

September 2022

Glenugie to Devils Pulpit

Woolgoolga to Ballina Pacific Highway upgrade
Hydrological mitigation report summary



Australian Government



Bridge over the Clarence River at Harwood

The Australian and NSW governments are jointly funding the Woolgoolga to Ballina Pacific Highway upgrade.

In this update

- Flood behaviour in the region
- Our flood management objectives
- Flood model outcomes
- Design and mitigation
- Independent hydrologist
- Flood input and future planning

Building in flood prone areas

Keeping flood behaviour in mind

Floods are a regular part of life for many of the communities living near the Woolgoolga to Ballina Pacific Highway upgrade, which travels through the Richmond and Clarence River regional floodplains.

While floods can sometimes bring a welcome relief to land affected by drought, they often interrupt our way of life and have serious consequences for individuals, the environment and the economy.

Minimising the impact of the upgrade on water flow and drainage has therefore been an important objective during the design and construction of the highway.

Flood behaviour is influenced by many factors including rainfall, the capacity of a watercourse or stream network to carry runoff, weather conditions before rainfall, ground cover, topography, levee heights and tidal influences. Land use can also affect the occurrence and frequency of flooding by making an area more sensitive to flooding.

A major highway upgrade like Woolgoolga to Ballina can affect some of these factors. In this update we explain how the upgrade has considered these factors and how we have been working with local councils and emergency services to improve the region's flood preparedness.

The Woolgoolga to Ballina upgrade has been built to meet its Minister's Conditions of Approval (MCoA), improving highway flood immunity to between a one in 20 and one in 100 year flood event.

The new bridge over the Clarence River, pictured below, is one example of how the upgrade has been built with future floods in mind by:

- extending the length of the bridge
- aligning its piers with the existing bridge



Bridge over the Clarence River at Harwood

History of flooding in the Clarence River catchment

The Woolgoolga to Ballina upgrade travels through the Clarence River regional floodplain and a number of local catchment floodplains including the Coldstream River and Pillar Valley, Pheasant, Chaffin, Champion, Mororo and Tabbimoble creeks.

The Clarence River catchment is the largest on the east coast of NSW with a catchment area of about 22,700 kilometres. Major flooding occurred as recently as 2021 and 2022 with floods in 1980, 1996, 2001 and 2013 some of the highest on record.

We know it will flood again in the Clarence Valley. For this reason, the upgrade has been designed to minimise its impact on future floods and improve the flood resilience of the highway and connecting local roads than was previously available.

Generally, the highway will remain open longer, providing communities with better access to refuge and resources.

We have considered the distinct flooding behaviour of the upper, mid and lower Clarence River catchments and local floodplain systems. The lower floodplain areas, in particular, are subject to frequent and extensive flooding.

Existing flood behaviour of the Clarence River catchment

The Clarence River catchment extends from the Border Ranges in the north; the Northern Tablelands (Stanthorpe to Glen Innes) in the west and from the Doughboy Ranges and the Dorrigo Plateau in the south.

The river flows south, east and ultimately north-east to the Pacific Ocean at Yamba. It passes through a number of towns and small urban centres including Grafton, Maclean, Yamba, Harwood and Iluka.

The local catchments within the Clarence River floodplain system behave differently and will experience varied impacts during flood events.

Glenugie to Tyndale

The new motorway has been built on the edge of the regional floodplain east of the former highway. It crosses the lower Clarence River catchments of Pheasants Creek and the Coldstream River.

Pillar Valley, Chaffin and Champions creeks are tributaries of the Coldstream River which generally flow south to north or east to west across the alignment towards the Clarence River. The terrain in this area is undulating and is largely forested with some areas of cleared pasture in the valleys.

Tyndale to Maclean

The new motorway has been built in an undeveloped area about one to two kilometres east of the former highway and eastern bank of the Clarence River South Arm. Some parts of the former highway experience a flood immunity of less than a one in five year flood event.

Floodwater from the Clarence River interacts with a number of cane drain systems, flood gates, water/catchment basins and tributaries, including Crackers and Lees drains, Shark Creek, Chaselings Basin, and Edwards Creek.

Maclean to Iluka Road

The new motorway saw the duplication of the former highway from Maclean to Iluka Road. It traverses Farlows Flat, the Clarence River at Harwood, Harwood Island, Serpentine Channel, Chatsworth Island, Clarence River North Arm, and Mororo.

The distribution of floodwaters from the Clarence River, Serpentine Channel and Clarence River North Arm, in conjunction with the flat island terrain and existing cane farm drain system, produces complex flow behaviours.

This area experiences widespread flooding in all events in the vicinity of the alignment, with some parts of the former highway experiencing a flood immunity of less than a one in five year flood event and road closures lasting up to several days.

Iluka Road to Devils Pulpit

The new motorway travels between Iluka Road and Devils Pulpit beside the former highway. Flooding in this area interacts with cane drain systems, flood gates, water/catchment basins and tributaries.

The new motorway runs through the Mororo Creek catchment. It crosses several small catchments in addition to the main catchment on the Clarence River floodplain.

Tabbimoble Creek is crossed further north and is the larger of the two local flooding sources with a catchment area of about 35 square kilometres. Water flows in a west-to-east direction via several main and sub-catchment* flow paths.

*A sub-catchment is a smaller catchment within a larger catchment.

How changes in the landscape can impact flooding

Construction projects have the potential to influence flooding by removing surfaces that soak up water and slow down runoff. Large structures such as bridges and embankments also have the potential to change the way water flows during a flood.

For these reasons, we have investigated the potential impact of the upgrade on flood levels, duration, velocity, and direction of floodwater.

Our flood management objectives

The Minister's Conditions of Approval set out the flood management objectives for the upgrade and allow only marginal changes to flood behaviour on adjacent land.

In sensitive areas (such as urban areas and cane growing land), the project could not increase flood levels by more than 50 millimetres or flood durations by more than five percent. Significant changes in flood velocity and flow direction were also prohibited.

Parameter	Location	Flood management objectives
Flood level	Residences	Up to 50 millimetre increase
	Cane farm land	Up to 50 millimetre increase
	Grazing, forested and other rural lands	Generally up to 250 millimetres with localised increase of up to 400 millimetres for short duration/ local catchment flooding acceptable over small areas (nominally less than 5 hectares)
Flood duration	Residences	No more than 5% increase
	Cane farm land	No more than 5% increase
	Grazing, forested and other rural lands	No more than 10% increase
Flood velocity	Residences	Velocity x depth to remain in the zone of low hazard for children below 0.4m ² /s
	Cane farm land	Below 1.0m/s where currently below this figure An increase of not more than 20% where existing velocity is above 1.0m/s
	Grazing, forested and other rural lands	Below 1.0m/s where currently below this figure An increase of not more than 20% where existing velocity is above 1.0m/s
Flood direction	Residences	No change to the direction of watercourses or the direction of flood flows except for constriction in and expansion out of discrete openings (culverts and bridges) and construction diversions
	Cane farm land	
	Grazing, forested and other rural lands	

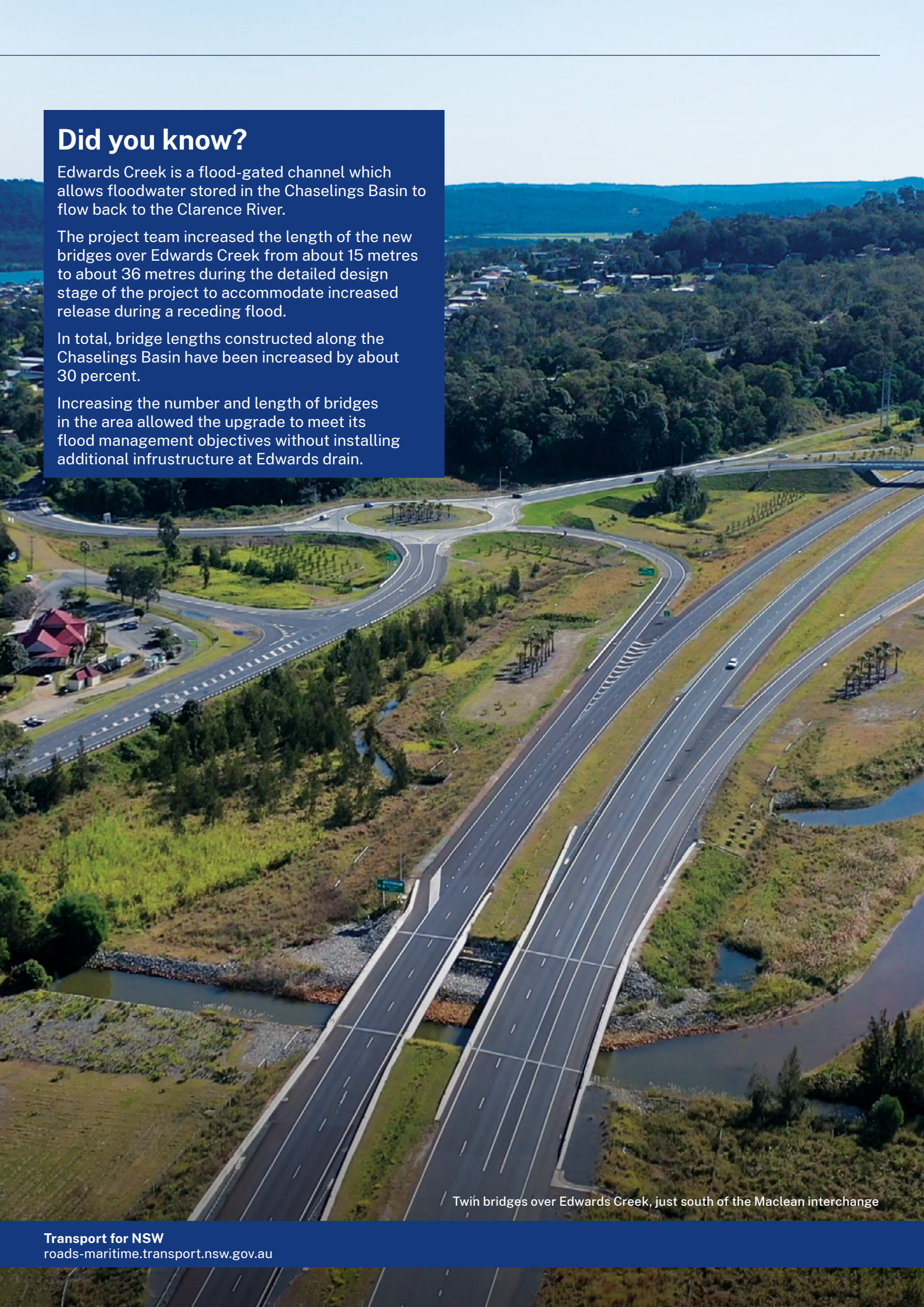
Did you know?

Edwards Creek is a flood-gated channel which allows floodwater stored in the Chaselings Basin to flow back to the Clarence River.

The project team increased the length of the new bridges over Edwards Creek from about 15 metres to about 36 metres during the detailed design stage of the project to accommodate increased release during a receding flood.

In total, bridge lengths constructed along the Chaselings Basin have been increased by about 30 percent.

Increasing the number and length of bridges in the area allowed the upgrade to meet its flood management objectives without installing additional infrastructure at Edwards drain.



Twin bridges over Edwards Creek, just south of the Maclean interchange

Our hydrological mitigation reports

We have been assessing the Woolgoolga to Ballina Pacific Highway upgrade's impact on flood behaviour since 2012. We have documented our results in separate hydrological mitigation reports for the Richmond River and Clarence River catchments. These reports are available online at www.pacifichighway.nsw.gov.au.

The reports demonstrate how we have addressed our flood management objectives, how we have assessed flooding and the steps we have taken to mitigate and manage impacts.

How we describe flood events

Floods are measured on the likelihood of an event occurring over a period of time. The hydrological mitigation report looks at the predicted impacts of the upgrade for a one in 5, one in 20, one in 50 and one in 100 year flood event as required by the projects conditions of approval.

A one in 100 year flood means there is a one percent chance this size flood will occur in any year. This probability is based on past flood events which are used to predict future events. A one in 20 year event means there is a five percent chance this size flood will occur in any year.

These statistics are based on probability, not certainty. A one in 100 year flood does not mean this size event will only occur once every 100 years. In fact, it is possible to have two one in 100 year flood events in the same year.

Flood models used to predict impacts

To predict the impacts of the upgrade on flood behaviour we refined and validated flood impact models and assessed more than 200 different design scenarios.

To build our understanding of flood behaviour in the region we have collected and considered information provided by residents and property owners and used data from real events in 1980, 1996, 2001 and 2013.

Typical information collected and assessed relating to flooding events includes floodplain ground levels, river bed levels, river flow estimates and average rainfall.

The models have been independently reviewed on several occasions and are considered to be highly reliable tools for flood management planning within the catchment.

Independent verification

Flood management specialist consultants WMAwater was approved by the NSW Department of Planning, Industry and Environment (DPIE) to review the flood models and outputs developed by the project team.

WMAwater completed an independent review of the flood models and has provided ongoing advice and recommendations to the project team throughout construction.

WMAwater also provided support for local landowners and agencies seeking advice about the impacts of the upgrade on flooding.

Flood model outcomes

We investigated many different designs in an effort to reduce flooding impacts. The design shown on page ten is a practical solution which has achieved minimal changes to flood level, duration, direction, and velocity.

In general, across the Clarence River regional catchment, you will see:

- a minor increase in flood levels to the west
- a minor decrease in flood levels to the east
- a minor increase in flood duration to the west and also to the east in some areas
- no perceptible change in flood velocity or direction

While we generally meet our flood management objectives, there are some localised areas where impacts exceed the prescribed limits.

The design of the upgrade has aimed to minimise the impacts as far as practical by ensuring any non-compliances are minor and localised and occur in non-sensitive areas or for short periods of time.

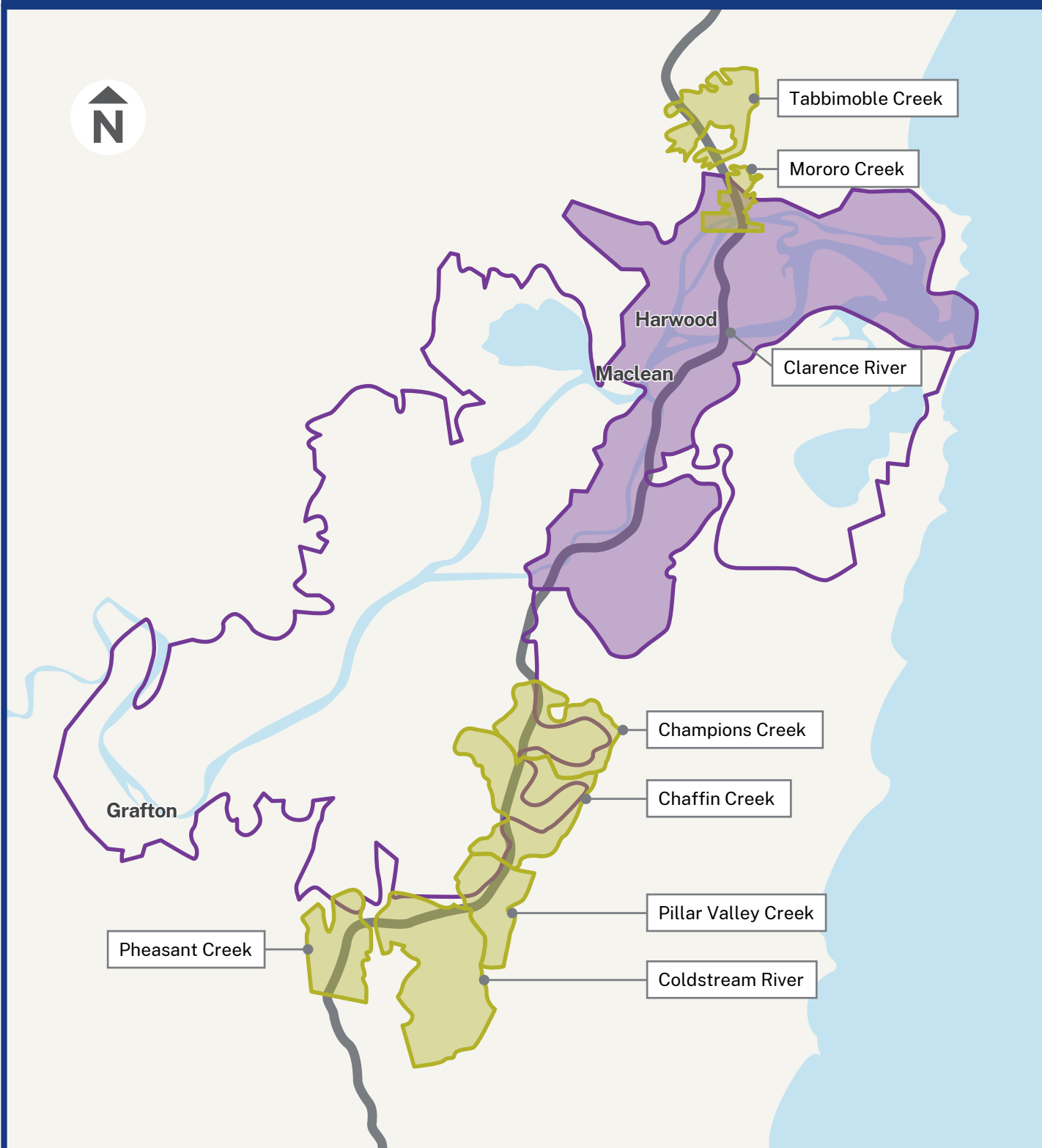
The outcomes are summarised in the table on page eight which shows the number of departures from our flood management objectives between Glenugie and Maclean. A departure is categorised as a significant impact that exceeds impact limits in a sensitive area.

Where possible we have worked with individual landowners to remedy these departures and agreed on reasonable and appropriate mitigation measures. Consultation with these landowners started in 2016.

If the project team has not spoken to you regarding a flood departure there has not been a significant impact identified at your property.

Did you know? We also used the flood model to test the impact of the upgrade under climate change conditions, including increased rainfall intensity and sea level rise.

Extent of the Clarence River regional model and local catchment models



KEY

- Pacific Highway
- Local Catchment Models

Clarence Regional Model

- (Focus Area)
- (Full Extent)

Assessment outcomes

Privately owned lots that have departures from the flood management objectives:

Location	Catchment	Number of departures from the flood management objectives
Glenugie to Tyndale	Pheasants Creek	Flood level impact at 4 locations
	Coldstream River	
	Pillar Valley Creek	
	Chaffin Creek	
	Champions Creek	
Tyndale to Maclean	Clarence River floodplain	None
Maclean to Iluka Road	Clarence River floodplain	Flood level impact at 6 locations
Iluka Road to Devils Pulpit	Tabbimoble Creek Mororo Creek	None

*Figures correct at time of printing

These departures are not predicted to have significant impacts on the use or productivity of the land and consultation has been carried out with all impacted stakeholders. The table does not include affected lots on Transport for NSW owned land.

How we mitigated our flood impacts

We mitigated the potential flood impacts of the upgrade by investigating many different design options to achieve better flooding outcomes, including changing the size and location of flood openings and increasing the overall length of floodway openings.

Transport for NSW seeks to provide the best design possible while delivering a balance of engineering, safety, environment and community outcomes. We have worked directly with stakeholders impacted by flooding and have addressed individual requests where feasible and reasonable.

Between Harwood and Chatsworth Island, the new northbound carriageway has been built to maintain flow of traffic during a one in 20 year flood. The flood immunity of the southbound carriageway and local access to this carriageway has been improved to a one in five year event. Southbound traffic will be moved to the northbound carriageway under a contraflow arrangement when a flood exceeds a one in five year

event. Using the existing southbound infrastructure created cost efficiencies and ensured local road connections could be maintained for longer during flood events.



Contraflow arrangement in place at Chatsworth Island during the 2021 floods

Infrastructure option testing and more bridges

Overall, we assessed over 200 configurations of bridge and flood relief culverts across the Clarence River floodplain.

During the detailed design phase of the project we were able to increase bridge openings by about 18 percent for improved flooding outcomes.

We chose to replace a number of culverts with bridges as they:

- provide additional and larger flood openings which improves water flows
- allow openings to be placed to suit localised floodwater flows
- are less susceptible to weather damage and therefore reduce recovery periods after weather events
- provide better passage for fauna.

The upgrade will increase flood levels at the Maclean levee by about 15 millimetres. To mitigate this, the low point of the Maclean levee was raised by about 100 millimetres for a distance of about 400 metres. As a result, the flood management objectives were achieved and the town now experiences an improved level of flood protection.

Drainage improvements

In some cases, we carried out local drainage improvements on private land. This occurred when our flood management objectives could not be met with changes to the design.

This work was carried out in consultation with landowners and may have included:

- upgrading the existing drainage network to maintain connectivity of flows and improve drainage time
- removing debris to reinstate or improve flow paths
- upgrading or replacing flood-gated outlets to improve drainage back to the Clarence River.

Contributions to local knowledge about flood patterns and emergency preparedness

We have worked with local authorities and emergency services during construction of the upgrade. We have provided the NSW State Emergency Service (SES) and local councils with information about our flood modelling process and the predicted flood behaviour associated with the upgraded highway.

We have also provided the SES with the results of the final updated flood model which will help them update their flood datasets and inform emergency response plans in preparation for the next flood.

Better access during flooding

In a flood, access out of the Clarence River floodplain and the surrounding local catchments is mainly via the Pacific Motorway and a number of connecting local access roads.

The Woolgoolga to Ballina upgrade will provide more efficient and reliable flood evacuation routes and increased connectivity between Glenugie and Devils Pulpit, than previously available.

We've improved flood immunity and reduced expected closure times by:

- raising the height of the new road
- adding drainage structures like culverts and bridges.

Thank you for your input

Work to understand and predict flooding around the Woolgoolga to Ballina Pacific Highway upgrade has occurred over many years.

We would like to thank all residents, local landowners, industry partners, flood focus group members, the sugar cane industry and local authorities. The time and knowledge you have given to us to help our understanding of how flooding works and how it affects you has been invaluable.

What now?

The hydrological mitigation report has addressed the departures listed and consultation has been completed. Any additional drainage or flooding queries that arise following completion of the upgrade will be addressed by Transport for NSW as required.

Transport for NSW is committed to investigating the flood events of 2022 to understand how the water flows interacted with the highway. We expect this will take some time to complete. We will continue to keep the community informed as the investigations progress.

Staging of the regional flood model development





Glenugie to Devils Pulpit



Bridges over the Coldstream, Pillar Valley



Bridge over Shark Creek, looking south



Bridges over the Clarence River North Arm, Mororo

Contact us



1800 778 900



pacific.highway@transport.nsw.gov.au



pacifichighway.nsw.gov.au



This document contains important information about road projects in your area. If you require the services of an interpreter, please contact the Translating and Interpreting Service on **131 450** and ask them to call the project team on **1800 778 900**. The interpreter will then assist you with translation.

September 2022

22.188

Privacy Transport for NSW ("TfNSW") is subject to the Privacy and Personal Information Protection Act 1998 ("PPIP Act") which requires that we comply with the Information Privacy Principles set out in the PPIP Act. All information in correspondence is collected for the sole purpose of assisting in the delivery of this project. The information received, including names and addresses of respondents, may be published in subsequent documents unless a clear indication is given in the correspondence that all or part of that information is not to be published. Otherwise TfNSW will only disclose your personal information, without your consent, if authorised by the law. Your personal information will be held by TfNSW at 76 Victoria Street, Grafton. You have the right to access and correct the information if you believe that it is incorrect.

Transport for NSW

roads-maritime.transport.nsw.gov.au