Background Paper - Flooding, Coastal Erosion, Water Quality and Water Scarcity

National position

The Flood Risk Management (Scotland) Act (2009) sets out that Local authorities must ensure local accountability relating to flood risk by leading on the preparation of local flood risk management plans, which supplement the national strategies prepared by SEPA and ensure actions are locally targeted and delivered. Local authorities also have the ability to make and build flood protection schemes.

National Planning Framework 4 – Policy 22 relates to Flood Risk and water management. Is sets out that Local Development Plans *"should strengthen community resilience to the current and future impacts of climate change, by avoiding development in areas at flood risk as a first principle. Resilience should also be supported by managing the need to bring previously used sites in built up areas into positive use; planning for adaptation measures; and identifying opportunities to implement improvements to the water environment through natural flood risk management and blue green infrastructure.*

Plans should take into account the probability of flooding from all sources and make use of relevant flood risk and river basin management plans for the area. A precautionary approach should be taken, regarding the calculated probability of flooding as a best estimate, not a precise forecast. For areas where climate change is likely to result in increased flood exposure that becomes unmanageable, consideration should be given to alternative sustainable land use."

Fife position

Fifeplan policy 12 on flooding and the water environment seeks to manage flood risk and surface water in order to avoid or reduce the potential for surface water flooding. It safeguards the functional floodplain and seeks to improve the quality of the water environment.

Fife Council has produced guidance on flooding and surface water management which includes links to other national guidance documents

Flood Risk in Fife

The Fife Strategic Flood Risk Assessment assesses the risk of flooding across Fife taking into account all sources of flooding.

River, Coastal and Surface Water flooding.

SEPA has mapped flood risk from river (fluvial) coastal and surface water sources (v2), this data has been used to determine the functional flood plan in Fife. Since the release of version 2.0 flood maps SEPA has published an updated 'Climate change allowances for flood risk assessment in land use planning' (March 2022). This documents updates figures for peak flow and peak rainfall allowances - the climate change uplift which needs to be taken into account as part of the consideration of flood risk (see table 1). Fife is covered by two river basin regions: Tay - which covers most of Fife, and Forth - which covers a relatively small area to the west of Fife (see figure 1 below).

Figure 1: Map showing river basin regions covering Fife.

METRIC	LUPS-CC1-v1 (Forth)	LUPS-CC1-v1 (Tay)	LUPS-CC1-v2 (Forth)	LUPS-CC1-v2 (Tay)	Note
Peak River Flow	40%	35%	56%	53%	Total change to the year 2100
Peak Rainfall Intensity	35%	35%	39%	39%	Total change to the year 2080
Sea Level Rise	0.86	0.85	0.86	0.85	Cumulative rise (in metres) from 2017 to 2100

Table 1: Climate Change uplift allowances for Forth and Tay river basins – comparison between version 1 and version 2 figures.

The predicted impact of this uplift on areas at risk of flooding has not yet been mapped.

As a result of the updated climate change uplifts and applying the precautionary principle it has been agreed that Fife Council will use the SEPA 1:1,000 River and Surface Water flooding extent maps as the key data to inform the Fife Strategic Flood Risk Assessment. There has been no update on the predicted sea level rise in Fife as part of the revised allowances.

Fife Strategic Flood Risk Assessment

A Strategic Flood Risk Assessment has been commissioned for Fife. The first stage of the work will support the evidence report and:

- provide a strategic overview of flood risk and flood risk management actions in the LDP area and will involve the collection, analysis and presentation of all existing and readily derivable information on flood risk and flood risk management actions from all sources;
- identify the flood risk area or area at risk of flooding in Fife, from all sources of flooding including from coastal erosion and geomorphic change;
- identify any significant cross boundary flooding and water issues;
- identify land with the potential to contribute to managing flood risk including natural flood management opportunities. This should include areas that have been identified for managed retreat/relocation arising from formal flood risk management planning processes;

- consider the cumulative impact on surface water management relative to planned and permitted development, which is considered likely to come forward, this should include any valid planning permissions and programming information from the most up to date land use audits and the FIFEplan Action Programme.

SEPA published guidance for planning authorities on Strategic Flood Risk Assessments in Oct 2023. This guidance reflects new policies in National Planning Framework 4 and the requirements of the evidence report stage of Local Development Plan processes. The Fife SFRA was developed based on interim advice provided by SEPA on what the SFRA should cover at for the evidence report.

Flooding from sewers

Up to the 1980's foul sewage generated from within properties (ie toilets, baths, sinks, etc) was mixed with surface water in a single pipe called a combined sewer. Due to environmental and flood risk management considerations, it is now recognised best practice to separate out foul sewage from surface water because of issues with the capacity of these pipes.

Retrofitting surface water management and reducing surface water intake is a key priority for Scottish Water. Their surface water policy sets out that they will not accept any new surface water connections to their combined sewers network. This is because the combined sewer pipes have a fixed capacity, which can be overwhelmed in periods of very intense rainfall. The volume of rainfall is not able to enter the gulleys and to be drained underground quick enough and can lead to localised pluvial flooding in natural low spots, taking with it pollutants and debris. This issue is becoming more prevalent as a result of climate change impacts.

The potential of flooding from combined sewers has been modelled by Scottish Water – it is referred to as section 16 mapping (which relates to the section in the Flood Risk Management (Scotland) Act 2009 which requires this to be mapped).

An integrated catchment study (ICS) is being carried out for the Dunfermline and Iron Mill Bay catchments which includes Rosyth to support the surface water management plan process and improve knowledge and understanding of surface water flood risk and interactions with other sources of flooding e.g. with the sewer network, watercourses and the sea. This work is being led by Scottish Water.

Flood Risk from reservoirs

SEPA has developed inundation maps to show areas at risk from uncontrolled releases of water from reservoirs. Each reservoir has been assigned a high, medium or low risk designation category depending on the impacts on receptors within the inundation zone in the extremely unlikely event of an uncontrolled release of water.

SEPA has produced a position statement regarding the use of these maps for land use planning – it includes the following text regarding the use of the maps for land use planning purposes:

"SEPA has carefully considered the usefulness of the information contained within the published reservoir inundation maps for other purposes, including land use and development planning.
A key consideration of this assessment is that it is not currently possible to assess the probability of an uncontrolled release of water from a reservoir in a manner consistent with the Flood Risk Framework within Scottish Planning Policy (SPP). Furthermore, the probability of failure of a reservoir structure managed under the 2011 Act is considered to be so low that it is beyond the scope of likely probabilities considered within the SPP Flood Risk Framework.
For these reasons the reservoir inundation maps are not considered to be appropriate to usefully inform flood risk advice within the context of Section 72 of the FRM Act and Scottish Planning Policy. It has therefore been concluded that the reservoir inundation maps should not be used for land use planning purposes*"*

This means that the reservoir inundation maps will not be used to inform the 2022 Fife Strategic Flood Risk assessment work.

Groundwater flooding
SEPA Groundwater flood risk mapping - The map is of a strategic nature to support flood risk management planning at a community level – the map provides an indication of the areas where groundwater could contribute to flooding from other sources.

Formal flood protection schemes
There are nine formal flood protection schemes in Fife which are protected by legislation (see table 2). These were built to a provide a standard of protection. However, the level of protection provided by these schemes has reduced over time and there is no contemporary assessment of the level of protection currently being provided by our flood protection measures, (the last time the level of protection was formally assessed was in 2007). What can be assumed is that they are not protecting as much land or as many properties as before.
One example is that of Cairneyhill Flood protection scheme. This once provided protection against 1:200 yr events – however, it is thought that this is now more likely to provide a 1:25 yr flood event level of protection today. (Source: Fife Council Flood Officers)
The Scottish Flood Defence Asset Database (SFDAD) provides flood risk management practitioners with access to information on Flood Protection Schemes and their associated defence assets within Scotland. SFDAD provides a record of where flood protection schemes exist, the level of protection provided and the general areas benefitting from these defences.

Table 2: List of Flood Protection Schemes in Fife

	Flood Protection Scheme	Scheme year	Type of flooding	Water course
1	Cairneyhill	1989	Fluvial	Torry Burn
2	Kincardine on Forth	1991	Tidal/fluvial	Peffermill Burn
3	Parkneuk	1987	Fluvial	Baldridge Burn
4	Dunfermline	2010	Fluvial	Tower Burn Lyne Burn
5	Auchtermuchty	1996	Fluvial	Auchtermuchty Burn
6	Dunshalt Village	1996	Pluvial	Surface run-off
7	Millfield of Cupar	1994	Pluvial	Surface run-off
8	Ceres Village	1994	Fluvial	Ceres Burn Craigrothie Burn Latch Burn
9	Pitscottie Village	1994	Fluvial	Ceres Burn Kininmonth Burn Blebo Burn

Flood Risk Management Plans
Fife is mainly covered by the Tay Estuary and Montrose Basin Local Plan District FRMP and the Forth Estuary Local Plan District FRMP, although there are also some very small parts of Fife covered by the Tay and Forth FRMP's (see figure 2).

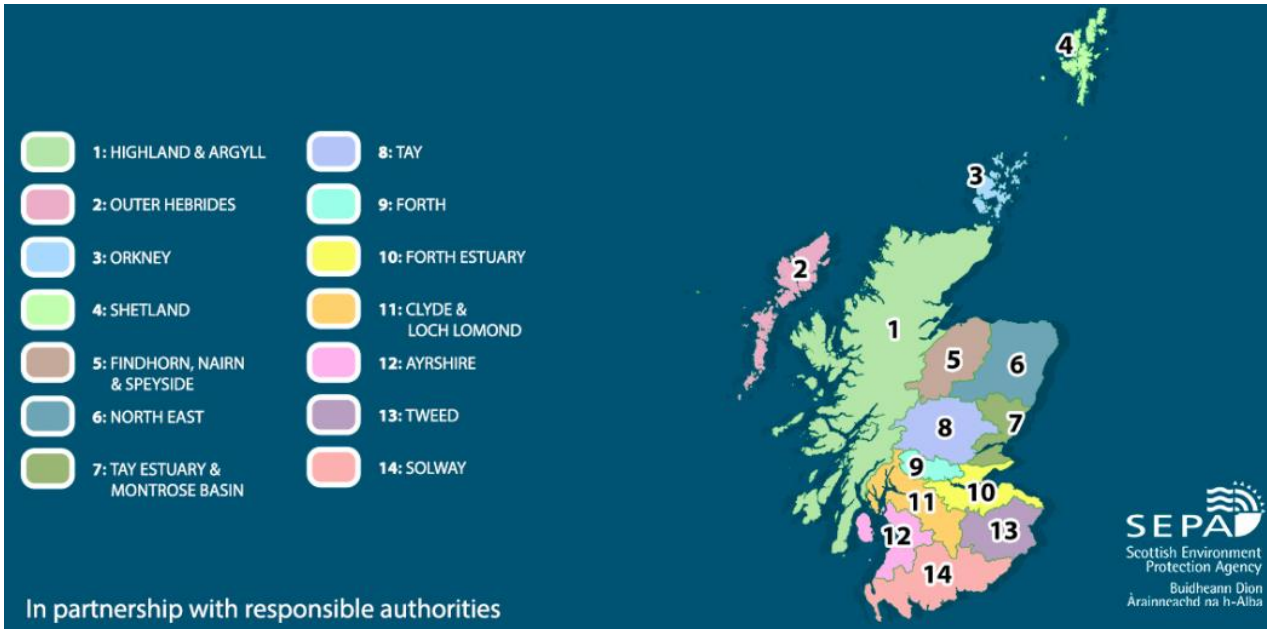


Figure 2: Flood Risk Management Plan Local Plan Districts in Scotland

These Flood Risk Management Plans identify potentially vulnerable areas within the local plan district; they set out the extent of risk in these areas and identify objectives and actions to manage that risk - including the need for more detailed flood studies or additional flood protection schemes.

Flood Studies
Flood risk management plans identify where more detailed information is required to assess flood risk. Table 3 sets out where additional flood studies have been carried out or are proposed to provide more detailed information and actions to manage flood risk.

Table 3: Flood Studies identified in Fife and current status

Area	**Status/ LFRMP timescale**	**Notes**
Flood risk from River Leven and Scoonie Burn	2022-28	Scoonie Burn Flood study is underway as part of the wider Leven Flood Study. Due to complete mid-April 2024.
East Wemyss flood study	Outline design and optioneering complete	Preferred option identified next stage to submit for funding.
Glenrothes Flood Study	Complete	No actions recommended to protect properties - not being taken further.
Kinglassie Flood Study	Complete	Works partially complete (culvert replacement) Property Flood Resilience and enhanced vegetation management still to be carried out.
Linktown (Kirkcaldy) Coastal Erosion/Flood Study	Outline design and optioneering complete	Detailed design and tender package work expected to be issued 2024-25
Cardenden Flood Study	Outline design and optioneering complete	Replacement bridge, walls and embankment work being progressed.

Cowdenbeath Flood Study and Surface Water Management Plan	Underway	Outline Design / Optioneering stage due for completion late-Jan 2024.
Dunfermline Flood Study	Outline design and optioneering complete	Detailed design and tender package work expected to be issued 2026-27
Rosyth Flood Study	2022-28	Priority area for Fife Council – Outline design work to be carried out as part of a package of 10 flood studies.
Rosyth Surface water Management Plan	complete	
Cairneyhill Flood Study	Outline design and optioneering complete	Detailed design and tender package work expected to be issued 2024-25
Kincardine and Culross Flood	Outline design and optioneering complete	Detailed design and tender package work expected to be issued 2024-25
Newburgh Coastal Erosion/Flood Study	Outline design and optioneering complete	Detailed design work would be required but is not currently being progressed
Kinness Burn Flood Study	Outline design and optioneering complete	Detailed design and tender package work expected to be issued 2024-25
Pitscottie and Kemback Flood Study	Outline design and optioneering complete	Detailed design and tender package work expected to be issued 2026-27
River Eden and Lady Burn Flood	Completed	Preferred option identified but high cost – staged approached being considered
Kingskettle and Kettlebridge natural flood management study	2022-28	Not yet started
Dunshalt natural flood management study	2022-28	Not yet started
Auchtermuchty Flood Study	Outline design and optioneering complete	Detailed design and tender package work expected to be issued 2026-27

Other flood risk management works required:

Freuchie Mill Flood study	Close to completion	Not a formal flood study under the flood act.
High Valleyfield		Minor earthworks to deflect water from leaving the trunk road towards the Bluther Burn.
Lade Braes, Dalgety Bay	Outstanding	Land drainage work required for housing development

Natural Flood Risk Management

Natural flood management involves balancing and integrating the restoration of natural features and processes with existing land uses. It does not therefore involve large scale land set aside but seeks to provide additional protection and climate proofing where defences are vital or already exist. Natural flood management may be used alongside more traditional engineering methods to help reduce, for example, the required height of flood walls or embankments, or to extend their life. Where the cost of traditional flood defences cannot be justified, such as where the number of properties at risk is very small, natural flood

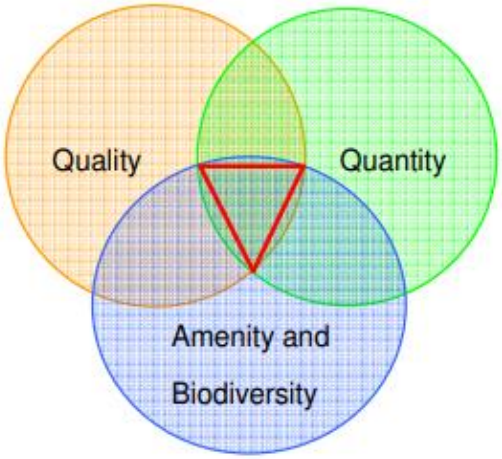
management might also be the most cost effective way for local communities to address flooding.

SEPA has produced a Natural Flood Management Handbook and mapped opportunity areas which have the most potential for natural flood management measures including:

- Run off reduction, - areas across Fife identified
- Floodplain storage – areas identified in the Howe of Fife and south of the Tay Coast and around Loch Ore, Loch Gelly and Loch Fitty;
- Sediment management – opportunities identified along watercourses;
- Estuarine surge attenuation – areas along the Tay Coast, Eden Mouth and west of Dalgety Bay identified;
- Wave energy dissipation – areas all along the Fife coast identified.

Sustainable Drainage Systems

Sustainable Drainage Systems (SuDS) refer to drainage systems that manage surface water, they take into account water quantity and quality (flooding and pollution), they should also consider biodiversity and amenity.
SUDS for Roads (2010) sets out the three-way urban drainage triangle which promotes the management of surface water runoff so that it minimises the impacts of development on the quality and quantity of road runoff, whilst maximising amenity and biodiversity opportunities.



Urban Drainage Triangle

SuDS are more sustainable than traditional drainage methods because they:

- Manage runoff volumes and flow rates from hard surfaces, reducing the impact of urbanisation on flooding
- Provide opportunities for using runoff where it falls
- Protect or enhance water quality (reducing pollution from runoff)
- Protect natural flow regimes in watercourses
- Are sympathetic to the environment and the needs of the local community
- Provide an attractive habitat for wildlife in urban watercourses
- Provide opportunities for evapotranspiration from vegetation and surface water
- Encourage natural groundwater/aquifer recharge (where appropriate)
- Create better places to live, work and play.

SuDS may also allow new development in areas where existing sewerage systems are close to full capacity, thereby enabling development within existing urban areas.[1]
A key issue for SuDs is vesting (adoption) and long term maintenance. Under Section 7 of the Sewerage (Scotland) Act 1968 a roads authority and Scottish Water may enter into an agreement on the provision, management and maintenance of Sustainable Urban Drainage Systems (SUDS), sewers and drains. Some councils have entered a collaborative agreement with Scottish Water whereby Scottish Water would maintain underground components of SuDS and the local authority would maintain the landscape elements of above ground components. Fife Council has not to date entered into a section 7 agreement with Scottish Water and long-term maintenance of SuDs remains an issue in Fife. Scottish Water is currently working through a backlog of unvested assets to assess the potential to vest them if they comply with Sewers for Scotland requirements.
Fife Council does not hold a record of all the SuDs that have been constructed in the area.

Coastal Erosion

Fife Shoreline Management Plan

The Fife Shoreline Management Plan provides an assessment of the risks associated with shoreline evolution, coastal flooding and erosion and presents a framework for policy to address risks to people and the developed, historic and natural environment for a sustainable future. Shoreline Management Plan's provide a large scale assessment of the coastal flooding and erosion risks and provide guidance and advice to operating authorities and private landowners on the management of their defences.

The current Shoreline Management Plan for Fife was published in 2011 and is now considerably out of date. Work on a revised Shoreline Management Plan for Fife (to be called an Adaption Plan) has started but there is no timescale for publication.

Dynamic Coast 2 project
The Dynamic Coast project was set up to provide the strategic evidence base on the extent of coastal erosion in Scotland. It is intended to support Scottish Government and Scottish Public Sector decision-making and indicate areas of highest coastal erosion risk, where a more detailed evidence base may be required. The initial research was published in 2017 it was updated and superseded in 2021 with Dynamic Coast 2 mapping which includes increased extents of eroding shoreline and the latest climate change projections on sea level rise.

The areas in Fife predicted to be at most risk from coastal erosion in the Dynamic Coast 2 mapping include:

- Land to the north and south of Tentsmuir Forest;
- West and East Sands, St Andrews;
- The East Neuk coast;
- The Wemyss coast;
- Pathhead Sands and Seafield in Kirkcaldy;
- The coast between Kirkcaldy and Inverkeithing
- Rosyth to Limekilns coast.

Geomorphic Risk
SEPA have mapped Geomorphic risk data. This data identifies sections along the river network where channel adjustment is likely to be significant, which is relevant to existing and proposed development as a result this information also identifies areas where undeveloped riparian buffers would be beneficial.

The mapping identifies the following areas in Fife where channel adjustment is predicted to be significant:

- River Eden through Cupar, Strathmiglo and Gateside
- River Leven through Levenmouth, Glenrothes, Leslie,
- River Ore and Den Burn in Cardenden;
- Lyne Burn in Dunfermline;
- Brankholm Burn in Rosyth and Inverkeithing
- Bluther Burn at High Valleyfield and Newmills.

Water Quality in Fife
River basin management planning (RBMP) protects and improves Scotland's water environment for the benefit of people, wildlife and the economy. SEPA is the lead agency delivering the river basin management plans and their objectives in Scotland. SEPA also

monitors the water environment by assessing water quality and quantity, and bathing waters.
Fife overall condition of surface water in 2020 (see figure's 3, 4 & 5).

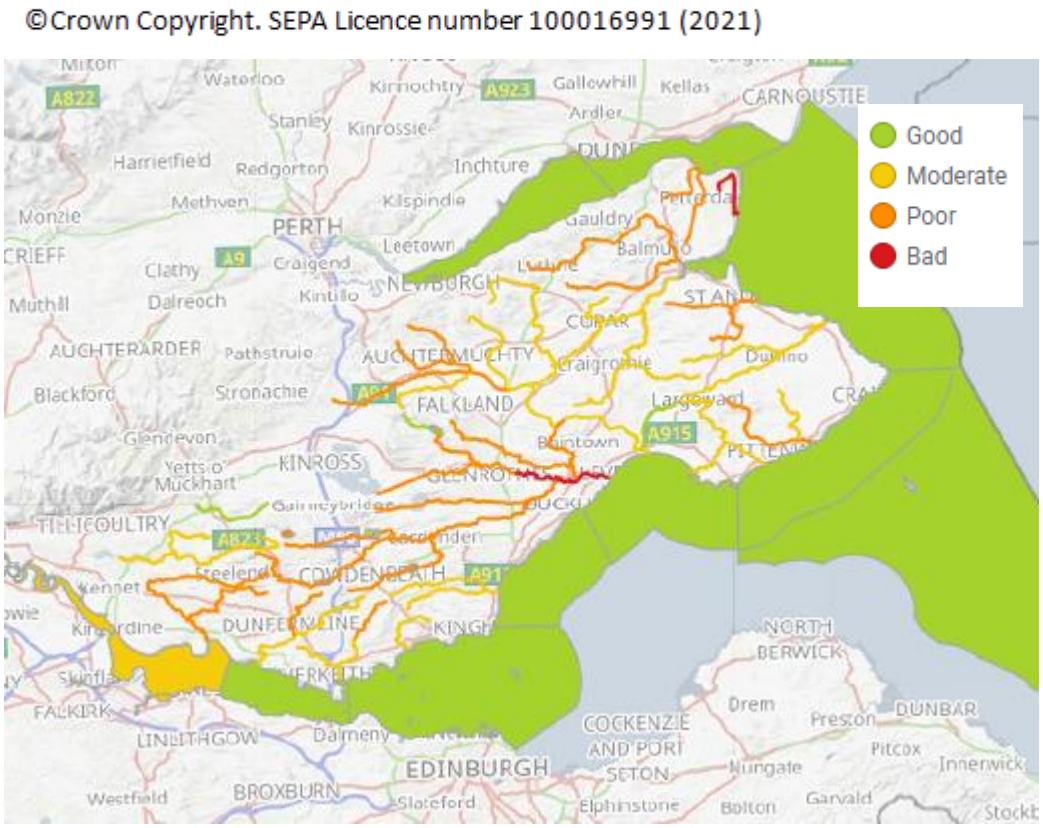


Figure 3: Overall condition of surface water in Fife - 2020
Source: https://informatics.sepa.org.uk/RBMP3/

The following water courses have been identified as bad quality (red on the above map):

Tentsmuir Sands Burn/Drain is a river in the North Fife Coastal catchment. The main stem is approximately 6.1 kilometres in length. Pressures identified:

- Modifications to the bed, banks and shores of the river due to forestry activity.
- Diffuse pollution from rural sources.

River Leven (Markinch to Estuary) is a river in the River Leven (Fife) catchment. The main stem is approximately 10.7 kilometres in length. Pressures identified:

- Barriers for fish migration from legacy structures
- Unknown pressures on water animals and plants
- Modifications to bed banks and shores from urban development
- Water abstraction from agricultural irrigation, business water use and hydroelectricity generation

Work is currently progressing on the River Leven which should help address some of these issues.

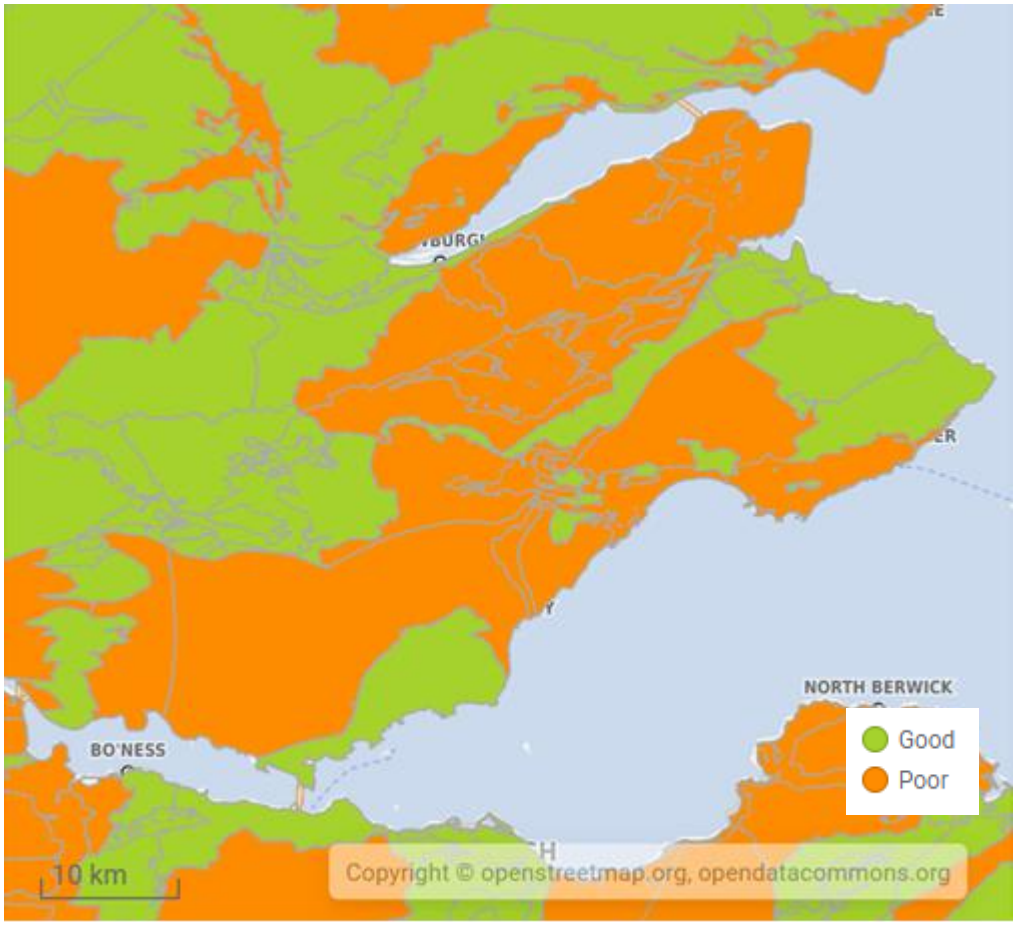


Figure 4: Ground water quality in Fife – 2020
Source: https://informatics.sepa.org.uk/RBMP3/

The following groundwater areas were assessed as in poor condition (shaded orange on Figure 4):

Methil groundwater - 164.3 square kilometres in area. Water quality was assessed as poor due to legacy pollution from mining or quarrying. Action to address the water quality in the is to be completed by 2027 but it is expected that ecological recovery will take longer.

Wormit groundwater - 119.7 square kilometres in area. Water quality assessed as poor due to diffusion from rural activities. Long term projection for good status.

Tentsmuir Coastal groundwater - 67.9 square kilometres in area. Water quality assessed as poor due to diffusion from rural activities. Long term projection for good status.

Auchtermuchty groundwater - 98.8 square kilometres in area. Water quality assessed as poor due to diffusion from rural activities. Projection for good status by 2027.

Eden Valley groundwater – 58.6 square kilometres in area. Waterflows and levels are assessed as poor due to water abstraction from agricultural irrigation, this will be addressed through regulation.

Falkland groundwater – 136.5 square kilometres in area. Waterflows and levels are assessed as poor due to water abstraction from agricultural irrigation, this will be addressed through regulation.

Leven Valley and South Fife Coastal groundwater – 75.5 square kilometres in area. Waterflows and levels are assessed as poor due to water abstraction from agricultural irrigation, this will be addressed through regulation.

Dunfermline and Kirkcaldy groundwater - 276.0 square kilometres in area. Waterflows and levels were assessed as poor due to water abstraction from business water use activities. Projected to be good condition by 2027. Water quality was also assessed as poor due to legacy pollution from mining or quarrying. Action to address the water quality has been completed but it is expected that ecological recovery will take longer.

Culross groundwater - 58.8 square kilometres in area. Water quality was assessed as poor due to legacy pollution from mining or quarrying. Action to address the water quality has been completed but it is expected that ecological recovery will take longer.
Alloa groundwater - 62.3 square kilometres in area. Water quality was assessed as poor due to legacy pollution from mining or quarrying. Action to address the water quality has been completed but it is expected that ecological recovery will take longer.
Balbeggie groundwater – 9.4 square kilometres in area. Water quality was assessed as poor due to legacy pollution from mining or quarrying. Projection for long term good status.
Glenrothes groundwater – 81.9 square kilometres in area. Waterflows and levels are assessed as poor due to business abstraction from agricultural irrigation, this will be addressed through regulation.
Since the previous assessment of water quality in 2014 there have been actions carried out to improve the quality of groundwater across a number of areas in particular, Leven Valley and South Fife Coastal, Eden Valley, East Neuk, Falkland and Glenrothes areas.

Figure 5: Bathing water quality in Fife 2020.
Source: https://informatics.sepa.org.uk/BathingWaters/

The following protected bathing waters in Fife are identified as poor:

- Kinghorn (Harbour Beach)
- Lower Largo

The principal pollution risks to these bathing water areas are from sewage sources. There is a risk that water pollution may occur after heavy rainfall. Bathing is not advised during or 1-2 days after heavy rainfall.

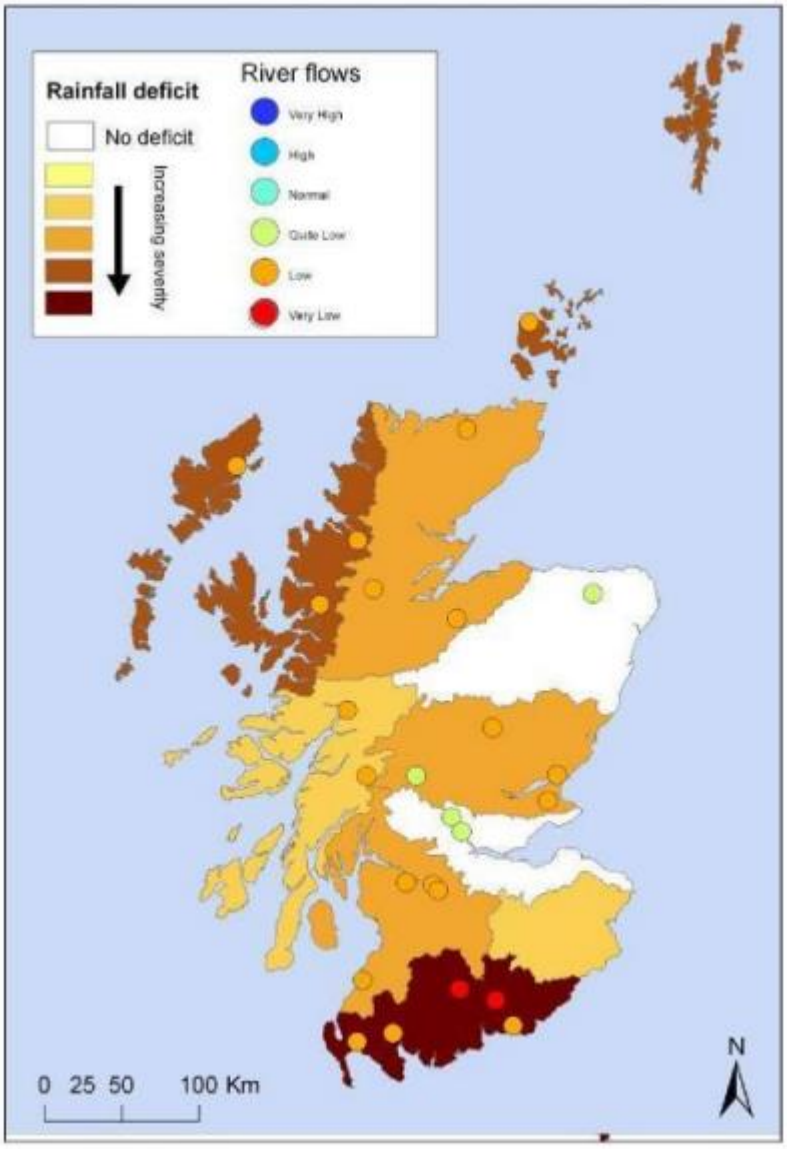
Water resilient places

Scottish Government published a Policy Framework for Water Resilient Places in Feb 2021 having identified the need to improve how we manage surface water in Scotland. Urban areas in particular face mounting challenges with surface water drainage and related flooding; and despite considerable capital investment, the continued densification of our towns and cities is adding to the pressure on drainage systems that are already at

capacity.The framework sets out three challenges that need to be addressed through cross sector working:
1. Facing up to the climate emergency – both mitigation and adaptation;
2. Delivering great blue-green places to live (at all scales) that are adaptable to future conditions;
3. Tackling surface water flooding.
To help with this challenge new development needs to be appropriately sited and designed and existing buildings need to transition to managing rainwater through blue green infrastructure instead of sewers in order to reduce the pressure on our drainage systems. Scottish Water has been particularly active in looking for opportunities to remove surface water from the combined sewer network. They have carried out studies and projects mainly in the more densely urban parts of Scotland but are now working with other Local Authorities. In Fife they are involved in partnership working on a number of projects including the Levenmouth Connectivity programme.
Creating water resilient places and managing surface water by utilising green and blue infrastructure has the potential to have wider benefits in terms of biodiversity enhancement, building nature networks and providing attractive greenspaces for people.

Community resilience
Community resilience is about communities and individuals using their collective resources and skills to help themselves prepare for, respond to and recover from emergencies. Flooding is one of the most common emergency situations in Scotland and affects many homes and communities.
Fife Council has a dedicated webpage for community resilience arrangements which provides advice, guidance and resources to support communities looking to form their own community resilience group. There are a number of such groups in Fife such as Cardenden Community Resilience Group which aims to build community resilience by raising awareness, support and funds for the residents of Cardenden.
Fife Council is helping communities affected by flooding to manage the response themselves by installing 42 flood 'pods' close to properties affected by flooding. The pods contain materials which can be used by individuals to protect their properties from flooding.

Water scarcity
The first National Water Scarcity Plan for Scotland was published in July 2020. It is a recognition that water scarcity is increasingly becoming an issue in Scotland due to climate change; with more prolonged periods of dry weather creating stress on public water supplies and private abstractions.
SEPA are responsible for the forecast, monitoring and report of the situation facing Scotland's water resources and produces a regular report during the summer months.



The north of Fife is the most affected by water scarcity. This map from the Scottish National Water Scarcity Plan shows that this part of Fife has generally a slight rainfall deficit and low river flows.
Water scarcity is a particular problem in North East Fife because many domestic properties north of the A92 between Newburgh and Balmerino are connected to private water supply sources such as springs, burns and shallow wells which can dry-up during summer; this is also a rural area with arable land which needs to be irrigated in dry spells. In August 2022 the water in the River Eden catchment reached 'significant scarcity' and river and groundwater levels became 'critical'. As a result SEPA suspended the majority of water abstraction licences in the River Eden catchment to protect the sustainability of local water environments. https://www.bbc.co.uk/news/uk-scotland-edinburgh-east-fife-62518164

Fife Council has published advice for private water supply owners and will provide emergency water provision when required. Fife Council informs SEPA of issues with private water supplies to help them understand the extent of water scarcity issues in the region.

Impact of water scarcity on biodiversity & habitat
Dry weather conditions causing low river flows and loch levels are natural and the ecology can generally adapt to the natural range of conditions. If dry weather is prolonged however, there comes a point where environmental impacts do occur.

As river levels drop, the depth and width of the channel will contract and flow velocities will reduce. This may fragment the river and reduce the suitable habitat space. In very shallow rivers the oxygen content can fall (as the water temperature rises or through respiration by aquatic plants) causing fish kills. A low flow in a river may prevent migratory fish from moving upstream and disrupt food supplies by impacting on aquatic invertebrates.