River flood map development

This document contains more detailed information on how Northland Regional Council's river flood maps are developed, following the release of newly updated river flood mapping in November 2021.

How were the flood maps developed?

Flood maps are developed using computer models taking into consideration historic flood levels, topography, rainfall and river flows to provide an indication of areas potentially exposed flood risk. These maps are more accurate, include climate change elements and show the likely extent of river flooding during significant flood events. An area showing a 'one-in-10-year flood extent' has a 10% chance of flooding annually, whilst the more conservative 'one-in-100-year flood extent' has a 1% chance of flooding annually.

Described below are the different storm / flood scenarios that were modelled and are shown on our maps:

- Regionwide Rivers Flood Hazard Zone 1 (RRFHZ1) – the area potentially susceptible to river flooding in a 10% Annual Exceedance Probability (AER) / 10Yr Average Return Interval (ARI)
- Regionwide Rivers Flood Hazard Zone 2 (RRFHZ2) – the area potentially susceptible to river flooding in a 2% AEP / 50Yr ARI
- Regionwide Rivers Flood Hazard Zone 3 (RRFHZ3) – the area potentially susceptible to river flooding in a 1% AEP / 100Yr ARI plus climate change.

River flood hazard zones were developed by two different external expert consultants between 2016 and 2021. The layers are derived by advanced models using empirical calculations.

Two different models were used to construct the river flood layers: TUFLOW (Water Technology, 2021), InfoWorks (URS, 2016).

As part of the development of the regionwide river flood mapping we have also taken the opportunity to update (new generation) of some of our 'Priority Rivers" catchment. A full list of our catchments in the region, including the ones that have been updated can be found in the technical report section.

We have applied a 'confidence level' to the hydraulic models which generate the flood extend maps for our Region. With the new maps, existing Priority River maps, and very site-specific analysis these can vary in their site-specific accuracy or from a regional perspective.

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Catchments / Model – Confidence Level Criteria:

- Calibrated (flood levels) / Validated
- LiDAR data / contours
- 1D/2D Model
- 1D or 2D Model (surveyed cross sections and structures)
- Surveyed cross-sections, structures and flood levels
- Site Specific / General Flood Susceptible (RRFM, Priority Rivers and subsequent site more specific)

Confidence Level will be from 1 to 5; with 5 being the highest confidence. The confidence level is based on its flood extend output 'accuracy' at this moment in time.

Over time individual river / catchment models will be updated on a needs and priority basis. These confidence levels in relation to each catchment can be found in technical reports, which you can access from our flood maps web page.

How were flood study areas identified?

Council staff and external specialists determined (scoping) what council needed to undertake in order to meet its legislative requirement.

The team looked at a range of inputs to determine the type of study relevant to the region. This included elements such as flood history, type of flooding experienced (i.e. overland flow/stream/river), existing flood data (i.e. flood gauges), catchment profile and importantly, whether LiDAR (very accurate survey data) was available for the location.

This scoping study then determined whether an overland flow path, 1D / 2D flood study or historical study would be undertaken.

What is a flood study and flood mapping?

A flood study is a technical investigation of flood behaviour for a particular catchment, river or stream. The aims of a flood study are to define existing flood behaviour, including depths, extents and velocities, to help inform practices such as building, land use planning, community awareness and disaster management, with the aim of minimising risk and protecting people, property and infrastructure.

A flood map visually shows the flood behaviour of a certain historic event or a range of flood scenarios. A flood study will usually produce a number of maps for each flood scenario or simulation of a past event that show (at least) the following:

- flood extent (how far the water spreads);
- an indication of flood depth (how deep the water is across the flooded area);
- an indication of flood velocity (how fast and in which direction the water is travelling); and
- flood hazard (low, medium, high and extreme areas of hazard based on factors including velocity of the water and whether this poses a threat).

The extent, depth, velocity and hazard maps provide a good visual basis for understanding the potential flooding that may affect your property.

What does a ‘historic’ flood study mean?

Historic flood studies utilise local knowledge, historic information and analysis of stream flow in a study area to understand the nature and extent of flood behaviour, such as depth and hazard from a historic event. Historic studies usually include a hydraulic model to reproduce a specific flood event experienced in a catchment using the best available data (e.g. surveyed flood levels and anecdotal information). Its results may be compared to a range of simulated flood scenarios to determine a probability rating for the historic event (e.g. was it a relatively small, frequent flood or somewhere between that and a large and rare event).

What does a ‘2D’ flood study mean?

Two-dimensional or 2D studies are a comprehensive type of flood study and are generally considered to provide the greatest level of certainty. The 2D study uses hydrologic and hydraulic modelling tools and techniques and includes detailed analysis of results. These types of flood studies identify comprehensive flood information, such as flood discharges, levels, depths, velocities and hazards under existing catchment conditions for a range of design rainfall events, from small frequent events to large and rare rainfall events.

What is AER and ARI?

The terms AEP (Annual Exceedance Probability) and ARI (Average Recurrence Interval) are used to describe the probability of a flow of a certain size occurring in any river or stream.

ARI is the average time period it’s predicted will pass between floods of a certain size. For example, a 200-year ARI flood flow will occur on average once every 200 years. Alternatively, AEP is the probability of a certain size of flood flow occurring in a single year. A 0.5% AEP flood flow means that a one-in-200-year flood has 0.5 percent chance of happening in any one year. In short, we also call such a flood a 200-year flood.

Therefore, the 200-year ARI flow and 0.5% AEP flow are different terms to describe a flow of the same size.

How likely is it that a certain sized flood will occur?

When managing the risk from future flooding, we use computer modelling that takes into consideration all the available data and then predicts the likelihood of different size flood events within a given period.

But it’s important to note that natural events such as flooding don’t occur with any regularity. For example, a more extreme flood, such as one-in-200-year flood, means that in any given 200-year period, such a flood may occur once, twice or more or not at all.

The probability of such a severe flood event to happen in any one year is 0.5 percent (or has 0.5% Annual Exceedance Probability (AEP). On the other hand a less severe flood event, such a one-in-50-year period, means there’s two percent chance of it occurring in any one year.

This table that shows the probability of certain sized flood events occurring over a range of time periods (one, 10, 30 and 70 years).

While the probability of a major flood occurring in any one year is relatively low, the probability of a flood occurring over the lifetime of a person (or building) increases significantly.

ARI	AEP	In any 1-yr period	In any 10-yr period	In any 30-yr period	In any 70-yr period
50 yrs	2%	1-in-50 chance	1- in-5.5 (18%)	1-in-2.2 (45%)	1-in-1.3 (76%)
100 yrs	1%	1-in-100 chance	1-in-10 (10%)	1-in-4 (26%)	1-in-2 (51%)
200 yrs	0.5%	1-in-200 chance	1-in-20 (5%)	1-in-7 (14%)	1-in-3.3 (30%)
500 ys	0.2%	1-in-500 chance	1-in-50 (2%)	1-in-17 (6%)	1-in-7.7 (13%)

A 100-year ARI flood occurred 10 years ago. Does that mean there will not be another for 90 years?

No. While on average, the 100-year ARI flow may occur once every 100 years, the probability of a flow of that size occurring in any particular year does not change. This is best described using the term AEP (Annual Exceedance Probability).

If a 1 per cent AEP flood flow was recorded this year, the probability of another flow of that size being recorded in the following year (or any other subsequent year) would still be 1 per cent.
It is statistically possible to have several 100-year ARI flows over a single period of 100 years just as it is statistically possible to go for 100 years without a single 100-year ARI flow recorded.

Is the 100-year ARI flood twice as large as the 50-year ARI flood?

No. The ARI of a flood is simply a statistical term that indicates the probability of a certain flow occurring in a river. The 100-year flood is not twice the size of the 50-year flood, just as the 500-year flood is not five times the size of the 100-year flood.

For most rivers the increase in flow between the 100-year and 500-year ARI floods may be about 30 per cent to 40 per cent. When considering this in terms of actual rainfall the difference between a 100-year ARI and 500-year ARI river flow may only amount to a few extra hours of very heavy rain.

Is the 100-year flood flow the same for every river?

No. The flow assigned to a particular ARI flood event completely depends on the size of the river. As well as catchment size, variability in the amounts of rain that fall in different catchments will also affect ARIs during any given flood. In a major flood that affects numerous rivers, the return period of the flow generated in each river will vary across the region.

Does the flow assigned to a particular return period always stay the same?

No. New Zealand is a young country and the period over which river flow and flood records exist is relatively short.
As records increase for a particular river, and improvements in the way river flow is measured are made, we can assess the probability of certain flood flows more accurately. For this reason, we review and update the return periods assigned to different river flows every five to 10 years.

Climate change and its related impacts on the occurrence of extreme weather events and on rainfall distribution are also likely to alter the frequency at which various river flows occur and therefore affect the flows assigned by Environment Canterbury to particular Average Recurrence Intervals.

How is climate change considered?

Climate change impacts, such as increased rain intensity, have been included in the flood scenarios prepared in a for all the flood studies. Council recognises that the climate is changing and, based on good engineering practice, it is important the flood scenarios investigate possible climate change impacts for river flooding.