

# Flood Risk Management Strategy

## Tay Estuary and Montrose Basin 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 .....	245
3.2	River flooding .....	246
	• River North Esk catchment .....	247
	• River South Esk catchment .....	256
	• Firth of Tay catchment group.....	264
	• Kincardine and Angus catchment group.....	271
3.3	Coastal flooding.....	279
3.4	Surface water flooding.....	288

## 3.1 Introduction

In the Tay Estuary and Montrose Basin Local Plan District, river flooding is reported across four 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 <sup>1</sup>	Annual Average Damages	Local authority
<b>River catchments</b>			
River North Esk catchment	170	£560,000	Aberdeenshire Council Angus Council Perth and Kinross Council
River South Esk catchment	230	£810,000	Angus Council Perth and Kinross Council
Firth of Tay catchment group	1,500	£4.0 million	Dundee City Council Fife Council Perth and Kinross Council
Kincardine and Angus catchment group	370	£1.1 million	Aberdeenshire Council Angus Council
<b>Coastal flooding</b>			
Tay Estuary and Montrose Basin coastal area	1,700	£5.3 million	Aberdeenshire Council Angus Council Dundee City Council Fife Council
<b>Surface water flooding</b>			
Tay Estuary and Montrose Basin Local Plan District	2,000	£4.3 million	Aberdeenshire Council Angus Council Dundee City Council Fife Council Perth and Kinross Council

**Table 1:** Summary of flood risk from various sources within the Tay Estuary and Montrose Basin Local Plan District

<sup>1</sup> Total number of residential and non-residential properties at risk of flooding.

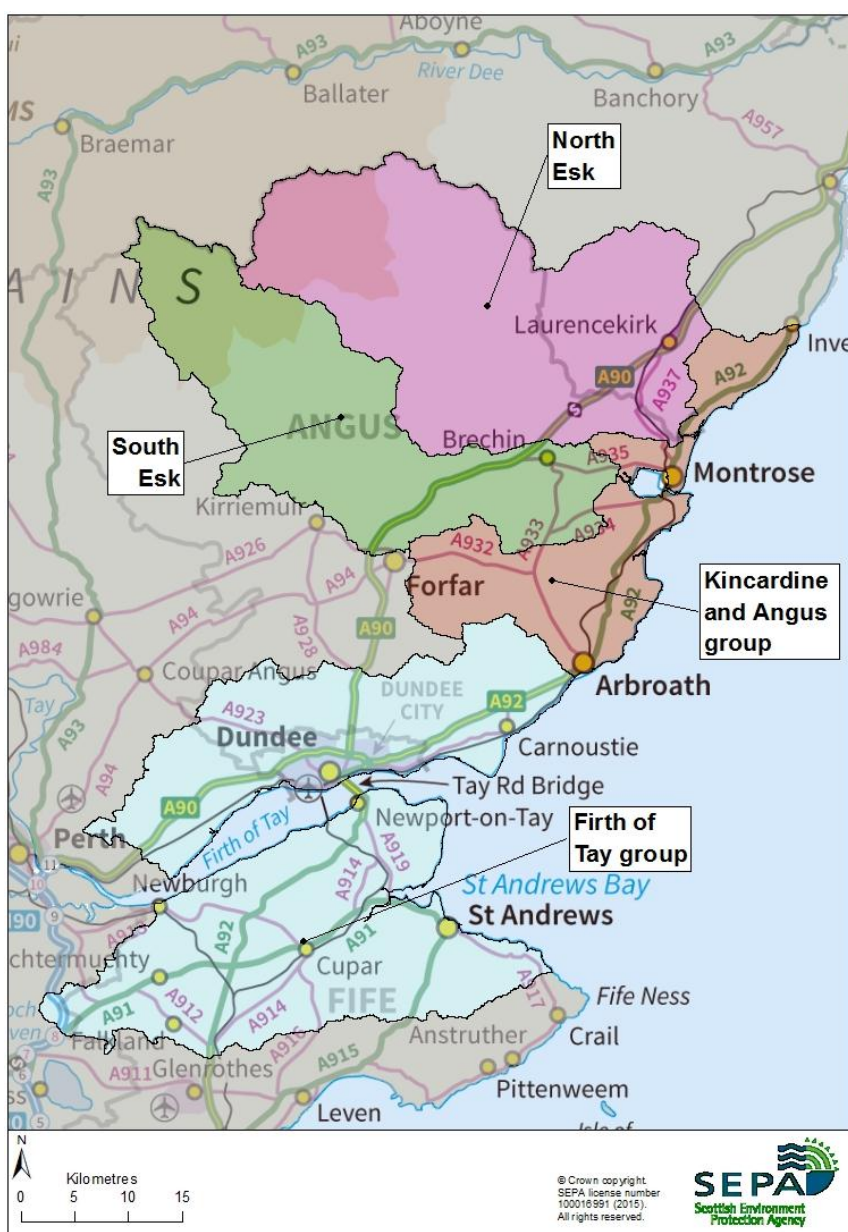
## 3.2 River flooding

### Tay Estuary and Montrose Basin 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 Estuary and Montrose Basin Local Plan District, river flooding is reported across four distinct river catchments, shown below.



## River flooding River North Esk catchment

### Catchment overview

The River North Esk catchment covers an area of 765km<sup>2</sup>. The main watercourses include the River North Esk, Luther Water and West Water. The catchment is mainly rural but also contains some dispersed urban centres including Laurencekirk and Fettercairn.

The Highland boundary fault cuts across the catchment from Kirkton of Menmuir in the west to Auchenblae in the east. The fault line marks distinct differences in topography, rainfall and land use.

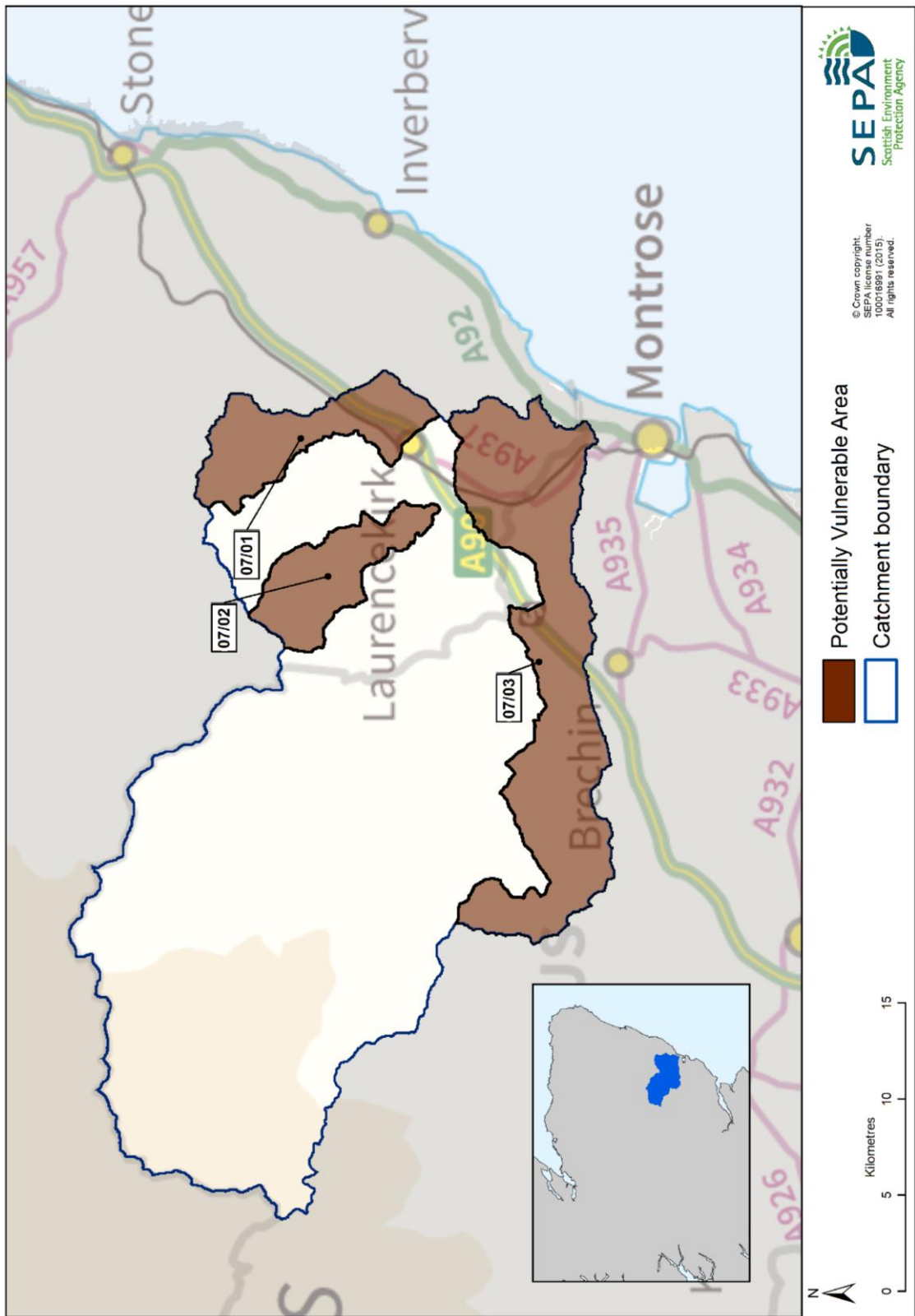
North of the Highland boundary fault the catchment is steep and upland in nature, rising to its highest point of 939m in its headwaters at Mount Keen. Rainfall is higher in the headwaters of the catchment with the average annual rainfall between 1000-1250mm. The land cover includes montane habitats, heather and heather grassland.

To the south of the Highland fault the catchment is more lowland in nature, featuring gentle slopes. In the lower reaches of the catchment rainfall is lower with average annual rainfall between 600-700mm. The catchment is more lowland in nature and the land cover is largely arable with more settlements.

### Flood risk in the catchment

Within the River North Esk catchment approximately 110 residential and 60 non-residential properties are at risk of river flooding. It is estimated that 67% of these properties are located within Potentially Vulnerable Areas. There are three Potentially Vulnerable Areas at risk of river flooding in this catchment (Figure 1):

- Laurencekirk (07/01)
- Fettercairn (07/02)
- North of Brechin (07/03).



**Figure 1:** The River North Esk catchment and Potentially Vulnerable Areas with a risk of river flooding

## Main areas at risk

The main areas at risk of river flooding, the number of properties at risk and the total Annual Average Damages caused by river flooding are shown in Table 1. The Annual Average Damages include damages to residential and non-residential properties, transport, emergency services and agriculture.

	Residential and non-residential properties at risk of river flooding	Annual Average Damages
Fettercairn	50	£100,000
Auchenblae	10	£89,000
Edzell	10	£1,000 <sup>1</sup>

**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 North Esk catchment are approximately £560,000. The damages are distributed as follows:

- 61% residential properties (£340,000)
- 14% agriculture (£80,000)
- 11% non-residential properties (£60,000)
- 7% emergency services (£40,000)
- 5% roads (£30,000)
- 2% vehicles (£10,000).

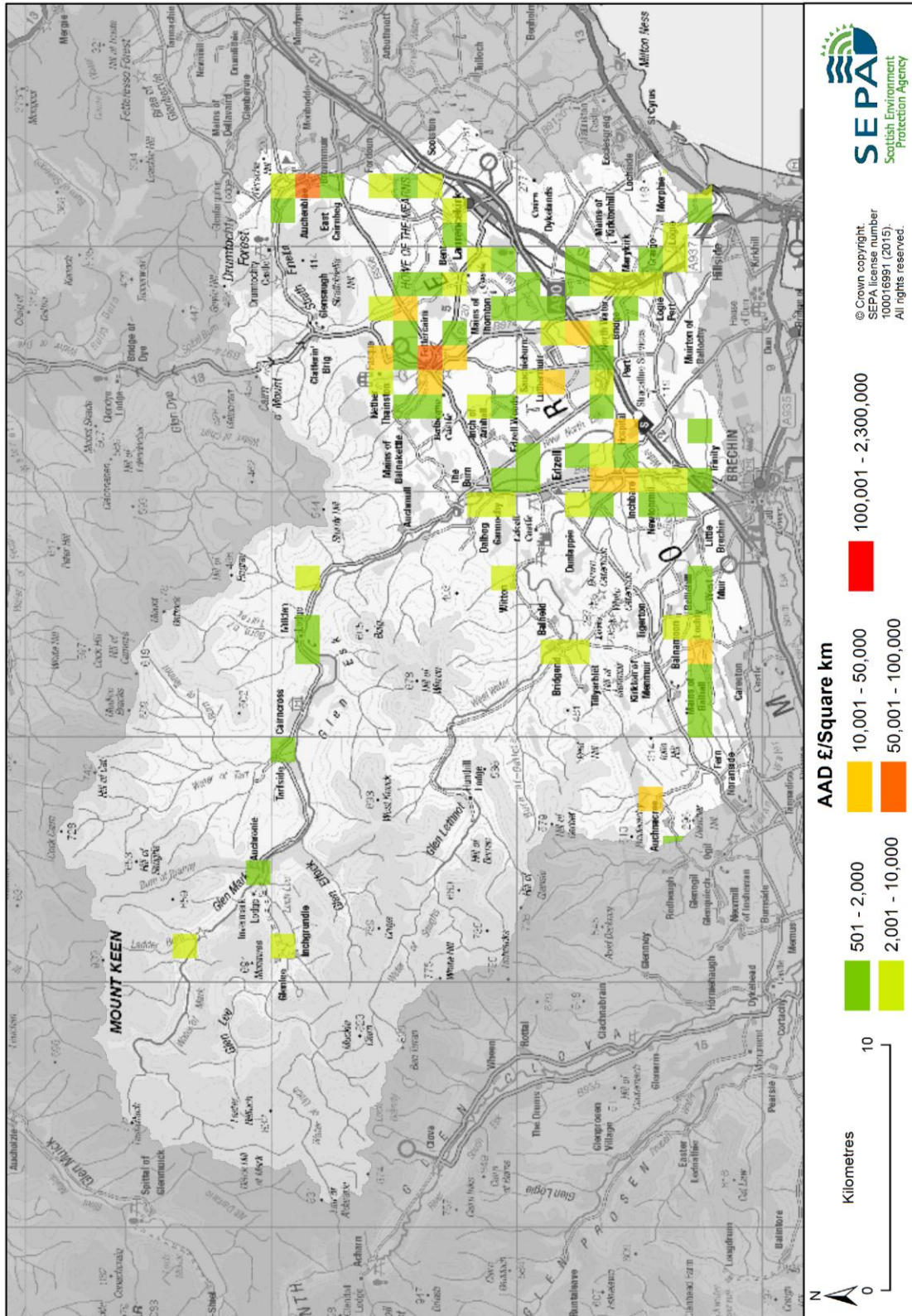
Figure 2 shows the Annual Average Damages throughout the catchment. The highest damages are in and around the towns of Fettercairn and Auchenblae. This is due to the higher density of residential properties and a scattering of non-residential properties affected by flooding from the Burn of Cauldcots and Luther Water respectively.

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

	Number at risk	Further detail
Community facilities	0	
Utility assets	0	
Roads (excluding minor roads)	6	3 A roads at 10 locations 3 B roads at 38 locations
Railway routes	1	Dundee to Aberdeen (4 locations at risk)
Agricultural land (km <sup>2</sup> )	23.5	

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

<sup>1</sup> The damages presented in this report are derived from SEPA data that is assessed at a strategic level. The damages and number of properties at Edzell may be underestimated due to small watercourses not being modelled



**Figure 2:** Annual Average Damages from river flooding

## Designated environmental and cultural heritage sites at risk

Within the catchment there are approximately 18 designated cultural heritage sites at risk of river flooding. These sites include scheduled monuments, gardens and designed landscapes and listed buildings.

It is estimated that three environmental designated areas are at risk of river flooding. This includes a Special Protection Area (the Cairngorms Massif) and two Sites of Special Scientific Interest, including the North Esk and West Water Palaeochannels.

## History of flooding

The River North Esk and its tributaries have a long history of flooding. Urban areas affected by flooding include Fettercairn and Edzell.

Perhaps the most significant flood occurred on 30 September 1962 when widespread torrential rain caused flooding and destruction in many areas of Angus with three bridges being swept away, the river rising 11 feet in two hours and a 23 year old camper being swept away by Water of Mark floodwaters.

The highest river level was recorded at SEPA's Logie Mill gauging station in November 2002 with a peak flow of 636 m<sup>3</sup>/s. This was the highest flow recorded at this gauging station since the start of recording in 1983. Seven houses and several people were evacuated in Marykirk, Logie and Kinnaber by emergency services. Houses and commercial property were affected in Laurencekirk and Fettercairn.

A recent flood happened on 21 December 2012 with 40 houses affected and 20 residents moved to temporary accommodation when Whishop Burn flooded in Edzell. Fettercairn also flooded affecting properties.

The earliest flood on record occurred in January 1933 with flooding occurring across the catchment. At a village near Laurencekirk a burn overflowed and houses were inundated.

Further detail about the history of flooding in this area 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 chapter 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 in Section 2.

## Flood protection schemes

There is one formal flood protection scheme in this catchment that reduces the risk of river flooding to Fettercairn with a 1 in 20 year flood event design standard of protection.



## River flood warning schemes

There are five 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. 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
Arnhall and Millhouse	River North Esk	5	20%
Edzell	River North Esk	1	0%
Inchbare	River North Esk	8	13%
Logie Mill and Craigo	River North Esk	13	85%
Marykirk	River North Esk	15	53%

**Table 3:** Flood warning areas

## Community groups

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

- Edzell Community Flood Action Group is a local group formed in the aftermath of the December 2012 flooding. Regular meetings are held to liaise between responsible authorities and residents to improve response and resilience
- Fettercairn Flood Resilience Group is a community run group set up in spring 2013 and supported, where possible, by Aberdeenshire Council.

## Property level protection

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

- Aberdeenshire Council provides a range of flood protection products at cost price with free delivery across Aberdeenshire, available for all types of flooding
- Aberdeenshire Council also owns and operates river level gauges on telemetry for Fettercairn and Marykirk
- Angus Council provides flood protection products at cost price for flood risk areas
- Angus Council also uses sandbags in some flood risk areas as part of an emergency response plan.

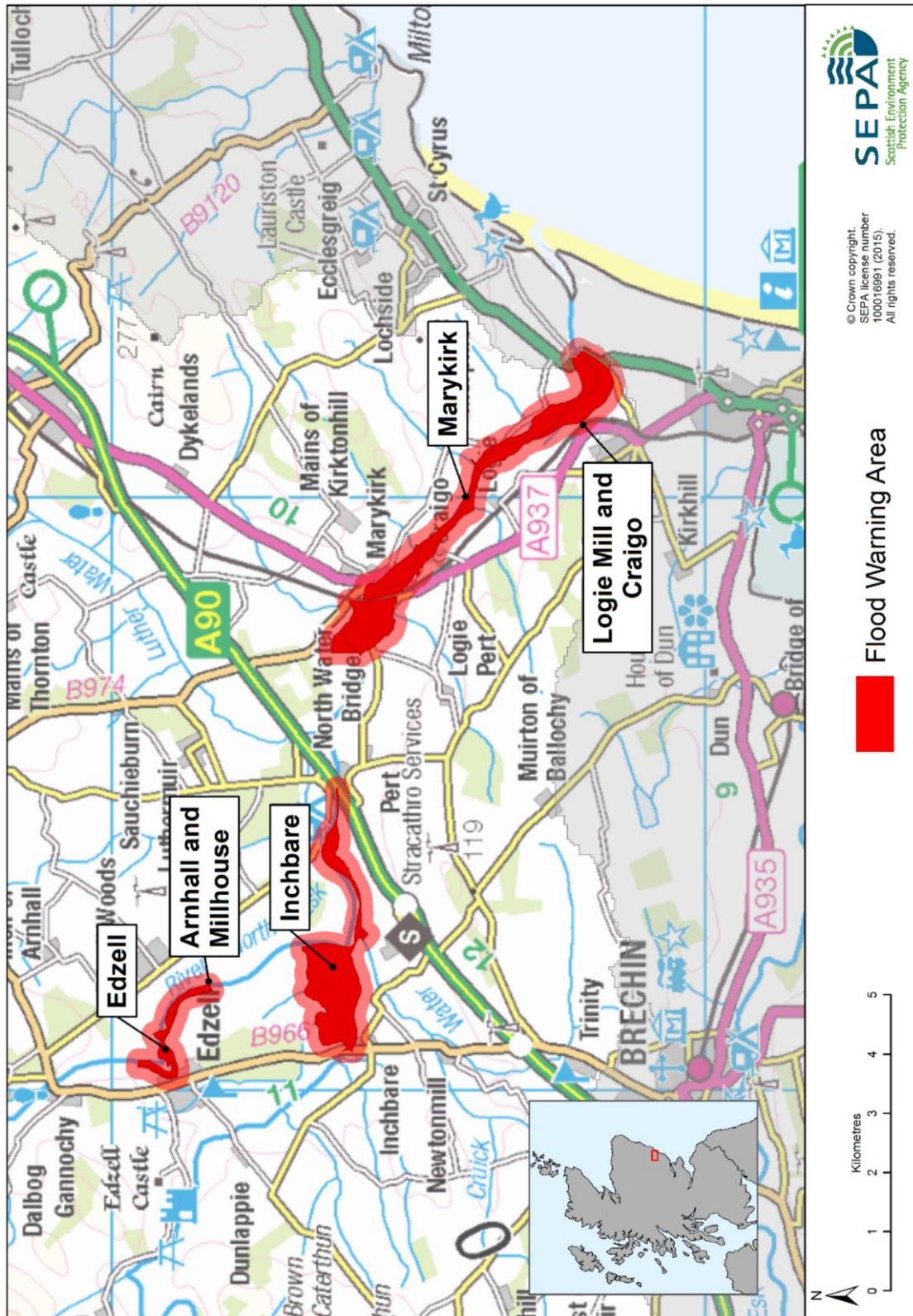


Figure 3: River flood warning areas

## 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 North Esk catchment may increase by 35%<sup>2</sup>. This would potentially increase the number of residential properties at risk of river flooding from approximately 110 to 140 and the number of non-residential properties from approximately 55 to 60.

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.

Natural flood management initiatives are already underway in this catchment. An example of a natural flood management project that benefits ecology and flood risk management is the Balmaleedy re-meandering project.

### Runoff reduction

Approximately one third of the River North Esk catchment contains areas of medium or high potential for runoff reduction. In the north this includes areas surrounding Mount Keen, Hill of Cat, Hill of Saughs and Hill of Cammie. In the south these areas can be found around the Hill of Warren and to the east the Cairn O' Mount.

### Floodplain storage

The potential for floodplain storage within the catchment appears limited to Loch Lee, upstream of the Luther Water at Laurencekirk, North Water Bridge at Marykirk, the Sauchie Burn near Luthermuir, and the River North Esk, south of Edzell at Inchbare.

### Sediment management

Across the catchment sediment erosion and deposition appears to be balanced, particularly in the upper reach of the River North Esk and its tributaries. Sediment deposition appears to be high on the Devilly Burn which may have some effect on the Fettercairn Potentially Vulnerable Area. In the lower reaches of the River North Esk,

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

sediment deposition appears to be high to the north west of Marykirk. This may occur due to higher levels of sediment erosion on the lower reach of the Black Burn and may be attributable to natural processes. Further investigation may be required to determine whether sediment management would be beneficial.

## River flooding River South Esk catchment

### Catchment overview

The River South Esk covers an area of 563km<sup>2</sup>. The main watercourses include the River South Esk, Brothock Water, Prosen Water and Noran Water. The catchment is mainly rural and contains the town of Brechin.

The Highland boundary fault cuts across the catchment from Balloch in the west to Ogil in the east. The faultline marks distinct differences in topography, rainfall and land use.

North of the boundary fault the catchment is steep and upland in nature rising to its highest point of 1,000m at the Mounth. Rainfall is higher in the headwaters with the average annual rainfall between 1250-1500mm.

To the south of the Highland fault, the catchment is more lowland in nature, with gentle slopes. The rainfall is lower with average between 700-800mm annually.

### Flood risk in the catchment

Within the River South Esk catchment approximately 150 residential and 80 non-residential properties are at risk of river flooding. It is estimated that 60% of these properties are located within the Potentially Vulnerable Area. There is one Potentially Vulnerable Area in this catchment area which covers the town of Brechin (07/05) (Figure 1).

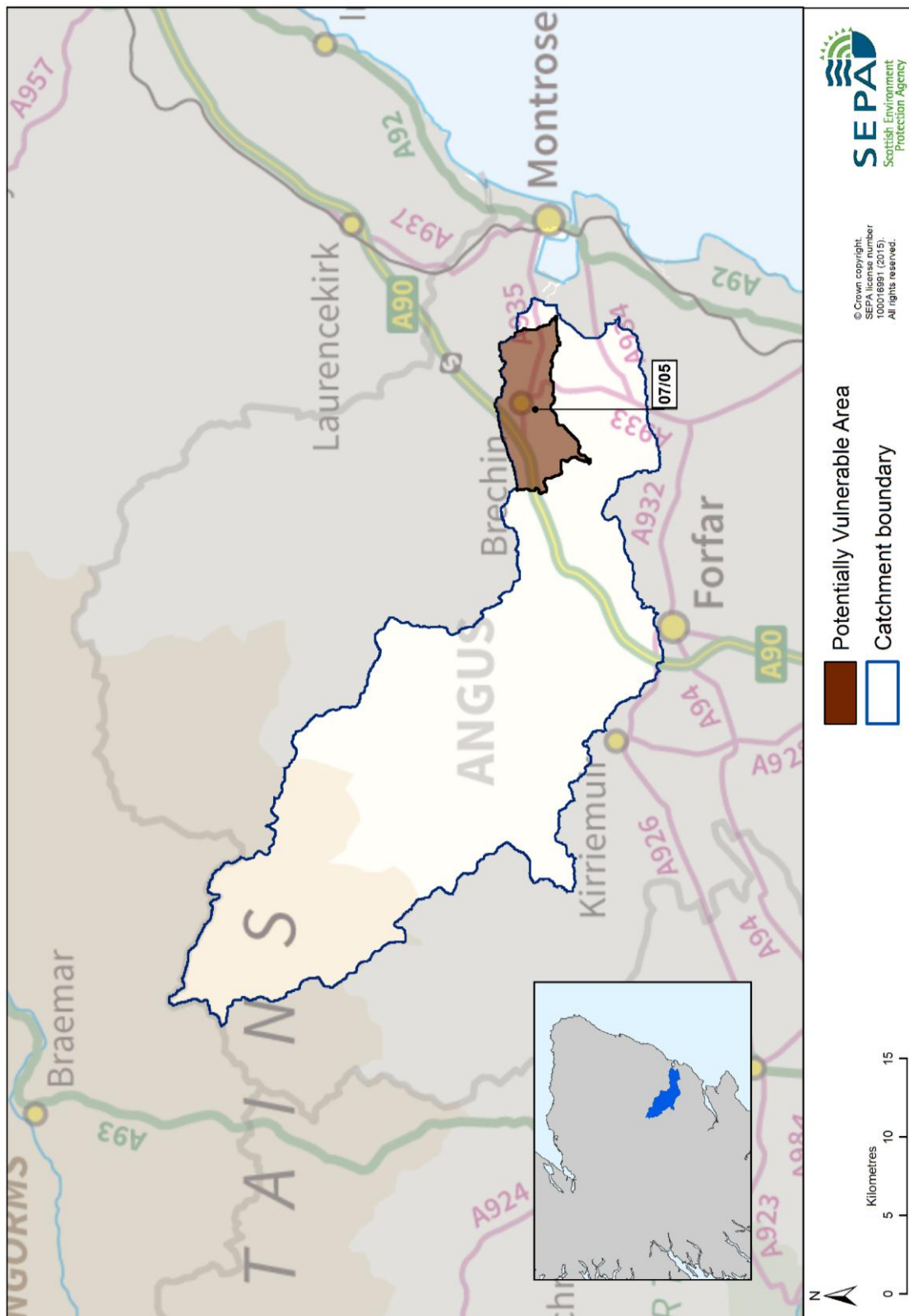
#### Main areas at risk

Brechin is the main urban area at risk of river flooding, where approximately 80 residential and 50 non-residential properties are at risk and the Annual Average Damages caused by river flooding are £410,000. This includes damages to residential and non-residential properties, transport and agriculture.

#### Economic activity and infrastructure at risk

The Annual Average Damages caused by river flooding in the River South Esk catchment are approximately £810,000. The damages are distributed as follows:

- 41% non-residential properties (£330,000)
- 38% residential properties (£310,000)
- 7% emergency services (£60,000)
- 7% agriculture (£60,000)
- 5% roads (£40,000)
- 2% vehicles (£14,000).



**Figure 1:** The River South Esk catchment and Potentially Vulnerable Areas with a risk of river flooding

Figure 2 shows the Annual Average Damages throughout the catchment. The highest damages can be seen to the south east of Brechin. This is due to the higher density of residential properties and a scattering of non-residential properties affected by flooding from the River South Esk.

Table 1 shows further information about infrastructure and agricultural land at risk of flooding within this catchment.

	Number at risk	Further detail
<b>Community facilities</b>	0	
<b>Utility assets</b>	<10	Includes: electricity substations, fuel extraction and telephone exchanges
<b>Roads (excluding minor roads)</b>	8	4 A roads at 27 locations 4 B roads at 22 locations
<b>Railway routes</b>	0	
<b>Agricultural land (km<sup>2</sup>)</b>	23.2	

**Table 1:** Infrastructure and agricultural land at risk of river flooding

### Designated environmental and cultural heritage sites at risk

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

Approximately 11 environmental designated areas are at risk of river flooding. These include two Special Areas of Conservation, four Special Protection Areas and five Sites of Special Scientific Interest. Amongst the sites at risk are Caenlochan and the Cairngorms Massif.

### History of river flooding

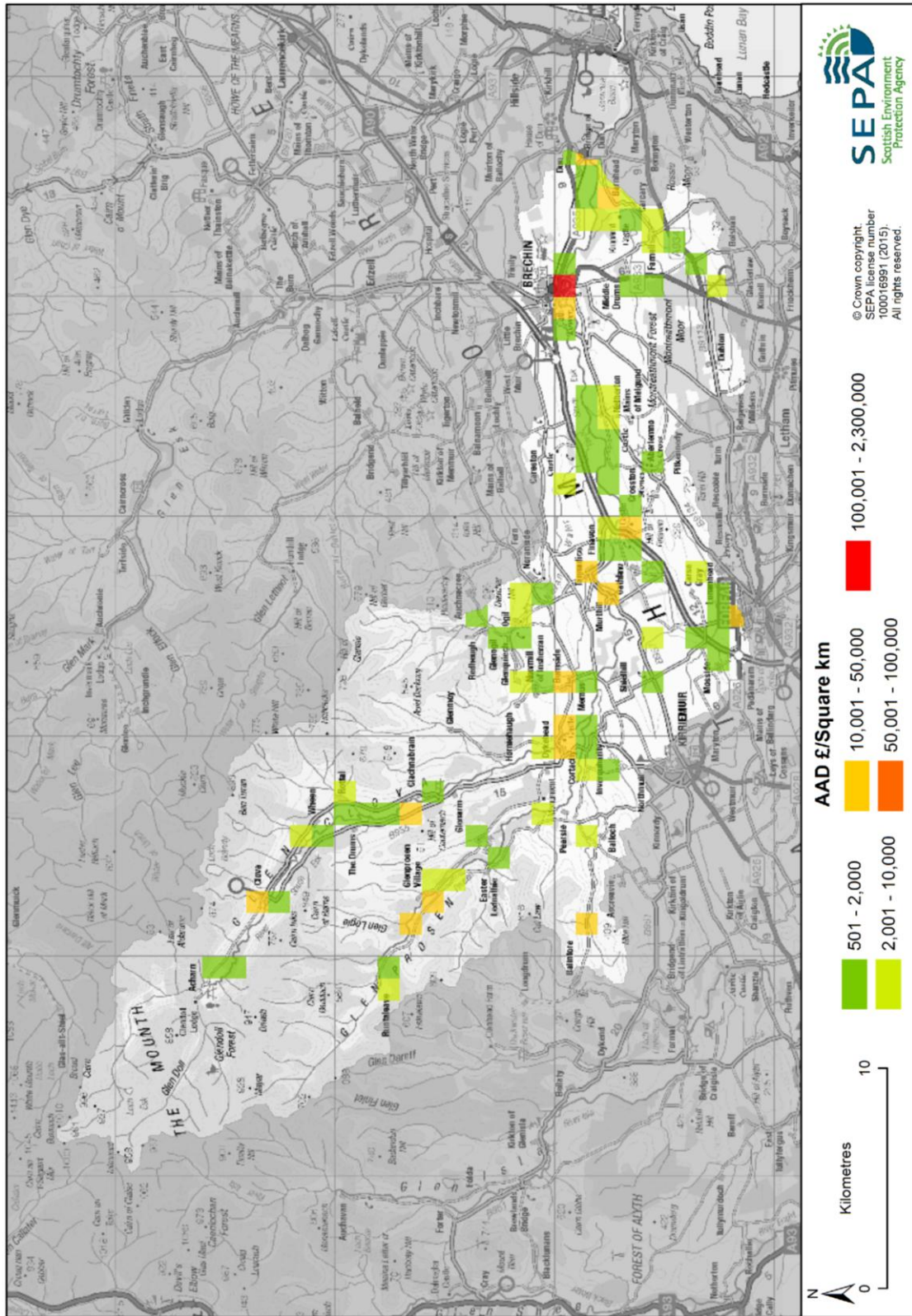
According to flood records, the town of Brechin has a long history of flooding.

Perhaps the most significant flood occurred on 5 October 1920 when the river reached 8-9 feet above normal levels. River Street flooded from Fordmouth to the bridge up to a depth of 5 inches. 58 houses flooded up to a depth of 3 feet.

The earliest flood on record dates back to 1774 when houses were inundated by flood water on River Street.

A recent flood occurred in November 2002, which was also the biggest flood recorded at the SEPA's Brechin gauging station. The river reached a peak of 2.8 metres above normal levels, flooding large areas of town and necessitating evacuation and temporary relocation of families. 30 properties were affected and roads were closed.

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



**Figure 2:** Annual Average Damages from river flooding



## 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 is one flood protection scheme currently under construction which is in Brechin and is due to be completed in January 2016. Natural flood management works are also underway as part of the flood protection scheme.

### River flood warning schemes

There are three river flood warning areas within this catchment, as shown in Table 2 and Figure 3. Table 2 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
Brechin	River South Esk	332	23%
Finavon and Tannadice	River South Esk	89	31%
Kinnaird/Bridge of Dun	River South Esk	40	53%

**Table 2:** River flood warning areas

### Property level protection

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

- Angus Council provides flood protection products at cost price for flood risk areas
- Angus Council also uses sandbags in some high risk areas as part of an emergency response plan.

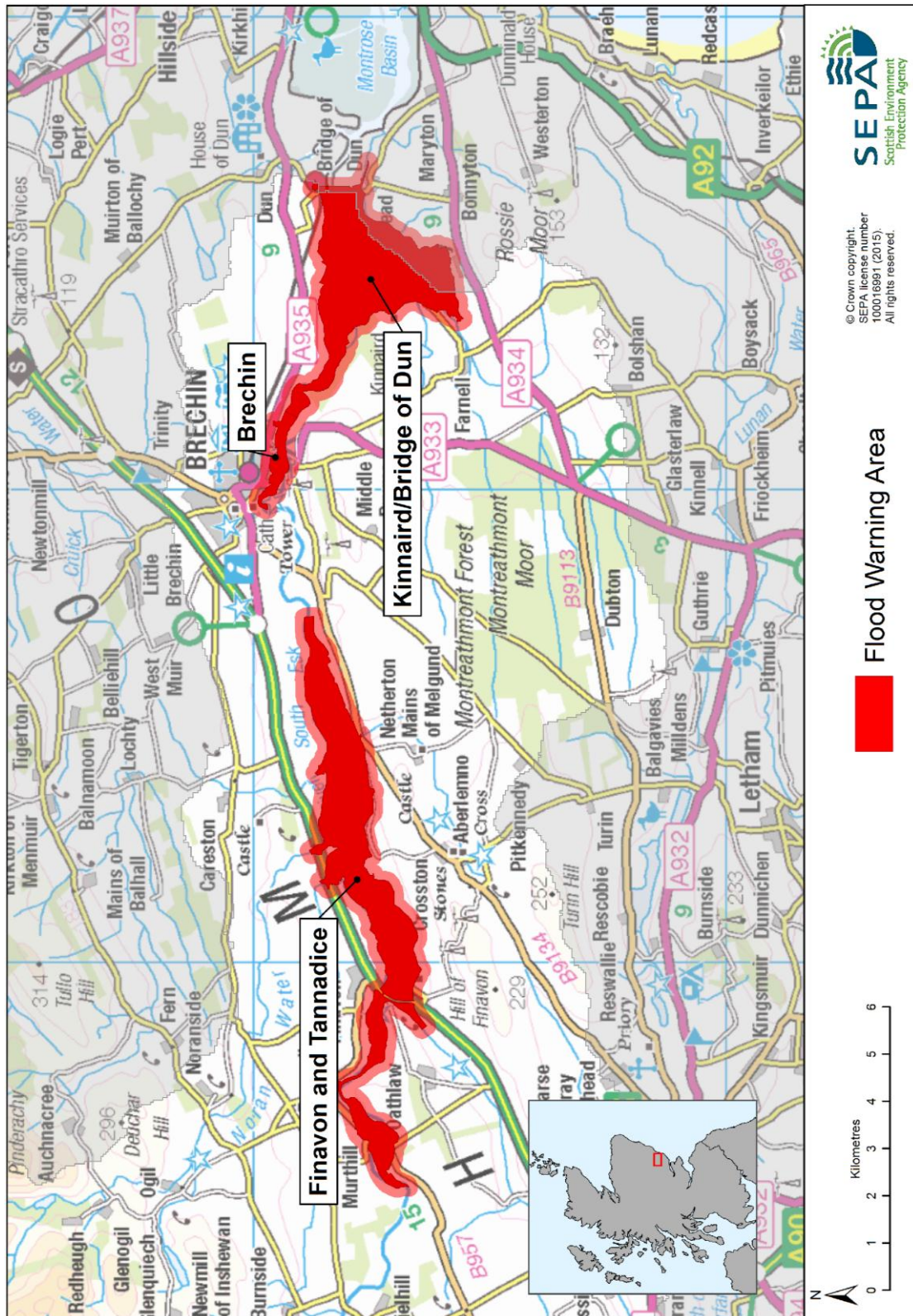


Figure 3: River flood warning areas

## 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 South Esk catchment may increase by 35%<sup>1</sup>. This would potentially increase the number of residential properties at risk of river flooding from approximately 150 to 280 and the number of non-residential properties from approximately 80 to 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.

A number of natural flood management initiatives are already underway in this catchment. Upland reforestation is being implemented by Angus Council as part of Brechin flood protection scheme. A further two projects are currently underway in this catchment. This is the South Esk pilot project, led by SEPA, and the Glen Clova tree planting project, led by the Esk Fisheries Board with support from Angus Council. Both initiatives have the potential to reduce flood risk whilst delivering multiple benefits.

### Runoff reduction

The greatest runoff reduction potential is in the north of the catchment. This includes areas surrounding Cairn Baddoch, Loch Brandy and Ben Tirran. Brechin Potentially Vulnerable Area is located in the south of the catchment and further investigation will be required to determine how much impact natural flood management actions could have on flooding in this area.

### Floodplain storage

Floodplain storage potential has been identified upstream and downstream of Brechin on the River South Esk. An area that it would be valuable to investigate further is located upstream of Brechin.

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<sup>1</sup> From the study 'An assessment of the vulnerability of Scotland's river catchments and coasts to the impacts of climate change' (CEH, 2011)

## **Sediment management**

Across the catchment there are reaches of moderate erosion and deposition. This is particularly true for the northern reaches of the River South Esk and its tributaries. Further downstream on the River South Esk, particularly between Finavon and Brechin, sediment erosion and deposition appears high. This may be attributable to natural processes. Further investigations may be required to determine whether natural flood management actions may help manage sediment in these stretches of the river.

## River flooding Firth of Tay catchment group

### Catchment overview

The Firth of Tay river catchment group comprises of a number of smaller catchments. It covers a total area of 1,051km<sup>2</sup>. The main rivers in this group are the Elliot Water, Monikie Burn, Barry Burn, Dighty Water, River Eden, Kenly Water and Motray Water.

The Firth of Tay catchment group is gently sloping with dry soils typical of a low lying east coast location. Land use is dominated by agriculture, mainly arable farming and horticulture.

The average annual rainfall for this catchment group is low for Scotland, with 600-700mm falling in the lower part of the catchment, rising to 800-1000mm in the upper catchment.

### Flood risk in the catchment

Within the Firth of Tay catchment group approximately 1,200 residential and 250 non-residential properties are at risk of river flooding. It is estimated that 83% of these properties are located within Potentially Vulnerable Areas. There are 11 Potentially Vulnerable Areas at risk of river flooding in this catchment group (Figure 1):

- Carnoustie and Barry (07/09)
- Monifieth (07/10)
- Downfield and Dundee (07/11)
- Invergowrie (07/12)
- Dundee and Broughty Ferry (07/13)
- Tayport and Newburgh (07/14)
- Lucklawhill (07/15)
- St Andrews to Guardbridge (07/16)
- St Andrews (Denhead and Strathkinness) (07/17)
- Cupar (07/18)
- Auchtermuchty and Pleasance (07/19).

### Main areas at risk

The main areas with a risk of river flooding can be seen in Table 1 which 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
Monifieth	280	£650,000
Dundee (incl. Invergowrie)	210	£390,000
Cupar	160	£260,000
St Andrews	140	£270,000
Carnoustie/Barry	120	£200,000
Auchtermuchty	60	£200,000
Strathmiglo	40	£100,000
Falkland	10	£29,000
Freuchie	10	£19,000
Tayport	10	£9,000

**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 Firth of Tay catchment group are approximately £4.0 million. The damages are distributed as follows:

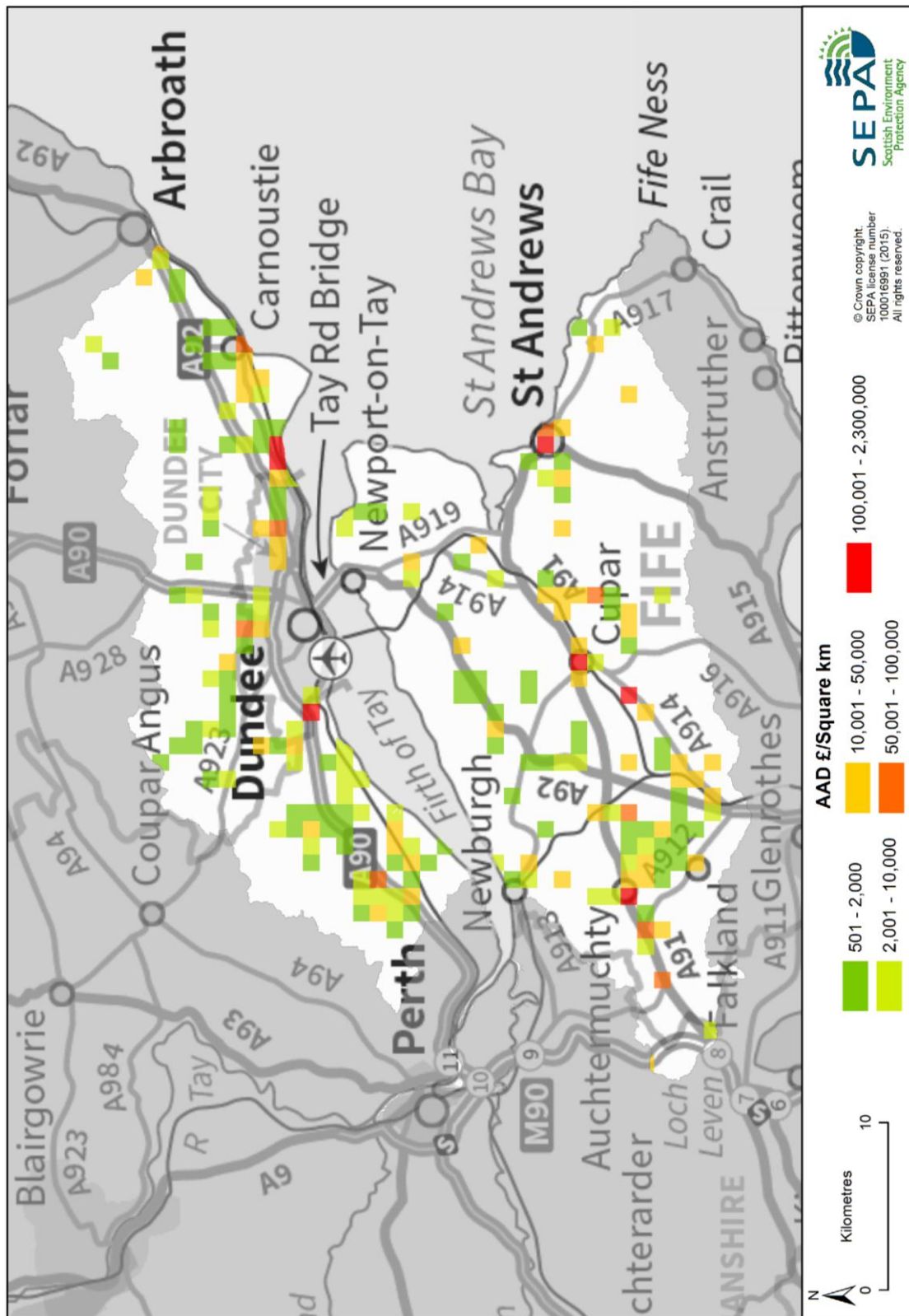
- 55% residential properties (£2.2 million)
- 30% non-residential properties (£1.2 million)
- 7% emergency services (£280,000)
- 4% agriculture (£150,000)
- 2% roads (£90,000)
- 2% vehicles (£80,000).

Figure 2 shows the Annual Average Damages throughout this catchment group. The highest damages can be seen west of Springfield due to a higher density of non-residential properties at risk of flooding from the River Eden and at Monifieth due to higher density of residential properties at risk of flooding from the Monifieth Burn.

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

	Number at risk	Further detail
<b>Community facilities</b>	0	
<b>Utility assets</b>	20	Includes electricity substations, fuel extraction and cooling sites
<b>Roads (excluding minor roads)</b>	25	1 M roads (M90) at 2 locations 10 A roads at 101 location, 14 B roads at 92 locations
<b>Railway routes</b>	4	Dundee to Aberdeen (15 locations at risk) Dundee to Dunblane (9 locations at risk) Dundee to Thornton junctions (8 locations at risk) Perth to Thornton junctions (13 locations at risk)
<b>Agricultural land (km<sup>2</sup>)</b>	44.2	

**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 group there are approximately 40 designated cultural heritage sites with a risk of river flooding. These sites include scheduled monuments, gardens and designed landscapes, battlefield sites and listed buildings.

It is estimated that 20 environmental designated areas are at risk of river flooding. This includes two Special Areas of Conservation, three Special Protection Areas and 15 Sites of Special Scientific Interest. Amongst these sites are the Firth of Tay and Eden Estuary, Barry Links and Tentsmuir.

## History of river flooding

Perhaps the most significant floods in this catchment group happened in January 1993 and April 1992. In January 1993 the River Eden caused serious flooding in Auchtermuchty and Strathmiglo with the highest recorded river level of 1.67m above normal level at SEPA's Strathmiglo gauging station. In April 1992 there was widespread flooding throughout Fife when more than 80mm of rain fell in 24 hours. This caused significant flooding in Cupar from the River Eden. This was also the highest recorded river level of 2.2m above normal levels at SEPA's Kemback gauging station.

A recent flood happened on 11 October 2012 in Pitscottie and Dura Den from the Ceres Burn when a road and part of a house was washed away.

The earliest flood recorded in this catchment group dates back to 22 October 1864 when widespread flooding throughout Fife was recorded. 49mm of rain fell in a single day.

Further detail about the history of flooding in this area 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 six flood protection schemes in this catchment group:

- Carnoustie (Barry Burn) Flood Prevention Scheme
- Millfield of Cupar Flood Prevention Scheme
- Ceres Village Flood Prevention Scheme
- Pitscottie Village Flood Prevention Scheme
- Auchtermuchty Flood Prevention Scheme
- Dunshalt Village Flood Prevention Scheme.

## Community groups

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

- Carse of Gowrie Sustainability Group
- Dighty Flood Action Group
- Falkland Flood Action Group
- Freuchie Flood Action Group
- Kettle and District Flood Action Group
- Strathmartine Community Council Flood Group.

## Property level protection

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

- Dundee City Council owns and operates an emergency flood plan for Dundee City
- Dundee City Council also supplies and distributes sandbags to Dundee City prior to and during flood events
- Fife Council operates an emergency flood plan
- Fife Council also installed flood pods containing flood protection products close to areas with properties at risk of flooding.

## 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 Firth of Tay catchment may increase by 35%<sup>1</sup>. This would potentially increase the number of residential properties at risk of river flooding from approximately 1,200 to 1,400 and the number of non-residential properties from approximately 250 to 270.

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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<sup>1</sup> From the study 'An assessment of the vulnerability of Scotland's river catchments and coasts to the impacts of climate change' (CEH, 2011)

In this catchment group the Lingo Burn in-stream works is a natural flood management project with potential benefits for ecology and flood risk management.

### **Runoff reduction**

This catchment group is largely urbanised and low lying therefore, potential sites to reduce runoff are scarce. The majority of potential sites are located on the south side of the Firth of Tay surrounding Cupar, St Andrews and the Tentsmuir Forest. Further local investigation will be required to determine how much impact natural flood management actions could have on flooding in this area.

### **Floodplain storage**

Contrary to the potential for runoff reduction, the potential to store water within the catchments appears high. There are a number of potential floodplain storage sites laying to the west of Dundee at Kilspindie and Inchtute and to the west of Cupar at the Howe of Fife. Other potential sites are scattered throughout the catchment group. Potentially Vulnerable Areas Tayport and Newburgh (07/14), Lucklawhill (07/15) and Auchtermuchty and Pleasance (07/19) contain large areas of potential floodplain storage that may benefit from further investigation.

### **Sediment management**

High erosion and sediment deposition occurs on the Rossie Drain, Motray Water and Pitairlie Burn and may potentially affect flooding in Potentially Vulnerable Areas Auchtermuchty and Pleasance (07/19), Lucklawhill (07/15) and Carnoustie and Barry (07/09). Sediment deposition also appears to be high on the Dighty Water on the outskirts of Dundee City and on the River Eden, south of Ladybank. While much of this may be attributed to natural processes, there may be river reaches that would benefit from actions to manage sediment, such as improvement of bankside vegetation.

## River flooding Kincardine and Angus catchment group

### Catchment overview

The Kincardine and Angus catchment group comprises of a number of smaller catchments. It covers an area of approximately 350km<sup>2</sup>. The main river catchments include the Lunan Water, Brothock Water and Den Finella Burn.

These catchments are gently sloping and low lying, with dry soils typical of east coast location. Intensive agriculture dominates the land use for arable and horticultural production.

The average annual rainfall for this catchment group is very low for Scotland, with 600-700mm falling in the lower part of the catchment, rising to 700-800mm in the upper catchment.

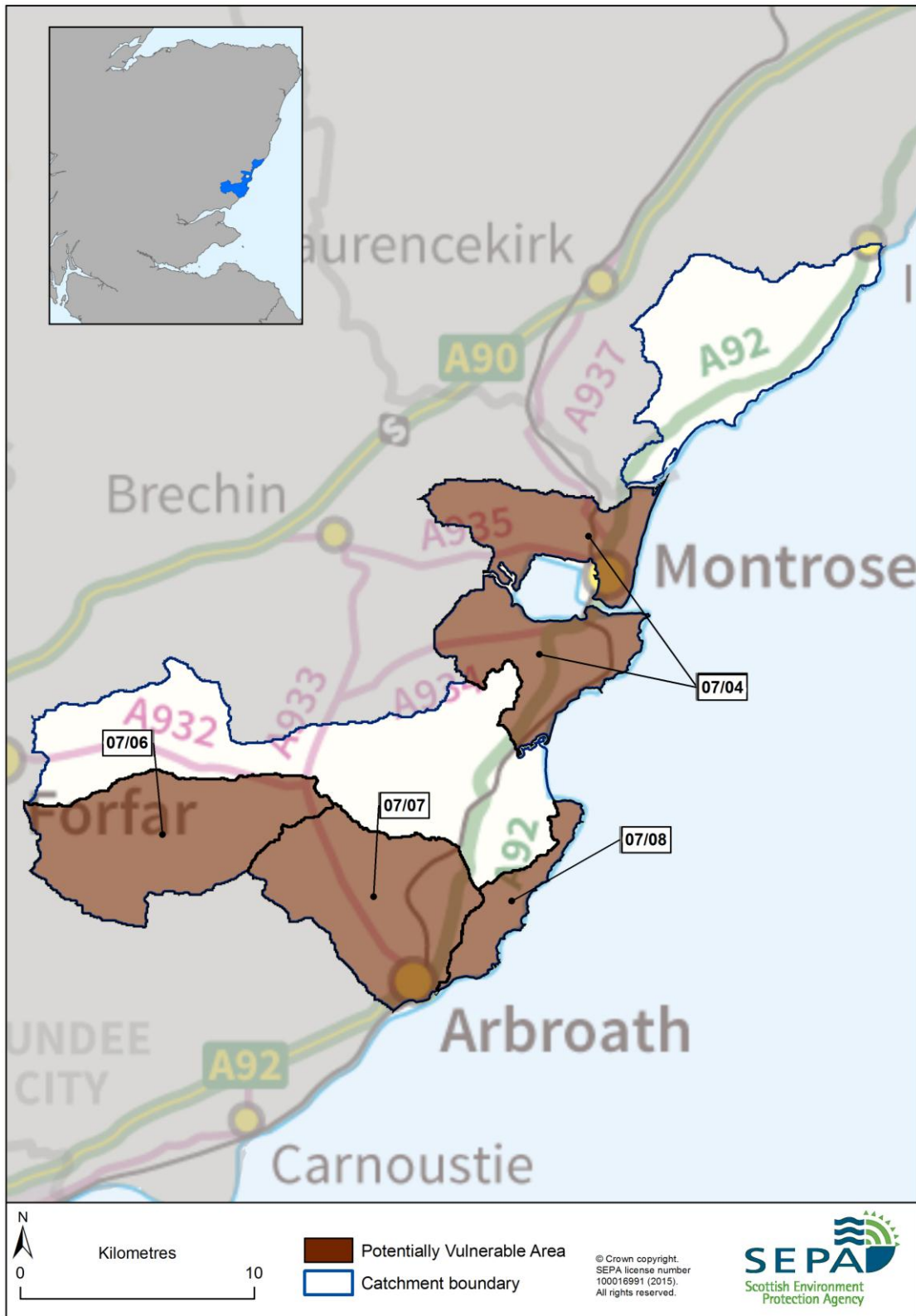
### Flood risk in the catchment

Within the Angus and Kincardine catchment group approximately 240 residential and 130 non-residential properties have a risk of river flooding. It is estimated that 92% of these properties are located within Potentially Vulnerable Areas. There are four Potentially Vulnerable Areas at risk of river flooding in this catchment group (Figure 1):

- Montrose Basin (07/04)
- Lunan Water (07/06)
- Arbroath (07/07)
- Coast North of Arbroath (07/08).

### Main areas at risk

Arbroath is the main urban area with a risk of river flooding, where approximately 190 residential and 110 non-residential properties are at risk and the Annual Average Damages caused by river flooding in Arbroath are £870,000. This includes damages to residential and non-residential properties, transport and agriculture.



**Figure 1:** The Kincardine and Angus catchment group and Potentially Vulnerable Areas with a risk of river flooding

## Economic activity and infrastructure at risk

The Annual Average Damages caused by river flooding in the Kincardine and Angus catchment group are estimated to be approximately £1.1 million. The damages are distributed as follows:

- 44% non-residential properties (£490,000)
- 44% residential properties (£480,000)
- 5% emergency services (£60,000)
- 3% agriculture (£30,000)
- 2% roads (£20,000)
- 2% vehicles (£20,000).

Figure 2 shows the Annual Average Damages throughout the catchment group. The highest damages can be seen around Arbroath. This is due to the higher density of residential and non-residential properties at risk of flooding from the Brothock Water.

Table 1 shows further information about infrastructure and agricultural land at risk of flooding within this catchment group.

	Number at risk	Further detail
<b>Community facilities</b>	0	
<b>Utility assets</b>	<10	Includes: electricity substations and fuel extraction sites.
<b>Roads (excluding minor roads)</b>	8	5 A roads at 51 locations 3 B roads at 16 locations
<b>Railway routes</b>	1	Dundee to Aberdeen (10 locations at risk)
<b>Agricultural land (km<sup>2</sup>)</b>	11.7	

**Table 1:** Infrastructure and agricultural land at risk of river flooding

## Designated environmental and cultural heritage sites at risk

Within the catchment group there are approximately 14 designated cultural heritage sites at risk of river flooding. These include scheduled monuments, gardens and designed landscapes, battlefield sites and listed buildings.

It is estimated that 10 environmental designated areas are at risk of river flooding. This includes a Special Area of Conservation (the River South Esk), two Special Protection Areas (Montrose Basin and St Cyrus) and seven Sites of Special Scientific Interest.



**Figure 2: Annual Average Damages from river flooding**

## History of flooding

The highest river level recorded at SEPA's gauging station on the Brothock Water, Arbroath was in November 2009 where the river levels reached 1.66m.

Perhaps the most significant flood in the Kincardine and Angus catchment group occurred on 10 February 1977, with widespread flooding from the Brothock Water in Arbroath between St Vigean's Junction and the harbour. Severe flooding was also reported upstream of Guthrie. People and property (both residential and non-residential) were impacted.

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

## 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 in Section 2.

### Flood protection schemes

There is one flood protection scheme in this catchment group, which reduces the risk of river flooding to Arbroath from Brothock Water.

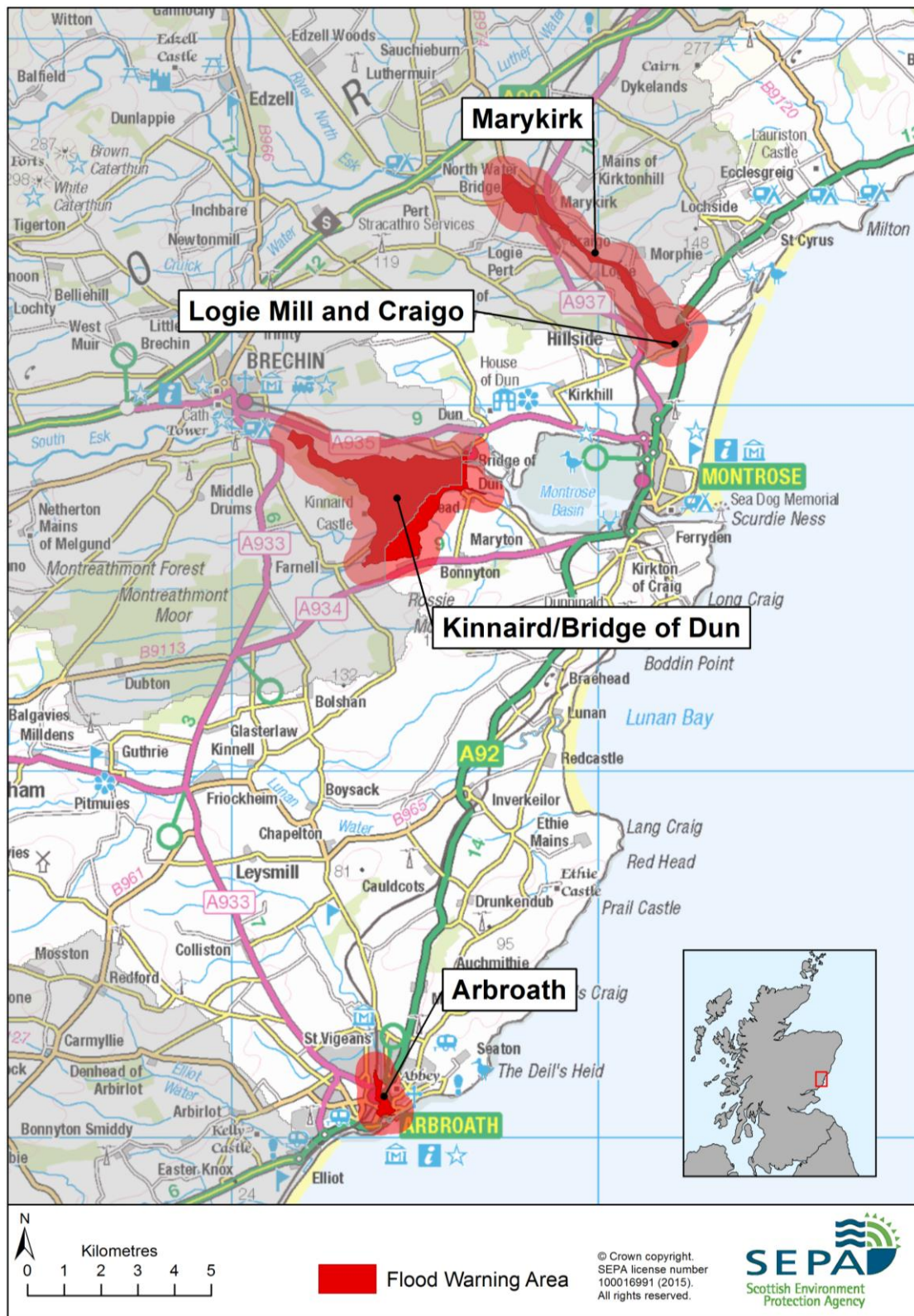
### River flood warning schemes

There are four river flood warning areas within this catchment group as shown in Table 2 and Figure 3. Table 2 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. 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
Arbroath	Brothock Water	674	14%
Kinnaird/Bridge of Dun	River South Esk	40	53%
Logie Mill and Craigo	River North Esk	13	85%
Marykirk	River North Esk	15	53%

**Table 2:** Flood warning areas





**Figure 3: Flood warning areas**

## Awareness raising campaigns and community groups

Ferryden Flood Action Group is currently being formed in this catchment group.

## Property level protection

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

- Angus Council provides flood protection products at cost price for flood risk areas
- Angus Council also uses sandbags in some high risk areas as part of an emergency response plan.

## 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 Kincardine and Angus catchment may increase by 35%<sup>1</sup>. This would potentially increase the potential number of residential properties at risk of river flooding from approximately 240 to 290 and the number of non-residential properties from approximately 130 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 of this document.

### Runoff reduction

Within this catchment group there appears to be very limited potential for runoff reduction.

### Floodplain storage

To the north west of Letham there are sites with a medium and high storage potential, along with other locations along the Lunan Water and Brothie Burn.

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<sup>1</sup> From the study 'An assessment of the vulnerability of Scotland's river catchments and coasts to the impacts of climate change' (CEH, 2011)

## **Sediment management**

Sediment deposition is higher on the upper reach of the Lunan Water, north of Letham which may affect Lunan Water Potentially Vulnerable Area (07/06). The Brothock Water also experiences some level of sediment deposition, particularly within Arbroath town centre. While much of this will be attributable to natural processes, there may be river reaches which would benefit from actions to manage sedimentation, such as improvement of bankside vegetation.

## 3.3 Coastal flooding

### Tay Estuary and Montrose Basin 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

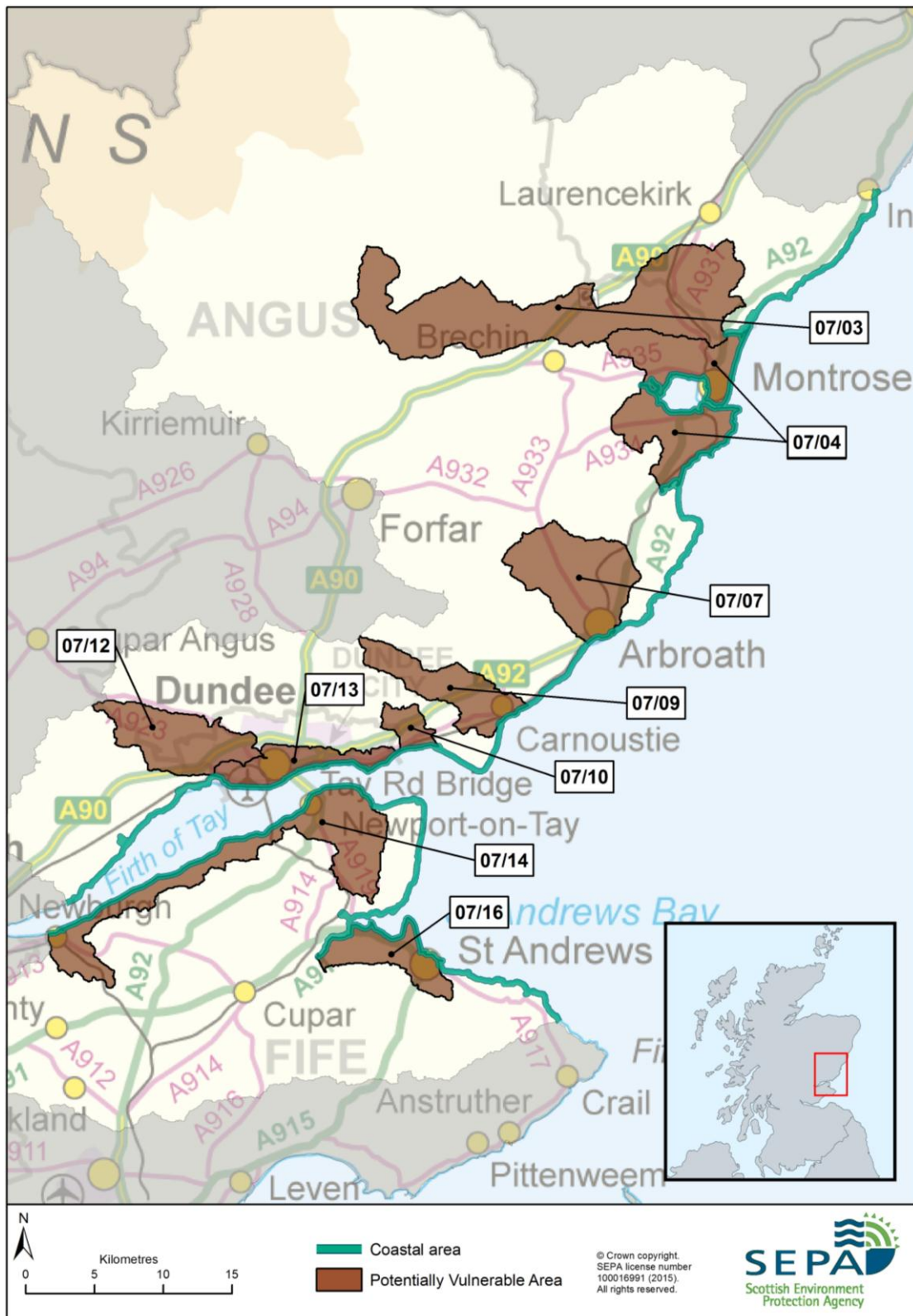
The Tay Estuary and Montrose Basin Local Plan District has 233km of coastline stretching from Inverbervie in the north to Fife Ness in the south. The coastline includes the Montrose Basin, the outer Firth of Tay and the areas of Angus and Fife that are exposed to the North Sea. There are several coastal communities in this area including Montrose, Arbroath, Carnoustie, Dundee and St Andrews.

The inner Firth of Tay typically includes habitats such as mudflats, salt marshes and reed beds. This area includes the largest continuous stand of reed bed in the UK. The outer Firth of Tay is more sandy beaches and dunes. The entrance to the Firth of Tay has large sand dune systems on both the north (Barry Links) and south shores (Tentsmuir Dunes).

#### Flood risk

Within the Tay Estuary and Montrose Basin Local Plan District approximately 1,400 residential properties and 340 non-residential properties are at risk of coastal flooding. It is estimated that 99% of these properties are located within Potentially Vulnerable Areas. There are nine Potentially Vulnerable Areas in this Local Plan District that have a risk of coastal flooding (Figure 1):

- North of Brechin (07/03)
- Montrose Basin (07/04)
- Arbroath (07/07)
- Carnoustie and Barry (07/09)
- Monifeith (07/10)
- Invergowrie (07/12)
- Dundee and Broughty Ferry (07/13)
- Tayport and Newburgh (07/14)
- St Andrews to Guardbridge (07/16).



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

## Main areas at risk

The main areas at risk of coastal flooding, the number of properties at risk and the total Annual Average Damages caused by coastal flooding are shown in Table 1. The Annual Average Damages include damages to residential and non-residential properties, transport, emergency services and agriculture.

	Residential and non-residential properties at risk of coastal flooding	Annual Average Damages
Dundee and Broughty Ferry	1,300	£3.5 million
Montrose	150	£310,000
Newburgh	130	£450,000
Carnoustie	50	£98,000
St Andrews	20	£47,000
Arbroath	20	£40,000
Newport on Tay/Tayport	10	£25,000
Ferryden	<10	£20,000

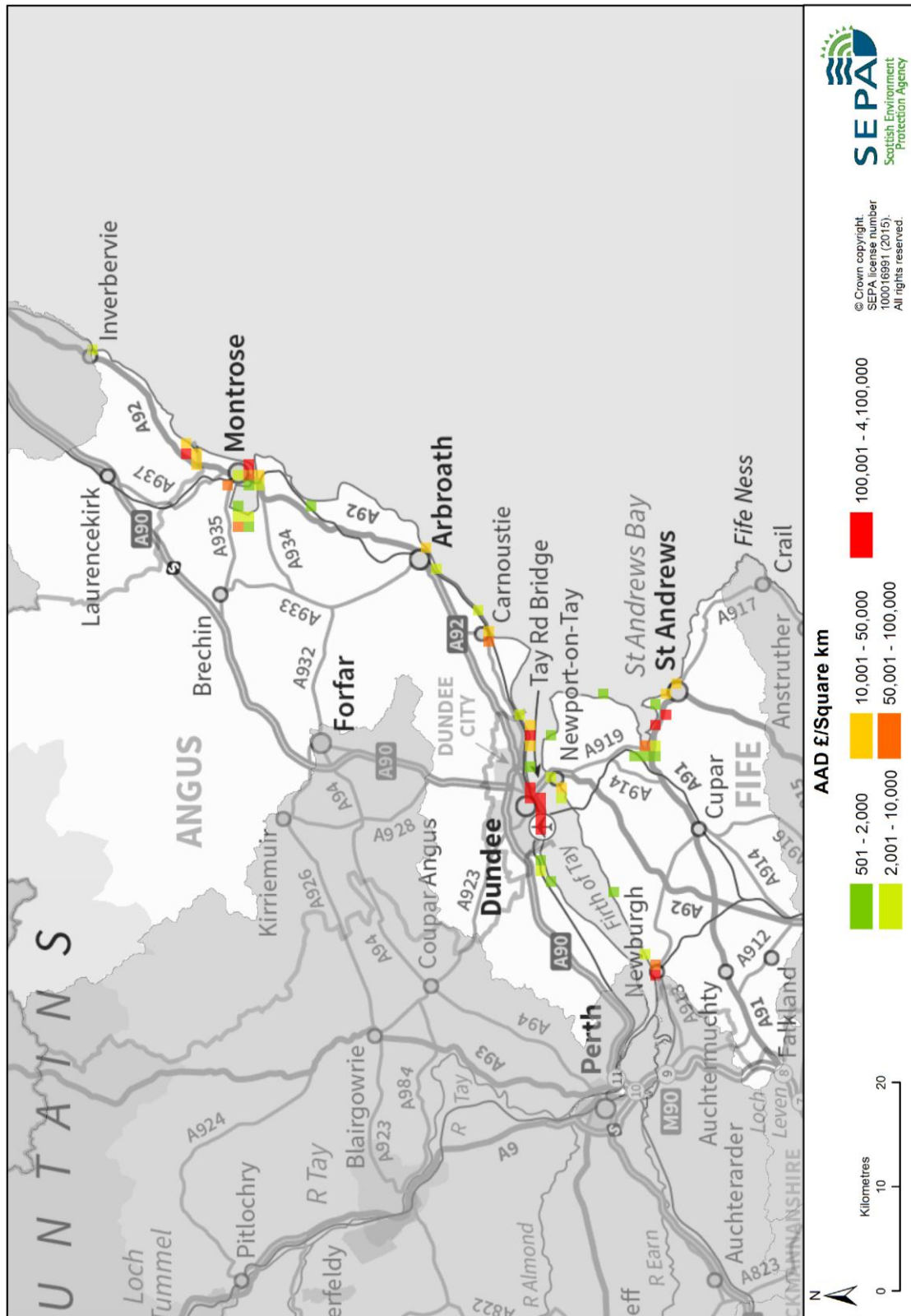
**Table 1:** Main areas at risk of coastal flooding

## Economic activity and infrastructure at risk

The Annual Average Damages caused by coastal flooding in the Tay Estuary and Montrose Basin Local Plan District are approximately £5.3 million. The damages are distributed as follows:

- 40% roads (£2.1 million)
- 28% non-residential properties (£1.5 million)
- 28% residential properties (£1.5 million)
- 3% emergency services (£170,000)
- <1% vehicles (£40,000)
- <1% agriculture (£20,000).

Figure 2 shows the Annual Average Damages throughout the coastal area. The highest damages can be seen around Dundee and Broughty Ferry due to the impact on roads and high density of businesses and homes. High damages can also be seen in Newburgh due to the density of residential properties along the coastline and around the Montrose Basin and Guardbridge due to the density of local businesses.



**Figure 2:** Annual Average Damages from coastal flooding

Table 2 shows further information about infrastructure and agricultural land at risk of coastal flooding.

	Number at risk	Further detail
<b>Community facilities</b>	<10	Includes: educational buildings and emergency services
<b>Utility assets</b>	30	Includes: electricity substations and telephone exchanges
<b>Roads (excluding minor roads)</b>	10	7 A roads at 107 locations 3 B roads at 4 locations
<b>Railway routes</b>	3	Dundee to Aberdeen (26 locations at risk) Dundee to Ladybank (3 locations at risk) Dundee to Dunblane (2 locations at risk)
<b>Airports</b>	1	Dundee airport
<b>Agricultural land (km<sup>2</sup>)</b>	8.6	

**Table 2:** Infrastructure and agricultural land at risk of coastal flooding

### Designated environmental and cultural heritage sites at risk

Within the coastal area there are approximately 18 designated cultural heritage sites at risk of coastal flooding. These include scheduled monuments, gardens and designed landscapes and listed buildings.

It is estimated that 23 environmental designated areas are at risk of coastal flooding. These include three Special Areas of Conservation, four Special Protection Areas and 16 Sites of Special Scientific Interest. Notably these include the Firth of Tay and Eden Estuary, St Cyrus and the Tayport – Tentsmuir Coast.

### History of coastal flooding

The Tay Estuary and Montrose Basin has a long history of coastal flooding. Urban areas often affected include Dundee, Broughty Ferry and Arbroath.

Probably the most significant flood occurred on 28 December 1879 with 75 deaths and damage to a lighthouse. Numerous homes were damaged when the Tay Bridge collapsed under heavy flooding from high tides. This flood was estimated to have a 25-49 year return period.

A recent flood happened on 15 December 2012 when a combination of wind and high tides caused large waves and coastal flooding along the east coast of Scotland.

The earliest flood on record dates back to 8 February 1868 when houses and roads flooded in Dundee and the Dundee Harbour was also impacted. This flood was estimated to have 25-49 year return period.

Further detail about the history of flooding in this area 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 in Section 2.

### Flood protection schemes

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

- Carnoustie Coastal Protection Scheme
- Monifieth Coastal Protection Scheme.

### Planned flood protection schemes

Planned flood protection schemes in this area include:

- To raise the sea wall at Dundee's central waterfront
- To extend coastal revetments in Broughty Ferry.

### Coastal flood warning schemes

There are nine coastal flood warning areas within this Local Plan District 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. Note that this is not the number of properties at risk of flooding.

Flood warning area (FWA)	Number of properties within FWA	% of properties registered January 2014
Arbroath Coastal	22	27%
Broughty Ferry	1,027	10%
Dundee Central	787	6%
Guardbridge	6	0%
Newburgh	160	21%
Newport on Tay	38	3%
Riverside West	27	19%
St Andrews	106	11%
Tayport	259	14%

**Table 3:** Coastal flood warning areas



**Figure 3:** Coastal flood warning areas

## Community groups

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

- Carse of Gowrie Sustainability Group
- Ferryden Community Action Group.

## Property level protection

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

- Dundee City Council owns and operates an emergency flood plan for Dundee
- Dundee City Council also supplies and distributes sandbags to Dundee prior to and during flood events
- Fife Council installed flood pods containing flood protection products close to areas containing properties at risk of flooding
- Aberdeenshire Council provides a range of flood protection products at cost price with free delivery across Aberdeenshire, available for all types of flooding
- Aberdeenshire Council also owns and operates river level gauges on telemetry for Fettercairn and Marykirk
- Angus Council provides flood protection products at cost price for flood risk areas
- Angus Council also uses sandbags in some high flood risk areas as part of an emergency response plan.

## 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 Tay Estuary and Montrose Basin Local Plan District is between 0.48m-0.49m by 2080. This may increase the number of residential properties at risk of coastal flooding from approximately 1,400 to 2,700 and the number of non-residential properties from approximately 340 to 590. 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.

### Wave energy

The assessment shows that there is generally high potential for wave attenuation along the coast from Inverbervie to Montrose and a medium to high potential along the coast from Montrose to Carnoustie. Medium to high potential has been identified around Carnoustie, Montrose, Arbroath, St Andrews, Dundee, Monifieth, Tayport and Newport on Tay.

The assessment shows that there may be potential for estuarine surge attenuation in and around Montrose, Dundee and Newport on Tay.

## 3.4 Surface water flooding

### Tay Estuary and Montrose Basin 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 Estuary and Montrose Basin Local Plan District approximately 1,100 residential properties and 860 non-residential properties are at risk of surface water flooding. It is estimated that 98% 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
Dundee	930	£1.2 million
Arbroath	230	£600,000
Cupar	180	£480,000
Carnoustie	80	£110,000
Montrose	60	£230,000
Brechin	60	£190,000
St Andrews	60	£67,000
Monifieth	50	£35,000
Leuchars	<10	£9,500
Tayport	<10	£6,700

**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 Estuary and Montrose Basin Local Plan District are approximately £4.3 million. The damages are distributed as follows:

- 47% non-residential properties (£2.0 million)
- 28% roads (£1.2 million)
- 20% residential properties (£880,000)
- 4% emergency services (£180,000)
- 1% vehicles (£30,000).

Figure 1 shows the distribution of Annual Average Damages throughout the Local Plan District. The highest Annual Average Damages are found along the Dundee coastline and Dundee city centre due to the high number of businesses located around the city's harbour. High damages are also seen in Montrose, Arbroath and Cupar.

Table 2 shows the approximate number of further infrastructure assets which are at risk of flooding within this Local Plan District.

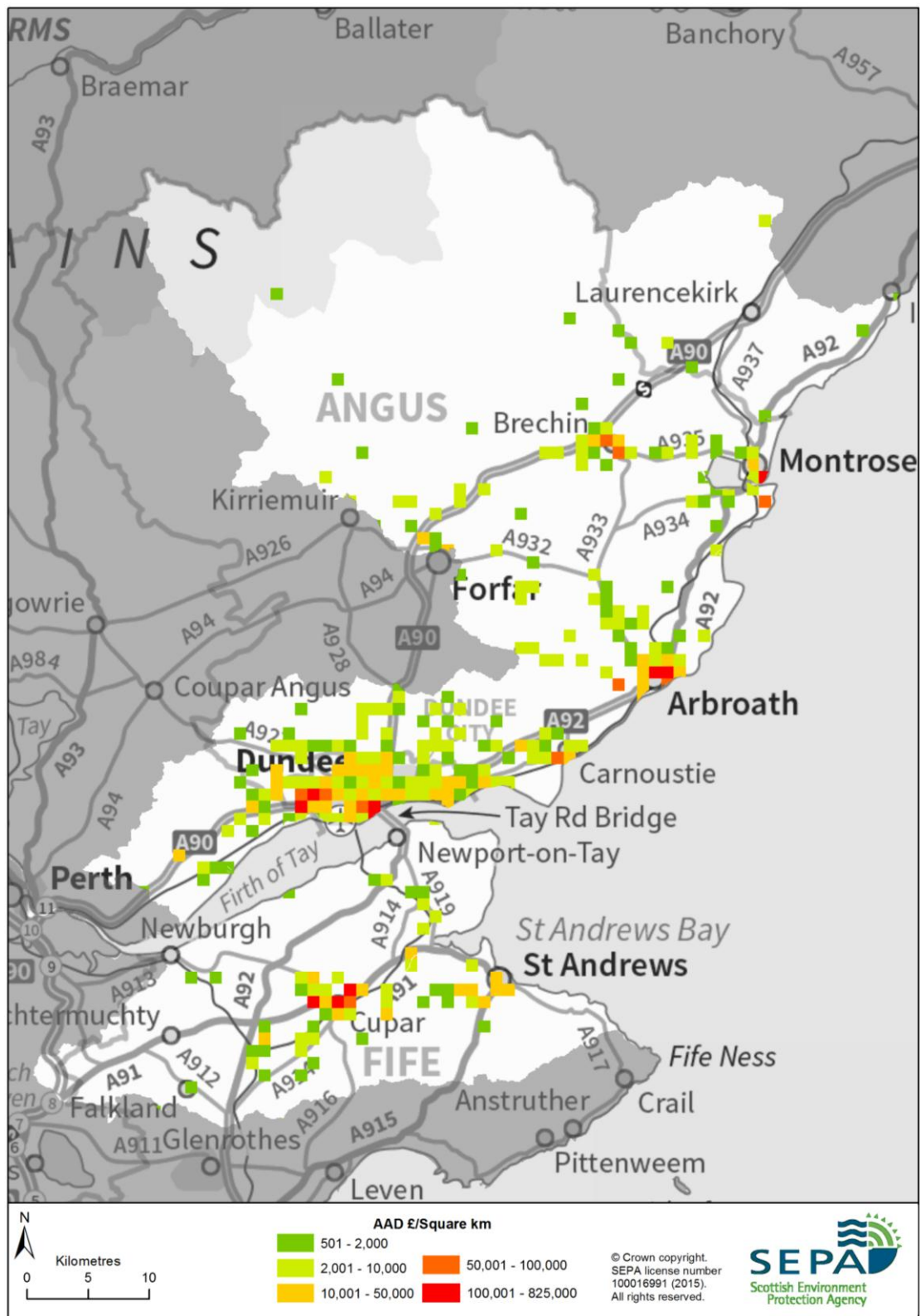
	Number at risk	Further detail
<b>Community facilities</b>	<10	Includes: educational buildings, healthcare services and emergency services
<b>Utility assets</b>	120	Includes: electricity substations, fuel extraction sites and telephone exchanges
<b>Roads (excluding minor roads)</b>	50	20 A roads at 630 locations 30 B roads at 230 locations
<b>Railway routes</b>	4	Dundee to Aberdeen (140 locations at risk) Dundee to Dunblane (30 locations at risk) Dundee to Ladybank (40 locations at risk) Perth to Ladybank (20 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 128 designated cultural heritage sites are at risk of surface water flooding. These sites include scheduled monuments, gardens and designed landscapes and listed buildings.

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



**Figure 1: Annual Average Damages from surface water flooding**

## History of surface water flooding

A number of surface water floods have been recorded mostly affecting Dundee.

Perhaps the most significant surface water flood occurred on 11 August 2004 in Dundee city centre and many smaller locations across the city. Additionally the green urban fringe of the city was affected by surface water runoff causing some roads to become impassable. The rainfall was estimated to have a 1 in 200 year magnitude.

A recent surface water flood occurred on 7 September 2010 in Dundee when businesses were forced to evacuate staff in Seagate, West Henderson's Wynd, Hospital Street and Dock Street.

The earliest surface water flood on record occurred on 16 August 2004 again in Dundee when the city centre was affected resulting in basement flooding and disruption to traffic flows. The rainfall was estimated to have a 1 in 100 year magnitude.

Further detail about the history of flooding 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.

### 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 the relevant Potentially Vulnerable Area chapters in Section 2.

### Flood protection schemes

There are two formal flood protection schemes for the management of surface water:

- Dunshalt Village Flood Protection Scheme
- Millfield of Cupar Flood Protection Scheme.



## Community groups

The following community groups are known to operate within the Tay Estuary and Montrose Basin Local Plan District:

- Carse of Gowrie Sustainability Group
- Dighty Flood Action Group
- Edzell Community Flood Action Group
- Falkland Flood Action Group
- Ferryden Flood Action Group
- Fettercairn Flood Resilience Group
- Freuchie Flood Action Group
- Kettle and District Flood Action Group
- Strathmartine Flood Group.

## Property level protection

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

- Aberdeenshire Council provides a range of flood protection products at a cost price with free delivery across Aberdeenshire, available for all types of flooding
- Aberdeenshire Council also owns and operates river level gauges on telemetry for Fettercairn and Marykirk
- Angus Council uses sandbags in some high risk areas as part of an emergency response plan
- Fife Council operates an emergency flood plan
- Fife Council also installed flood pods containing flood protection products close to areas with properties at risk of flooding.

## 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 pluvial 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 1,100 to 1,600 and the number of non-residential properties from approximately 860 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.