Flood Risk Management Strategy

Tay Local Plan District

This section provides supplementary information on the characteristics and impacts of river, coastal and surface water flooding. Future impacts due to climate change, the potential for natural flood management and links to river basin management are also described within these chapters.

Detailed information about the objectives and actions to manage flooding are provided in Section 2.

Section 3: Supporting information

3.1 Introduction

In the Tay Local Plan District, river flooding is reported across two distinct river catchments. Coastal flooding and surface water flooding are reported across the whole Local Plan District.

A summary of the number of properties and Annual Average Damages from river, coastal and surface water flooding is outlined in Table 1.

	Total number of properties at risk[1]	Annual Average Damages	Local authority
River catchments			
River Tay catchment	2,100	£7.4 million	Angus Council Perth and Kinross Council Stirling Council
River Earn catchment	730	£2.8 million	Perth and Kinross Council Fife Council Stirling Council
Coastal flooding			
Tay coastal area	260	£550,000	Perth and Kinross Council
Surface water flooding			
Tay Local Plan District	940	£1.9 million	Angus Council Fife Council Perth and Kinross Council Stirling Council

Table 1: Summary of flood risk from various sources within the Tay Local Plan District

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[1] Total number of residential and non-residential properties at risk of flooding.

3.2 River flooding

Tay Local Plan District

This section provides supplementary information on river flooding at the catchment level. It provides an overview of the catchment's natural characteristics, flood risk and the existing actions to manage flooding. It outlines the likely impact of climate change and the potential for natural flood management.

Detailed information about the objectives and actions to manage flooding are provided in Section 2.

In the Tay Local Plan District, river flooding is reported across two distinct river catchments, shown below.

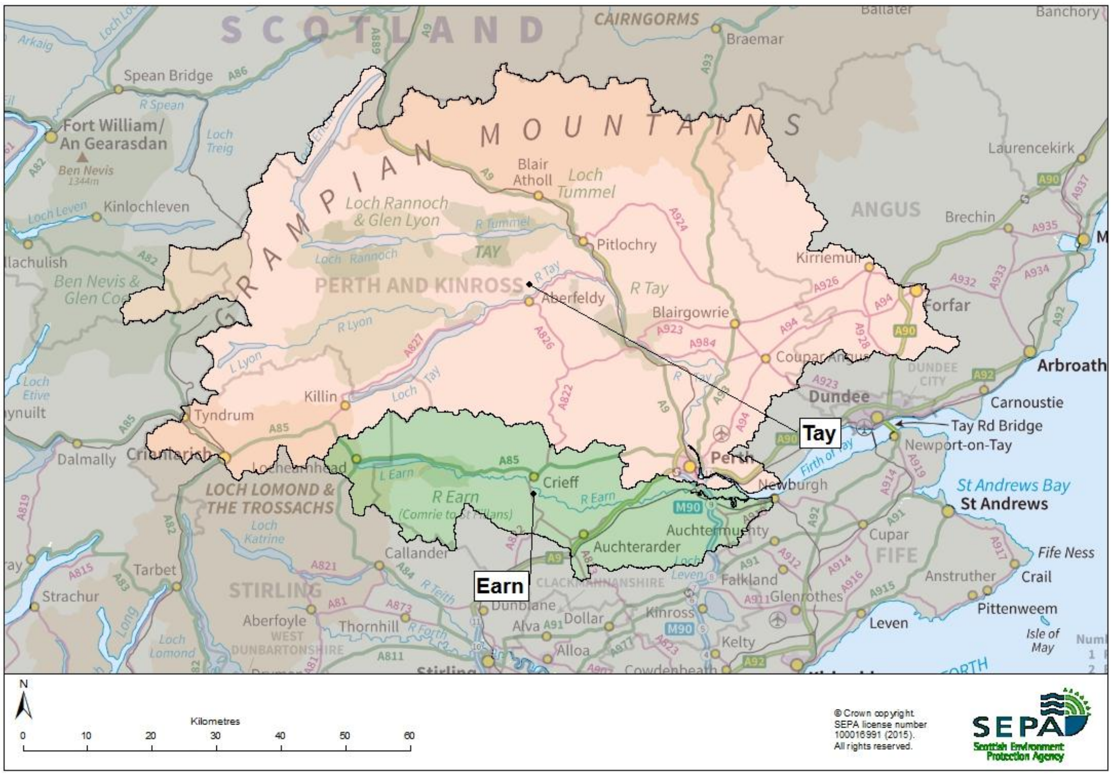

Figure 1: River catchments within the Tay Local Plan District

River flooding
River Tay catchment

This chapter provides supplementary information on river flooding at the catchment level. It provides an overview of the catchment's natural characteristics, flood risk and the existing actions to manage flooding. It outlines the likely impact of climate change and the potential for natural flood management.

Detailed information about the objectives and actions to manage flooding are provided in Section 2.

Catchment overview

The River Tay has the largest catchment area and is the longest river in Scotland. It covers an area of 5,088km^2 and is around 190km in length. More water flows through the River Tay than any other river in the United Kingdom. The main tributaries include the River Garry, River Tummel, River Lyon, River Braan, River Isla and River Almond. The largest lochs in the River Tay catchment include Loch Ericht, Loch Rannoch and Loch Tay. Many of the lochs and rivers in the River Tay catchment are managed to produce hydropower.

The Highland boundary fault cuts across the catchment from Buchantly (Glen Almond) in the west to Kirriemuir in the east. The fault line marks distinct differences in topography, rainfall and land use.

North of the boundary fault the catchment is steep and upland in nature. Rainfall is higher in the upland section of the catchment, with average annual rainfall between 1500mm-3000mm. South of the boundary fault the catchment is more lowland in nature, with gentle slopes. Rainfall is lower than average with annual rainfall between 800mm-1000mm.

Flood risk in the catchment

Within the River Tay catchment approximately 1,400 residential and 750 non-residential properties are at risk of river flooding. It is estimated that 70% of these properties are located within Potentially Vulnerable Areas. There are 13 Potentially Vulnerable Areas at risk of river flooding in this catchment (Figure 1):

- Blair Atholl (08/01)
- Kinloch Rannoch (08/02)
- Aberfeldy and Pitlochry (08/03)
- Alyth (08/04)
- Kirriemuir and Forfar (08/05)
- Blairgowrie (08/06)
- Coupar Angus (08/07)
- Luncarty, Stanley, Bankfoot, Dunkeld and Birnam (08/08)
- Tyndrum and Crianlarich (08/09)
- Almondbank (08/10)
- Scone (08/11)
- Perth to Kinfauns (north of A90) (08/12)
- Perth centre (08/13).

Main areas at risk

The main areas at risk of river flooding can be seen in Table 1. The table shows the number of properties at risk and the Annual Average Damages caused by river flooding. This includes damages to residential and non-residential properties, transport and agriculture.

	Residential and non-residential properties at risk of river flooding	Annual Average Damages
Dunkeld and Birnam	250[1]	£280,000
Almondbank	240	£1.2 million
Pitlochry	160	£620,000
Aberfeldy	160	£360,000
Perth	120	£1.3 million
Bankfoot	110	£290,000
Forfar	80	£450,000
Alyth	60	£150,000
Scone	40	£88,000
Tyndrum	30	£130,000
Methven	30	£98,000
Kirriemuir	20	£39,000
Coupar Angus	20	£29,000
Meigle	10	£83,000
Blairgowrie and Rattray	10	£7,000
Killin	<10	£16,000
Crianlarich	<10	£8,000
Weem	<10	£7,000

Table 1: Main areas at risk of river flooding

Economic activity and infrastructure at risk

The Annual Average Damages caused by river flooding in the River Tay catchment is approximately £7.4 million. The damages are distributed as follows:

- 42% residential properties (£3.1 million)
- 38% non-residential properties (£2.8 million)
- 7% emergency services (£500,000)
- 7% agriculture (£500,000)
- 4% roads (£300,000)
- 2% vehicles (£200,000).

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[1] The numbers presented in this report are derived from SEPA data that is assessed at a strategic level. Perth and Kinross Council have estimated that there are substantially lower numbers of people at risk from river flooding in Dunkeld.

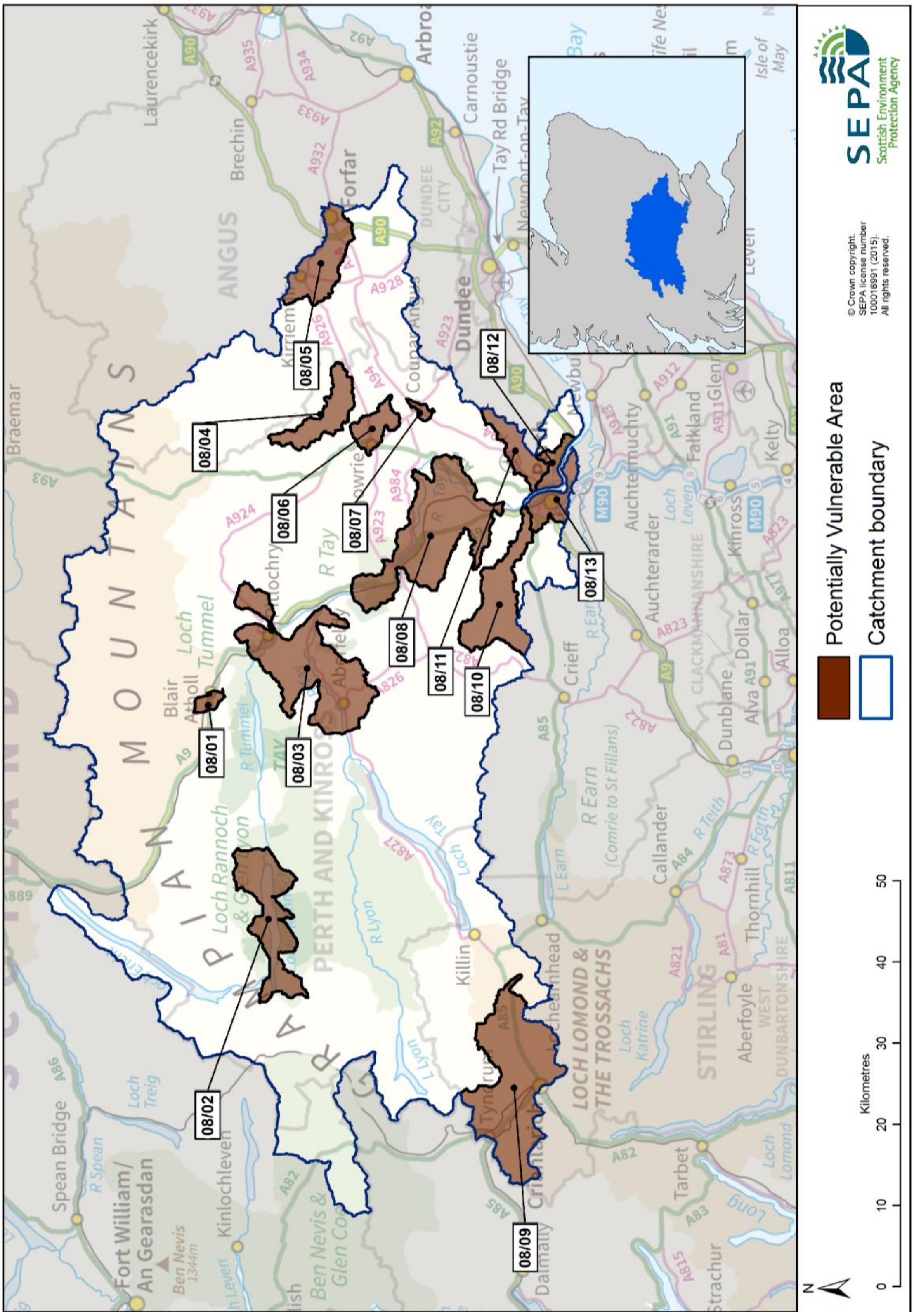

Figure 1: The River Tay catchment

Figure 2 shows the Annual Average Damages throughout the River Tay catchment. The highest damages can be seen south of Almondbank due to a high density of non-residential properties.

Table 2 shows further information about infrastructure and agricultural land at risk of flooding within this catchment.

	Number at risk	Further detail
Community facilities	10	Includes: educational buildings and emergency services
Utility assets	70	Includes: electricity substations and telephone exchanges
Roads (excluding minor roads)	32	1 M roads (M90) at 6 locations 15 A roads at 310 locations 16 B roads at 145 locations
Railway routes	4	Dundee to Dunblane (16 locations at risk) Glasgow Queen Street to Mallaig (9 locations at risk) Glasgow Queen Street to Oban (8 locations at risk) Perth to Inverness (50 locations at risk)
Agricultural land (km²)	153	

Table 2: Infrastructure and agricultural land at risk of river flooding

Designated environmental and cultural heritage sites at risk

Within the catchment it is estimated that 117 designated cultural heritage sites are at risk of river flooding. These sites include scheduled monuments, gardens and designed landscapes, battlefield sites and listed buildings.

It is estimated that 105 environmental designated areas are at risk of river flooding. These include 17 Special Areas of Conservation, 11 Special Protection Areas and 77 Sites of Special Scientific Interest. Amongst these sites are Ben Lawers, the Cairngorm Massif, Glen Etive and Glen Fyne and the Rannoch Lochs.

Part of the River Tay catchment lies within the boundary of the Loch Lomond and the Trossachs National Park and the Cairngorms National Park. The National Parks are recognised for the outstanding national importance of their natural and cultural heritage, and some of these features may be at risk of flooding.

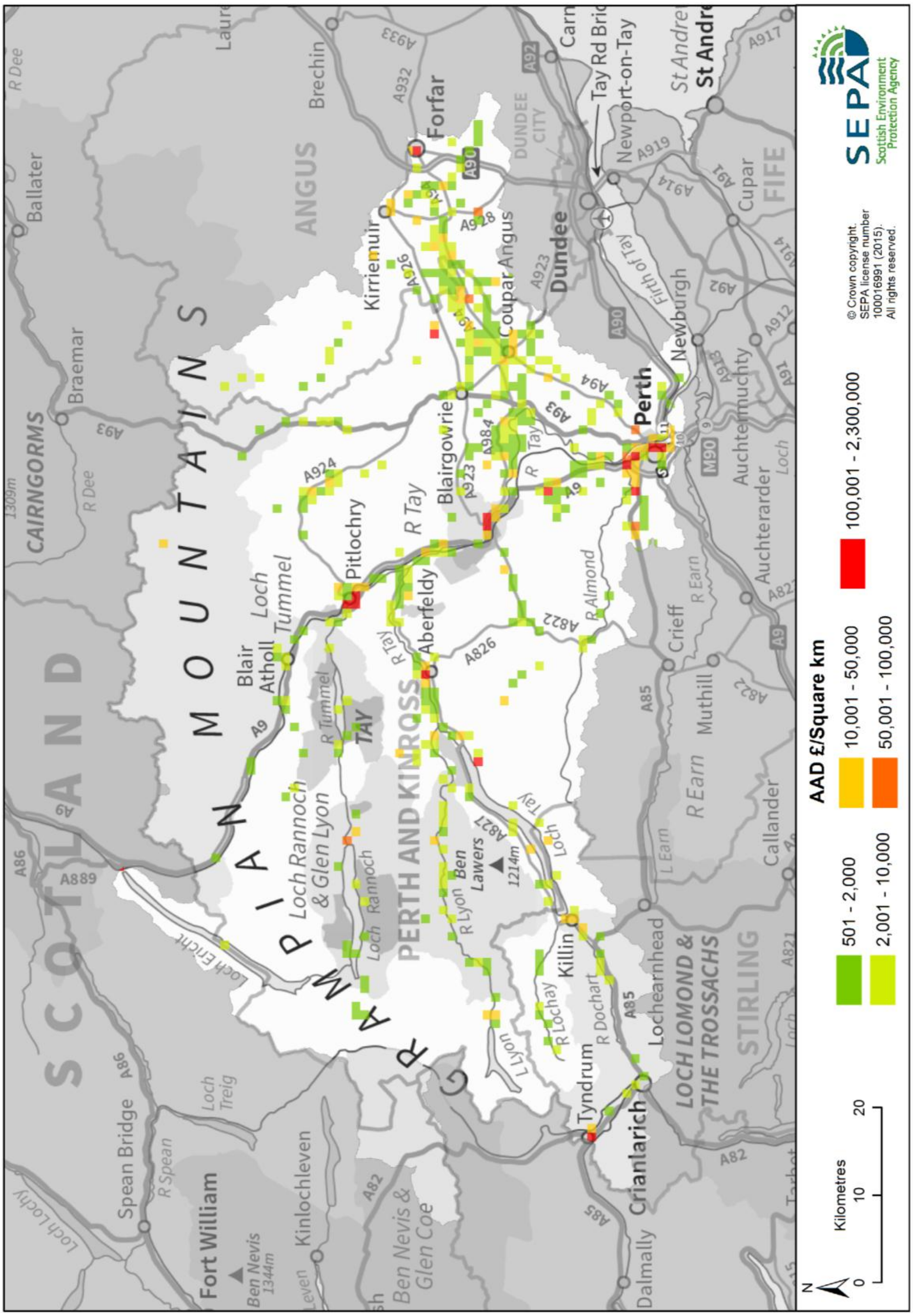

Figure 2: Annual Average Damages from river flooding

History of river flooding

The River Tay catchment has a long history of flooding. Areas often affected include Perth, Aberfeldy, Dunkeld and Pitlochry.

Perhaps the most significant River Tay flood is believed to have occurred in February 1814 where flood waters at Perth reached 7m above normal levels. Ice caused large blockages of bridges and widespread flooding to the Perth region. North and South Inch were submerged for two days.

A recent significant flood occurred on 13 December 2006 when the River Tay flooded numerous houses in Aberfeldy, Dunkeld, Logierait and Dalguise as well as isolated rural properties. The railway was also washed out at Dalguise.

More recently Alyth flooded after heavy rainfall on 17 July 2015 with over 50 properties in the Springbank Road area being evacuated. This rainfall event was widespread with properties in Prieston Road, Bankfoot also being flooded from the nearby Garry Burn.

The earliest flood on record occurred in October 1621 when the River Tay flooded after constant heavy rain over two days. There was an evacuation of numerous properties and severe damage to Milne’s Bridge. Perth was surrounded by water up to six days after the event.

Further detail about the history of flooding in this area is available in the relevant Potentially Vulnerable Area chapters.

Managing flood risk

A range of public bodies have responsibility for managing flood risk in Scotland and they are working closer than ever before to target action in the areas where the greatest benefit can be gained. Members of the public also have a role to play and are the first line of defence against flooding by taking action to protect themselves and their property from flooding. Further information about roles and responsibilities is provided in Section 1.

This section describes the existing actions that are in place to manage flood risk and are in addition to the information presented in the relevant Potentially Vulnerable Area chapters.

Flood protection schemes

There are three flood protection schemes in this catchment to reduce the risk of river flooding:

- Kirriemuir (Gairie Burn) Flood Prevention Scheme
- Perth Flood Prevention Scheme
- Weem Flood Prevention Scheme.

Almondbank Flood Protection Scheme is currently under construction and due to be completed in early 2017.

River flood warning schemes

There are 23 river flood warning areas within this catchment as shown in Table 3 and Figure 3. Table 3 shows the total number of properties in the flood warning area and the percentage of those properties that have signed up to receive flood warnings. Please note that this is not the number of properties at risk of flooding.

Flood warning area (FWA)	River	Number of properties within FWA	% of properties registered January 2014
Aberbothrie	River Isla	15	53%
Aberfeldy	River Tay	114	36%
Almondbank	River Almond	141	57%
Ballinluig to Logierait	River Tay	33	48%
Basement Properties from North Inch to Friarton Bridge	River Tay	3,773	5%
Blairgowrie to the River Isla	River Ericht	26	58%
Boat of Murthly	River Tay	2	50%
Bridge of Ruthven to Leitfie	River Isla	11	73%
Caputh to Kinclaven	River Tay	75	59%
Dalguise	River Tay	46	52%
Dunkeld and Burnmouth Road	River Tay	102	30%
Glen Lyon	River Tay	7	100%
Inveralmond Industrial Estate	River Almond	241	27%
Kemphill to Bridge of Isla	River Isla	4	100%
Kenmore	River Tay	46	39%
Logierait to Victoria Bridge	River Tay	12	100%
Moulinearn	River Tay	8	50%
North Muirton Industrial Estate to North Inch	River Almond	1,525	26%
Pitlochry to Ballinluig	River Tay	8	88%
Stanley Mills	River Tay	39	36%
The River Isla at Coupar Angus	River Isla	5	40%
The River Tummel in Pitlochry	River Tummel	144	41%
Upper Tay	River Tay	56	59%

Table 3: River flood warning areas

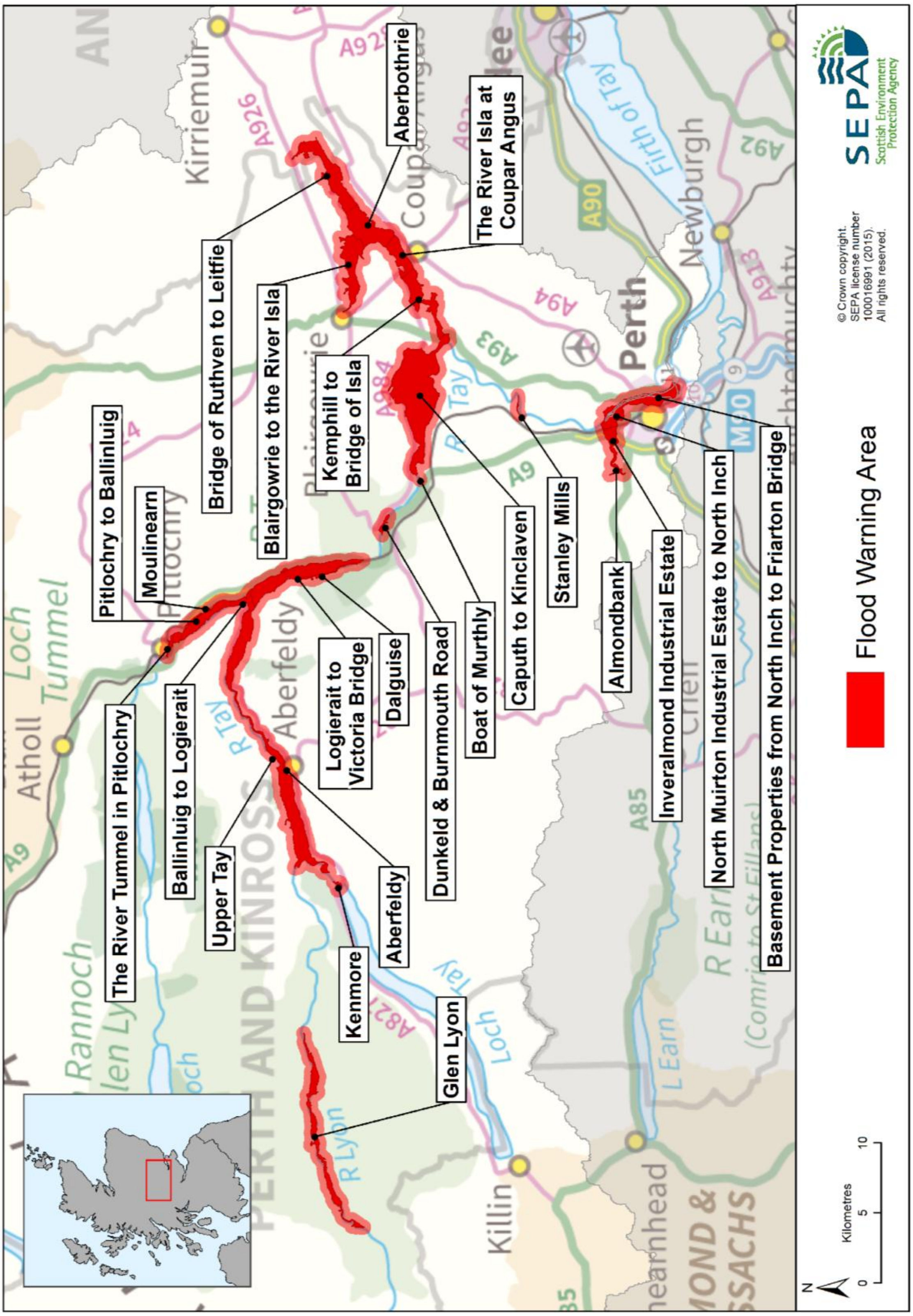

Figure 3: River flood warning areas

Community groups

The following community groups are known to operate within this catchment:

- Aberfeldy Resilience Group
- Perth Business Community Resilience Group.

Pitlochry, Blair Atholl and Kenmore are currently developing community resilience plans which consider flooding.

Property level protection

Each local authority has its own incentives or subsidies to help property owners with property level protection. Within the River Tay catchment, Perth and Kinross Council is piloting a project for flood protection products for properties in a number of flood risk areas.

Climate change and future flood risk

The UK Climate Projections (UKCP09) predicts that climate change may lead to warmer and drier summers, warmer and wetter winters with less snow, and more extreme temperature and rainfall. The predicted increase in rainfall and river flows may increase the potential for river flooding.

Under the UKCP09 high emissions scenario for 2080, average peak river flows for the River Tay catchment may increase by 35%[2]. This would potentially increase in the number of residential properties at risk of river flooding from approximately 1,400 to 3,600 and the number of non-residential properties from approximately 750 to 1,100.

The predicted increases in flood risk are solely based on the impact of a changing climate on the magnitude of flooding; they do not take into account any potential increase due to population change, development pressures or urban creep, nor do they take into account any mitigation as a result of actions contained in this or future Flood Risk Management Strategies.

Potential for natural flood management

The assessment of the potential for natural flood management is shown on SEPA's flood maps (http://www.sepa.org.uk/environment/water/flooding/flood-maps/). The maps indicate the potential for runoff reduction, floodplain storage and sediment management. They show areas where natural flood management could be effective and where further detailed assessment should take place. This information was used to identify where local authorities could include natural flood management as part of flood risk management schemes and studies. The proposed schemes and studies are listed in the relevant Potentially Vulnerable Area chapters of this document.

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[2] From the study 'An assessment of the vulnerability of Scotland's river catchments and coasts to the impacts of climate change' (CEH, 2011)

Natural flood management initiatives are already underway in this catchment:

- River Mashie Scoping Study
- Lindores Loch Environmental Improvement Actions Plan
- Tay Priority Catchment
- Lead Burn Drain Measurements.

Runoff reduction

In the River Tay catchment, potential for runoff reduction is located in the upper reaches of tributaries and smaller catchments, in particular the River Garry and the Loch Earn catchment. This may benefit the Aberfeldy and Pitlochry Potentially Vulnerable Area (08/03) and the Luncarty, Stanley, Bankfoot, Dunkeld and Birnam Potentially Vulnerable Area (08/08).

Floodplain storage

A number of potential floodplain storage areas have been identified in eastern parts of the River Tay catchment. Floodplain storage may in particular benefit the Potentially Vulnerable Areas that include Alyth (08/04), Forfar (08/05) and Scone (08/11). The Gairie Burn at Kirriemuir and the Annaty Burn upstream of Scone may warrant further consideration for floodplain storage or floodplain woodland planting.

Sediment management

Areas of high deposition and erosion have been identified across the River Tay catchment. This may be attributed to natural processes as well as man-made channel modifications. In the east of the catchment, some watercourses have been modified which may contribute to the high deposition, potentially warranting further investigation.

River flooding
River Earn catchment

Catchment overview

The River Earn catchment is 973km^2. The main watercourses are River Earn, Water of Ruchill, Machanay Water and River Farg.

The catchment headwaters are very steep rising to 985m at Ben Vorlich. Land use within the low lying areas is dominated by intensive agriculture, including arable and horticulture. Higher up the catchment, arable is replaced with pasture and improved /acid grasslands. In the upper parts of the catchment dominant land cover is coniferous woodland.

The average annual rainfall for this catchment is low to average for Scotland, with 800mm-1000mm falling in the lower part of the Earn catchment, rising to 1500mm-2000mm in the upper catchment.

Flood risk in the catchment

Within the River Earn catchment approximately 630 residential properties and 100 non-residential properties are at risk of river flooding. It is estimated that 89% of these properties are located within Potentially Vulnerable Areas. There are four Potentially Vulnerable Areas at risk of river flooding in this catchment (Figure 1):

- Comrie (08/14)
- Forteviot (08/15)
- Dunning (08/16)
- Bridge of Earn (08/17).

Main areas at risk

The main areas at risk of river flooding can be seen in Table 1. The table shows the number of properties at risk and the Annual Average Damages caused by river flooding. This includes damages to residential and non-residential properties, transport and agriculture.

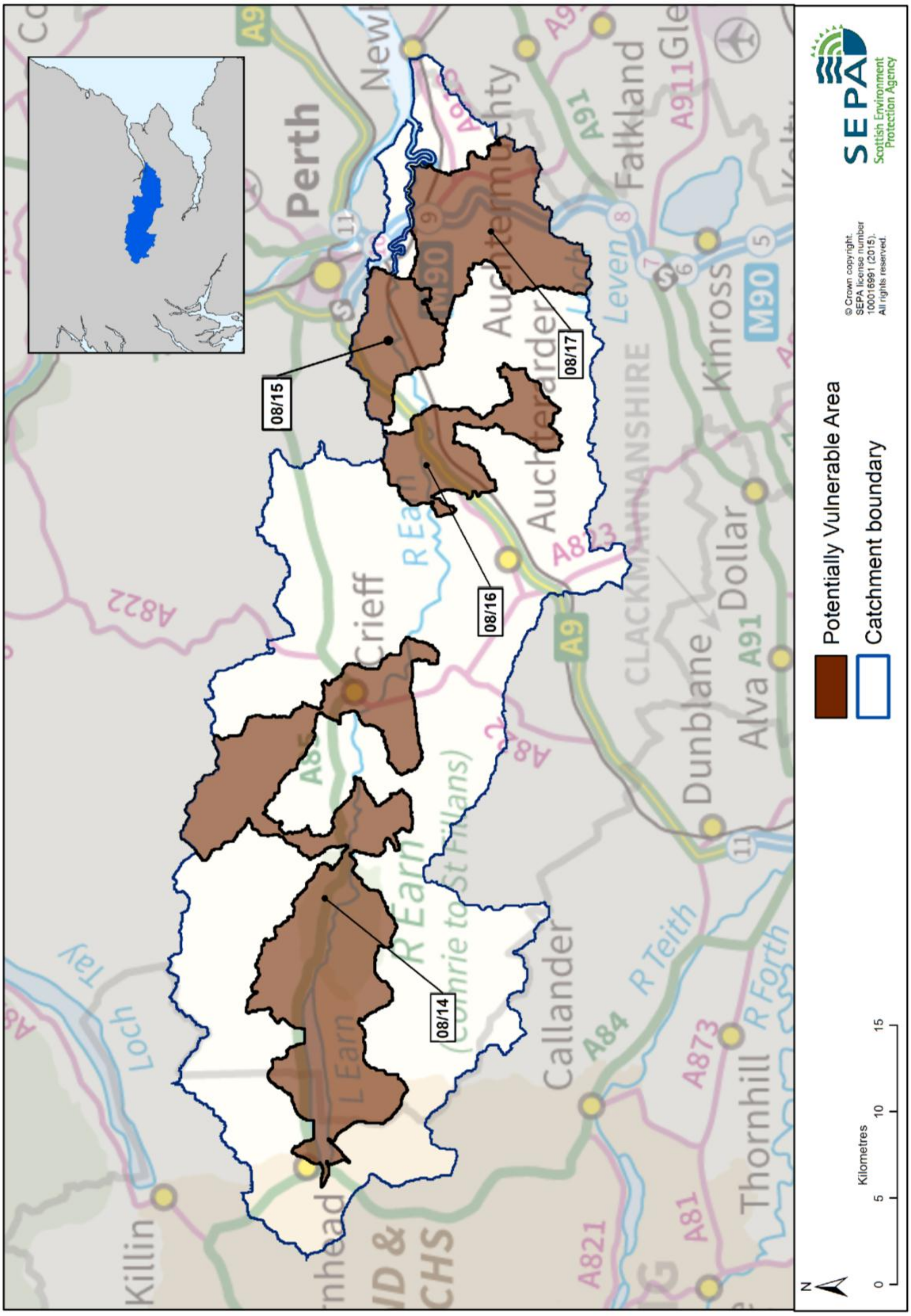

Figure 1: The River Earn catchment

	Residential and non-residential properties at risk of river flooding	Annual Average Damages
Comrie	410	£1.1 million
St Fillans	50	£310,000
Dunning	40	£100,000
Bridge of Earn	40	£240,000
Crieff	20	£22,000
Lochearnhead	10	£100,000
Auchterarder	<10	£17,000

Table 1: Main areas at risk of river flooding

Economic activity and infrastructure at risk

The Annual Average Damages caused by river flooding in the River Earn catchment are approximately £2.8 million. The damages are distributed as follows:

- 65% residential properties (£1.8 million)
- 17% non-residential properties (£480,000)
- 8% emergency services (£210,000)
- 4% roads (£120,000)
- 4% agriculture (£100,000)
- 2% vehicles (£70,000).

Figure 2 shows the Annual Average Damages from river flooding throughout the catchment. The highest damages can be seen around Comrie due to the high density of residential properties at risk of flooding from the River Earn.

Table 2 shows further information about infrastructure and agricultural land at risk of flooding within this catchment.

	Number at risk	Further detail
Community facilities	<10	Includes: educational buildings, healthcare facilities and emergency services
Utility assets	10	Includes: electricity substations and telephone exchanges
Roads (excluding minor roads)	16	1 M road (M90) at 8 locations 8 A roads at 101 locations 7 B roads at 29 locations
Railway routes	2	Dundee to Dunblane (14 locations at risk) Perth to Thornton junctions (6 locations at risk)
Agricultural land (km²)	42.2	

Table 2: Infrastructure and agricultural land at risk of river flooding

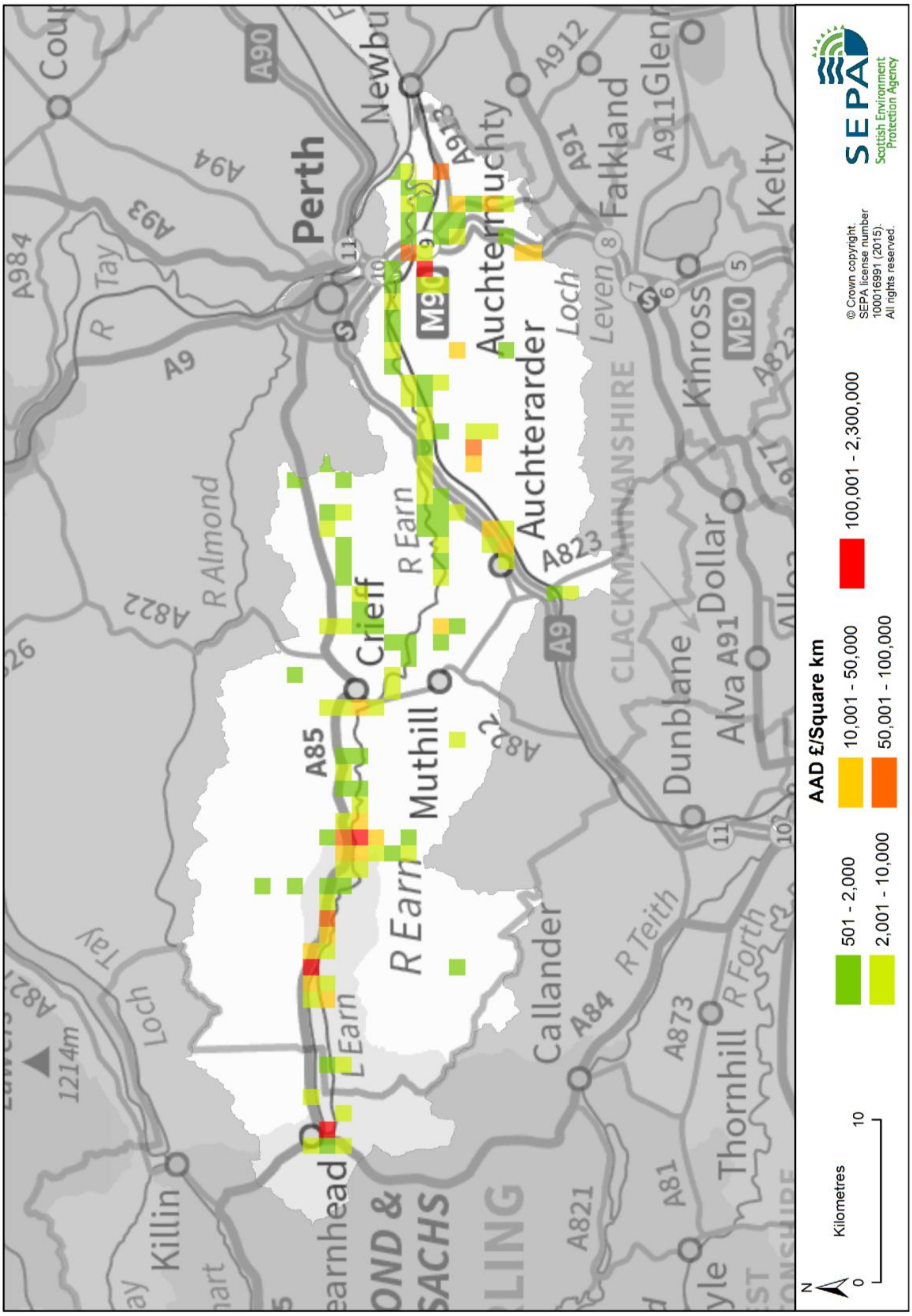

Figure 2: Annual Average Damages from river flooding

Designated environmental and cultural heritage sites at risk

Within the catchment there are approximately 36 designated cultural heritage sites at risk of river flooding. These sites include scheduled monuments, gardens and designed landscapes, battlefield sites and listed buildings.

Approximately 19 environmental designated areas have a risk of river flooding. This includes three Special Areas of Conservation, a Special Protection Area and 15 Sites of Special Scientific Interest. This includes South Tayside Goose Roosts, Methven Moss and Upper Strathearn Oakwoods.

Part of the River Earn catchment lies within the boundary of the Loch Lomond and the Trossachs National Park. The National Park is recognised for the outstanding national importance of its natural and cultural heritage and some of these features may be at risk of flooding.

History of river flooding

The River Earn catchment has a long history of flooding. The most frequent floods have been recorded in the towns of Dalginross and Comrie.

The highest river level recorded at the SEPA's Dalginross gauging station on the River Earn was in January 1993, where the river levels reached 3.58m. This flood was perhaps the biggest on record in this catchment with hundreds of properties flooded in Perth and Kinross and the surrounding areas. The flood caused over £20 million of damage.

A recent flood recorded in the River Earn catchment occurred on 19 November 2012 when around 150 properties flooded in Dalginross from the Water of Ruchill and 200 people were evacuated from their homes. This followed a flood on 27 August 2012 when around 60 properties flooded in the same location.

The earliest flood on record dates back to 17 March 1903 when a large stretch of embankment was washed away by flooding at New Comrie, seriously affecting railway infrastructure and causing major disruption to traffic.

Further detail about the history of flooding in this area is available in the relevant Potentially Vulnerable Area chapters.

Managing flood risk

A range of public bodies have responsibility for managing flood risk in Scotland and they are working closer than ever before to target action in the areas where the greatest benefit can be gained. Members of the public also have a role to play and are the first line of defence against flooding by taking action to protect themselves and their property from flooding. Further information about roles and responsibilities is provided in Section 1.

This section describes the existing actions that are in place to manage flood risk and are in addition to the information presented in the relevant Potentially Vulnerable Area chapters.

Flood protection schemes

There are two flood protection schemes that reduce the risk of river flooding:

- Bridge of Earn Flood Protection Scheme
- Water of Ruchill Flood Protection Scheme.

River flood warning schemes

There are six river flood warning areas within this catchment as shown in Table 3 and Figure 3. Table 3 shows the total number of properties in the flood warning area and the percentage of those properties that have signed up to receive flood warnings. Please note that this is not the number of properties at risk of flooding.

Flood warning area (FWA)	River	Number of properties within FWA	% of properties registered July 2014
Bridge of Earn	River Earn	238	36%
Bridge of Earn to the River Tay	River Earn	30	77%
Carse of Lennoch to Lochlane	River Earn	7	100%
Comrie	River Earn and Water of Ruchill	551	35%
Crieff to Innerpeffray	River Earn	73	40%
Innerpeffray to Bridge of Earn	River Earn	27	96%

Table 3: River flood warning areas

Awareness raising campaigns and community groups

Comrie Resilience Group is active within this catchment. The community in Glenfarg is also developing a community resilience plan which will consider flooding.

Property level protection

Each local authority has its own incentives or subsidies to help property owners with property level protection. Perth and Kinross Council is piloting a project for flood protection products for properties in a number of flood risk areas.

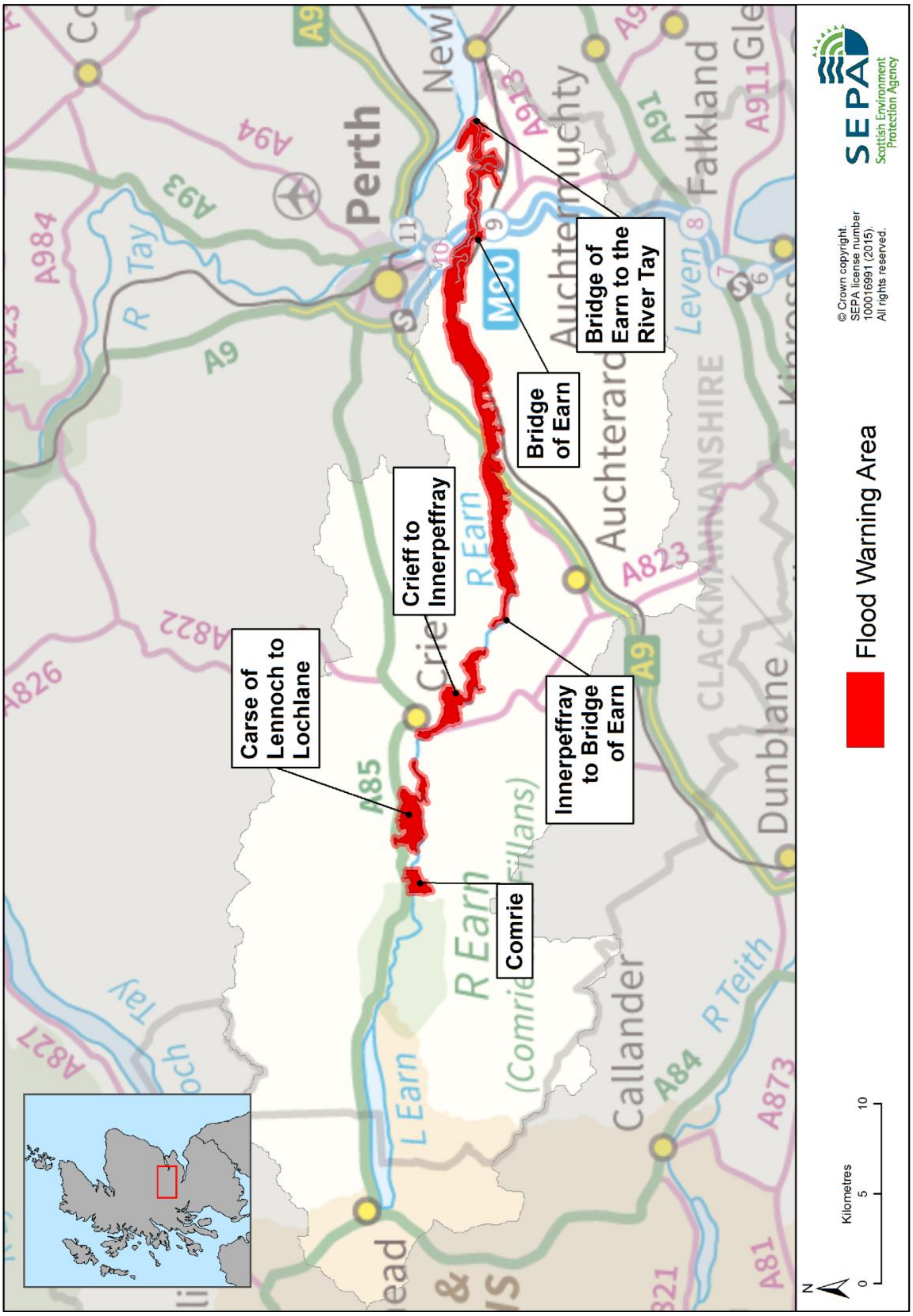

Figure 3: Flood warning areas

Climate change and future flood risk

The UK Climate Projections (UKCP09) predicts that climate change may lead to warmer and drier summers, warmer and wetter winters with less snow, and more extreme temperature and rainfall. The predicted increase in rainfall and river flows may increase the potential for river flooding.

Under the UKCP09 high emissions scenario for 2080, average peak river flows for the River Earn catchment may increase by 35%[1]. This would potentially increase in the number of residential properties at risk of river flooding from approximately 630 to 1,100 and the number of non-residential properties from approximately 100 to 150.

The predicted increases in flood risk are solely based on the impact of a changing climate on the magnitude of flooding; they do not take into account any potential increase due to population change, development pressures or urban creep, nor do they take into account any mitigation as a result of actions contained in this or future Flood Risk Management Strategies.

Potential for natural flood management

The assessment of the potential for natural flood management is shown on SEPA's flood maps (http://www.sepa.org.uk/environment/water/flooding/flood-maps/). The maps indicate the potential for runoff reduction, floodplain storage and sediment management. They show areas where natural flood management could be effective and where further detailed assessment should take place. This information was used to identify where local authorities could include natural flood management as part of flood risk management schemes and studies. The proposed schemes and studies are listed in the relevant Potentially Vulnerable Area chapters.

Runoff reduction

The highest potential for runoff reduction is located in the west and the north parts of the catchment. Actions to reduce runoff may benefit Comrie Potentially Vulnerable Area (08/14).

Floodplain storage

The River Earn catchment shows good potential for floodplain storage with areas identified along the whole length of the catchment. In particular it is worth noting the storage potential upstream of Comrie Potentially Vulnerable Area (08/14). Loch Earn, the Pow Water and the surrounding area also have good potential for floodplain storage.

Sediment management

Areas of erosion and deposition occur along the entire length of the River Earn. Much of this will be attributable to natural processes. However, some reaches of the river Earn and its tributaries have been modified by human activity and show high erosion and deposition. These reaches may benefit from natural flood management actions to manage sedimentation, such as improvement of bankside vegetation.

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[1] An assessment of the vulnerability of Scotland's river catchments and coasts to the impacts of climate change (CEH, 2011)

3.3 Coastal flooding

Tay Local Plan District

This chapter provides supplementary information on flooding for coastal areas. It provides an overview of the natural characteristics of the coast, a summary of flood risk within the coastal area and a brief history of flooding. It also outlines the likely impact of climate change and the potential for natural flood management.

Information about the objectives and actions to manage flood risk are provided in Section 2.

Coastal overview

The coastal area of the Tay Local Plan District is around 74km in length. It incorporates the lower reaches of the River Tay and River Earn and includes the inner Firth of Tay.

The main area affected by coastal flooding is the city of Perth where the River Tay and the River Earn meet the Tay Estuary.

The interaction between coastal and river flooding is important in this area. Coastal flooding along the inner Firth of Tay is less influenced by waves due to the sheltering effects of the estuary but is still influenced by storm surges.

Flood risk

Within the Tay Local Plan District approximately 190 residential properties and 70 non-residential properties are at risk of coastal flooding. It is estimated that 97% of these properties are located within Potentially Vulnerable Areas. There are four Potentially Vulnerable Areas in this Local Plan District that are a risk of coastal flooding (Figure 1):

- Perth to Kinfauns (08/12)
- Perth centre (08/13)
- Forteviot (08/15)
- Bridge of Earn (08/17).

Main areas at risk

Perth is the main area that has been identified at risk of coastal flooding, where approximately 230 residential and non-residential properties are at risk of coastal flooding with Annual Average Damages estimated at £350,000. This includes damages to residential and non-residential properties, transport and agriculture.

Figure 2 shows the distribution of Annual Average Damages throughout this Local Plan District.

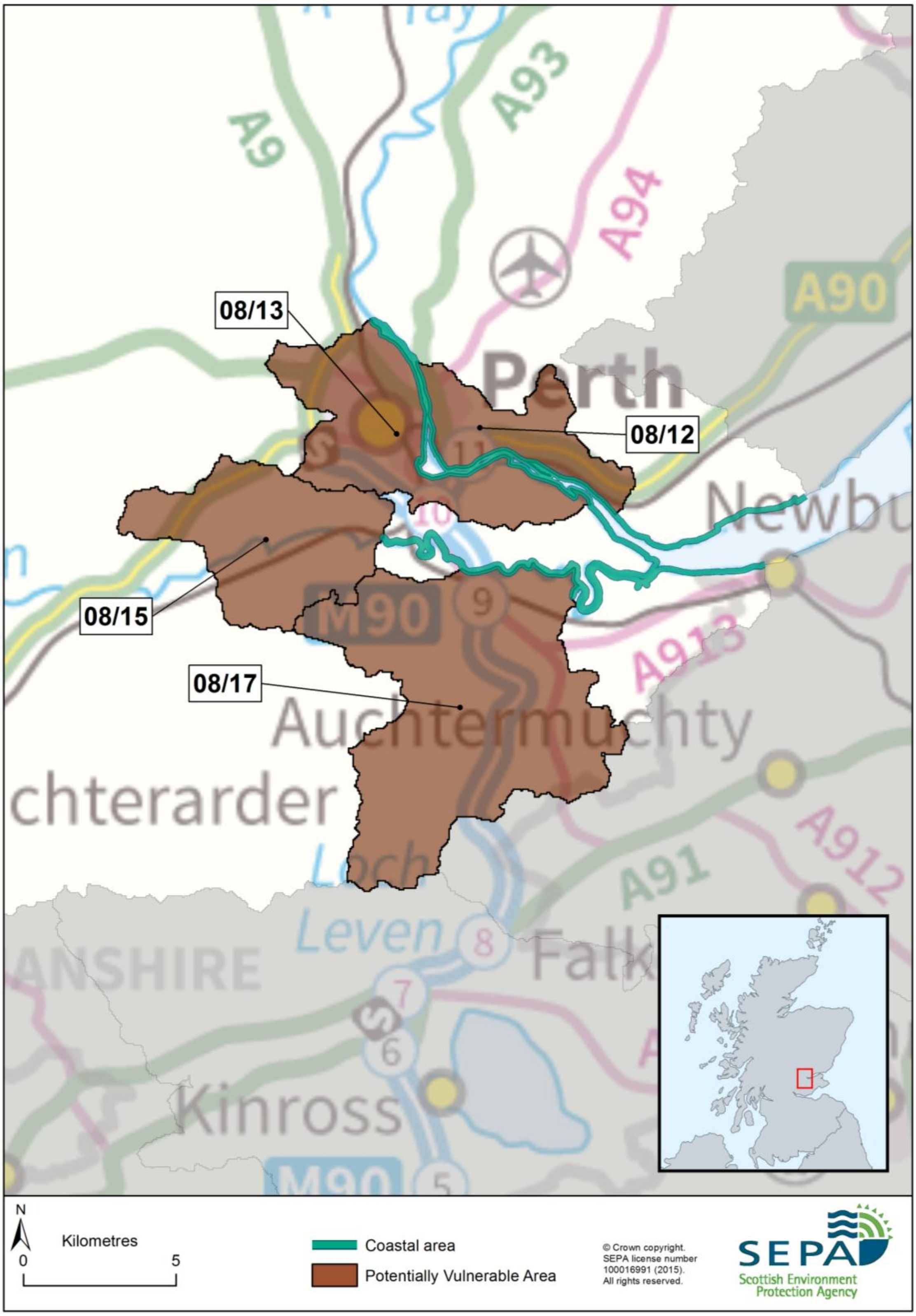

Figure 1: Tay Local Plan District coastal area and Potentially Vulnerable Areas with a coastal flood risk

Economic activity and infrastructure at risk

The Annual Average Damages caused by coastal flooding across the whole Tay coastal area are approximately £550,000. The damages are distributed as follows:

- 42% non-residential properties (£230,000)
- 40% residential properties (£220,000)
- 7% roads (£42,000)
- 6% emergency services (£32,000)
- 4% agriculture (£20,000)
- 1% vehicles (£6,000).

Figure 2 shows the Annual Average Damages throughout the coastal area. The highest damages can be seen to residential properties in Perth. This is followed by damages to industrial units along the southern bank of the estuary of Perth and around Perth Harbour.

Table 1 shows further information about infrastructure and agricultural land at risk of coastal flooding.

	Number at risk	Further detail
Community facilities	<10	Includes educational buildings
Utility assets	<10	Includes electricity substations
Roads (excluding minor roads)	6	1 M road (M90) at 10 locations 5 A roads at 17 locations
Railway routes	2	Perth to Ladybank (2 locations at risk) Dundee to Dunblane (16 locations at risk)
Agricultural land (km²)	6.9	

Table 1: Infrastructure and agricultural land at risk of coastal flooding

Designated environmental and cultural heritage sites at risk

Within the catchment it is estimated there are approximately eight designated cultural heritage sites at risk of river flooding. These sites include scheduled monuments, battlefield sites and listed buildings.

It is estimated that five environmental designated areas are at risk of coastal flooding. These include two Special Areas of Conservation, one Special Protection Area and two Sites of Special Scientific Interest, notably the Firth of Tay and Eden Estuary.

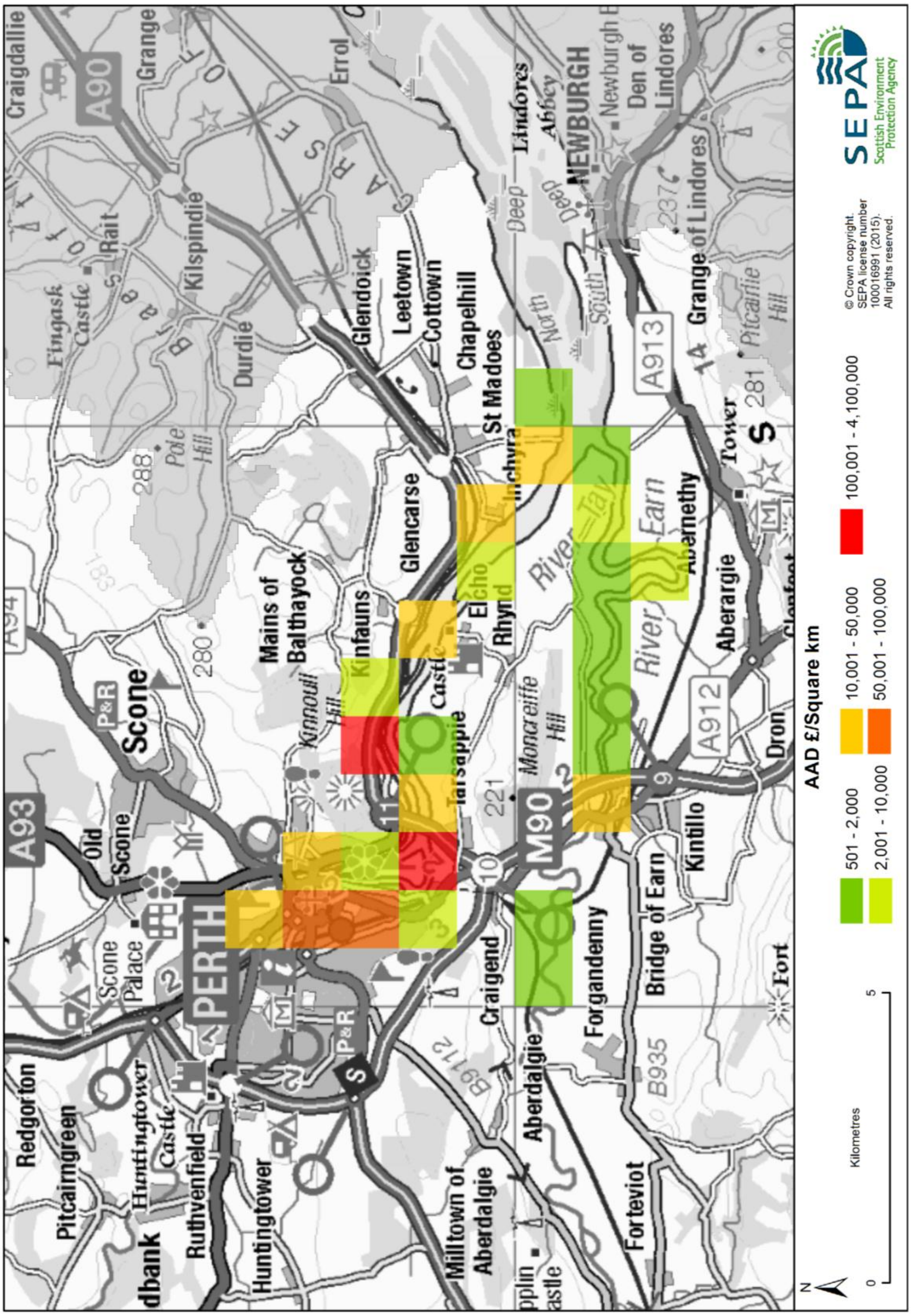

Figure 2: Annual Average Damages from coastal flooding

History of coastal flooding

No significant coastal floods have been identified in the Inner Tay Estuary. However, a number of river flooding events have occurred which may have had tidal influences. Further detail is available in the relevant Potentially Vulnerable Area chapters in Section 2.

Managing flood risk

A range of public bodies have responsibility for managing flood risk in Scotland and they are working closer than ever before to target action in the areas where the greatest benefit can be gained. Members of the public also have a role to play and are the first line of defence against flooding by taking action to protect themselves and their property from flooding. Further information about roles and responsibilities is provided in Section 1.

This section describes the existing actions that are in place to manage flood risk and are in addition to the information presented in the relevant Potentially Vulnerable Area chapters.

Flood protection schemes

There are no formal coastal flood protection schemes in this area. However, the Perth Flood Protection Scheme and the Bridge of Earn Flood Protection Scheme may contain elements that reduce the risk of coastal flooding.

Coastal flood warning schemes

There are no coastal flood warning areas in this area but river flood warning areas around Perth take into account coastal and tidal data.

Community groups

The following community groups are known to operate within this coastal area:

- Carse of Gowrie Sustainability Group
- Perth Business Community Resilience Group.

Perth and Kinross Council is part of a wider community resilience group which works with various communities in its local authority area.

Property level protection

Each local authority has its own incentives or subsidies to help property owners with property level protection:

- Fife Council installed flood pods, which contain flood protection products, close to areas containing properties at risk of flooding.

Climate change and future flood risk

UK Climate Projections (UKCP09) predicts that climate change may increase sea levels. The magnitude of sea level rise varies around the coastline.

For the UKCP09 high emissions scenario, the predicted average sea level increase for the inner Firth of Tay is 0.48m by 2080. This may increase the number of residential properties at risk from coastal flooding from approximately 190 to 460 and the number of non-residential from approximately 70 to 260. Coastal flood modelling by SEPA has not taken into account the impacts of a future climate on wave overtopping or storminess, which could increase the number of people affected by coastal flooding.

The predicted increases in flood risk are solely based on the impact of a changing climate on the magnitude of flooding; they do not take into account any potential increase due to population change, development pressures or urban creep, nor do they take into account any mitigation as a result of actions contained in this or future Flood Risk Management Strategies.

Potential for natural flood management

The assessment of the potential for natural flood management is shown on SEPA’s flood maps (http://www.sepa.org.uk/environment/water/flooding/flood-maps/). The maps indicate the potential for wave attenuation and estuarine surge attenuation. They show areas where natural flood management could be effective and where further detailed assessment should take place.

This information was used to identify where local authorities could include natural flood management as part of flood risk management schemes and studies. The proposed schemes and studies are listed in the relevant Potentially Vulnerable Area chapters in Section 2 of this document.

Wave energy

In the Tay Local Plan District there are sites with medium potential for estuarine surge attenuation located at the mouth of the River Earn. However, these sites are mostly located outside Potentially Vulnerable Areas.

3.4 Surface water flooding

Tay Local Plan District

This chapter provides supplementary information on surface water flooding across the Local Plan District. It provides an overview of the main areas at risk and the history of surface water flooding. The predicted impacts on infrastructure are also identified. The impacts on environmental sites and agricultural land have not been assessed.

Information about the objectives and actions to manage flood risk are provided in Section 2.

Flood risk

Within the Tay Local Plan District approximately 380 residential properties and 560 non-residential properties are at risk of surface water flooding. It is estimated that 87% of these properties are located within Potentially Vulnerable Areas.

Main areas at risk

The main areas at risk of surface water flooding can be seen in Table 1, which shows the number of properties at risk and the Annual Average Damages caused by surface water flooding. The damages include impacts to residential and non-residential properties, vehicles, emergency services and roads.

	Residential and non-residential properties at risk of surface water flooding	Annual Average Damages
Perth	270	£300,000
Forfar	120	£160,000
Blairgowrie	90	£86,000
Scone	60	£110,000
Comrie	40	£53,000
Crieff	20	£30,000
Kirriemuir	10	£29,000

Table 1: Main areas at risk of surface water flooding

Economic activity and infrastructure at risk

The Annual Average Damages caused by surface water flooding in the Tay Local Plan District are approximately £1.9 million. The damages are distributed as follows:

- 44% roads (£810,000)
- 34% non-residential properties (£640,000)
- 19% residential properties (£345,000)
- 3% emergency services (£55,000)
- 1% vehicles (£6,000).

Of the economic damages assessed, the highest proportion is from damages to roads, with the A90 and A9 particularly affected. Figure 1 shows the distribution of Annual Average Damages throughout the Tay Local Plan District. The highest damages can be seen around Perth due to the higher number of residential properties, commercial properties and community facilities.

Table 2 shows the approximate numbers of further infrastructure assets which are at risk of flooding within this catchment.

	Number at risk	Further detail
Community facilities	<10	Includes: educational buildings and emergency services
Utility assets	50	Includes: electricity substations, fuel extraction sites and telephone exchanges
Roads (excluding minor roads)	50	1 M road (M90) at 30 locations 21 A roads at 560 locations 28 B roads at 210 locations
Railway routes	5	Dundee to Dunblane (40 locations at risk) Glasgow Queen Street to Mallaig (10 locations at risk) Glasgow Queen Street to Oban (10 locations at risk) Perth to Inverness (80 locations at risk)

Table 2: Infrastructure at risk of surface water flooding

Designated environmental and cultural heritage sites at risk

Within the Local Plan District it is estimated that approximately 135 designated cultural heritage sites are at risk of surface water flooding. These sites include scheduled monuments, gardens and designed landscapes, battlefield sites and listed buildings.

The impact of surface water flooding on environmental sites has not been assessed and is assumed to be relatively low.

History of surface water flooding

Two surface water flood events have been recorded as significant in this Local Plan District.

Heavy rain caused surface water flooding in Perth on 16 July 2011, with homes and businesses affected. Extensive surface water flooding around Perth on 21 July 2010 affected properties and roads.

Further detail about the history of flooding is available in the relevant Potentially Vulnerable Area chapters in Section 2.

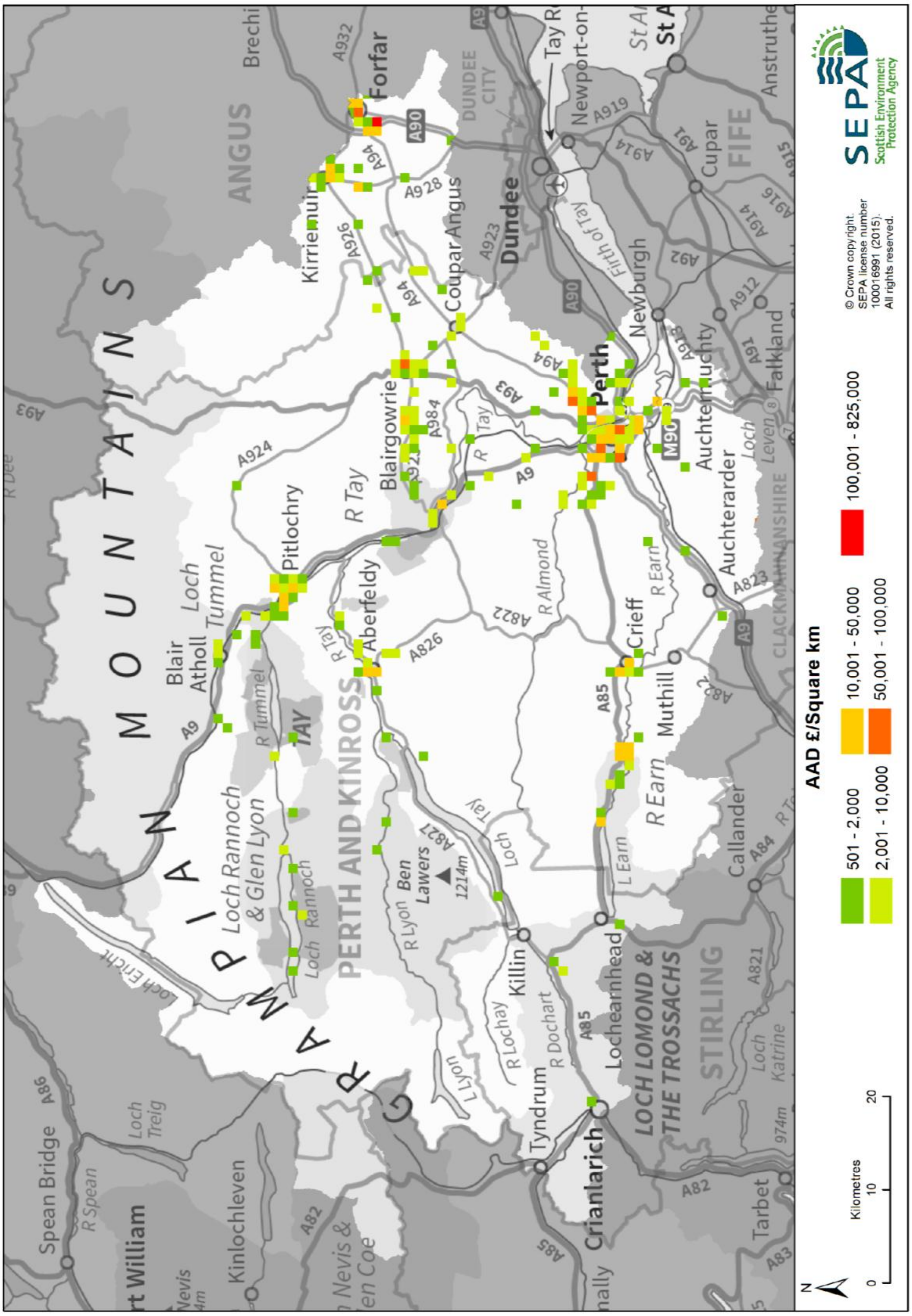

Figure 1: Average Annual Damages from surface water flooding

Managing flood risk

Surface water management priority areas

The areas at highest risk from surface water flooding have been prioritised. These priority areas were identified using SEPA flood models, supplemented with historical flood information and, where available, more detailed modelling from local authorities. These priority areas require the preparation of surface water management plans, the details of which can be found in Section 2.

A range of public bodies have responsibility for managing flood risk in Scotland and they are working closer than ever before to target action in the areas where the greatest benefit can be gained. Members of the public also have a role to play and are the first line of defence against flooding by taking action to protect themselves and their property from flooding. Further information about roles and responsibilities is provided in Section 1.

Flood protection schemes

There are three formal flood protection schemes which have aspects that contribute to the management of surface water flooding in the Local Plan District:

- Perth Flood Protection Scheme;
- Weem Flood Protection Scheme;
- Kirriemuir Flood Protection Scheme.

Community groups

The following community groups are also known to operate within the Tay Local Plan District:

- Aberfeldy Resilience Group;
- Comrie Resilience Group;
- Perth Business Community Resilience Group;
- Pitlochry, Blair Atholl, Glenfarg and Kenmore are at different stages of developing community resilience plans, which include flooding;
- Perth and Kinross Council is also part of a wider community resilience group which works with various communities within the local authority area.

Property level protection

Each local authority has its own incentives or subsidies to help property owners with property level protection. In this Local Plan District:

- Fife Council provides Aquasacs for use in emergencies and these area available from stores throughout Fife;
- Perth and Kinross Council is currently working towards introducing a pilot project for flood protection products for properties in a number of flood risk areas.

Climate change and future flood risk

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

Under these conditions it is estimated that the number of residential properties at risk of surface water flooding may increase from approximately 390 to 550 and the number of non-residential properties from approximately 560 to 710.

The predicted increases in flood risk are solely based on the impact of a changing climate on the magnitude of flooding; they do not take into account any potential increase due to population change, development pressures or urban creep, nor do they take into account any mitigation as a result of actions contained in this or future Flood Risk Management Strategies.