3: Flood Risk

Defining the Flood Risk

The latest computer modelling techniques have been used to estimate the likelihood of flooding from the Gelly Burn, the South Queich, the Clash Burn and Loch Leven.

A range of river flows have been estimated for different flood events based on rainfall data, historic flow data and catchment characteristics. These flows were independently checked by, and agreed with, SEPA.

The estimated river flows were then applied to the computer model which contains the river channels, structures and floodplains, allowing us to see which areas may be at risk. We checked the model outputs against historic flood data, including recorded river flow information and photos/reports from affected areas. This gives us a best verified estimate of flood extent depth and velocity throughout the study area. Figure 5 illustrates the predicted flood extent and movement of floodwaters.

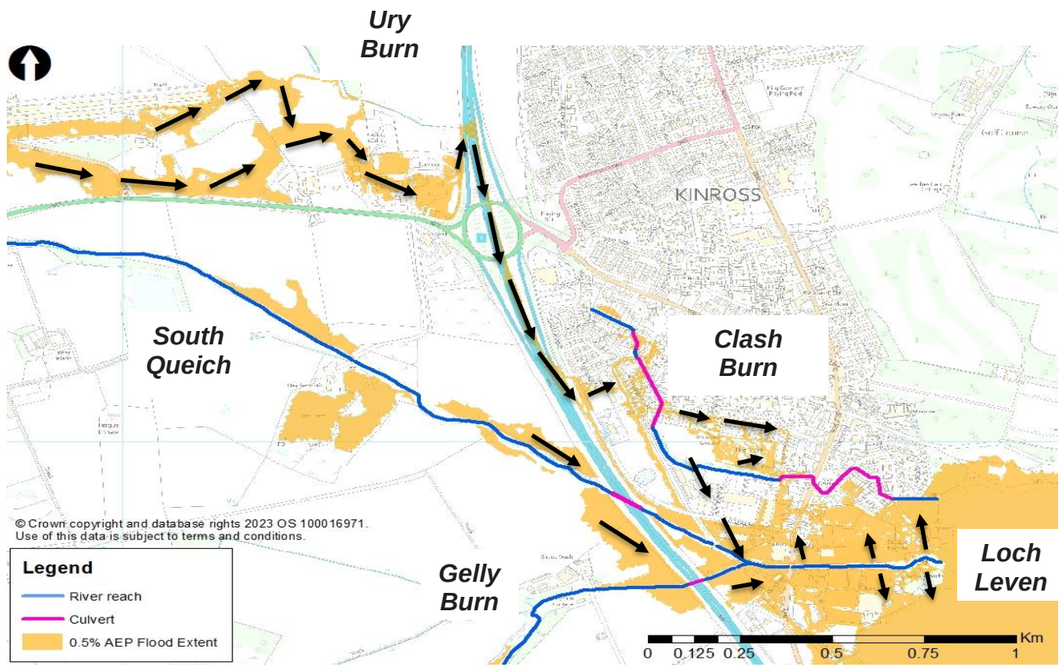

Figure 5: Predicted Flood Extent (1 in 200 year flood or 0.5% AEP)

Flooding Sources

Flooding on the South Queich and Gelly Burn occurs when the flow of water exceeds the capacity of the river channel. The limited flow capacity of culverts at various locations also contributes to flooding around Queich Place, Clashburn Road, High Street, Todd and Duncan, and the BCA sites.

The South Queich also floods upstream of the M90 when the river channel capacity is exceeded in extreme events. Flooding occurs at the Kinross Services adjacent to the M90, before spilling on to the M90 carriageway. The floodwaters flow south and interact with flooding from the Clash Burn near The Myre playing fields.

Flooding occurs on the Clash Burn when the flow capacity of the culverts at Montgomery Way and Hopefield Place is exceeded. The overland flow then travels south along Montgomery Way and Montgomery Street, resulting in limited flooding to various properties. Floodwater flows towards the Myre playing fields and affects residential properties on Smith Street.

Extreme water levels in Loch Leven impact commercial premises where the South Queich flows into the Loch. The South Queich also contributes to flooding here in extreme events.

Flood risk in numbers for a 0.5% AEP event

- 128 residential and 62 non-residential properties expected to be flooded from rivers, 4 commercial properties affected by Loch Leven
- Estimated Annual Average Damages of £2M
- Flood risk to roads including M90, Clashburn Way, High Street, Hopefield Place, Myre Terrace, Smith Street causing disruption to community
- Flood Risk to heritage assets – Loch Leven Heritage Trail and Special Protection Area impacted

Quantifying Flood Risk

Flooding is a natural phenomenon which can never be entirely prevented. The language used to describe flooding can be confusing. Floods of different magnitudes are described on a statistical basis as either:

- An **annual probability** – the percentage chance of a flood occurring in any year. This is known as the Annual Exceedance Probability – or AEP for short. The lower the AEP, the more severe the flood event (e.g. the flood with a 0.5% AEP will result in more flooding than the 10% AEP event).

- A **return period** - the statistical average length of time separating flood events of a similar size. The return period is a measure of the rarity of a flood event.

For example, the flood with a return period of 50 years can also be described as having a 2% chance of occurring in any one year.

This does not mean that the 1 in 200 year flood will only happen every 200 years, or that it will not happen again for 200 years - flooding can happen at any time.

See Figure 6 for a visual representation of AEP/return periods.

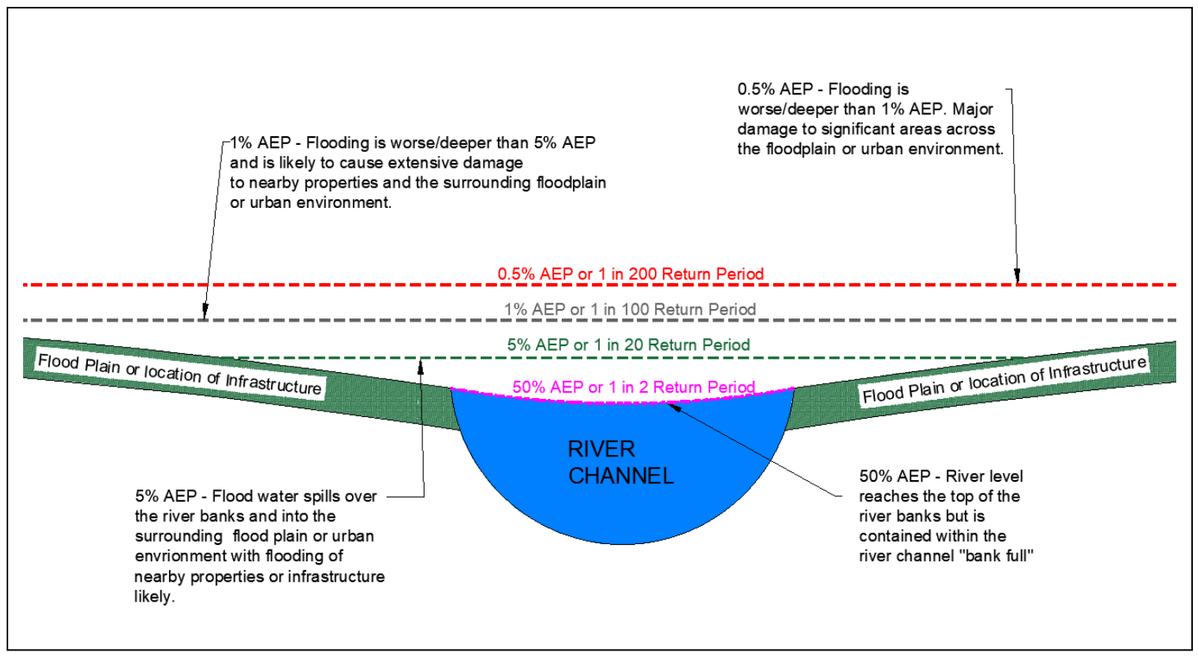

Figure 6: Visual representation of AEP and return periods.

Level of Flood Protection

The flood scheme investigations have considered various forms of flood defences to protect the area up to the 1 in 200 year flood event (the flood that has a 0.5% chance of occurring in any year).

RPS's investigations have used the peak flows in Table 2, which were agreed with SEPA and are based on recorded data (where available). Table 3 shows how these values compare to the four highest flows recorded since 2006.

The standard of protection for the scheme has been assessed considering a number of factors including:

- The height, extent and 'buildability' of the proposed flood defences
- The environmental impact of the scheme
- Climate change impacts and safety factor impacts ('Freeboard')
- The estimated costs of the design, construction, maintenance and safe operation of the proposed scheme

In addition to the 1 in 200 year peak flood levels, the proposed flood defences must also include 'freeboard' which provides a factor of safety to the design and accounts for the uncertainty within the hydraulic modelling, the type of flood defence and also the localised effects of water turbulence.

Recent SEPA guidance suggests increasing the peak design river flows by 39% to allow for future climate change. This has been fully considered as part of the investigations noted above. For the proposed flood scheme, it was not feasible to incorporate this for flood cells 1 (South Queich) and 3 (Kinross Services), in addition to the 1 in 200 year level of protection, due to the excessive heights of the proposed defences that would be required and the associated visual impact and 'buildability' issues. However, the foundation designs for the flood defences in these flood cells will allow for the flood defences to be raised in future to adapt to climate change if required. Climate change allowances have however been incorporated into the designs for flood cell 2 (Clash Burn).

The aim of the proposed scheme at Kinross is to protect the area against a 1 in 200 year flood event (the flood that has a 0.5% chance of occurring in any one year) with an addition for 'freeboard'.

A flood scheme can only protect up to a certain standard and there will always be a residual risk of water overtopping the flood defences, should a greater flood occur.

Table 2: Design flows for watercourses

Flood Event	Chance of Flood Being Exceeded in Any Given Year	Gelly Burn (m^3/s)	South Queich (m^3/s)
1 in 10 year	10.0%	5.2	19
1 in 30 year	3.3%	7	24
1 in 75 year	1.3%	9	29
1 in 100 year	1.0%	10	31
1 in 200 year	0.5%	11	36

Table 3: Comparison of Design Flows against Recorded Flood Events

Date of Event	Flood Event	Chance of Flood Being Exceeded in Any Given Year
13 December 2006	1 in 16 year	6% AEP
25/26 January 2008	1 in 33 year	3% AEP
Nov 2009 and March 2012	1 in 20 year	5% AEP
16 & 22 February 2020	1 in 50 year	2% AEP