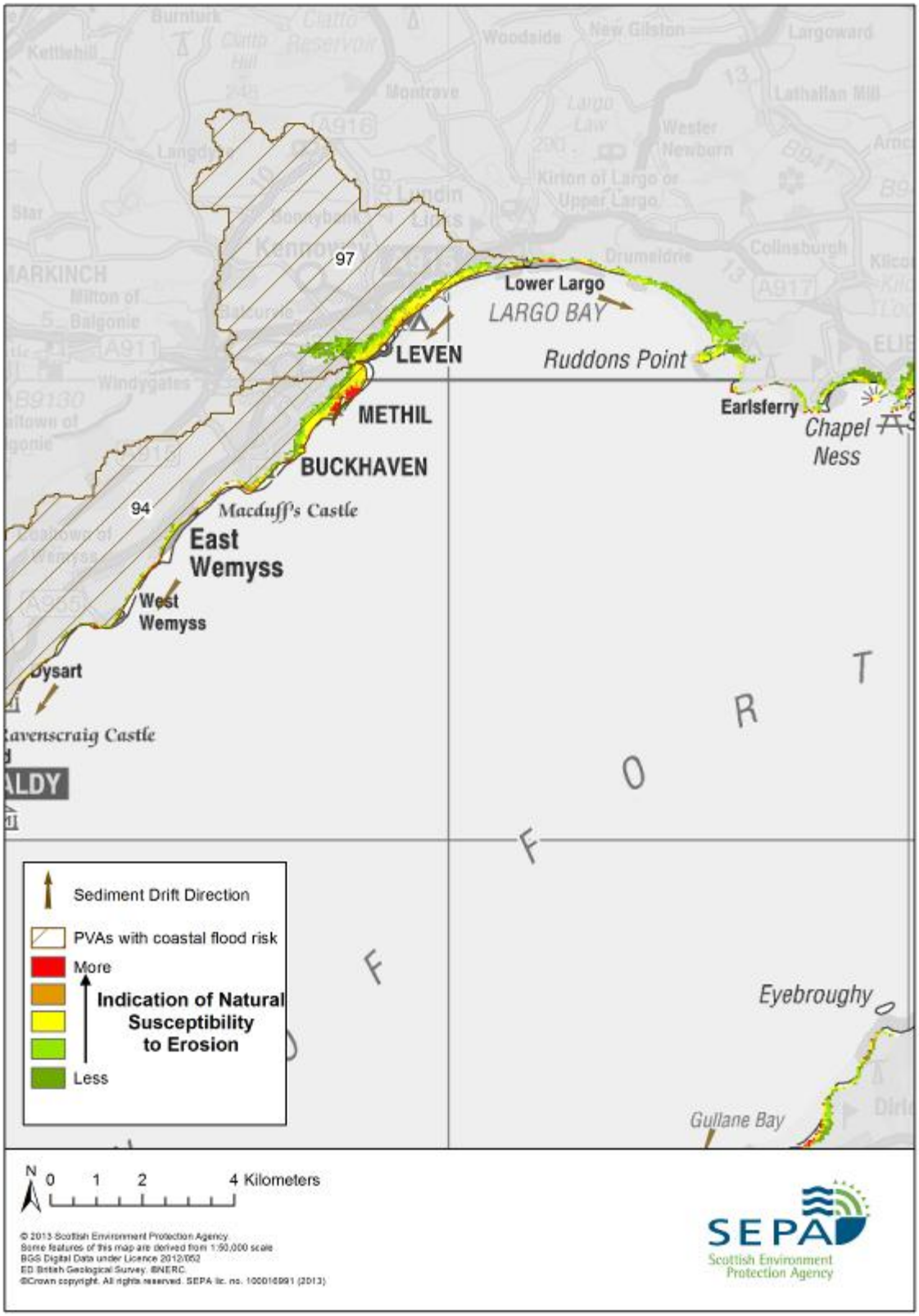

Figure 4: Natural susceptibility to erosion showing the coast between West Wemyss and Earlsferry

4.3.5 Potential for Natural Flood Management

Natural Flood Management refers to the restoration, enhancement or alteration of natural features and characteristics. SEPA has undertaken an assessment of the potential for natural flood management in Scotland. This assessment provides a high level strategic assessment of those areas where the implementation of certain types of measures would be most effective and where further investigation may be merited. The maps showing potential for natural flood management are available on the SEPA website (http://map.sepa.org.uk/floodmap/map.htm) and examples of these maps are shown in Figure 5 and Figure 6.

Two types of natural flood management measures have been considered for coastal flooding; estuarine surge attenuation and wave energy dissipation. Estuarine surge attenuation can reduce the impacts of coastal surges. Wave energy dissipation provides opportunities to reduce erosion through reducing wave power. For the Forth Estuary Local Plan District the findings of the assessment indicate:

Mid Firth of Forth (North and south coast from Clackmannashire Bridge to North and South Queensferry)

There is potential for estuarine surge attenuation to be used to reduce flood risk in and around Kincardine and Rosyth (Figure 5).Along much of the mid Firth of Forth there is also medium potential for estuarine surge attenuation, particularly around parts of Grangemouth, Bo'ness and South Queensferry. There appears to be a greater potential for wave dissipation), which could provide possible flood risk benefits around Grangemouth and South Queensferry, with lesser potential at Bo'ness. The feasibility of implementing any natural flood management schemes may however be limited due to the large amount of industry along this coastline.

North Queensferry to Fife Ness (Outer Firth of Forth)

Whilst the potential for estuarine surge attenuation along the North Queensferry to Fife Ness coastline is limited, there is potential for benefits around North Queensferry and Inverkeithing. The potential for wave dissipation is more widespread with medium to high potential along most of the coastline in this area.

South Queensferry to North Berwick (Outer Firth of Forth)

There is medium to high potential for estuarine surge attenuation to the west of Edinburgh at South Queensferry. There is also high potential for wave dissipation along most of the South Queensferry to North Berwick coastline.

North Berwick to english border

There is limited to no potential for estuarine surge attenuation along North Berwick to the english border, however there may be potential for wave dissipation in this area, particularly around Dunbar and within Potentially Vulnerable Area 10/26.

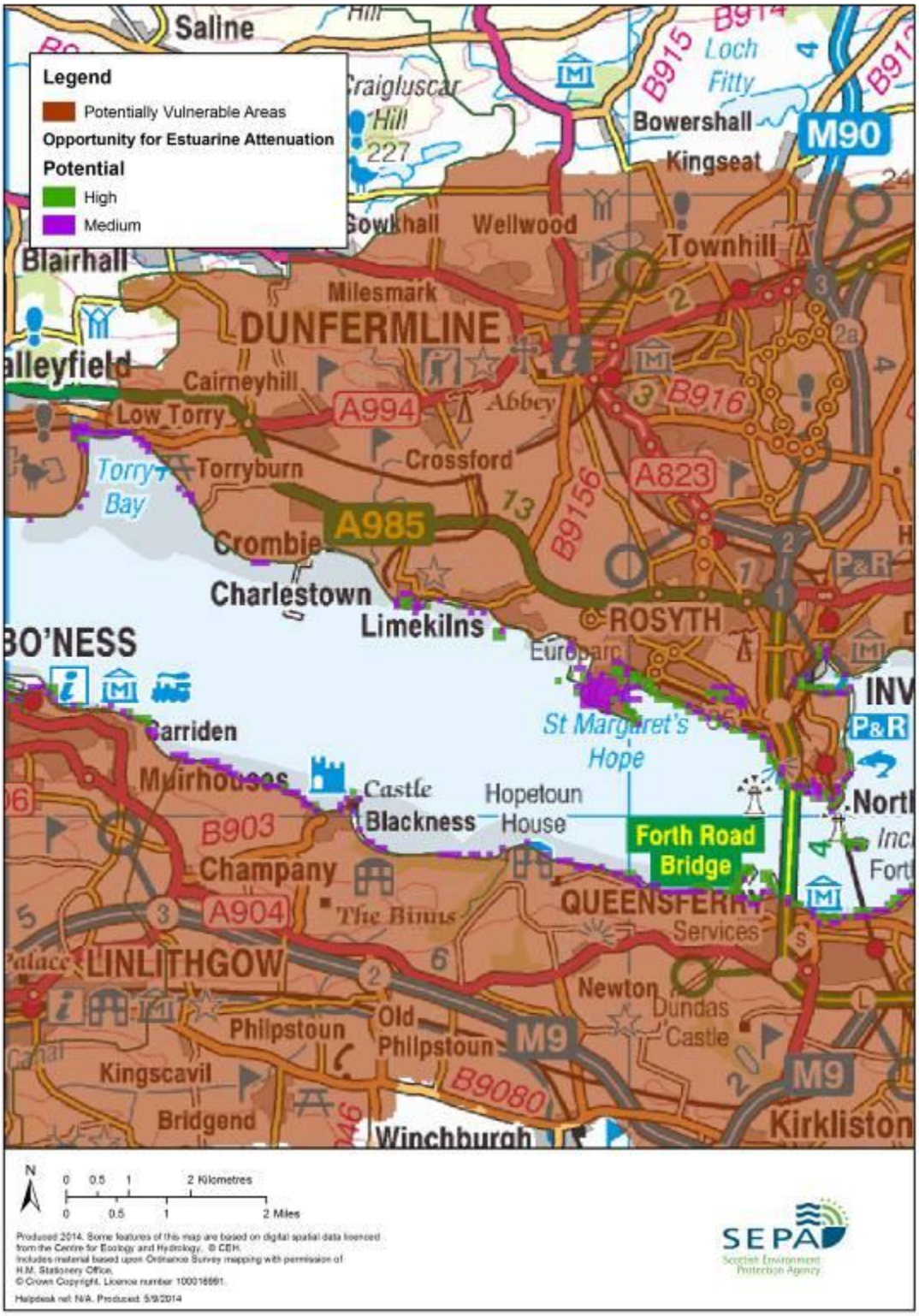

Figure 5: Opportunity Areas for estuarine surge attenuation at the coastline around Rosyth

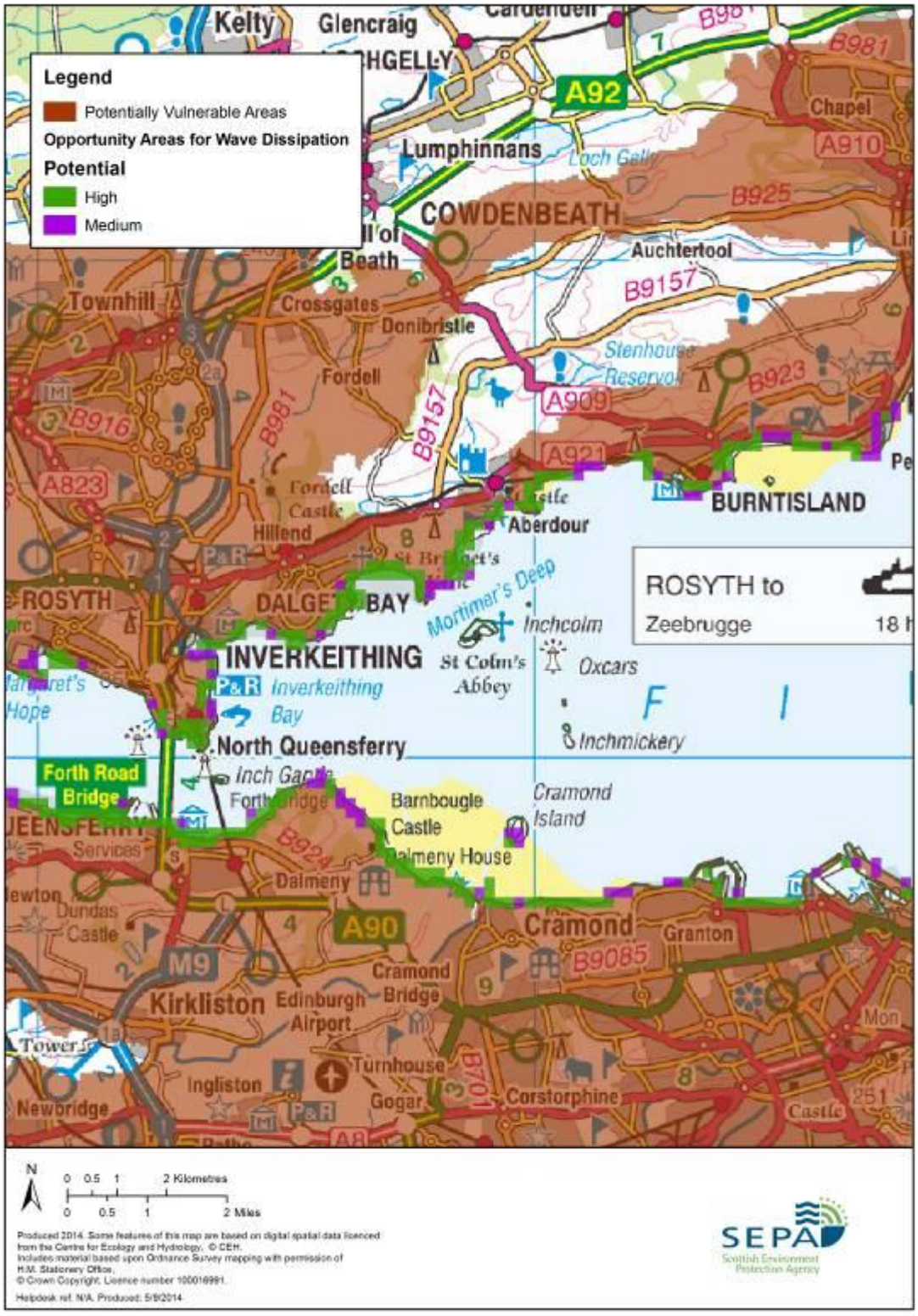

Figure 6: Opportunity Areas for wave dissipation at the coastline around the Forth Road Bridge

4.3.6 Links with River Basin Planning

The first river basin management plans were published in 2009. They are currently being reviewed and will be updated in December 2015). These plans aim to protect and improve the condition of Scotland's rivers, lochs, estuaries and coastal waters. In the plans, the coast is divided into stretches known as water bodies, for the Forth Estuary these are separated into sections below.

The status of water bodies is classified as high, good, moderate, poor or bad. High status means water bodies are close to a natural or undisturbed state. Classification takes account of water quality (the biology and chemicals present) and habitat (the condition of the shoreline and sea bed). The river basin management plans aim to prevent deterioration of estuaries and coastal waters and restore them to at least good status by 2027. If actions to restore coastal waters or estuaries to good status would have a significant social or economic impact (such as increase the risk of flooding), they are designated as heavily modified. For heavily modified water bodies the river basin management plans aim to achieve the best condition possible without impacting on the reason for designation, known as good ecological potential. Some actions to restore estuaries or coastal waters can help manage the risk of coastal flooding. Similarly, actions to manage the risk of coastal flooding can help restore estuaries or coastal waters. As such, river basin management plans and Flood Risk Management Strategies must be coordinated.

North Queensferry to Fife Ness

There are three coastal water bodies in the North Queensferry to Fifeness coastal area. All the water bodies are at good or better status. This means it is unlikely any opportunities to improve habitats will be prioritised. However, SEPA recognise there are gaps in our understanding of the condition of estuarine and coastal habitats and current classification may underestimate these impacts. Changes to water bodies identified as pressures in this coastal area include approximately 8.5km of shoreline protection structures and 1.5km of land reclaimed from the sea.

Mid Firth of Forth (North and south coast from Clackmannashire Bridge to North and South Queensferry)

There is one estuarine and four coastal water bodies in the Mid Firth of Forth coastal area. The Mid Forth Estuary water body is designated as heavily modified and needs actions taken to reach good ecological potential. Changes to water bodies identified as pressures in this coastal area include approximately 1.5km of flood protection structures and 9.5km of shoreline protection structures. There is also approximately 15.5km^2 of land reclaimed from the sea, 35% for agricultural use.

South Queensferry to North Berwick

There is one estuarine and four coastal water bodies in the South Queensferry to North Berwick coastal area. The Leith Docks to Port Seton water body is designated as heavily modified and needs actions taken to reach good ecological potential. Changes to water bodies identified as pressures in this coastal area include approximately 16.0km of shoreline protection structures and 4.0km of land reclaimed from the sea.

North Berwick to english border

There is one estuarine and three coastal water bodies in the North Berwick to english border coastal area. In the North Berwick to english border coastal area all the water bodies are at good or better status. This means it is unlikely that any opportunities to improve habitats will be prioritised. However, SEPA recognise there are gaps in our understanding of the condition of estuarine and coastal habitats and current classification may underestimate these impacts. Changes to water bodies identified as pressures in this coastal area include

approximately 2.5km of flood protection structures and 2.0km of shoreline protection structures. There is also approximately 0.5km^2 of land reclaimed from the sea, 39% for agricultural use.

Consultation on priorities to restore water bodies for the second river basin management plans closes on 20 May 2015. More information on these plans can be viewed on SEPA's website (www.sepa.org.uk).

Appendix

Further information on existing actions

As well as the formal flood protection/prevention schemes to address coastal flooding in the LPD, Table A1 shows other existing actions that are in place.

Table A1: Existing actions and natural features that contribute to the management of coastal flooding

Location	Name of structure or natural feature	Description	Owned and / or maintained by
Portobello, Leith and Granton	Coastal Defence	Wave Return Walls	City of Edinburgh Council
Eastfield	Coastal defence	Masonry wall and rock armour revetment	City of Edinburgh Council, and pprivate
Joppa	Coastal defence	Masonry wall and revetment, some rock armour. Pumping station.	City of Edinburgh Council, Scottish Water, and private
Portobello	Promenade & beach	Concrete wave wall & replenished beach	City of Edinburgh Council, beach leased from Crown Estates
Seafield	Coastal defence	Concrete wave wall, concrete & masonry revetment	City of Edinburgh Council, Network Rail
Newhaven to Granton	Coastal defence	Masonry walls and revetment. Pumping station.	City of Edinburgh Council, Scottish Water
West Shore Rd	Coastal defence	Masonry wall, concrete wall, rock armour, none.	City of Edinburgh Council, Forth Ports PLC
Silverknowes/Cramond	Promenade	Rock armour & concrete revetment, concrete wave wall.	City of Edinburgh Council
Cramond	Cramond mole	Masonry and concrete mole, sewer outfall	City of Edinburgh Council, Scottish Water
South Queensferry	Various, including buildings	Masonry and concrete walls. NOTE Coast Protection Act stops at Hound Point, on Dalmeny foreshore.	City of Edinburgh Council,Various
Leith	Leith Docks	Various, with impounding sea lock	Private owners
Belhaven Bay	Coastal Defence	Man-made: Earthen embankment, masonry wall. Natural: Sand beach, saltmarsh, mudflat (approx. 7km in length)	East Lothian Council
Winterfield Golf Course	Coastal Defence	Man-made: Gabions, rock revetment (consisting of anti-tank traps), masonry wall. Natural: Rock outcrops (approx. 1.5km in length)	East Lothian Council
Dunbar Cliffs	Coastal Defence	Man-made: Gabions, rock revetment, concrete walls, harbour.	East Lothian Council

		Natural: Rock outcrops (approx. 1.5km in length)	
Dunbar East Beach	Coastal Defence	Man-made: Concrete, masonry walls, groyne. Natural: Rock outcrops, sand beach. (approx. 1.5km in length)	East Lothian Council
Dunbar Golf Course	Coastal Defence	Man-made: Masonry wall, gabions, rock revetment (tipped rocks). Natural: Rock outcrops, pocket beaches. (approx. 2km in length)	Private Owners
Thorntonloch	Coastal Defence	Man-made: Rock revetment (tank-traps) and dune planting. Natural: Sand beach (approx. 4.5km in length)	East Lothian Council
West Barns	Coastal Defence	Natural: Rock outcrops, pocket beaches. (approx. 5.5km in length)	East Lothian Council
Torness Power Station	Coastal Defence	Man-made: Concrete revetment/wall with rock armouring (approx. 4.5km in length)	Private Owners
Eastfield to River Esk (Musselburgh)	Coastal Defence	Man-made: Concrete/masonry walls (some of which are property walls). Rock armour. River training works at the River Esk. Natural: mudflats, beaches. (approx. 2km in length)	East Lothian Council
Ash Lagoons (Musselburgh)	Coastal Defence	Man-made: Concrete sea-wall. (approx. 3km in length)	Private owners
The Cast (Prestonpans)	Coastal Defence	Man-made: Rock revetment (mix of rocks tipped at back of beach), Gabions backed by geotextile matting. Natural: Beach (approx. 1km in length)	East Lothian Council
Prestonpans	Coastal Defence	Man-made: Masonry or concrete walls (mainly property walls). A wide flat concrete platform covering pipes from the power station fronts the property walls. Natural: Beach (approx. 1.5km in length)	East Lothian Council
Humlocks and Cockenzie Power Station	Coastal Defence	Man-made: Rock revetment, Concrete wall, with rock armour protection at toe. (approx. 1km in length)	East Lothian Council
Cockenzie and Port Seton	Coastal Defence	Man-made: Harbours, Masonry property walls, Concrete walls, Rock armour. Natural: Sand Beach (approx. 2km in length)	East Lothian Council, private owners
Gosford Bay	Coastal Defence	Man-made: Masonry sea wall with gabions, Rock revetment consisting of tank traps and tipped rubble.	East Lothian Council

		Natural: Sand beach and rock platforms. (approx. 6km in length)	
Aberlady Bay	Coastal Defence	Man-made: Concrete, masonry wall. Natural: Beaches, saltmarshes, mudflats. (approx. 5km in length)	East Lothian Council
Gullane Bay	Coastal Defence	Man-made: None, although the dunes have been heavily modified and stabilised in the 1960's and 1970's. Natural: Sand beach (approx. 5km in length)	East Lothian Council
Archerfield and Yellowcraig	Coastal Defence	Man-made: None identified. Natural: Shingle beach (approx. 3km in length)	East Lothian Council, private owners
Broad Sands and West Links	Coastal Defence	Man-made: Gabions, Timber wall. Natural: Sand beach (approx. 3km in length)	East Lothian Council
North Berwick	Coastal Defence	Man-made: Timber wall, concrete/masonry walls, harbour, geotextile, rock revetment (tipped rocks) Natural: Sand beach. (approx. 2.5km in length)	East Lothian Council
Bo'ness	Flood defences	Flood defence walls, bunds and harbour entrance works. Scheme under '61 Act	Falkirk Council
Grange Burn, Grangemouth	Flood Defences	Burn embankments and flood relief channel. Scheme under the 1961 Act	Falkirk Council
Grangemouth Docks	Coastal Structures	Masonry Structures	Private owners
Kincardine to Preston Island	Coastal Defence	Masonry Revetment	Private owners
Preston Island	Coastal Defence	Masonry Revetment	Private owners
Preston Island to Torryburn	Coastal Defence	Masonry Revetment and Masonry Wall	Private owners
Torryburn to Crombie Pier	Coastal Defence	Made Ground Embankment	Private owners
Crombie Pier to Charlestown	Coastal Defence	Masonry Revetment	Private owners
Charlestown	Coastal Defence	Masonry Revetment and Masonry Harbour/docks	Private owners
Charlestown to Limekilns	Coastal Defence	Concrete/Masonry Wall, Masonry Pier, Gabion Wall	Private owners
Limekilns to Rosyth	Coastal Defence	Soil/Vegetation Embankment	Private owners
Rosyth to North Queensferry	Coastal Defence	Harbour/Docks, Rock Armour Revetment	Private owners
North Queensferry	Coastal Defence	Masonry Walls, Masonry Railway Pier, Masonry Town Pier, Gabion Walls, Bedrock Cliff/Escarpment	Private owners
North Queensferry to Preston Crescent	Coastal Defence	Harbour/Docks, Masonry Revetment	Private owners and Fife Council
Preston Crescent to St	Coastal Defence	Rock armour Revetment	Private owners

Davids Bay			
St Davids Bay to Braefoot Point	Coastal Defence	Rock armour Revetment, Sand/Shingle Beach/Foreshore	Private owners
Braefoot Point	Coastal Defence	Rock armour Embankment, Steel/Concrete Embankment	Private owners
Braefoot Point to Aberdour	Coastal Defence	Sand/Shingle Beach/Foreshore, Masonry Wall	Private owners
Aberdour	Coastal Defence	Masonry Wall, Masonry Revetment	Private owners and Fife Council
Aberdour to Silvershands	Coastal Defence	Masonry Harbour.Docks, Masonry Embankment, Cliff/Escarpment, Beach/Foreshore	Private owners and Fife Council
Silvershands to Bendameer Ho	Coastal Defence	Masonry Revetment, Bedrock Rock Outcrops	Private owners
Bendameer Ho to Ross Point	Coastal Defence	Rock armour Revetment, Concrete Parapet Wall	Private owners
Ross Point to Pettycur Bay	Coastal Defence	Harbour/Docks, Rock armour Revetment, Sand Dunes, Bedrock Cliff/Escarpment, Masonry Wall	Private owners and Fife Council
Pettycur Bay to Kinghorn Beach	Coastal Defence	Bedrock Cliff/Escarpment	Private owners
Kinghorn Beach to Craigfoot	Coastal Defence	Bedrock Cliff/Escarpment, Masonry Wall, Concrete Pier	Private owners
Craigfoot Walk to Kirkcaldy Harbour	Coastal Defence	Concrete Wall, Concrete/Masonry Harbour/Docks	Private owners and Fife Council
Kirkcaldy Harbour to Dysart Harbour	Coastal Defence	Made Ground Beach/Foreshore, Bedrock Cliff/Escarpment, Masonry/Sheet pile Harbour/Docks	Private owners and Fife Council
Dysart	Coastal Defence	Rock armour Revetment	Fife Council
Dysart to West Wemyss Harbour	Coastal Defence	Coal Mining Spoil Cliff/Escarpment, Coal Mining Spoil Embankment, Shingle Beach/Foreshore, Masonry Wall	Private owners and Fife Council
West Wemyss	Coastal Defence	Masonry Harbour/Docks, Rock armour Revetment, Concrete Wall	Private owners and Fife Council
West Wemyss to East Wemyss	Coastal Defence	Sand/Shingle Beach/Foreshore, Made Ground Cliff/Escarpment, Rock armour Revetment	Private owners
East Wemyss	Coastal Defence	Rock armour Revetment	Private owners
East Wemyss to Buckhaven	Coastal Defence	Soil/Vegetation Embankment	Private owners
Buckhaven (West)	Coastal Defence	Rock armour Revetment	Private owners
Buckhaven (East)	Coastal Defence	Rock armour Revetment, Sheet piling Harbour/Docks	Private owners
Methil	Coastal Defence	Concrete/Masonry Harbour/Docks, Concrete/Masonry Wall	Private owners
Leven	Coastal Defence	Concrete Sea Wall, Brickwork Promenade	Fife Council
Leven to Lundin Links	Coastal Defence	Gabion Mattress Embankment,	Private owners

		Sand/Vegetation Dunes, Sand/Timber Dunes, Masonry Wall	
Lower Largo	Coastal Defence	Masonry Walls, Masonry Pier	Private owners
Lower Largo to Earlsferry	Coastal Defence	Sand/Vegetation Dunes, Bedrock Cliff/Escarpment	Private owners
Earlsferry to Elie	Coastal Defence	Masonry Wall, Sand/Vegetation Dunes, Wall, Masonry Harbour	Private owners
Elie to St Monans	Coastal Defence	Soil/Bedrock Cliff/Escarpment	Private owners
St Monans	Coastal Defence	Masonry/Concrete Walls, Masonry Harbour/Docks	Private owners
St Monans to Pittenween	Coastal Defence	Bedrock/Made Ground Cliff/Escarpment, Concrete/Masonry Outdoor Pools	Private owners
Pittenween	Coastal Defence	Masonry Walls, Masonry Harbour/Docks, Bedrock Cliff/Escarpment	Private owners
East of Pitenweem to Anstruther Wester	Coastal Defence	Bedrock Cliff/Escarpment, Bedrock Beach/Foreshore, Concrete/Masonry Wall	Private owners
Anstruther	Coastal Defence	Masonry Walls, Masonry Harbour/Docks	Private owners
Anstruther Easter to Crail	Coastal Defence	Bedrock Beach/Foreshore, Bedrock Cliff/Escarpment	Private owners
Crail	Coastal Defence	Soil/Bedrock Cliff/Escarpment, Masonry Harbour/Docks, Masonry/Concrete/Gabion Walls	Private owners
Burnmouth (Cowdrait)	Cowdrait seawall	Other structure - (approx. 200m in length)	Scottish Borders Council
Eyemouth	Bantry seawall	Coastal Defence promoted under the Coast Protection Act 1948 (approximately 330m in length	Scottish Borders Council
Eyemouth	Wellsbrae seawall	Other structure - (approx. 80m in length)	Scottish Borders Council
Seafield	Sewage works	Concrete revetment	Scottish Water
Leith	Leith Docks	Various, with impounding sea lock	Forth Ports PLC
Granton	Granton Harbour	Masonry and concrete wals and revetments	Forth Ports PLC
Dalmeny	Dalmeny foreshore	Natural, masonry revetment and walls at Barnbougle Castle	Dalmeny Estates
Burnmouth (Ross)	Ross Point	Natural feature – rocky headland (approx. 135m in length)	N/A
Burnmouth (Ross)	Ross seawall	Other structure - (approx. 90m in length)	non local authority structure
Burnmouth (Cowdrait)	Cowdrait Beach	Natural feature – shingle beach (approx. 180m in length)	N/A
Burnmouth (Lower)	Lower Burnmouth Seawall	Other structure - (approx. 80m in length)	non local authority structure
Burnmouth (Lower)	Burnmouth Harbour	Other structure	non local authority structure
Burnmouth (Partanhall)	Partanhall Seawall	Other structure - (approx. 190m in length)	non local authority structure
Burnmouth (Partanhall)	Burnmouth Hill	Natural feature – rocky headland (approx. 239m in	N/A

		length)	
Eyemouth	Dulse Craig	Natural feature – rocky headland (approx. 110m in length)	N/A
Eyemouth	Eyemouth Harbour	Other structure – embankment and harbour walls	non local authority structure
Eyemouth	Eyemouth Beach	Natural feature – sandy beach beside the seawalls	N/A
Eyemouth	Kings Mount	Natural feature – rocky headland (approx. 120m in length)	N/A
Eyemouth	Hurter and Luff Hard Rocks	Natural feature – offshore rocks	N/A
Coldingham sands	Milldown Point	Natural feature – rocky headland (approx. 148m in length)	N/A
Coldingham sands	Coldingham sands	Natural feature – dunes and sandy beach (approx. 500m in length)	N/A
Coldingham sands	Jock's Nose	Natural feature – rocky headland (approx. 569m in length)	N/A
St Abbs	Castle Rock	Natural feature – rocky cliffs (approx. 90m in length)	N/A
St Abbs	St Abbs Marine Station Seawalls	Other structure – (approx. 143m in length)	non local authority structure
St Abbs	St Abbs Harbour	Other structure	non local authority structure
St Abbs	Rockhouse seawall	Other structure - (approx. 70m in length)	non local authority structure
St Abbs	Black Craighead	Natural feature - Rocky cliffs (approx. 190m in length)	N/A
St Abbs	Maw Carr	Natural feature – offshore rocks	N/A
Pease Bay	Greenheugh Point	Natural feature – rocky headland (approx. 410m in length)	N/A
Pease Bay	Pease Bay	Natural feature – shingle beach with some erosion protection (beach approx. 270m in length)	N/A (erosion protection non local authority structure)
Pease Bay	Pease Sands	Natural feature – sandy beach with sand dunes (the bents) (approx. 660m in length)	N/A
Cove Harbour	Horse Road Rock	Natural feature – rocky headland (approx. 350m in length)	N/A
Cove Harbour	Cove Harbour	Other structure	non local authority structure
Cove Harbour	The Boyne Dyke	Natural feature – rocky headland (approx. 60m in length)	N/A
	Shore Goats	Natural feature – rocky shore (approx. 106m in length)	N/A

SECTION 3:

MAIN CATCHMENTS AND COASTAL AREAS WITHIN FORTH ESTUARY LOCAL PLAN DISTRICT

CHAPTER 4.2: RIVER FLOODING

East Lothian and Berwickshire Group Catchment

Local Plan District (LPD)	Local Authorities
Forth Estuary (LPD 10)	Midlothian, Scottish Borders, East Lothian

River flooding in the Forth Estuary Local Plan District (LPD) is being summarised in three catchment reports; for the East Lothian and Berwick Group, Almond and Edinburgh Group and Firth of Forth catchments. This section summaries flood risk for the East Lothian and Berwick Group (Figure 1).

The East Lothian and Berwick group covers an area of 860km^2 and contains a number of catchments. The main river catchments in this group are the River Tyne, Eye Water, Horn Burn, Ale Water, Pease Burn, Dunglass Burn, Tower Burn, Mill Burn, Biel Water and East Peffer Water. There are four Potentially Vulnerable Areas (PVAs) in this catchment group (Figure 1)

The flood maps were developed using consistent methods for the whole of Scotland. There is inherent uncertainty in all flood modelling due to the assumptions and simplifications required to represent complex natural processes. In seeking to improve overall confidence this national approach was supplemented where possible with more detailed, local assessments. The resultant maps are suitable for identifying the flood risk to communities and helping to assess the right combination of actions required to address those risks. They are not suitable for defining the flood risk to individual properties or for the detailed design of actions, such as flood defences.

The information on river flooding does not take account of the interaction with coastal, surface water or groundwater flooding. Floods in steep catchments, in heavily culverted areas or where rivers have been heavily modified with man-made structures are represented with less confidence. Confidence is greater in locations with good topographical information and local river flow data. Confidence is also improved where models compare well with local historical data or detailed modelling. The modelling covers catchments greater than 3km^2 in size.

4.2.1 River Flooding Impacts

Within the East Lothian and Berwick catchment group approximately 460 residential properties and 180 non-residential properties are at a medium likelihood of river flooding. The total Annual Average Damages caused by river flooding in the catchment group are estimated to be approximately £1.7 million. It is estimated that 76% of residential and non-residential properties at a medium likelihood of river flooding are located within the PVAs.

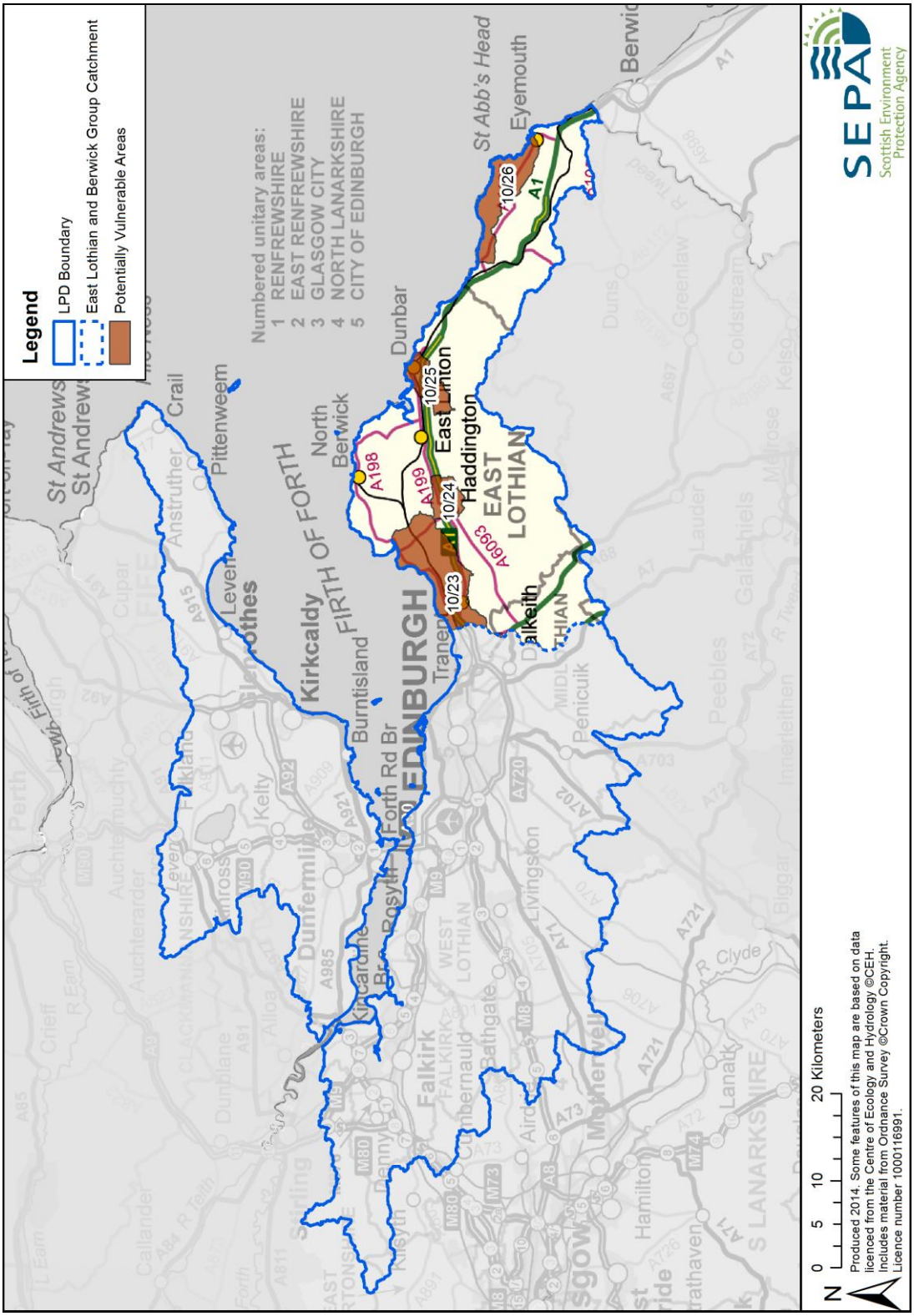

Figure 1: The East Lothian and Berwickshire catchment group

Main urban centres and infrastructure at risk

The main urban areas with a medium likelihood of river flooding can be seen in Table 1. Table 1 shows the number of residential properties at risk and the total Annual Average Damages caused by river flooding, which includes damages to residential properties, non-residential properties, transport and agriculture. Figure 2 shows the number of residential properties at risk of river flooding throughout the catchment group.

Table 1: Main urban areas with a medium likelihood of river flooding

Locations	Number of residential properties with a medium likelihood of flooding	Total Annual Average Damages
Haddington	230	£560,000
Longniddry	30	£97,000
Tranent	30	£76,000
Eyemouth	20	£85,000
Dunbar and West Barns	20	£50,000
Gifford	10	£55,000
Garvald	<10	£44,000
East Linton	<10	£18,000
Ayton	<10	£12,000
North Berwick	<10	£9,000
Cockenzie and Port Seton	<10	<£1,000

Within the catchment approximately 40 infrastructure assets have a medium likelihood of river flooding. Approximate numbers are outlined below:

- Utility Assets:
    - 10 Electricity Substations
- Transport Routes:
    - Roads
        - A Roads: 9 Roads, affected at 65 locations
        - B Roads: 15 Roads, affected at 58 locations.
    - Railway routes
        - Berwick-upon-Tweed to Edinburgh (33 locations at risk)
        - North Berwick to Drem Junction (at risk of flooding in 1 location)

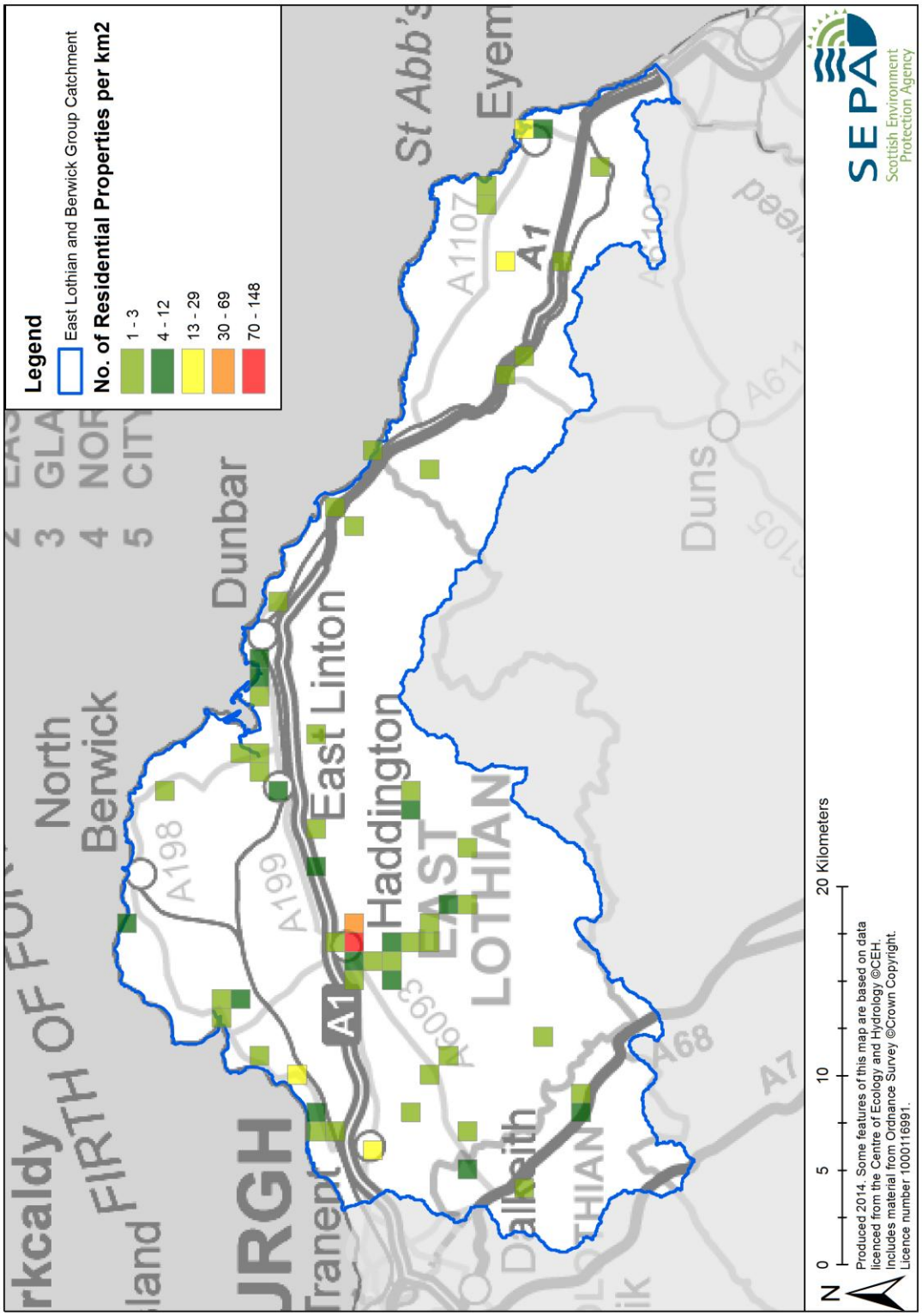

Figure 2: Residential properties with a medium likelihood from river flooding

History of river flooding

The most significant river flooding event in the East Lothian and Berwick catchment is believed to have occurred in August 1948 with reports of Haddington High Street being flooded up to 57 inches from the River Tyne. The Eye Water and Whiteadder Water also caused significant flooding during this event.

Other significant historical flood events in the East Lothian and Berwick catchment include;

- 7 July and 25 Sept 2012, Haddington; Property flooding, due to drains / watercourses backing up and unable to discharge into the River Tyne due to high levels. Wider property flooded avoided by actions East Lothian council.
- 7 January 2005, Eye Water; Combination of river and tidal flooding affecting properties at Harbour Road and various other premises
- 22 October 2002, Belhaven and West Barns; Belhaven Hospital flooded. Patients had to be evacuated after ward closed and the Generator room was shut down. Flooding to Duke Street and West Barns Steadings
- 12 August 1948, River Tyne, Eye Water and Whiteadder Water; The waters of the River Tyne rose 2 inches at Haddington above the bottom of the plate which commemorates a previous flood of October, 1775, and flooded the High Street of the town to a depth of 57 inches. Water inundated Eyemouth, up to the second floor of some buildings and houses evacuated at the harbour. Residents from Biel Mill Lodge, West Barns also had to be rescued. The flood event is known to have affected a large area with railway lines and road bridges damaged or destroyed and multiple buildings flooded
- 1926 & 1932, Haddington; Photographic evidence of large flood events in Haddington
- 1775, Haddington; Large flood event in Haddington inundating most of the town

Economic activity

The total Annual Average Damages (AADs) caused by river flooding in the East Lothian and Berwick catchment group are estimated to be around £1.7 million. This consists of;

- 18% Non-Residential properties (£300,000 direct damages)
- 59% Residential properties (£820,000 direct damages, £190,000 indirect damages)
- 4% Roads (£60,000 direct damages)
- 7% Emergency services (£120,000 indirect damages)
- 4% Vehicles (£60,000 direct damages)
- 8% Agriculture (£150,000 direct damages)

Out of the economic damages assessed the highest damages in the catchment is to residential properties followed by damages to non-residential properties.

Figure 3 shows the total AADs throughout the LPD. The highest damages can be seen around Haddington due to a highly dense area of residential and non-residential property being affected by flooding from the River Tyne.

Economic damages to airports and rail were not assessed as information on damages at a strategic scale is not available.

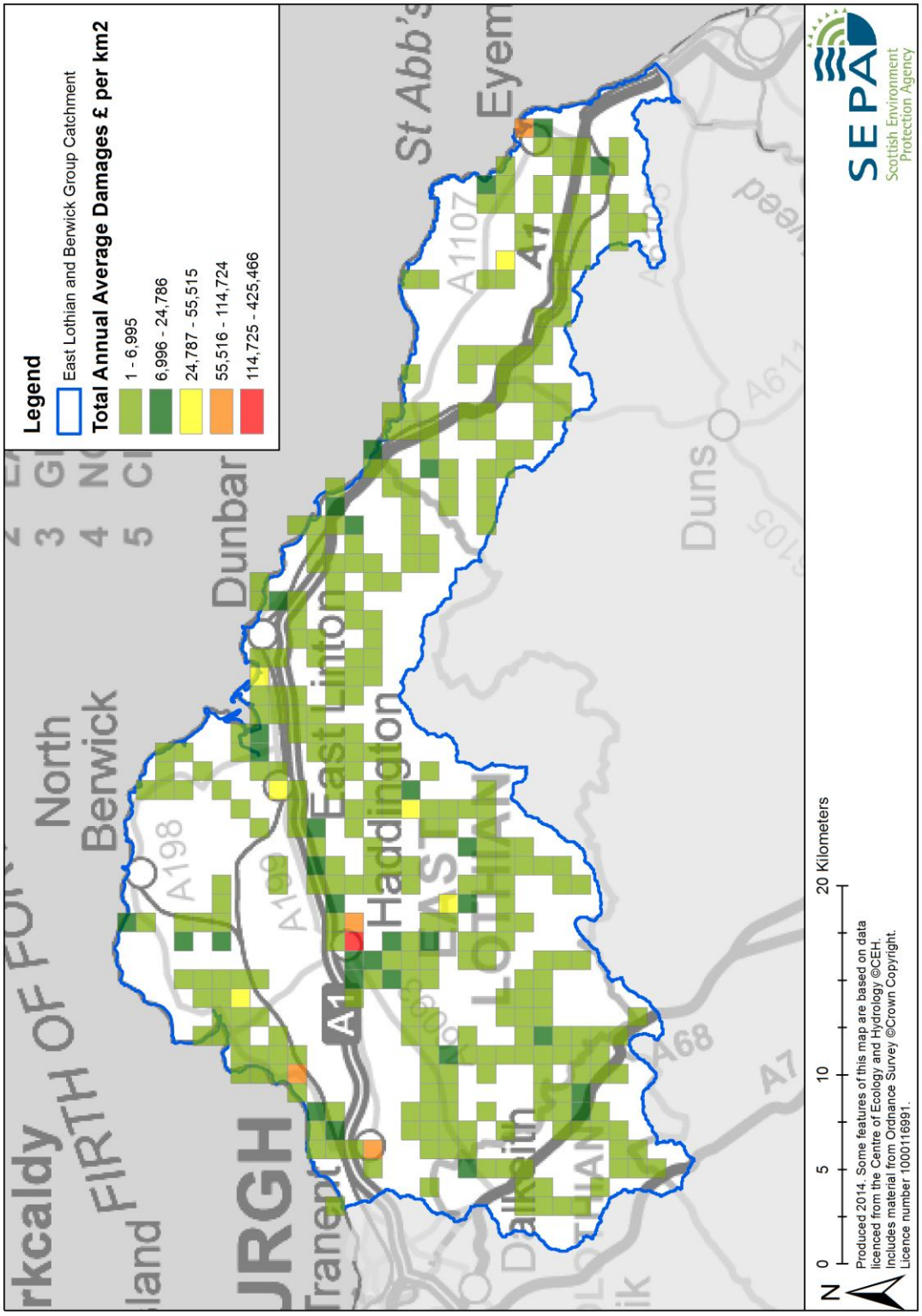

Figure 3: Annual Average Damages from river flooding

Areas of Environmental and Cultural Importance at Risk of Flooding

Within the catchment approximately 36 cultural heritage sites have a medium likelihood of river flooding. This consists of 16 Scheduled Monuments, 18 Gardens & Designated Landscapes and 2 Battlefield sites.

It is estimated that approximately 17 environmental sites have a medium likelihood of river flooding. This includes 2 Special Areas of Conservation (SAC), 2 Special Protection Areas (SPA) and 13 Sites of Special Scientific Interest (SSSI).

4.2.2 Managing Flood Risk Across the Catchment

Many organisations work together to manage flood risk and individuals also have a responsibility for taking action to protect themselves and their property from flooding. Further information on the roles of different organisations in flood risk management and details on what individuals or businesses can do to prepare for flooding can be found in the leaflet Prepare for flooding - a guide for residents and businesses available on the SEPA website www.sepa.org.uk/flooding/flooding_publications.aspx.

Existing measures that are in place to manage river flood risk in the LPD are described below.

Existing flood protection schemes

There are no formal flood protection/prevention schemes constructed under the Flood Prevention (Scotland) Act 1961 or the Flood Risk Management (Scotland) Act 2009 to reduce the risk of river flooding.

In addition to formal flood protection schemes, other measures exist that may reduce the risk of river flooding, this may include other structures and natural flood management measures. These other measures can been seen in the Appendix in Table A1

Existing river flood warning schemes

SEPA's Floodline service provides flood alerts and flood warnings throughout Scotland to the public and to organisations that have flooding related duties.

Flood alerts are issued over wide geographical areas (normally matching local authority boundaries) using information from the Met Office to determine if flooding is possible. Where SEPA has a river or coastal flood monitoring system, flood warnings can be issued for a more specific local area.

There are four river flood warning target areas within this catchment as shown in Table 2 and Figure 4. Table 2 shows the total number of properties in the flood warning target area (not the number of properties at risk of flooding) and the percentage of those properties that have signed up to receive flood alerts and flood warnings.

Table 2: Flood warning target areas

Flood warning target area	River	Number of properties within FWTA	% of properties registered – July 2013
Grantshouse to Eyemouth	Eye Water	13	100%
Haddington (Green) [1]	River Tyne	212	70%
Haddington (Orange)	River Tyne	179	41%
Haddington (Red)	River Tyne	549	34%

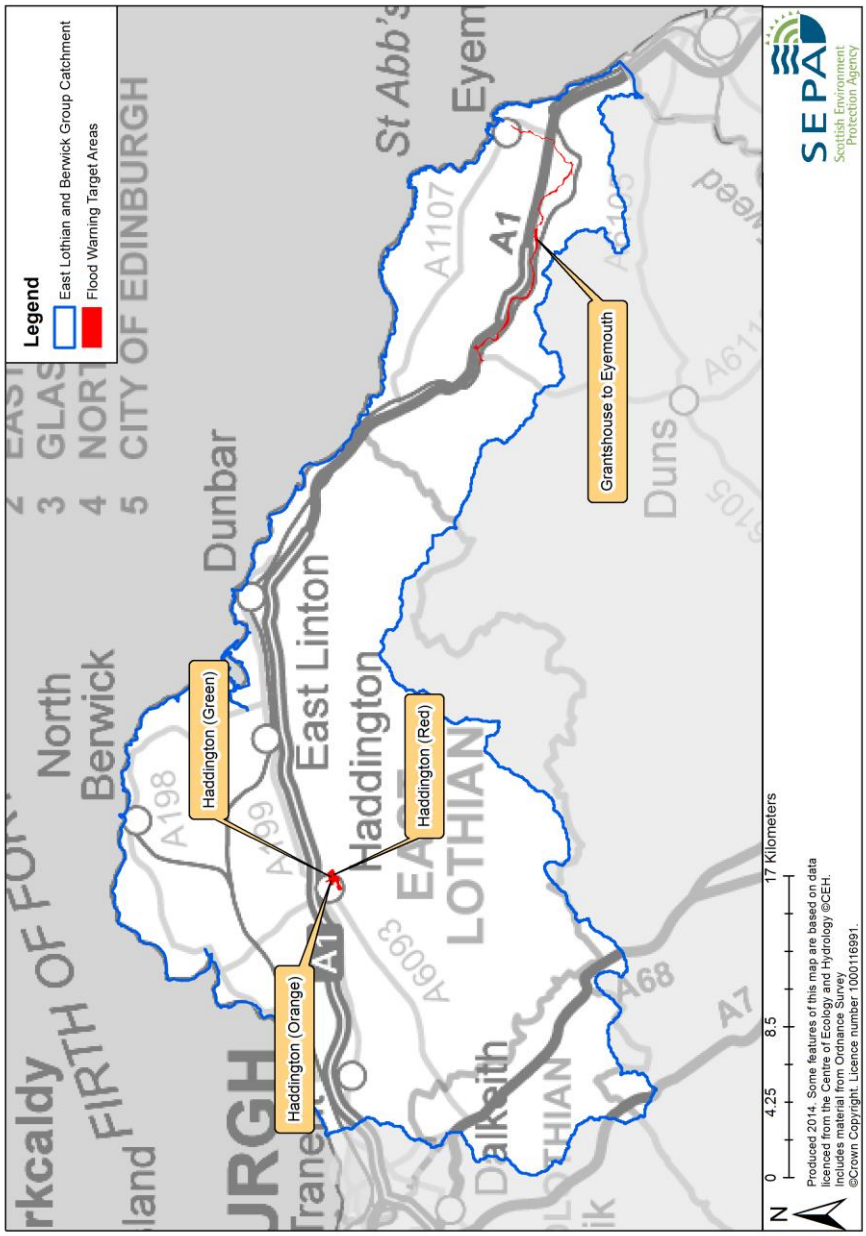

Figure 4: Flood warning target areas

[1] These "coloured" Flood Warning Target Areas for Haddington reflect East Lothian council's emergency plan

Awareness raising campaigns & community groups

SEPA and the local authorities work closely with many other organisations that have flooding related duties and interests such as the police, fire & rescue services, the Scottish Government and the Scottish Flood Forum. SEPA and the local authorities, often in partnership with these organisations, undertake various awareness raising campaigns that include community events, information leaflets, educational plays in schools, the use of social media and advertising.

In addition the following community groups that help with flood resilience are known to operate within this catchment:

- Friends of the River Tyne
- North Berwick Environment Group
- John Muir Trust
- East Lothian Tenants and Residential Panel.

In addition to the above there are also various local community councils that operate throughout the East Lothian Council district.

Property level resilience/resistance measures

Some local authorities have their own policies regarding property level protection. Contact your local authority or view their website for more information.

The following incentives or subsidies have been put in place to provide property owners with property level resilience/resistance measures:

- East Lothian Council strategically deploy temporary flood barriers and sand bags when properties are threatened by flooding
- Scottish Borders Council offer discounted flood protection products to homes and businesses at risk in the Scottish Borders. Several properties in Eyemouth have taken up scheme and been protected from flooding as a result
- Scottish Borders Council provision and maintenance of dedicated sandbag stores in areas of flood risk to ensure sandbags are readily available to the public in the event of a flood. These are mainly located at Fire Stations

Flood risk management studies

Scottish Water, in partnership with City of Edinburgh Council, East Lothian Council and Midlothian Council, are undertaking an Integrated Catchment Study to address sources of flooding within this river catchment group. This study covers the urban areas of Edinburgh, Dalkeith, Musselburgh and Port Seton.

As well as the aforementioned catchment study, the following studies relating to river water management have been identified within the East Lothian and Berwick Group catchment:

Table 3: Flood Risk Management Studies

Year	Month	Study Name
2013	March	Eyemouth Overtopping and Flood Study
2009	-	Haddington Flood Study Final Report, Jacobs,
2004	February	Hydraulic Modelling of the Biel Water for Scottish Water (ABV, Black and Veatch and AMEC joint venture)

4.2.3 Climate Change and Future Flood Risk

The UK Climate Projections (UKCP09) report predicts future climate change may lead to warmer and drier summers, warmer and wetter winters with less snow, and more extreme temperature and rainfall events. The predicted increase in rainfall and consequent increases in river flows may increase the potential for river flooding. Based on the following study; *An assessment of the vulnerability of Scotland's river catchments and coasts to the impacts of climate change (CEH, 2011),* predicted increases in rainfall and river flows vary throughout Scotland based on UKCP09 2080 horizon projections.

For the UKCP09 high emissions scenario, the predicted average increase in peak river flows for the East Lothian and Berwick catchment by 2080 may be in the order of 39%. Within the East Lothian and Berwick Group catchment it is estimated that the medium likelihood plus climate change scenario will increase the number of residential properties at risk of river flooding from approximately 580 to 950 and the number of non-residential properties from approximately 220 to 270.

4.2.4 Catchment Characterisation

Hydrology

The East Lothian and Berwick group covers an area of 860km^2 and contains a number of catchments. The main river catchments in this group are the River Tyne, Eye Water, Horn Burn, Ale Water, Pease Burn, Dunglass Burn, Tower Burn, Mill Burn, Biel Water and East Peffer Water.

This river catchment unit comprises of a number of predominately rural small catchments which have steep headwaters in the Lammermuir Hills gently rolling topography. The Eye Water catchment is recognised as a flashy watercourse due to, steep valley sides, and limited tree cover. The Time to Peak at Eyemouth is 12 hours.

The average annual rainfall (based on rainfall data from 1961-1990) for this catchment is low for Scotland, with 600-700mm falling in the lower part of the catchment, rising to 700-900mm in the upper catchment.

Topography & Soils

On average its soils are generally dry (Scottish context) due to its sheltered location on the east coast. The general soil type is of fineto medium textured lodgement till (formerly boulder clay), glaciolacustrine and estuarine deposits overlain by non-calcareous mineral gleys with wetness class III or IV[2].

[2] Based in the Hydrology of Soil Types (HOST) classification, Scottish Soils; http://preview.scottishsoils.aea.com/

Groundwater

This type of flooding is caused by water rising up from underlying rocks or flowing from springs. Groundwater is generally a contributing factor to flooding in Scotland rather than the primary source. Based on the SEPA groundwater flood maps there are areas in the catchment surrounding Haddington where groundwater will significantly influence the duration and extent of flooding from other sources.

The SEPA ground water flood map can be viewed on the SEPA website: http://map.sepa.org.uk/floodmap/map.htm

Land Cover

Intensive agriculture predominates in the low lying areas of the catchment and the land cover is almost exclusively arable and horticulture mixed with small areas of grassland.

The main types of land cover present in the East Lothian and Berwick Group catchment are detailed in Figure 5, these are:

- <1% Urban
- 71% Arable and Horticulture
- 3% Coniferous woodland
- 8% Improved Grassland
- 2% Acid Grassland
- 6% Heather and Heather Grassland
- 9% Other

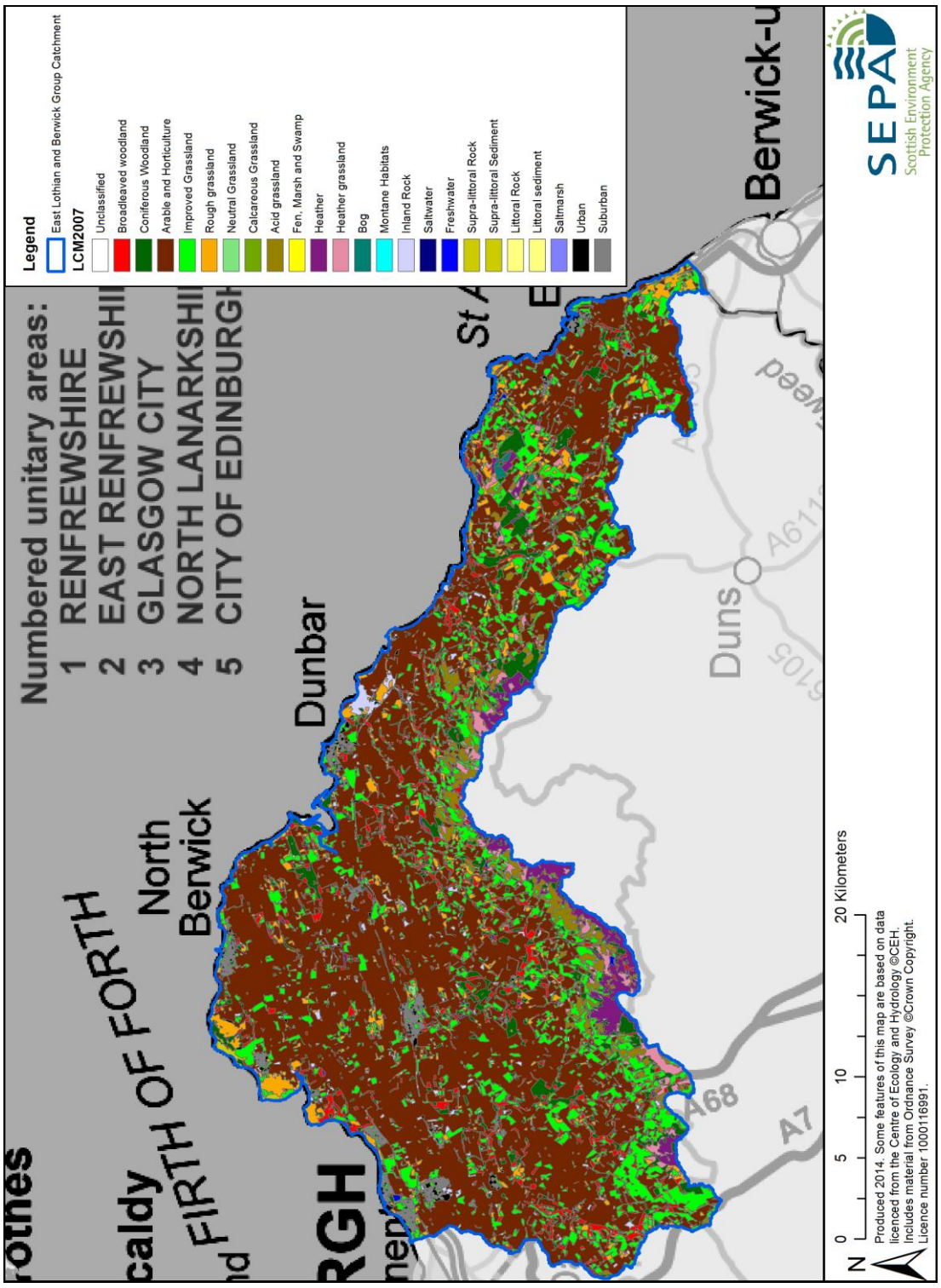

Figure 5: Land cover map

4.2.5 Potential for Natural Flood Management

Natural Flood Management (NFM) refers to the restoration, enhancement or alteration of natural features and characteristics to help reduce the risk of flooding. SEPA have carried out a high level assessment of the potential for Natural Flood Management which identifies those areas where the implementation of certain types of NFM measures might be most effective and where further investigation may be merited. The maps showing potential for NFM are available on the SEPA website (http://map.sepa.org.uk/floodmap/map.htm) and an example map is shown in Figure 6.

Three types of natural flood management measures have been considered for river flooding:

- Reducing surface water run-off
- Floodplain storage
- Sediment management

The river characterisation considers the potential for runoff reduction, floodplain storage and sediment management. The outputs do not directly recommend which specific measure should be implemented where, nor does it facilitate the quantification of the flood risk management benefit, or wider benefits of undertaking a specific natural flood management activity. The outputs instead provide a high level strategic assessment of those areas within the Catchment where the implementation of certain types of NFM measures would be most effective and merit further investigation.

Runoff Reduction

In the East Lothian and Berwick catchment, potential for runoff reduction (as indicated by the SEPA NFM maps) is confined mainly to areas upstream of the Biel Water/Luggate Burn. These areas are just upstream of the Dunbar and West Barns PVA 10/25 on the aforementioned watercourses which contribute to flows within the PVA and in turn any measures on these potential runoff reduction sites may benefit the PVA.

Floodplain Storage Potential

Floodplain storage potential (as indicated by the SEPA NFM maps) is greatest on the River Tyne upstream of Haddington and PVA 10/24 (Figure 6). Elsewhere in the catchment, areas of floodplain storage potential are limited and can be considered insufficient in terms of potential benefits to at risk areas in the catchment.

NFM within in the River Tyne catchment has the potential to help reduce flows within the Haddington PVA (10/24). Further local assessment would be required in order to determine the suitability of these areas and to quantify any benefits measures may have.

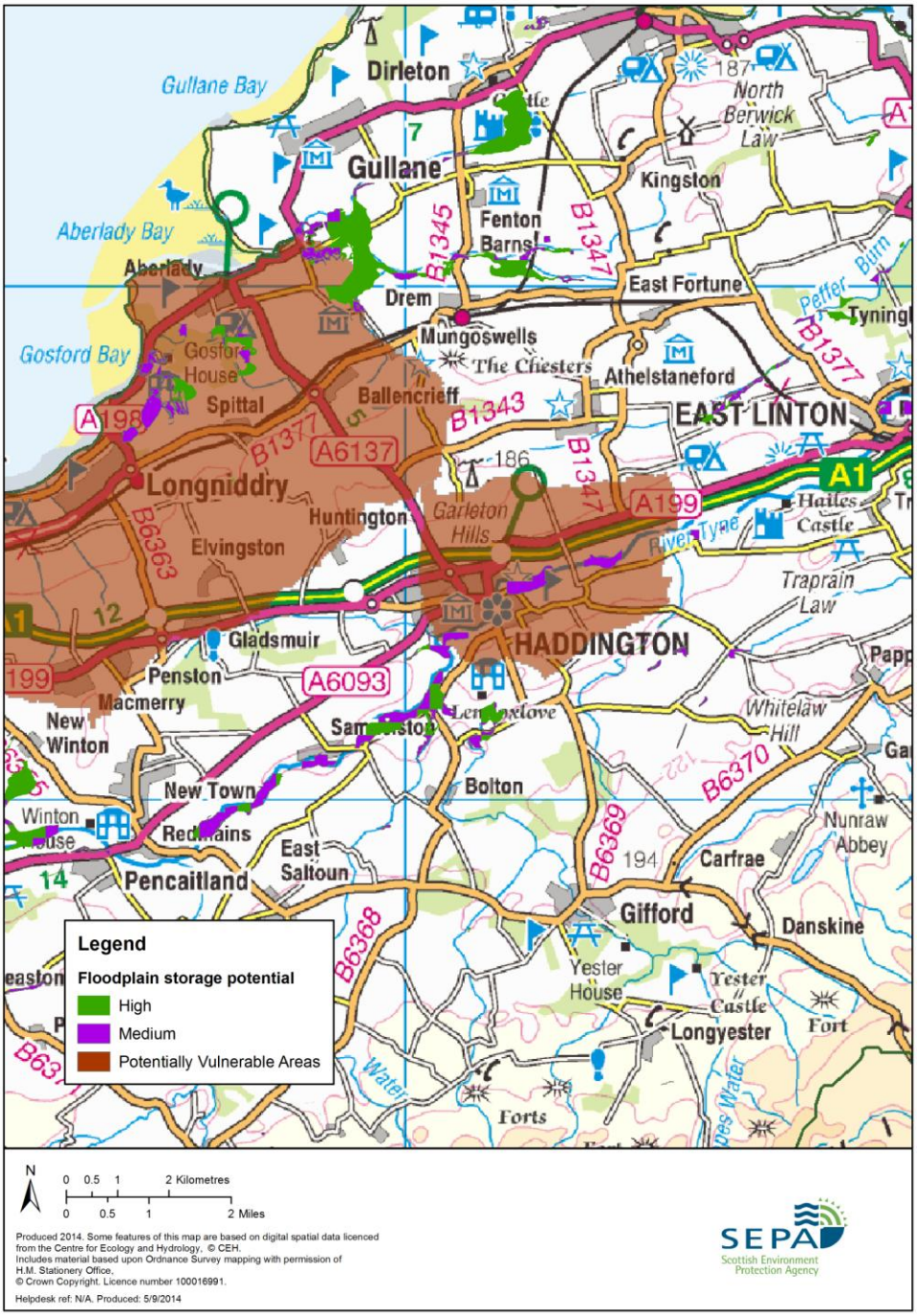

Figure 6: Potential for floodplain storage on the River Tyne

Sediment Management

Areas of high deposition and high erosion have been identified across the East Lothian and Berwick catchment. This level of erosion and deposition is likely to occur for a number of reasons including natural processes or as a result of channel modification. Across the catchment, SEPA information on river modifications identifies a number of watercourses which have had some low level channel modifications which may account for some of the high erosion and deposition. Deposition may also be as a result of the aforementioned natural processes as well as sediment transfer from land surrounding the watercourse, particularly if this is agricultural land or woodland areas.

4.2.6 Links with River Basin Planning

The first river basin management plans were published in 2009. They are currently being reviewed and will be updated in December 2015 (the same time as the FRM Strategies). These plans aim to protect and improve the condition of Scotland's rivers, lochs, estuaries and coastal waters. In the plans, rivers are divided into stretches known as water bodies that have a catchment area greater than 10km^2. There are 29 river water bodies in the East Lothian and Berwick catchment

The status of water bodies is classified as high, good, moderate, poor or bad. High status means water bodies are close to a natural or undisturbed state. Classification takes account of water quality (the biology and chemicals present); habitat (the condition of river beds and banks, and obstacles to fish passage); and water flows (the volume of water removed and stored in reservoirs or held back behind dams). The plans aim to prevent deterioration of rivers and restore them to at least good status by 2027. If actions to restore rivers to good status would have a significant social or economic impact (such as increase the risk of flooding), they are designated as heavily modified. For heavily modified water bodies the plans aim to achieve the best condition possible without impacting on the reason for designation, known as good ecological potential. Some actions to restore rivers can help manage the risk of rivers flooding. Similarly, actions to manage the risk of flooding can help restore rivers. As such, river basin management plans and FRM Strategies must be coordinated.

The water bodies most relevant where actions to reduce the risk of river flooding are required are those affected by habitat damage or rural diffuse pollution (run off from agricultural land or commercial forestry containing harmful chemicals or excess sediment or nutrients), where restoration actions could also help reduce the risk of river flooding. The storage of water in reservoirs for hydropower or water supply activities can also provide opportunities to better manage the risk of river flooding.

In the East Lothian and Berwick catchment there are eight river water bodies that are less than good status due to loss or damage to habitat, and 10 due to water quality partially caused by rural diffuse pollution. There are no heavily modified river water bodies in this catchment.

Consultation on priorities to restore water bodies for the second river basin management plans closes on 20 May 2015. More information on these plans can be viewed on SEPA's website (www.sepa.org.uk).

Appendix

Further Information on Existing Measures

As well as the formal flood protection schemes other measures exist that reduce the risk of river flooding and can be seen in Table A1. This may include other structures and natural flood management measures.

Table A1: Existing measures and natural features that contribute to the management of river flooding

Location	Type of structure of feature	Description	Owned and / or maintained by
Eyemouth	Sluice Gate	Located at west end of Eyemouth Harbour to relieve peak flows on the Eye Water	Eyemouth Harbour Trust

SECTION 3:

MAIN CATCHMENTS AND COASTAL AREAS WITHIN FORTH ESTUARY LOCAL PLAN DISTRICT

CHAPTER 4.2: RIVER FLOODING

Almond and Edinburgh Group Catchment

Local Plan District	Local Authorities
Forth Estuary (LPD 10)	City of Edinburgh, East Lothian, Midlothian, North Lanarkshire, Scottish Borders, South Lanarkshire and West Lothian.

River flooding in the Forth Estuary Local Plan District (LPD) is being summarised in three catchment reports; for the East Lothian and Berwick Group, Almond and Edinburgh Group and Firth of Forth catchments. This section summaries flood risk for the Almond and Edinburgh Group (Figure 1).

The Almond and Edinburgh Group catchment covers an area of 930km^2. The main watercourses within the catchment are Water of Leith, Braid Burn, River Esk, Niddrie Burn, River Almond, Brox Burn and Gogar Burn. There are eight Potentially Vulnerable Areas (PVAs) and one candidate PVA in this catchment area (Figure 1).

The flood maps were developed using consistent methods for the whole of Scotland. There is inherent uncertainty in all flood modelling due to the assumptions and simplifications required to represent complex natural processes. In seeking to improve overall confidence this national approach was supplemented where possible with more detailed, local assessments. The resultant maps are suitable for identifying the flood risk to communities and helping to assess the right combination of actions required to address those risks. They are not suitable for defining the flood risk to individual properties or for the detailed design of actions, such as flood defences.

The information on river flooding does not take account of the interaction with coastal, surface water or groundwater flooding. Floods in steep catchments, in heavily culverted areas or where rivers have been heavily modified with man-made structures are represented with less confidence. Confidence is greater in locations with good topographical information and local river flow data. Confidence is also improved where models compare well with local historical data or detailed modelling. The modelling covers catchments greater than 3km^2 in size.

4.2.1 River Flooding Impacts

Within the Almond and Edinburgh catchment group approximately 5,700 residential properties and 630 non-residential properties are at a medium likelihood of river flooding. The total Annual Average Damages (AADs) caused by river flooding in the catchment group are estimated to be approximately £10.0 million. It is estimated that 97% of residential and non-residential properties at a medium likelihood of river flooding are located within the PVAs.

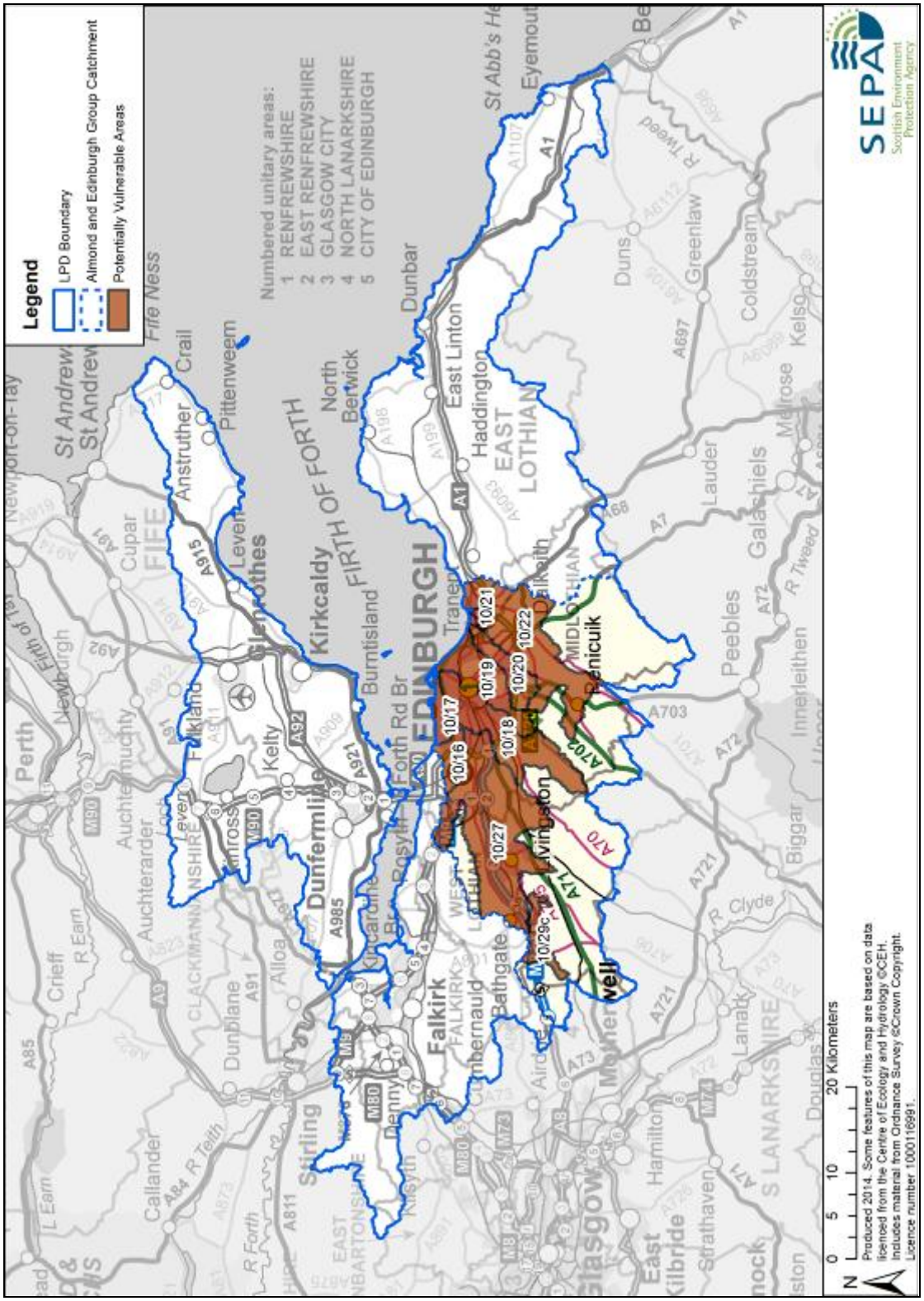

Figure 1: The Almond and Edinburgh group catchment

4.2.1 Catchment Overview

Main urban centres and infrastructure at risk

The main urban areas with a medium likelihood of river flooding can be seen in Table 1. Table 1 shows the number of residential properties at risk and the total Annual Average Damages (AADs) caused by river flooding, which includes damages to residential properties, non-residential properties, transport and agriculture. Figure 2 shows the number of residential properties at risk of river flooding throughout the catchment group.

Table 1: Main urban areas with a medium likelihood of river flooding

Locations	Number of residential properties with a medium likelihood of flooding	Total Annual Average Damages
Edinburgh	4,000	£5,600,000
Musselburgh	1,300	£2,700,000
Whitburn	140	£180,000
Broxburn	120	£210,000
Harthill	20	£63,000
Dalkeith and Newbattle	10	£21,000
Bathgate and Blackburn	<10	£19,000
West Calder	<10	£12,000
East Calder	<10	£11,000
Lasswade and Bonnyrigg	<10	£9,000
Penicuik	<10	£2,000
Kirkliston	<10	£1,000
Livingston	<10	<£1,000

Within the catchment approximately 110 infrastructure assets have a medium likelihood of river flooding. Approximate numbers are outlined below:

Utility Assets:

- 40 Electricity Substations
- <10 Mineral and Fuel Extraction sites

Community Facilities

- <10 emergency service sites
- <10 schools & nurseries
- <10 care centres/homes

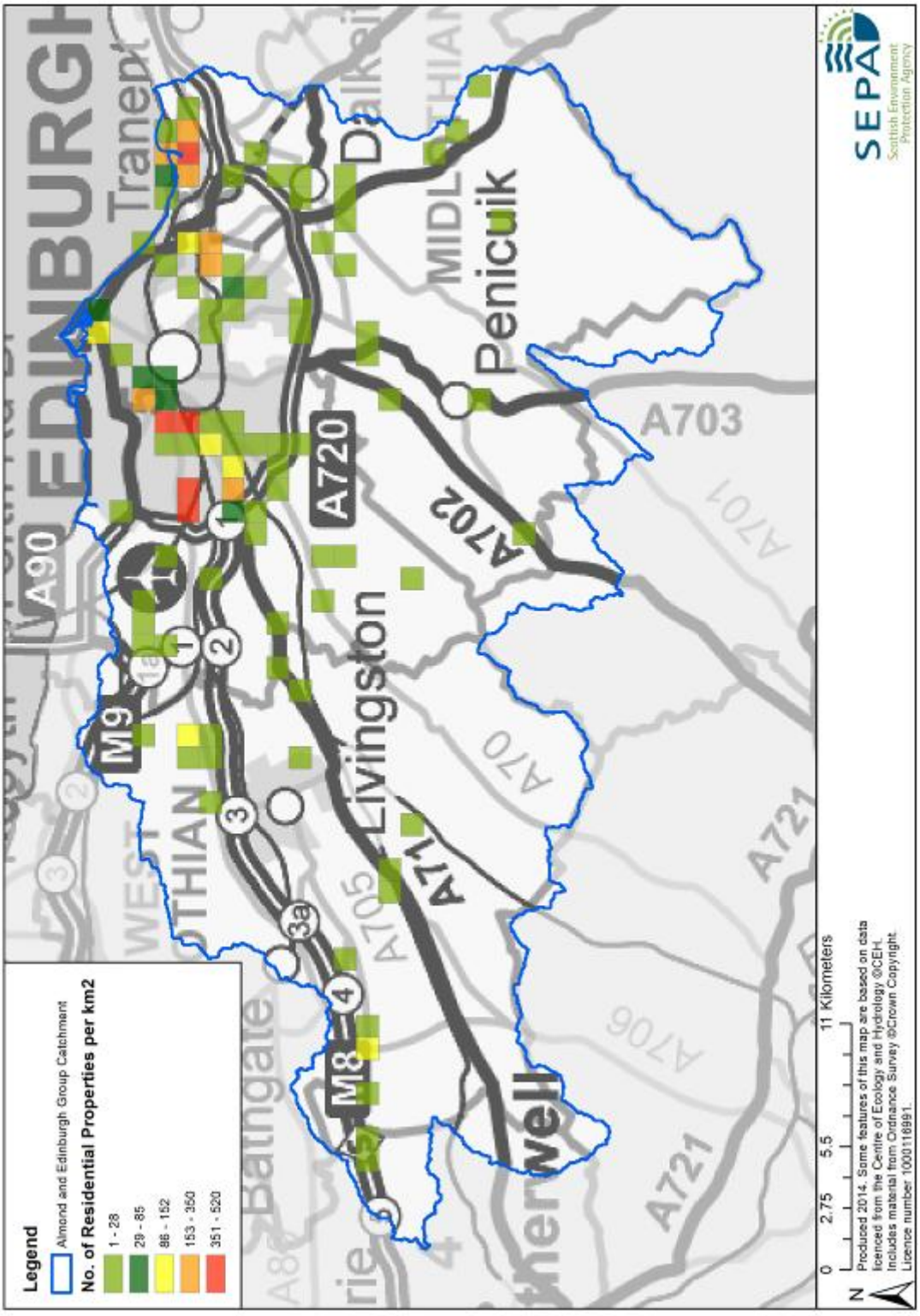

Figure 2: Residential properties with a medium likelihood of river flooding

Transport Routes:

- Roads
  - 2 M Roads (M8 and M9), affected at 25 locations
  - 26 A Roads, affected at 186 locations, and;
  - 25 B Roads, affected at 84 locations.

- Railway routes
  - Berwick-upon-Tweed to Edinburgh (4 locations at risk)
  - Carstairs to Edinburgh (10 locations at risk)
  - Drumgelloch to Newbridge Junction (2 locations at risk)
  - Edinburgh Waverly to Glasgow Queen Street (8 locations at risk)
  - Fife Circle, Dalmeny to Winchburgh and Haymarket West Junctions (7 locations at risk)
  - Midcalder Junction to Holytown Junction (8 locations at risk)

- Airports:
  - Edinburgh Airport

History of river flooding

The most significant river flooding event from the Water of Leith is believed to have occurred in August 1907 with water levels reported to be as deep as 6 feet in the Roseburn area of Edinburgh. The most significant river flooding event from the River Esk is believed to have occurred in August 1948 with severe flooding to Musselburgh causing evacuation of many areas of the town. Water levels were recorded at 7.47mAOD at Inveresk Mill. The highest river level recorded at the SEPA gauging station on the River Almond at Whitburn was in December 1994, where the river levels reached 2.25mAOD.

Other significant historical flood events in the Almond and Edinburgh catchment include:

- 20 August 2008, Broxburn; Over 100 properties and at least 5 businesses also flooded after over topping for the Brox Burn caused extensive damage in the area (specifically Webster Court, Badgers Park, West Main Street, New Holygate, Ashbank Cottages, Parkwood Gardens, Station Road/West Burnside and within Burnvale Village)
- 2004/2005, Broxburn; A series of flood events during this period eventually led to the promotion of the Broxburn Flood Prevention Scheme
- 8 November 2000, Water of Leith, River Almond, Braid Burn and Gogar Burn; Flooding on the Water of Leith casued boundary walls at Saughton, Balgreen, Stockbridge, Warriston and Bonnington to collapse reuslting in the innundation of over 500 properties, Murrayfield Statium, Murrayfield Ice Rink and 2 residential care homes. High water levels also caused flooding at Edinburgh Airport and Kirkliston
- 26 April 2000, Braid Burn; Areas from Colinton to Portobello flooded to an estimated depth of greater than 2m in some areas
- 6 October 1990, Water of Leith and River Esk; Flooding on the Water of Leith resulted in a peak flow of approximately 90 m^3/s. Flooding known to have occurred in multiple locations with the Roseburn area the worst hit Musselburgh was also affected by flooding from the Esk

- 3 November 1984, Water of Leith; Flooding on the Water of Leith resulted in the innundation of two sheltered housing schemes. The Saughton and Roseburn areas were worst affected. Estimated 30 year return period
- 13 August 1948, River Esk; Evacuation required in Musselburgh after flooding occurred in Eskside West, Eskside East, Shorthope Street, Millhill and areas of the High Street. Water levels were recorded at 7.47mAOD at Inveresk Mill
- 17 August 1920, Water of Leith; Roseburn Park area of Edinburgh under six feet of water
- 18 January 1909, River Almond; All the rivers in the southern and central counties of Scotland were in high flood with much of the resulting damage affecting property and livestock at Bathgate
- 15 October 1907, Water of Leith; Water levels at Curie 1.5m above normal levels resulting in the flooding of Woodhall Paper Mill at Juniper Green. Flooding retained at Cannonmill due to retaining walls however flood overtopped at Warringting Green causing road closures
- 1 February 1884, River Almond; Overtopping on the River Almond resulted in large areas of flooding in Whitburn
- 8 October 1832, Water of Leith; Reports of areas being inundated for three days at Slateford, Canonmills and Warriston due to heavy rains and overtopping on the Water of Leith

Economic activity

The total Annual Average Damages (AADs) caused by river flooding are estimated to be approximately £10.0 million. This consists of;

- 26% Non-Residential properties (£2,600,000 direct damages)
- 63% Residential properties (£5,000,000 direct damages, £1,300,000 indirect damages)
- 1% Roads (£80,000 direct damages)
- 5% Emergency services (£500,000 indirect damages)
- 4% Vehicles (£450,000 direct damages)
- 1% Agriculture (£70,000 direct damages)

Out of the economic damages assessed the highest damages in the catchment is to residential properties followed by damages to non-residential properties.

Figure 3 shows the total AADs throughout the catchment group. Highest damages can be seen around Musselburgh due to combination of dense areas of non-residential and residential property surrounding the banks of the River Esk that carrying significant average annual damage figures during river flooding. High damages can also be seen in the Murrayfield area of Edinburgh due to a combination of scattered high damage non-residential property and areas of dense residential property.

Economic damages to airports and rail were not assessed as information on damages at a strategic scale is not available.

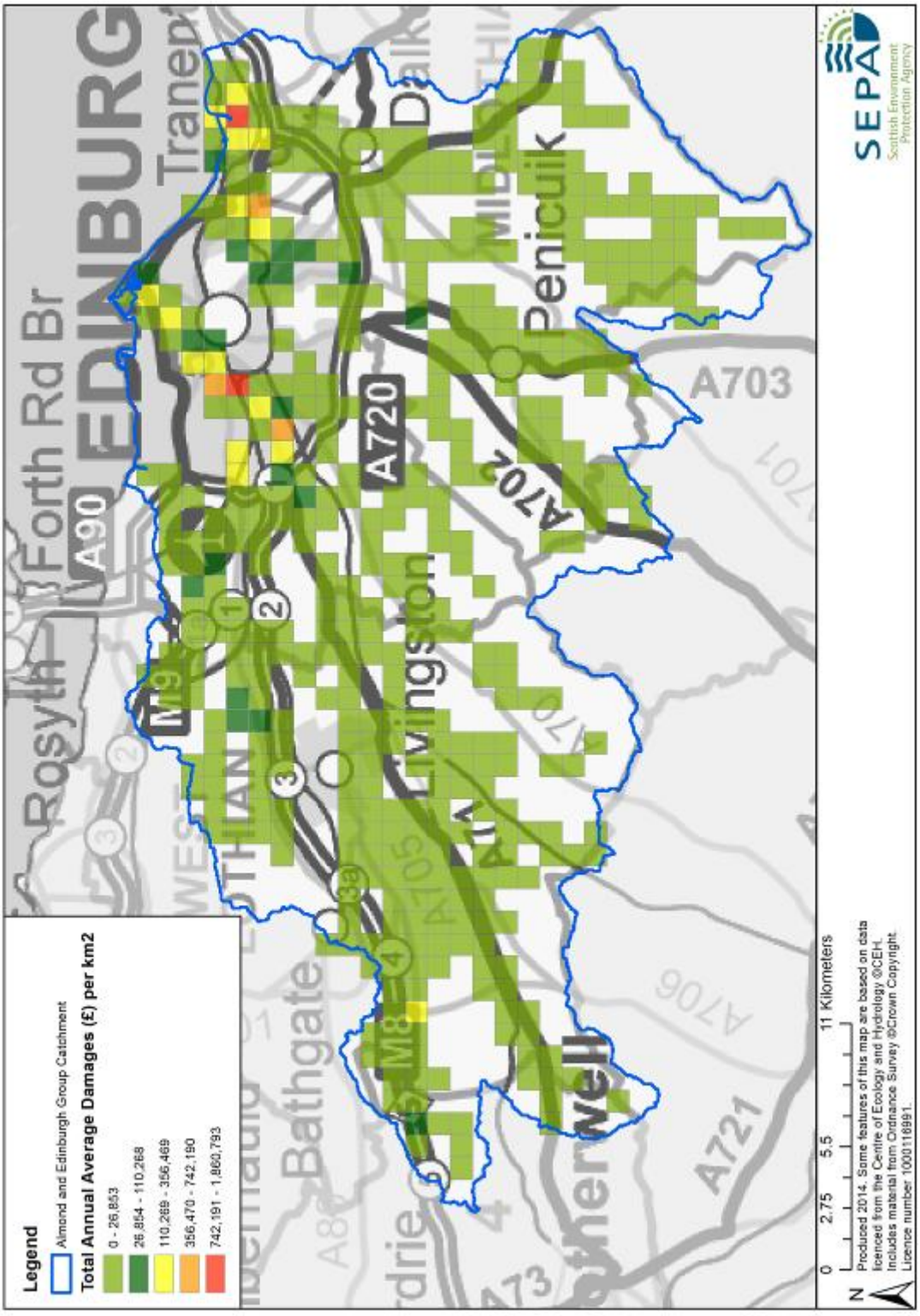

Figure 3: Annual Average Damages from river flooding

Areas of environmental and cultural importance at risk of flooding

Within the catchment approximately 51 cultural heritage sites a medium likelihood of river flooding, consisting of 20 Scheduled Monuments, 28 Gardens & Designated Landscapes, 2 Battlefield sites and 1 World Heritage Site.

It is estimated that approximately 21 environmental sites a medium likelihood ofriver flooding. This includes 3 Special Protection Areas (SPA) and 18 Sites of Special Scientific Interest (SSSI).

4.2.2 Managing flood Risk Across the Catchment

Many organisations work together to manage flood risk and individuals also have a responsibility for taking action to protect themselves and their property from flooding. Further information on the roles of different organisations in flood risk management and details on what individuals or businesses can do to prepare for flooding can be found in the leaflet Prepare for flooding - a guide for residents and businesses available on the SEPA website www.sepa.org.uk/flooding/flooding_publications.aspx.

Existing measures that are in place to manage river flood risk in the LPD are described below.

Existing flood protection schemes

There are four formal flood protection/prevention schemes constructed under the Flood Prevention (Scotland) Act 1961 or the Flood Risk Management (Scotland) Act 2009 to reduce the risk of river flooding. The schemes are;

- C53 Polton Road Bridge Relief Culvert Flood Prevention Scheme (Bilston Burn) –Construction of flood relief culvert crossing under C53 public road. Located immediately upstream of existing small span masonry arch bridge. Protection for up to 7 properties, boundary walls and C53 public road, when watercourse backs up from arch bridge. *Design Standard of Protection 100 years.*

- Braid Burn Flood Prevention Scheme (2003) – The scheme is designed to mitigate flooding of the Braid Burn and to protect residential and commercial property. Operations include the improvement and replacement of culverts and bridges, new embankments, flood walls, strengthening of existing defences, completed 2010. *Design Standard of Protection 200 years plus 12% Climate Change.*

- Water of Leith (Roseburn) FPS 1984 – Scheme to protect Roseburn area of Murrayfield. *Design Standard of Protection* originally built to 100 years, however the scheme is now currently providing an SoP of between 50 and 100 years.

- Water of Leith Flood Prevention Scheme (2003) – (phase 1) The Scheme involves the construction of defence walls and embankments within Stockbridge, Bonnington, Vietch's Square and Warriston. Scheme is nearing completion. *Design Standard of Protection years plus 12% Climate Change to 2054.* Phase 2, which includes the protection of Murrayfield and Roseburn as part of the complete Water of Leith Scheme, has been confirmed by the Scottish Government and construction is due to start in 2014.

- Water of Leith (advanced works) – Reservoir works under the Water of Leith Scheme to Harperrig (July 2008) and Treipmuir/Harlow (2010).

- Broxburn Flood Prevention Scheme (2007) - The scheme is designed to protect approximately 50 residential and 20 commercial properties in the town of Broxburn from the Brox Burn and its tributaries. Operations include the construction of flood defence walls and embankments, improved debris management system, channel conveyance improvements and replacement of vehicle and pedestrian bridges. Scheme was substantially completed in January 2014. *Design Minimum Standard of Protection is 75 years plus 20% climate change allowance.*

In addition to formal flood protection schemes, other measures may exist that reduce the risk of river flooding, this may include other structures and natural flood management measures. These other measures can been seen in the Appendix in Table A1.

Planned flood protection schemes

The following areas are where the local authority has undertaken a detailed appraisal of options to manage flood risk and where a preferred option has been identified that is likely to be constructed as a formal Flood Protection Scheme under the Flood Risk Management (Scotland) Act 2009.

Water of Leith Phase 2 - Timescales for implementing the Water of Leith Phase 2 Flood Protection Scheme will be set out in the Local Flood Risk Management Plan.

Existing river flood warning schemes

SEPA's Floodline service provides flood alerts and flood warnings throughout Scotland to the public and to organisations that have flooding related duties.

Flood alerts are issued over wide geographical areas (normally matching local authority boundaries) using information from the Met Office to determine if flooding is possible. Where SEPA has a river or coastal flood monitoring system, flood warnings can be issued for a more specific local area.

There are fourteen river flood warning target areas within this catchment as shown in Table 2 and Figure 4. Table 2 shows the total number of properties in the flood warning target area (not the number of properties at risk of flooding) and the percentage of those properties that have signed up to receive flood alerts and flood warnings.

Table 2: Flood warning target areas

Flood warning target area	River	Number of properties within FWTA	% of properties registered – July 2013
Bonnington	Water of Leith	228	33%
Cameron Toll	Braid Burn	56	2%
Colinton Mains	Braid Burn	574	12%
Cramond	River Almond	33	42%
Dean Village	Water of Leith	150	26%
Longstone/Stenhouse	Water of Leith	402	20%
Mid Liberton	Braid Burn	49	18%

Flood warning target area	River	Number of properties within FWTA	% of properties registered – July 2013
Musselburgh	River Esk	339	79%
Portobello	Braid Burn	230	13%
Roseburn	Water of Leith	871	35%
Stockbridge	Water of Leith	636	41%
The Inch Park	Braid Burn	232	15%
The Inch Park (Island Area)	Braid Burn	50	8%
Warriston	Water of Leith	1,117	23%

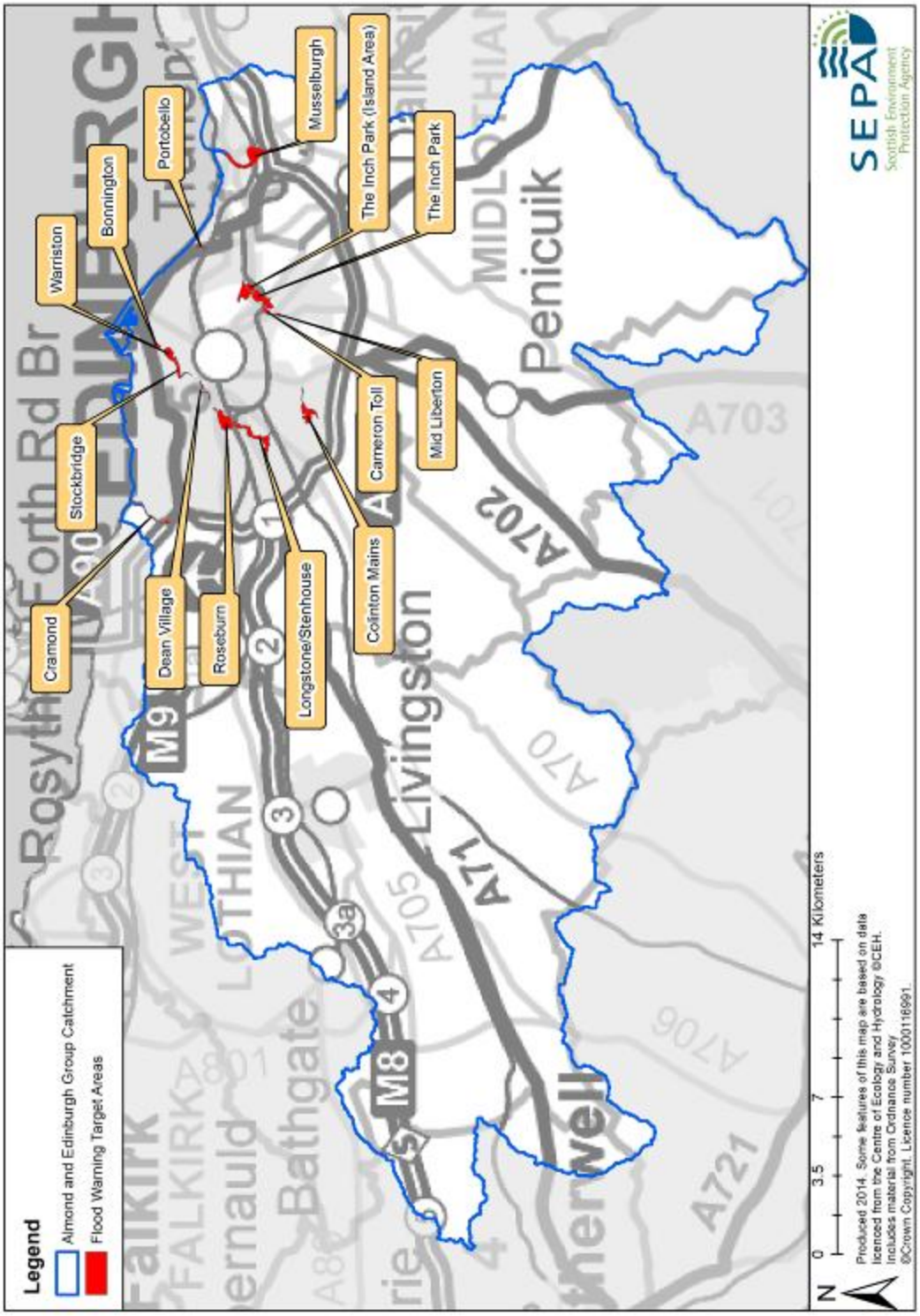

Figure 4: Flood warning target areas

Awareness raising campaigns & community groups

SEPA and the local authorities work closely with many other organisations that have flooding related duties and interests such as the police, fire & rescue services, the Scottish Government and the Scottish Flood Forum. SEPA and the local authorities, often in partnership with these organisations, undertake various awareness raising campaigns that include community events, information leaflets, educational plays in schools, the use of social media and advertising.

In addition the following community groups that help with flood resilience are known to operate within this catchment:

- Musselburgh and Inveresk Community Council
- East Lothian Tenants and Residents Panel
- East Burnside Village Community Flood Action Group, Broxburn

In addition to the above there are also various local community councils that operate throughout the East Lothian Council district.

Property level resilience/resistance measures

Some local authorities have their own policies regarding property level protection. Contact your local authority or view their website for more information.

The following incentives or subsidies have been put in place to provide property owners with property level resilience/resistance measures:

The City of Edinburgh Council own 450m of temporary pallet barriers that can be utilised to protect properties from river flooding. In addition to this, the Council also owns 8,000 sandbags and there are a further 1,500 sandbags located in fire stations throughout the City which can be utilised by the public during flood events.

- The City of Edinburgh Council also operate Emergency Action Packs that are used to determine where people should be deployed during flood events. This includes drawings, maps and sandbag constructions drawings.
- East Lothian council strategically deploy temporary flood barriers and sand bags when properties are threatened by flooding.
- West Lothian Council provides sandbags for public use during an emergency situation. Sandbags and 'Aquasacs' are stored at key Fire Stations throughout the council area.

Flood risk management studies

The following flood risk management studies have been identified within the Almond and Edinburgh Group catchment relating to river flood risk management:

Table 3: Flood risk management studies

Year	Month	Study Name
2012	-	Musselburgh Flood Study Final Report, *Jacobs*
2008	October	Niddrie Burn Catchment Study, Edinburgh, *Halcrow*
2008	-	Boghead and Bog Burn FAS Review, *Entec*
2007	November	Gogar Burn Diversion, *Black & Veatch*
2007	-	Braid Burn Flood Prevention Scheme Hydrological and Hydraulic Modelling Report, *Faber Maunsell*
2003	September	Water of Leith Flood Prevention Scheme project appraisal report, *Arup*
2002	-	Water of Leith Flood Prevention Scheme, Hydrological and Hydraulic Design, Engineer's Report, *Arup*
-	-	East Lothian Council Shoreline Management Plan Summary Report, *Babtie*

4.2.3 Climate Change and Future Flood Risk

The UK Climate Projections (UKCP09) report predicts future climate change may lead to warmer and drier summers, warmer and wetter winters with less snow, and more extreme temperature and rainfall events. The predicted increase in rainfall and consequent increases in river flows may increase the potential for river flooding. Based on the following study; *An assessment of the vulnerability of Scotland's river catchments and coasts to the impacts of climate change (CEH, 2011),* predicted increases in rainfall and river flows vary throughout Scotland based on UKCP09 2080 horizon projections.

For the UKCP09 high emissions scenario, the predicted average increase in peak river flows for the Almond and Edinburgh Group catchment may be in the order of 39% by 2080. Within the Almond and Edinburgh Group catchment it is estimated that the medium likelihood plus climate change scenario will increase the number of residential properties at risk of river flooding from approximately 5,800 to 9,000 and the number of non-residential properties from approximately 630 to 1,100.

4.2.4 Catchment Characterisation

Hydrology

The main watercourses within the catchment are Water of Leith, Braid Burn, River Esk, Niddrie Burn, River Almond, Brox Burn and Gogar Burn. The Water of Leith and River Esk both have notable managed waterbodies that could be used to help managed flood risk. Other waterbodies in the remaining catchments are likely to be too small to be beneficial. The rate of rise for the catchments will vary, those that are gently sloping and dry will have a slow rate of rise. Conversely the steep urbanised catchments are likely to be flashy.
The average annual rainfall (based on rainfall data from 1961-1990) for this catchment is low to average for Scotland, with 600-700mm falling in the lower part of the catchment, rising to 900-1100mm in the upper catchment.

Topography & Soils

The topography of the catchments vary with those draining the Pentland Hills relatively steep and the remainder draining gently rolling areas.

On average its soils are generally dry (Scottish context) due to its sheltered location on the east coast. The general soil type is of fineto medium textured lodgement till (formerly boulder clay), glaciolacustrine and estuarine deposits overlain by non-calcareous mineral gleys with wetness class III or IV[1].

Groundwater

This type of flooding is caused by water rising up from underlying rocks or flowing from springs. Groundwater is generally a contributing factor to flooding in Scotland rather than the primary source. Based on the SEPA groundwater flood maps there are areas surrounding Musselburgh where groundwater will significantly influence the duration and extent of flooding from other sources in this catchment.

The SEPA ground water flood map can be viewed on the SEPA website:

[1] Based in the Hydrology of Soil Types (HOST) classification, Scottish Soils; http://preview.scottishsoils.aea.com/

http://map.sepa.org.uk/floodmap/map.htm

Land cover

This catchment has a high distribution of urban and suburban areas compared to other catchments in the south east region. Across the catchment the land cover is largely arable and horticulture with the upland areas containing a mix of improved grassland, heather and coniferous woodland.

The main types of land cover present in the Almond and Edinburgh catchment are detailed in Figure 5, these are:

- 3% Urban
- 8% Suburban
- 38% Arable and Horticulture
- 7% Coniferous woodland
- 15% Improved Grassland
- 8% Acid Grassland
- 8% Heather and Heather Grassland
- 13% Other

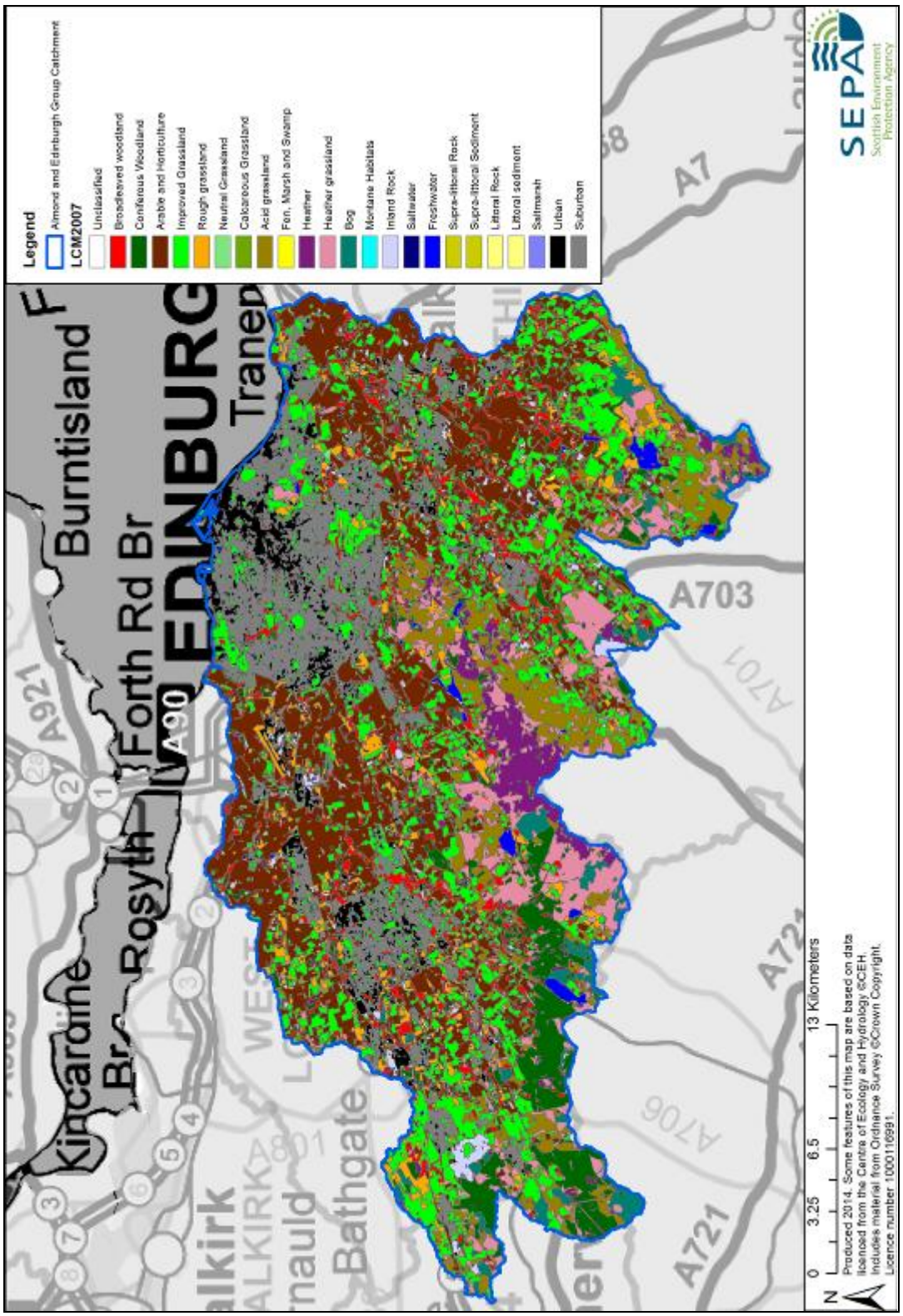

Figure 5: Land cover map

4.2.5 Potential for Natural Flood Management

Natural Flood Management (NFM) refers to the restoration, enhancement or alteration of natural features and characteristics to help reduce the risk of flooding. SEPA have carried out a high level assessment of the potential for Natural Flood Management which identifies those areas where the implementation of certain types of NFM measures might be most effective and where further investigation may be merited. The maps showing potential for NFM are available on the SEPA website (http://map.sepa.org.uk/floodmap/map.htm) and an example map is shown in Figure 6.

Three types of natural flood management measures have been considered for river flooding:

- Reducing surface water run-off
- Floodplain storage
- Sediment management

Runoff reduction

Areas of runoff reduction potential are mainly scattered to the south and south east of this catchment and limited to mainly sites of medium potential. The largest of these areas surround Portmore Loch and Galdhouse Reservoir as well sites at Crosswood Reservoir and in areas surrounding West Calder. These sites of medium runoff reduction potential mainly lie out with the catchments PVA boundaries.

Floodplain storage potential

Sites with flood plain storage potential are extremely limited within this catchment (Figure 6). The two main sites are a site of medium potential surrounding Edinburgh Airport and site in the far south of the catchment on the Gladhouse Reservoir which contains areas of both medium and high potential.

Sediment management

Channel erosion appears to be quite widespread throughout the catchment, with all water bodies experiencing either moderate or appropriate levels of erosion. High levels of erosion are experienced on the lower reach of the Niddry Burn as it joins the River Almond, on the upper reach of the Lead Burn south west of Howgate, on the River South Esk downstream of both the Gladhouse Reservoir and the Roseberry Reservoir as well as Downstream of the Green Burn and continuing into the Crosswood Burn, north of the Crosswood Reservoir. Like with channel erosion, sediment deposition is fairly widespread throughout the catchment. Sites of note due to large sediment deposition extents are the Bickerton Burn and How Burn both south and north of Whitburn respectively, the Threipmuir and Harperig reservoirs both south and south west of Balerno respectively which may experience capacity reduction due to sediment build up, and the River Almond, particularly north and north west of Edinburgh Airport.

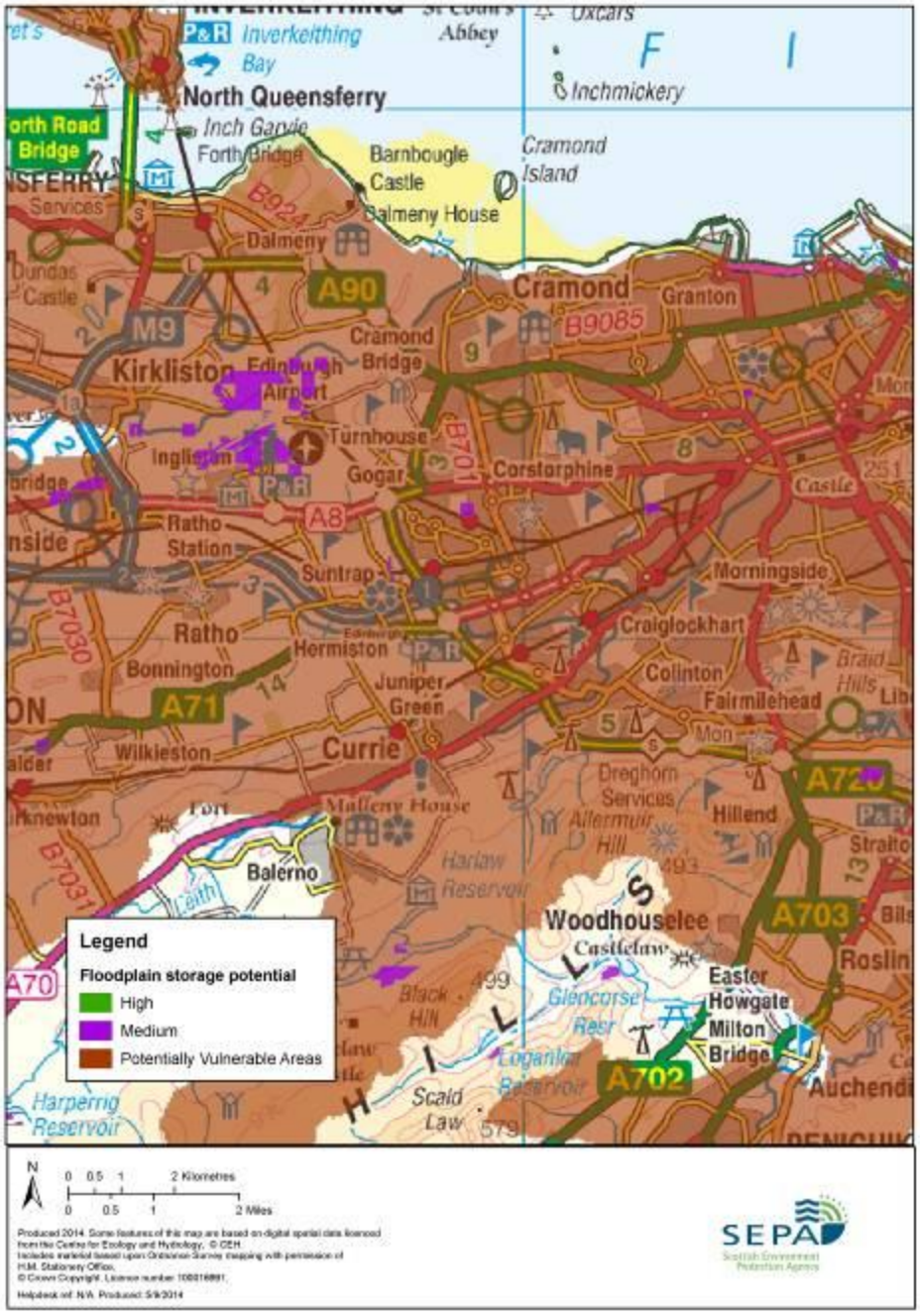

Figure 6: Potential for floodplain storage in the Almond and Edinburgh group catchment

4.2.6 Links with River Basin Planning

The first river basin management plans were published in 2009. They are currently being reviewed and will be updated in December 2015 (the same time as the FRM Strategies). These plans aim to protect and improve the condition of Scotland's rivers, lochs, estuaries and coastal waters. In the plans, rivers are divided into stretches known as water bodies that have a catchment area greater than 10km^2. There are 47 river water bodies in the Almond and Edinburgh catchment

The status of water bodies is classified as high, good, moderate, poor or bad. High status means water bodies are close to a natural or undisturbed state. Classification takes account of water quality (the biology and chemicals present); habitat (the condition of river beds and banks, and obstacles to fish passage); and water flows (the volume of water removed and stored in reservoirs or held back behind dams). The plans aim to prevent deterioration of rivers and restore them to at least good status by 2027. If actions to restore rivers to good status would have a significant social or economic impact (such as increase the risk of flooding), they are designated as heavily modified. For heavily modified water bodies the plans aim to achieve the best condition possible without impacting on the reason for designation, known as good ecological potential. Some actions to restore rivers can help manage the risk of rivers flooding. Similarly, actions to manage the risk of flooding can help restore rivers. As such, river basin management plans and FRM Strategies must be coordinated.

The water bodies most relevant where actions to reduce the risk of river flooding are required are those affected by habitat damage or rural diffuse pollution (run off from agricultural land or commercial forestry containing harmful chemicals or excess sediment or nutrients), where restoration actions could also help reduce the risk of river flooding. The storage of water in reservoirs for hydropower or water supply activities can also provide opportunities to better manage the risk of river flooding.

In the Almond and Edinburgh catchment there are five river water bodies that are less than good status due to loss or damage to habitat, and 10 due to water quality partially caused by rural diffuse pollution. There are also 11 water bodies designated as heavily modified. All of these need actions taken to reach good ecological potential. There are seven water bodies designated for flood protection actions, these are the Bavelaw Burn (Threipmuir Reservoir to Water of Leith), Braid Burn (Upstream Dreghorn Barracks to Portobello), Gogar Burn (Union Canal to River Almond), River Almond (Maitland Bridge to Cramond), Water of Leith (Harperrig Reservoir to Poet's Burn confluence), Water of Leith (Murray Burn confluence to Estuary) and Water of Leith (Poet's Burn to Murray Burn confluences). Four of these are also designated for urbanisation. The Murray Burn is also designated for urbanisation and there are three other water bodies designated for drinking water supply.

Consultation on priorities to restore water bodies for the second river basin management plans closes on 20 May 2015. More information on these plans can be viewed on SEPA's website (www.sepa.org.uk).

Appendix

Further information on existing measures

As well as the formal flood protection schemes measures exist that reduce the risk of river flooding and can be seen in Table A1. This may include other structures and natural flood management measures.

Table A1: Existing measures and natural features that contribute to the management of river flooding

Location	Type of structure or feature	Description	Owned and / or maintained by
School Green/Lasswade	Temporary Pallet barrier	Temporary Pallet barrier with a maximum length of 100m. Barrier protects up to 10 residential properties in School Green and Lasswade as well as other sites in the council area when appropriate (purchased 2005)	Midlothian Council
Edinburgh Airport	Embankments	Flood defence embankments on the Gogar Burn and River Almond to protect Edinburgh Airport.	Edinburgh Airport
Newbridge/Kirkliston	Agricultural Flood Bunds	Agricultural Flood Bunds on the River Almond	Local Landowners
Niddrie Burn River Restoration	Offline storage	2 stage channel through Little France	City of Edinburgh Council

SECTION 4:

MAIN CATCHMENTS, COASTAL AREAS & SURFACE WATER MANAGEMENT WITHIN THE FORTH ESTUARY LOCAL PLAN DISTRICT

CHAPTER 4.1: SURFACE WATER FLOODING

The purpose of this section is to provide an overview of surface water flood risk within the Forth Estuary Local Plan District (LPD).

The flood maps were developed using consistent methods for the whole of Scotland. There is inherent uncertainty in all flood modelling due to the assumptions and simplifications required to represent complex natural processes. In seeking to improve overall confidence this national approach was supplemented where possible with more detailed, local assessments. The resultant maps are suitable for identifying the flood risk to communities and helping to assess the right combination of actions required to address those risks. They are not suitable for defining the flood risk to individual properties or for the detailed design of actions, such as flood defences.

SEPA surface water flood modelling identifies where water ponds and collects during heavy rainfall. Assumptions have been made about the volume of rainfall lost to drainage systems or runoff. Confidence is improved where models compare well with recent flood events or more detailed local information. In certain locations regional assessment has allowed the identification of how water flows through urban areas during storms. For some areas a consideration of flooding from sewerage systems has been included. The maps do not assess flooding from culverted watercourses or groundwater.

4.1.1 Surface water flooding impacts

Within the Forth Estuary LPD approximately 5,400 residential properties and 2,400 non-residential properties are at a medium likelihood of surface water flooding. The total Annual Average Damages (AAD) caused by surface water flooding in the LPD are approximately £12 million. It is estimated that 92% of residential and non-residential properties at a medium likelihood of surface water flooding are located within the Potentially Vulnerable Areas.

Main urban centres and infrastructure at risk

The main urban areas with a risk of surface water flooding can be seen in Table 1. Table 1 shows the approximate number of residential properties at risk and the total AAD caused by surface water flooding, which includes damages to residential properties, non-residential properties and transport. Figure 1 shows the distribution of residential properties at risk of surface water flooding throughout the LPD.

The highest risk areas have been identified as priority areas for surface water management planning. These priority areas were identified using the SEPA modelling, evidence from historical surface water flood events other more detailed modelling held by the local authorities where available. The priority areas can be seen in the Appendix, Table A1.

Table 1: Main urban areas with a medium likelihood of surface water flooding

Locations	Number of residential properties at a medium likelihood of flooding	Total Average Annual Damages
Edinburgh	2,500	£2,500,000
Linlithgow	260	£560,000
Falkirk	210	£170,000
Bo'ness	200	£440,000
Livingston	200	£380,000
Dunfermline	190	£630,000
Buckhaven-Methil-Leven	170	£210,000
Glenrothes-Markinch-Leslie	130	£340,000
Bathgate-Blackburn	110	£130,000
Broxburn	100	£130,000
Cairneyhill	80	£50,000
Kirkcaldy	70	£210,000
Cowdenbeath	70	£150,000
Armadale	70	£60,000
Rosyth	50	£74,000
Grangemouth	50	£62,000
Carron-Carronshore	50	£51,000
Musselburgh	50	£46,000
Dalkeith	40	£320,000
Newtongrange	40	£140,000
Penicuik	40	£110,000
Culross	40	£70,000
Polmont	40	£60,000
Cumbernauld (East)	40	£60,000
Whitburn	40	£40,000
Lasswade-Bonnyrigg	30	£64,000
Burntisland	30	£40,000
Loanhead	20	£40,000
Tranent	20	£34,000
Lochore	20	£27,000
Larbert-Stenhousemuir	20	£ 24,000
Cardenden-Auchterderran-Bowhill	20	£24,000
Bonnybridge-Banknock	20	£20,000
Denny-Dunipace	10	£46,000
Haddington	10	£32,000
Kinross	10	£28,000
Milnathort	10	£11,000

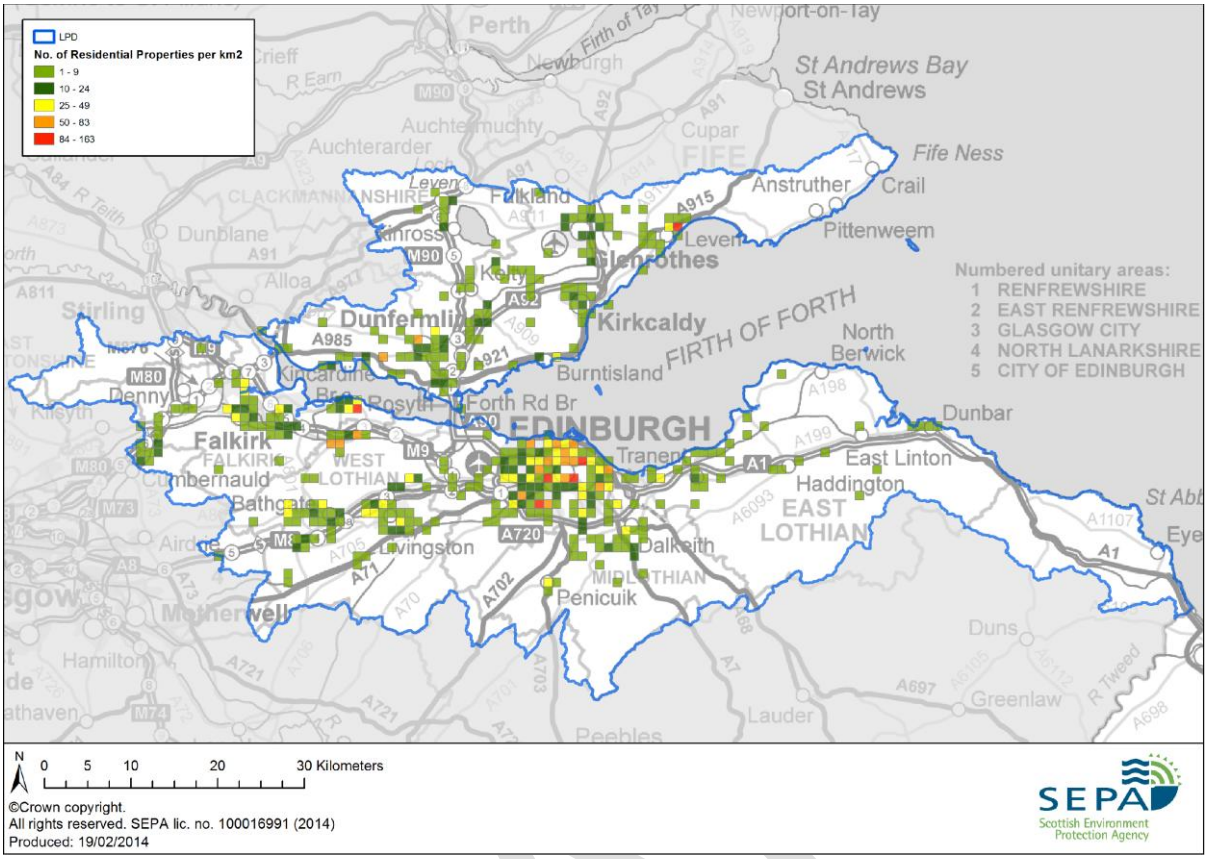

Figure 1: Residential properties with a medium likelihood of surface water flooding

Within the LPD approximately 630 infrastructure assets have a medium likelihood of surface water flooding. Approximate numbers are outlined below:

- Utility assets:
    - 370 electricity substations
    - 30 mineral and fuel extraction sites
    - <10 telecommunications sites
    - <10 power stations

- Community facilities:
    - 20 schools
    - <10 healthcare facilities
    - <10 cultural institutes

- Transport routes:
    - 181 Roads (of which; 5 Motorways are affected at 280 locations, 68 A Roads are affected at 2,000 locations, 108 B Roads are affected at 1,200 locations)
    - 9 Railway routes
        - Berwick-upon-Tweed to Edinburgh affected at 80 locations
        - Carmuirs Junction to Polmont Junction affected at 15 locations
        - Carstairs to Edinburgh affected at 60 locations

    - Drumgelloch to Newbridge Junction affected at 45 locations
    - Dunblane to Larbert / Stirling affected at 15 locations
    - Edinburgh to Glasgow Queen Street affected at 90 locations
    - Fife Circle, Dalmeny to Winchburgh and Haymarket West Junctions affected at 110 locations
    - Mid Calder Junction to Holytown Junction affected at 50 locations
    - Perth to Ladybank (affected at 10 locations)
- Edinburgh Airport
- Fife Airport

Economic activity

The total AAD caused by surface water flooding in the Forth Estuary LPD are approximately £12 million. This consists of:

- 32% Residential properties (£2,900,000 direct damages, £930,000 indirect damages)
- 26% Non-residential properties (£3,200,000 direct damages)
- 39% Roads (£4,700,000 direct damages)
- 3% Emergency services (£400,000 indirect damages)
- <1% Vehicles (£120,000 direct damages)

Economic damages to airports and rail were not assessed as information on damages at a strategic scale is not available. Out of the economic damages assessed, the highest damages in the LPD are to roads, of which the the M9 and the Edinburgh City Bypass are significantly affected. Damages to residential and non-residential properties are also a significant contribution. Figure 2 shows the total AADs throughout the LPD. High damages can be seen in Edinburgh due to the number of residential and non-residential properties. High damages can also be seen in Dunfermline, largely due to the number of non-residential properties affected.

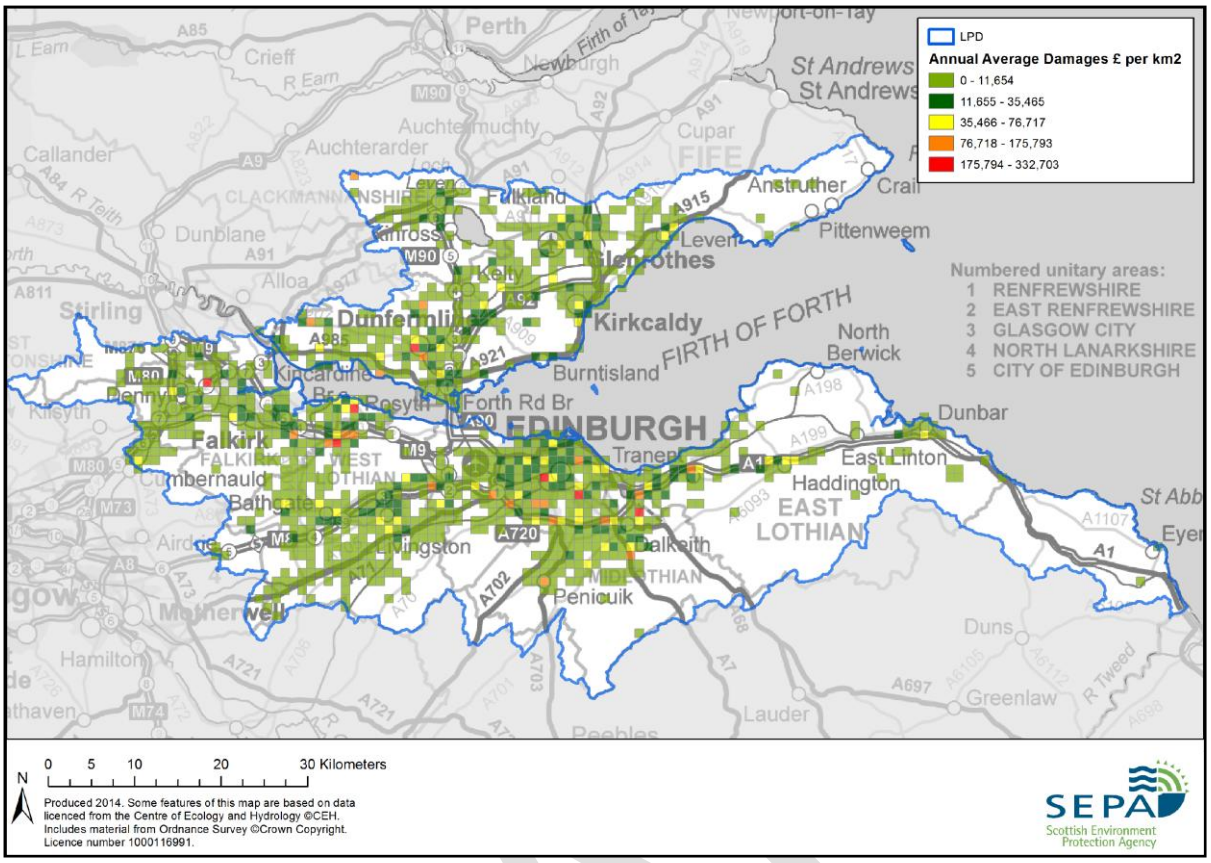

Figure 2: Annual Average Damages from surface water flooding

Areas of environmental and cultural importance at risk of flooding

Within the LPD approximately 260 cultural heritage sites have a medium likelihood of surface water flooding. This includes approximately 160 Scheduled Monuments, 90 Gardens and Designated Landscape sites, <10 World Heritage Sites and <10 Battlefield sites.

The impact of surface water flooding on environmental sites was not assessed, as due to the nature of surface water flooding, it was considered that the impacts to these sites would be relatively low.

History of surface water flooding

The following surface water flooding events have been identified as significant by local authorities and with information from the SEPA historical flood event database, this list is not exhaustive:

- 25 July 2013, Eyemouth: Flooding in Albert Road, Church Street and Harbour Road resulting in both residential and commercial property flooding.
- 28 June 2012, Eyemouth: Flooding in Albert Road, Church Street and Harbour Road resulting in both residential and commercial property flooding.
- 08 July 2011, Edinburgh: Flooding of homes and businesses in Edinburgh. Balcarres Street in Morningside was identified as the area worst affected area with around 20 residential and three commercial properties flooding, (the majority of the 20 residential properties were tenement buildings and only the ground floor properties

have been counted). Four properties were also affected from this flooding event at Greenbank Road.

- 06 July 2009, Milnathort: Heavy rain caused surface water flooding in areas of Fife and Perth and Kinross, including Milnathort.
- 05 December 2008, Pencaitland: occupants were evacuated from Huntlaw Road.
- 08-14 August 1948, Eyemouth: Low-lying areas of Eyemouth flooded by surface water flowing down Northburn Road.
- Musselburgh: There is a history of groundwater flooding in Musselburgh, particularly around the Pinkie area.

4.1.2 Managing surface water flood risk

Many organisations work together to manage flood risk and individuals also have a responsibility for taking action to protect themselves and their property from flooding. Further information on the roles of different organisations in flood risk management and details on what individuals or businesses can do to prepare for flooding can be found in the leaflet Prepare for flooding - a guide for residents and businesses available on the SEPA website www.sepa.org.uk/flooding/flooding_publications.aspx .

Existing actions that are in place to manage surface water flood risk in the LPD are described below.

Existing flood protection schemes

There are no formal flood protection schemes for the management of surface water flooding in the LPD.

Other structures exist that are not formal flood protection schemes but do reduce the risk of surface water flooding, these other structures can be seen in the Appendix in Table A2.

Awareness raising campaigns & community flood action groups

SEPA and the local authorities work closely with many other organisations that have flooding related duties and interests such as the police, fire & rescue services, the Scottish Government, Scottish Flood Forum and the Tweed Forum. SEPA and the local authorities, often in partnership with these organisations, undertake various awareness raising campaigns that include community events, information leaflets, educational plays in schools, the use of social media and advertising.

In addition the following community groups that help with flood resilience are known to operate within this LPD:

- East Lothian Tenants and Residents Panel.
- Eyemouth community resilience group.
- Friends of River Tyne.
- Musselburgh and Inveresk Community Council.
- St Abbs community resilience group.
- Various local community councils operate throughout the East Lothian Council district.
- Perth and Kinross Council are part of a wider community resilience group which works with various communities including Milnathort to develop community resilience plans.

Property level resilience/resistance actions

Some local authorities have their own policies regarding property level protection. Contact your local authority or view their website for more information.

The following incentives or subsidies have been put in place to provide property owners with property level resilience/resistance actions:

- The City of Edinburgh Council has issued properties on Balcarres Street with door and vent flood guards.
- The City of Edinburgh Council store sandbags at key Fire Stations.
- East Lothian Council strategically deploy temporary flood barriers and sand bags when properties are threatened by flooding.
- Fife Council have installed flood pods containing flood sacks close to flood affected properties.
- Perth and Kinross Council are currently working towards introducing a pilot project for flood protection products for properties in flood risk areas.
- Scottish Borders Council operate a subsidised flood protection products scheme for residential and non-residential property owners in flood risk areas.
- Scottish Borders Council has provided and maintains dedicated sandbag stores in areas of flood risk to ensure sandbags are available to the public in the event of a flood.
- West Lothian Council provide 'Aquasacs' which are stored at key Fire Stations through the council area.

Development planning policy

Development planning policy aims to direct future development away from areas that may be at risk of flooding. Further it aims to ensure that any new development does not contribute to increased flood risk elsewhere through the incorporation of sustainable urban drainage systems.

Surface water management studies

Scottish Water, in partnership with local authorities, are undertaking two Integrated Catchment Studies to address surface water and other sources of flooding within the following areas:

- Edinburgh and Lothians Integrated Catchment Study, in partnership with the City of Edinburgh Council, East Lothian Council and Midlothian Council. The study covers a wide geographical area including; Edinburgh, Dalkeith, Musselburgh and Port Seton
- Falkirk Integrated Catchment Study, in partnership with Falkirk Council. The study covers a wide geographical area including; Falkirk, Grangemouth and Bo'ness

Other studies relating to surface water management include:

- Milnathort Surface Water Investigation (Atkins), Perth and Kinross Council.
- Scottish Water investigation into the mitigation of the risk of sewer flooding in Milnathort (ongoing).
- Pluvial Screening Study (Jacobs, June 2010) – screening study of Edinburgh City Council area, City of Edinburgh Council.

4.1.3 Climate change and future flood risk

UK Climate Projections (UKCP09) predicts future climate change may lead to warmer and drier summers, warmer and wetter winters with less snow, and more extreme temperature and rainfall events. The surface water flood modelling which was undertaken considered climate change scenarios with a 20% increase in rainfall intensity.

For the medium likelihood plus climate change scenario it is estimated that the number of residential properties at risk of surface water flooding may increase from approximately 5,400 to 9,900 and the number of non-residential properties from approximately 2,400 to 4,400. With future impacts of climate change considered, new surface water flood risk may arise in Gorebridge where currently there is estimated to be a very low risk of surface water flooding.

4.1.4 Links with river basin planning

The first river basin management plans were published in 2009. They are currently being reviewed and will be updated in December 2015 (the same time as the flood risk management studies). These plans aim to protect and improve the condition of Scotland's rivers, lochs, estuaries and coastal waters. In the plans, rivers are divided into stretches known as water bodies that have a catchment area greater than 10km^2. There are 143 river water bodies in the Forth Estuary LPD.

The status of water bodies is classified as high, good, moderate, poor or bad. High status means water bodies are close to a natural or undisturbed state. Classification takes account of water quality (the biology and chemicals present), habitat (the condition of river bed and banks and obstacles to fish passage), and water flows (the volume of water removed and stored in reservoirs or held back behind dams). The plans aim to prevent deterioration of rivers and restore them to at least good status by 2027. Some actions to restore the water quality of rivers can help manage the risk of surface water flooding. Similarly, actions to manage the risk of flooding can help restore the water quality of rivers. As such, river basin management plans and FRM Strategies must be coordinated.

Water bodies that are affected by loss or damage to habitat and urban diffuse pollution (run off from impermeable surfaces carrying oil, toxic metals or harmful chemicals to rivers) may benefit from actions that reduce the risk of surface water flooding.

There are 17 urban areas identified as priorities to produce surface water management plans in the Forth Estuary LPD. Opportunities for multiple benefits will be identified as part of this planning process. Fourteen of these urban areas have water bodies that are less than good status for water quality (although multiple factors could be contributing to this), and 10 due to loss or damage to habitat. There are also four bathing waters not in sufficient condition due to a combination of urban diffuse pollution and sewer or surface water overflows in high intensity rainfall events. These are Fisherrow West, Kinghorn (Harbour), Kirkcaldy (Seafield) and Portobello West.

Scottish Water has identified six sewerage catchments in this LPD to undertake integrated catchment studies by 2021. These studies will help inform where there may be opportunities for actions that reduce the risk of surface water flooding and improve water quality.

Consultation on priorities to restore water bodies for the second river basin management plans closes on 20 May 2015. More information on these plans and bathing water profiles can be viewed on SEPA's website (www.sepa.org.uk).

Appendix

Priority areas for surface water management planning

Areas with the highest risk of surface water flooding have been identified as priority areas for surface water management planning. 17 priority areas have been identified in the Forth Estuary LPD (Table A1). The priority areas were identified using the SEPA surface water flood modelling, evidence from historical events and, where available, other more detailed modelling from the local authorities.

The initial indicator used to identify priority areas was based on the SEPA modelling and included areas with 50 or more residential properties have a medium likelihood of flooding or where the Annual Average Damages were equivalent to 50 residential properties (£55,800 for surface water flooding). This threshold is consistent with that used to identify PVAs in the National Flood Risk Assessment (NFRA).

If areas were close to this threshold or where there were uncertainties in the SEPA modelling, other evidence from historical flood events or other more detailed modelling was used. If other evidence indicated a high risk of surface water flooding then these areas were included.

Table A1: Priority areas for surface water management planning in the Forth Estuary Local Plan District

Priority Area for SWM Planning	Further Description	PVA's	Local Authorities	Reason for priority area
Bathgate	*Bathgate*	*10/13, 10/27*	*West Lothian*	*High risk indicated by SEPA modelling*
Bo'ness	*Bo'ness, including Carriden, Muirhouses,*	*10/12*	*Falkirk*	*High risk indicated by SEPA modelling*
Broxburn	*Broxburn, including Eastern Uphall*	*10/27*	*West Lothian*	*High risk indicated by SEPA modelling*
Cairneyhill	*Cairneyhill including Crombie and Muirside*	*10/06, 10/07*	*Fife*	*High risk indicated by SEPA modelling*
Cowdenbeath	*Cowdenbeath including Leuchatsbeath and Lumphinnans*	*N/A*	*Fife*	*High risk indicated by SEPA modelling*
Cumbernauld (East)	*Cumbernauld (East), Cumbernauld (West) is in the Clyde and Loch Lomond LPD (PVA 11/04)*	*10/11*	*North Lanarkshire*	*High risk indicated by SEPA modelling*
Dunfermline	*Dunfermline, including Bowershall, Crossford, Wellwood, Townhill and Halbeath*	*10/06*	*Fife*	*High risk indicated by SEPA modelling*
Edinburgh	*Edinburgh including, Musselburgh, Penicuik, Lasswade, Loanhead, Newtongrange and Dalkeith*	*10/16, 10/17, 10/18, 10/19, 10/20, 10/21, 10/22, 10/27*	*City of Edinburgh, East Lothian, Midlothian*	*High risk indicated by SEPA modelling and history of significant surface water*

				flood events
Falkirk	*Falkirk including Stenhousemuir and Carron*	*10/11*	*Falkirk*	*High risk indicated by SEPA modelling*
Glenrothes	*Glenrothes including Markinch*	*10/04*	*Fife*	*High risk indicated by SEPA modelling*
Kirkcaldy	*Kirkcaldy including Cluny*	*10/05*	*Fife*	*High risk indicated by SEPA modelling*
Leven	*Leven including Eastern Methil*	*10/03, 10/05*	*Fife*	*High risk indicated by SEPA modelling*
Linlithgow	*Linlithgow including Whitecross*	*10/13*	*Falkirk, West Lothian*	*High risk indicated by SEPA modelling*
Livingston	*Livingston including Mid Calder*	*10/27*	*West Lothian*	*High risk indicated by SEPA modelling*
Milnathort	*Milnathort*	*10/04*	*Perth and Kinross*	*High risk indicated by more detailed modelling provided by local authority and history of significant surface water flood events*
Polmont	*Polmont, including Maddiston*	*10/11, 10/13*	*Falkirk*	*High risk indicated by SEPA modelling*
Rosyth	*Rosyth*	*10/10*	*Fife*	*High risk indicated by SEPA modelling*

Further information on existing actions

Although there are no formal flood protection schemes to manage surface water flooding in the LPD, other existing actions that are in place that reduce the risk of surface water flooding can be seen in Table A2.

Table A2: Existing actions that may contribute to the management of surface water flooding

Location	Name of structure	Description	Owned and / or maintained by
Edinburgh	Braid Burn flood prevention scheme	Redford to Portobello - Not a action for surface water flooding, but has implications for management	City of Edinburgh Council
Edinburgh	Water of Leith flood prevention Scheme phase 1	Stockbridge to Bonnington - Not a action for surface water flooding, but has implications for management	City of Edinburgh Council
Gogarburn underpass	Gogarburn pumping station	Road drainage pumping station	City of Edinburgh Council

Edinburgh	Greenbank Crescent	Reprofiling of Greenbank Crescent to redirect surface water flooding into the Braid Burn	City of Edinburgh Council
Macmerry	Macmerry West Railway Walk Attenuation System	Detention Basin and Geo-cellular Storage Units	East Lothian Council
Any location	Temporary flood barrier	East Lothian council temporary flood barriers can deployed anywhere.	East Lothian Council
Grangemouth, Grange Burn	Grange Burn Flood Prevention Scheme	Raised embankments and flood relief channel constructed under the 1961 Act to contain and re-direct flows from two burns towards the River Avon	Falkirk Council
Glensburgh Road, Grangemouth	Pump installation	Pump is on a surface water drain and operated during periods of high tide, when flap valve is closed, to discharge surcharge to the River Carron	Falkirk Council
Lasswade	Temporary flood barrier	Proprietary temporary Pallet Barrier, covering School Green, Lasswade	Midlothian Council
Kinross	Bund and Wall at Myre Terrace	Prevents surface water flowing from the Myre Park and into Myre Terrace and Smith Street.	Perth & Kinross Council