



RURAL FLOODPLAIN MANAGEMENT PLANS

Background document to the Floodplain Management Plan for the Lower Namoi Valley Floodplain 2020

Water Management Act 2000

September 2020



Published by NSW Department of Planning, Industry and Environment

dpie.nsw.gov.au

Title: Background document to the Floodplain Management Plan for the Lower Namoi Valley Floodplain 2020

Subtitle: *Water Management Act 2000*

First published: September 2020

Department reference number: INT19/126991

More information

Industry.nsw.gov.au/water

Acknowledgements

Floodplain management plans are being prepared under the NSW Healthy Floodplains Project, which is funded by the Australian Government's Sustainable Rural Water Use and Infrastructure Program as part of the implementation of the Murray–Darling Basin Plan in NSW.

© State of New South Wales through Department of Planning, Industry and Environment 2020. You may copy, distribute, display, download and otherwise freely deal with this publication for any purpose, provided that you attribute the Department of Planning, Industry and Environment as the owner. However, you must obtain permission if you wish to charge others for access to the publication (other than at cost); include the publication in advertising or a product for sale; modify the publication; or republish the publication on a website. You may freely link to the publication on a departmental website.

Disclaimer: The information contained in this publication is based on knowledge and understanding at the time of writing (September 2020) and may not be accurate, current or complete. The State of New South Wales (including the NSW Department of Planning, Industry and Environment), the author and the publisher take no responsibility, and will accept no liability, for the accuracy, currency, reliability or correctness of any information included in the document (including material provided by third parties). Readers should make their own inquiries and rely on their own advice when making decisions related to material contained in this publication.

Contents

List of figures	i
List of tables	ii
Abbreviations	i
Purpose	1
The Lower Namoi Valley Floodplain	1
Flooding behaviour	5
Key changes to the natural flooding regime	6
Developing the plan	7
Step 1: Define the floodplain boundary	9
Step 2: Identify existing flood works	12
Step 3: Review existing rural floodplain management arrangements	13
Rural floodplain development guidelines and floodplain management studies	13
<i>Water Act 1912</i> rural floodplain management plans	14
Step 4: Determine the floodway network	16
Design floods	18
Modelling	19
Hydrologic models	19
Hydraulic models	19
Hydraulic criteria for the floodway network	23
Floodways	23
Inundation extent	25
Summary	26
Step 5: Identify and prioritise floodplain assets	27
Ecological assets	27
Identifying ecological assets	27
Flood dependency of wetlands and other floodplain ecosystems	32
Cultural assets	37
Cultural asset type—Aboriginal cultural values	37
Cultural asset type—heritage sites	39
Flood dependency of Aboriginal cultural values and heritage sites	39
Prioritisation of cultural assets	40
Prioritisation of Aboriginal heritage sites	40
Prioritisation of Aboriginal values	41
Step 6: Prepare a socio-economic profile	42
Study area geography	42
Data sources	43

Demographic profiles.....	44
Household income.....	44
Lower Namoi Valley Floodplain Economy	44
Employment by industry	44
Lower Namoi Valley Floodplain Economy	44
Estimated employment of the Lower Namoi Valley Floodplain	45
Economic wellbeing indicators.....	45
Agricultural production.....	45
Step 7: Delineate management zones	47
Description of management zones	49
Management Zone AD—major discharge areas, defined floodways (MZ AD)	49
Management Zone AID—major discharge areas, ill-defined floodways (MZ AID)	50
Management Zone B—flood storage and secondary flood discharge (MZ B).....	50
Management Zone C—flood fringe and flood-protected developed areas (MZ C).....	51
Management Zone CU—urban areas management by local council (MZ CU)	51
Management Zone D—special protection zone (MZ D).....	51
Hydraulic criteria.....	52
Ecological criteria	53
Ecological refinements to Management Zone AD	54
Cultural criteria	57
Criteria to better reflect current floodplain management arrangements.....	58
Modifying the management zones	59
Summary of management zone criteria	59
Step 8: Determine rules	65
Permissible flood works.....	65
Types of flood works	65
Permissible flood works by management zone	66
Flood flow corridors.....	66
Specific requirements for permissible flood works	67
Access roads	67
Supply channels	68
Stock refuges.....	69
Infrastructure protections works	70
Ecological enhancement work	71
Aboriginal cultural value enhancement works	72
Heritage site enhancement works	72
Certain other flood works in Management Zone AD—flood flow corridors.....	73
Undetermined flood work applications in Management Zone AD	74

Flood flow corridors in Management Zone AID	75
Justification for specifications	76
Advertising requirements	76
Justification for specifications	76
Assessment criteria	77
Ecological and cultural impacts	78
Social (drainage) impacts	80
Local hydraulic impacts	80
Cumulative hydraulic impacts	82
Existing flood works and structures	84
Rules for existing unlicensed flood works	84
Amending an existing flood work approval	84
Exemptions to flood work approvals	84
Step 9: Consider existing floodplain management arrangements	86
Floodplain boundary	86
Management zones	87
Rules (including assessment criteria)	88
Changes in flood flow corridors	88
Change to permissible flood works	88
Changes to advertising requirements	89
Changes in assessment criteria	90
Existing flood works and structures	92
Step 10: Assess socio-economic impacts	93
Purpose	93
Methodology	93
Phase 1: preliminary assessment	94
The base case	94
Impact of rule changes in Narrabri to Wee Waa FMP 2005 area	96
Impact of rule changes in guideline and other floodplain areas	97
Summary of negative impacts	98
Impacted areas	99
Estimated values of economic impacts	101
Summary	104
Phase 2: detailed analysis	104
Role of socio-economics in FMP development	105
Consultation and review of the plan	106
Consultation process	106
Technical assessment	106

Targeted consultation	107
Public exhibition	109
Review	111
Interagency Regional Panel	111
Plan finalisation and commencement	112
References	113
Glossary	116

List of figures

Figure 1. Key features of the Namoi catchment and the Lower Namoi Valley Floodplain	2
Figure 2. Semi-permanent wetland in the Lower Namoi Valley Floodplain. Jo Taylor, 2015.....	3
Figure 3. Overview of the Floodplain Management Plan for the Lower Namoi Valley Floodplain 2020	4
Figure 4. Ten steps to develop rural floodplain management plans under the <i>Water Management Act 2000</i>	8
Figure 5. Changes made to the existing designated floodplain boundary when delineating the Lower Namoi Valley Floodplain boundary	11
Figure 6. Overall footprint of existing flood works in the Lower Namoi Valley Floodplain.....	12
Figure 7. History of floodplain management in the Lower Namoi Valley Floodplain.....	15
Figure 8. Finger diagram of hydraulic categories comprising the floodway network	16
Figure 9. Map of the Lower Namoi floodway network.....	17
Figure 10. The approximate extent of the five hydraulic models within the Lower Namoi Valley Floodplain	20
Figure 11. Hydraulic modelling results (depth-velocity product) from all five models for the large design flood event (February 1971—4% AEP at the Namoi River Mollee gauge GS 419039)	22
Figure 12. Modelled inundation extent of the small design flood (December 2004—13% AEP at the Namoi River Mollee gauge GS 419039).....	24
Figure 13. Ecological assets identified in the Lower Namoi Valley Floodplain	30
Figure 14. Ecological asset sub-types identified in the Lower Namoi Valley Floodplain.....	31
Figure 15. High priority planning units selected in Marxan in the Lower Namoi Valley Floodplain	36
Figure 16. Regional population trend by Local Government Area 2004–14 (Source: Based on ABS data, ABS 2016)	44
Figure 17. Finger diagram of management zones in the Lower Namoi Valley FMP 2020.....	47
Figure 18. Overview of the management zones in the Lower Namoi Valley Floodplain.....	48
Figure 19. Namoi River near Pilliga is an example of Management Zone AD. Joanna Taylor, 2015.	49
Figure 20. Bungle Gully Dam. J. Taylor, OEH 2015	53
Figure 21. Refinements to management zones based on ecological criteria.	56
Figure 22. Bar graph showing the contribution of each of the criteria (hydraulic, ecological, cultural, existing floodplain planning arrangements) to each management zone.....	60
Figure 23. Pie graph showing the proportion of the Lower Namoi Valley Floodplain mapped as each of the six management zones.....	61
Figure 24. Change in the floodplain boundary when comparing the floodplain made under Part 8 of the <i>Water Act 1912</i> with the Lower Namoi Valley Floodplain made under the <i>WM Act</i>	87
Figure 25. Land capability of areas zoned Management Zone AD (ecological and cultural criteria)	100

Figure 26. Land use of the areas added to Management Zone AD as part of ecological and/or cultural amendments.....	103
Figure 27. Differences between floodways presented at targeted consultation and floodways presented at public exhibition.....	109

List of tables

Table 1. Changes made to the Lower Namoi Floodplain designated under Part 8 of the <i>Water Act 1912</i> when delineating the Lower Namoi Valley Floodplain boundary.....	9
Table 2. Annual exceedance probability (AEP) for large historic flood events at selected locations in the Lower Namoi Valley Floodplain	18
Table 3. Annual exceedance Probability (AEP) for small historic flood events at selected locations in the Lower Namoi Valley	18
Table 4. Hydraulic models in each floodplain section	19
Table 5. Summary of criteria used to delineate the hydraulic categories in the floodway network.....	26
Table 6. Hydro-ecological functional groups that comprise wetlands ¹ in the Lower Namoi Valley Floodplain	33
Table 7. Hydro-ecological functional groups that comprise other flood-dependent ecosystems in the Lower Namoi Valley Floodplain	34
Table 8. Description of study area geographies used the socio-economic profile.....	42
Table 9. Management zone recommendations for ecological asset types.....	54
Table 10. Contribution of each criteria to each management zone in hectares (rounded to the nearest 100 ha).....	59
Table 11. Percentage contribution of each criteria to each management zone.....	60
Table 12. Criteria for Management Zone AD (133,600 ha).....	61
Table 13. Criteria for Management Zone AID (21,400 ha).....	62
Table 14. Criteria for Management Zone B (221, 700 ha)	63
Table 15. Criteria for Management Zone C (189,700 ha)	63
Table 16. Criteria for Management Zone CU (2,800 ha).....	64
Table 17. Criteria for Management Zone D	64
Table 18. Categories of impacts that flood work applications must be assessed against to be approved by management zone.....	77
Table 19. Summary of the types of assessment criteria in previous FMPs considered in the Lower Namoi Valley FMP 2020.....	91
Table 20. Comparison of hydraulic assessment criteria with the previous FMP and the adjacent Upper Namoi Valley FMP 2019	91
Table 21. Summary of rule changes between the Base Case and the Lower Namoi Valley FMP 2020	95
Table 22. Impacts of the Lower Namoi Valley FMP 2020	99
Table 23. Land capability of areas that are Management Zone AD (ecological and cultural)...	100
Table 24. Land use in the Lower Namoi Valley FMP 2020	103
Table 25. Public exhibition display products for the Draft Lower Namoi Valley FMP	110

Abbreviations

Abbreviation	Description
ABS	Australian Bureau of Statistics
ADS40	Airborne Digital Sensor
AEP	annual exceedance probability
AHD	Australian Height Datum
AHIMS	Aboriginal Heritage Information Management System
ASDST	Aboriginal Sites Decision Support Tool
ATWG	Aboriginal Technical Working Group
DEM	digital elevation model
Lower Namoi Valley FMP 2020	<i>Floodplain management plan for the Lower Namoi Valley Floodplain 2020</i>
FMP	floodplain management plan
FPWEC	First Peoples' Water Engagement Council
FRMP	floodplain risk management plan
FRMS	floodplain risk management study
GVAP	gross value of agricultural production
Gwydir Valley FMP 2016	Floodplain Management Plan for the Gwydir Valley Floodplain 2016
HHIMS	Historic Heritage Information Management System
IPW	Infrastructure protection work
IRP	Interagency regional panel
IRSAD	Index of Relative Socio-economic Advantage and Disadvantage
LiDAR	light detection and ranging
LGA	local government area
LLS	Local Land Services
MDB	Murray–Darling Basin
MDBA	Murray–Darling Basin Authority

Abbreviation	Description
ML	megalitres
MZ AD	management zone—major discharge areas, defined floodways
MZ AID	management zone—major discharge areas, ill-defined floodways
MZ B	management zone—flood storage and secondary flood discharge,
MZ C	management zone—flood fringe and flood-protected developed areas
MZ CU	management zone—urban areas
MZ D	management zone—special protection
NOW	(former) NSW Office of Water
NSW	New South Wales
OEH	(former) NSW Office of Environment and Heritage
PCT	plant community type
SEIFA	Socio-Economic Indexes for Areas
TAG	Technical Advisory Group
Upper Namoi Valley FMP 2019	Floodplain Management Plan for the Upper Namoi Valley Floodplain 2019
VIS	NSW Vegetation Information System
WM Act	<i>Water Management Act 2000</i>
WSP	water sharing plan

Purpose

The purpose of this document is to inform local landholders and the wider community about how the rural floodplain management planning approach presented in the *Rural floodplain Management Plans: Technical manual for plans developed under the Water Management Act 2000* (the technical manual) has been applied across the Lower Namoi Valley Floodplain. This document should be read in conjunction with the technical manual and the *Floodplain Management Plan for the Lower Namoi Valley Floodplain 2020* (the Lower Namoi Valley FMP 2020).

The Lower Namoi Valley Floodplain

This document pertains to the area known as the Lower Namoi Valley Floodplain as shown in Figure 1 and Figure 3. The Lower Namoi Valley Floodplain is part of the Namoi Valley, which covers 4.2 million ha from the head of the MacDonal River westward to Walgett. The Namoi Valley forms part of the Barwon–Darling River system and is bound by the Great Dividing Range in the east, the Liverpool Ranges and Warrumbungle Ranges in the south, and the Nandewar Ranges and Mount Kaputar to the north. Elevations range from over 1,500 m above sea level in the south and east of the valley to just 100 m above sea level on the alluvial floodplain west of Narrabri.

The Lower Namoi Valley Floodplain is declared to be a floodplain under the Water Management (General) Regulation 2018. The Dictionary to the *Water Management Act 2000* provides that a *floodplain* means land declared by the regulations to be a floodplain.

The Lower Namoi Valley Floodplain covers 570,700 ha from Narrabri in the east to Walgett in the west at the confluence of the Namoi and Barwon Rivers. The northern boundary is aligned to the Gwydir Valley Floodplain, for which a rural floodplain management plan (FMP) commenced in August 2016 (the Gwydir Valley FMP 2016). The western boundary is aligned to the Barwon–Darling Valley Floodplain, for which a rural FMP commenced in June 2017 (the Barwon–Darling Valley FMP 2017). The eastern boundary is at Narrabri and aligns to the Upper Namoi Valley Floodplain, for which a rural FMP commenced in June 2019 (the Upper Namoi Valley FMP 2019). The southern boundary is aligned to significant cadastral features, such as roads, that best match the historical extent of flooding in the area.

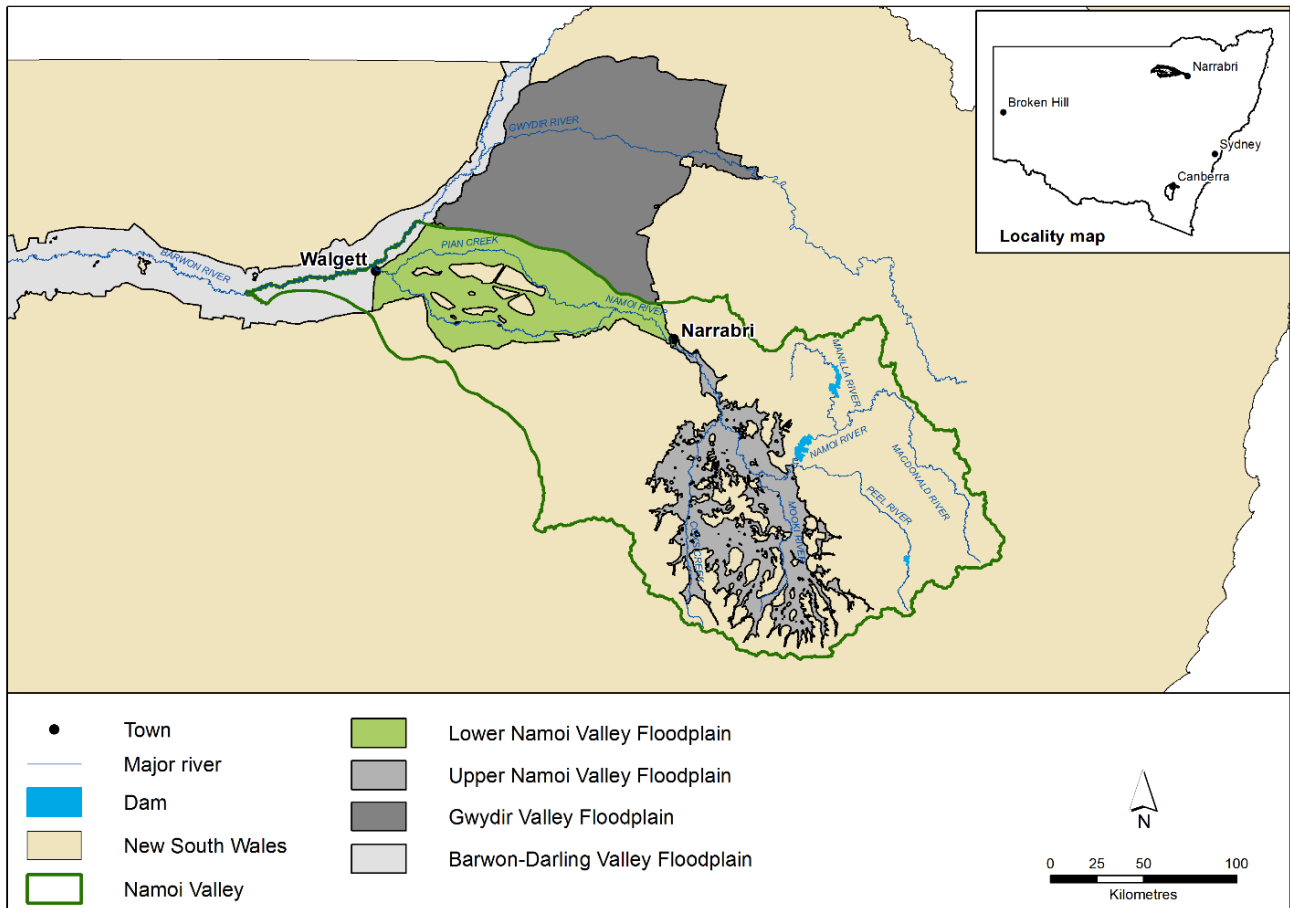


Figure 1. Key features of the Namoi catchment and the Lower Namoi Valley Floodplain

Stream flows in the catchment are regulated by Keepit Dam on the Namoi River, Split Rock Dam on the Manilla River and Chaffey Dam on the Peel River. Regulated water released from these dams is mainly used for irrigation purposes.

The main headwater tributaries of the Namoi River include the MacDonald, Manilla, Peel and Mooki Rivers, which join the Namoi River upstream of Boggabri. Coxs Creek is a major tributary feeding into the Namoi River from the west of the floodplain. The Namoi River is subject to the Water Sharing Plan (WSP) for the Upper Namoi and Lower Namoi Regulated River Water Sources 2003.

Floodwaters into the Lower Namoi Valley Floodplain originate from the Upper Namoi Valley via the Namoi River, but also from a number of smaller tributaries, which drain the southern side of the valley to the south of the Pilliga. The floodplain also exchanges flow with the Gwydir/Thalaba rivers to the north of Pian Creek.

The Lower Namoi Valley Floodplain supports many small lagoons, wetlands and anabranches, as well as floodways and widespread areas of floodplain woodlands. Although extensively cleared, ecosystems on the floodplain are unique and diverse, with many depending on flooding to support their structure, function and long-term survival. River red gum dominates the banks and immediate floodplain of the Namoi River between Narrabri and where it joins with Pian Creek. A short distance from the banks, coolibah trees extend across the floodplain (Green and Dunkerley 1992). The floodplain is characterised by a primary channel (approximately 50 m wide and 6 m deep) with a network of converging and diverging anabranches and flood channels (Lambert and Short 2004).

The Gamilaroi¹ Nation is the traditional owner of the entire Namoi Valley and the floodplain contains many cultural sites and values that are important to the local Aboriginal community. Many of these sites and values are flood-dependent, such as Coolamon scars on flood-dependent living trees. Bungle Gully, at 820 ha in area, is the largest wetland in the floodplain. Although the dam is man-made, it acts as important waterbird breeding habitat and is just one of many ecologically and culturally significant sites in the floodplain.



Figure 2. Semi-permanent wetland in the Lower Namoi Valley Floodplain. Jo Taylor, 2015.

¹ Also known as Kamilaroi, Gamilaraay and Gomeroi

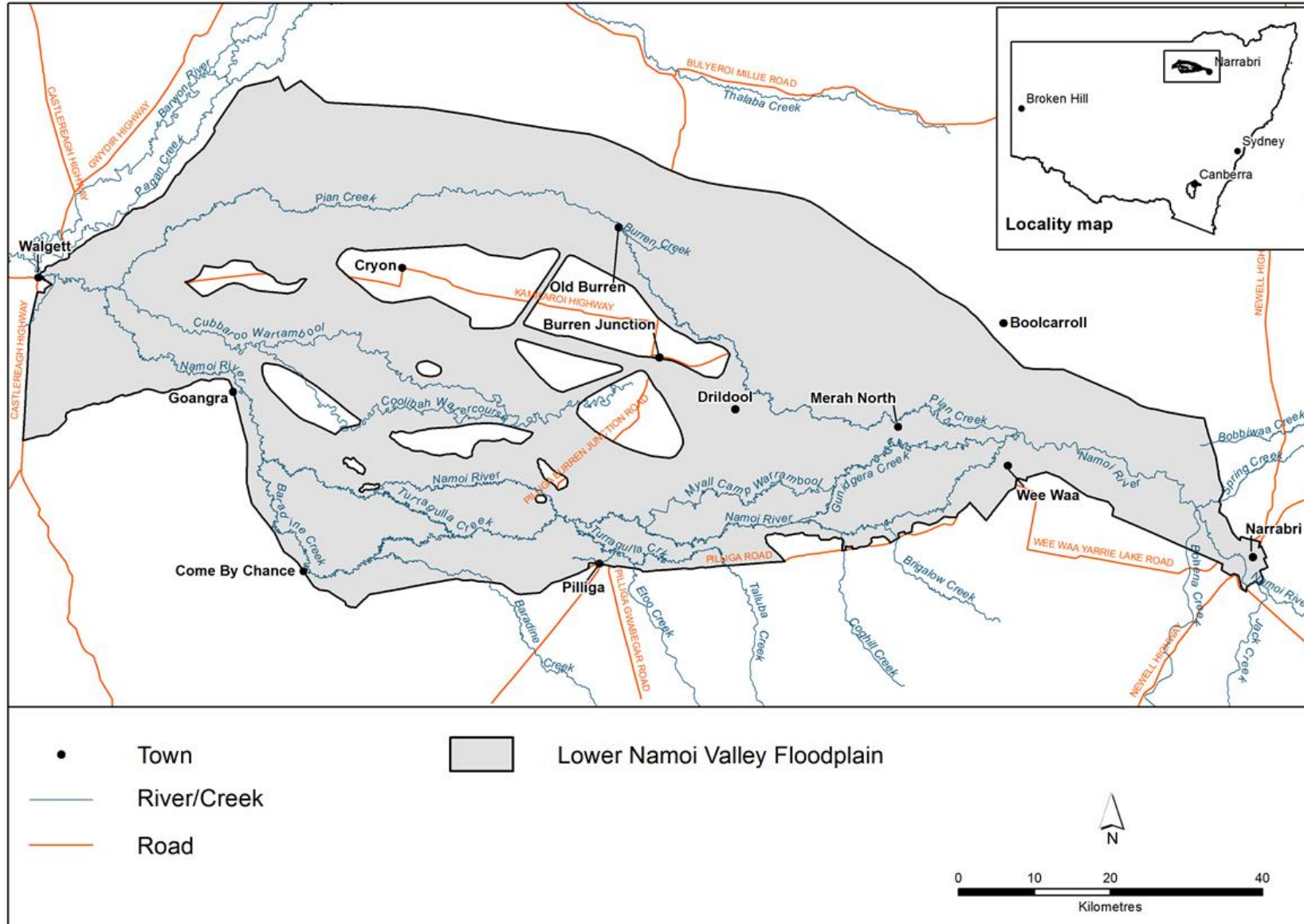


Figure 3. Overview of the Floodplain Management Plan for the Lower Namoi Valley Floodplain 2020

Note. The boundary of the Lower Namoi Valley Floodplain is shown on the Floodplain Management Plan Map on the NSW legislation website.

The Namoi Valley contains some of the most fertile and productive agricultural lands in the state, representing about 1% of the NSW gross regional product per year, or \$3.081 million (OEH 2010). Primary industries provide about 40% of the region's gross regional product, which is chiefly comprised of agriculture (16%) and associated irrigation industries (48%) (OEH 2010). Broadacre cropping is widespread, with crops such as cotton and wheat generally being the dominant irrigated crops by area and value. Floodplain development has enhanced the agricultural productivity of land used for grazing, dryland cropping and irrigated cropping. Recreational fishing and the associated tourism are also considerable in the Namoi catchment.

The NSW Government has been responsible for rural floodplain management in the Namoi Valley since the 1970s. Before then, the region was dominated by low-intensity grazing. This meant that there was an absence of flood works that might affect flooding. When Keepit Dam was completed in 1960, the regulated water supply allowed for significant irrigation development to support large-scale and intensive crop production. Major flood events in the 1970s revealed that the spread of uncoordinated earthworks had produced major changes in the traditional patterns of flooding in many locations (Burton et al 1994). Development in the floodplain further intensified from the 1990s onwards.

Today, the area between Narrabri and Burren Junction contains intensive irrigation development and a large number of constructed embankments protecting cropped land from small to medium floods. There is less floodplain development downstream of Burren Junction, although there is some embanked farmland along the Namoi River and Pian Creek. As of March 2020, about 107,400 ha of (20%) floodplain area is covered by floodplain works in the Lower Namoi Valley Floodplain. These floodplain works include levees, earthworks, banks and channels that have been built to protect crops, stock and properties from flooding; provide on-farm access; and to manage irrigation, stock and domestic water. Works such as these, which affect the distribution of floodwaters, are referred to as flood works.

Although historic flood-flow patterns in the region have been modified as a result of floodplain development, the NSW Government has been working to manage this change and to reduce any disadvantage that may be experienced by adjacent landowners. Historically, government planning has focused on the highly developed area between Narrabri and Burren Junction.

The Lower Namoi Valley FMP 2020 has been prepared in accordance with the floodplain planning and environmental protection provisions of the *Water Management Act 2000* (WM Act). The Lower Namoi Valley Floodplain captures the previous Narrabri to Wee Waa Floodplain Management Plan 2005 and much of the original floodplain that was designated under section 166 of Part 8 of the *Water Act 1912*. Part 8 of the *Water Act 1912* has since been repealed and replaced by provisions in the WM Act.

Existing floodplain management arrangements have been consolidated in the Lower Namoi Valley FMP 2020, which applies floodplain management principles consistently across the extent of major flooding. Similar to current management measures, the new plan aims to coordinate flood work development to maintain flooding behaviour while minimising risk to life and property from the effects of flooding. The Lower Namoi Valley FMP 2020 provides management zones and transparent rules to be used when determining flood work development approvals for new flood works and amendments to existing flood works.

Flooding behaviour

Major floods tend to occur in the summer months from January to March. During this time, heavy localised thunderstorms occur regularly in the valley and often the rainfall on the plains is as heavy as in the hills. Summer rains are caused by the southerly movement of high-pressure cells over the valley from Queensland, which allow the passage of cyclonic low-pressure systems. Although not an annual event, these long-duration cyclonic storms can produce very heavy rainfalls and are usually the cause of severe flooding. In winter, rainfall is generally low and unreliable.

In any one area in the floodplains of the Namoi Valley, there is considerable variation in the extent, duration and source of flooding between different flood events. This is because the spatial distribution of rainfall and the arrival times of peak sub-catchment inflows along the main channel system all vary considerably between flood events. Unlike most other inland rivers, the Namoi receives significant flood-producing tributaries along the bulk of its course to the Barwon River.

Floodwaters originate from the Upper Namoi valley catchments as well as from smaller tributaries that drain the southern side of the valley to the south of Pilliga. These systems have extensive floodplains independent of the Namoi River and drive the variable flood behaviour of the overall floodplain. Flows out of the Pilliga Scrub can cause severe flooding even without significant flows from the upstream catchment.

The main headwater tributaries of the Namoi River are the Manilla, Peel and Mooki rivers. The Manilla and Peel rivers flow from the high mountainous country in the east and north of the catchment and have higher run-off than the Mooki River. This is because most of the valley above Keepit Dan can produce high run-off as it flows through undulating to often rugged country.

The Lower Namoi also exchanges flow with the Gwydir/Thalaba rivers to the north of Pian Creek. These flow exchanges can vary depending on the relative size and timing of events in the Gwydir and Namoi valleys.

Within the Lower Namoi Valley Floodplain, Pian Creek and Gunidgera Creek are major rivers that branch off from the Namoi River near Wee Waa. Pian Creek continues flowing westward until it re-joins the Namoi River upstream of Walgett. Floodwaters from the Namoi River will spill west and northwest through the Gunidgera and Pian creek systems. Both of these creek systems have an extensive floodplain independent of the Namoi River, which have been extensively developed. These creeks are both used to distribute regulated irrigation supplies to properties along their reaches. Development and river regulation have also caused water to remain in these rivers and creeks for longer intervals, when prior to development they would have been mostly dry. There is less floodplain development downstream of Burren Junction, although there is some embanked farmland along the Namoi River and Pian Creek.

Upstream of Wee Waa towards Narrabri, the flooding is largely undivided. However, moving west, flood flows are directed into many different defined floodways between the Namoi River and Gunidgera Creek, and between Pian Creek and the Gwydir Valley to the north. In large floods, some of these floodways carry flows of the same magnitude as those in the main river channel corridor. Floodplain development restricts the immediate floodplain near Wee Waa and water is redistributed across larger formed floodways to the north and south. During major flood events, all of the country west of Wee Waa is inundated, with the exception of high ridges adjacent to and north of Pian Creek.

The Lower Namoi Valley Floodplain drains very slowly because of the small capacities of the major channels and the slow rates of rise and fall of floods. Flood depths in the east can range from 0.3 m to 1.5 m and velocities are low. Slow-moving floodwaters on flat slopes often lead to long-duration flooding. Flood damage from major 1950s floods was caused by long periods of inundation, which accompanied the slow rates of rise and fall of floods.

Major floods occur in Narrabri about once every 10 years and very large floods occur every 40 to 50 years (URS Australia Pty Ltd 2011). About 1.5 km upstream of Narrabri town centre, the Namoi River splits into the main river on the west side and Narrabri Creek on the east side. High-level flood runners fragment the town during floods. The two branches join back together about 10 km downstream of Narrabri's town centre. The town of Narrabri is located within the boundary of the Lower Namoi Valley Floodplain.

Key changes to the natural flooding regime

The construction of Keepit Dam in 1960 on the Namoi River, Chaffey Dam in 1976 on the Peel River and Split Rock Dam in 1984 on the Manilla River, combined with coinciding river regulation

and land-use changes have changed the nature, frequency, extent and duration of flooding in the Lower Namoi Valley Floodplain.

Key changes to the nature of flooding include:

- alteration of the direction and depth of flood flows in some areas
- alteration of the carrying capacity of rivers, creeks and overland flow paths in some areas
- increase in the velocity of flood-flow rates, with flows getting to the lower reaches of the floodplain due to land-use changes.

Some parts of the floodplain have experienced a decrease in flooding duration in some flood events due to the construction of Keepit Dam, Chaffey Dam and Split Rock Dam, while others have been subject to a potential increase in frequency due to land-use changes.

Developing the plan

The Lower Namoi Valley FMP 2020 was developed by the Water group within the NSW Department of Planning, Industry and Environment (the department), with technical input provided by the department's Energy, Environment and Science group. The department employed a ten-step process, as outlined in the technical manual and Figure 4 below, that involves collecting best-available data and analysis of current floodplain management arrangements to inform hydraulic, ecological, cultural and socio-economic assessments. During the steps involving the collection of data and undertaking of technical assessments, the Lower Namoi Technical Advisory Group (TAG) and Aboriginal Technical Working Group (ATWG) were engaged in consensus-based decision-making. The outputs from the assessments ensure that the steps used to determine the floodplain boundary, management zones and rules are supported by good science.

Consultation on the Draft Lower Namoi Valley FMP 2020 occurred in two stages: targeted consultation and public exhibition. The consultation stages align with the department's internal policy, originally developed for the making and review of water sharing plans under the WM Act. During targeted consultation and public exhibition, community feedback was invited on the boundary, management zones, rules and assessment criteria in the FMP. Targeted consultation with stakeholders, including members of the Aboriginal Community, occurred at Narrabri, Wee Waa, Pilliga and Walgett between October and November 2015. Public exhibition of the Draft Lower Namoi Valley FMP occurred over 60 days from 13 February 2017 until 13 April 2017. Outcomes from the targeted consultation and public exhibition process are provided in this document in 'Consultation and review of the plan'.

An Interagency Regional Panel (IRP) was responsible for the formal review and whole-of-government endorsement of the Lower Namoi Valley FMP 2020. Facilitated by the department, the IRP reviewed the draft plan prior to targeted consultation and public exhibition. The IRP also reviewed all submissions received during public exhibition and was responsible for the endorsement of the final boundary, management zones, rules and assessment criteria prior to commencement. Further details on the IRP review process are outlined in 'Consultation and review of the plan'.

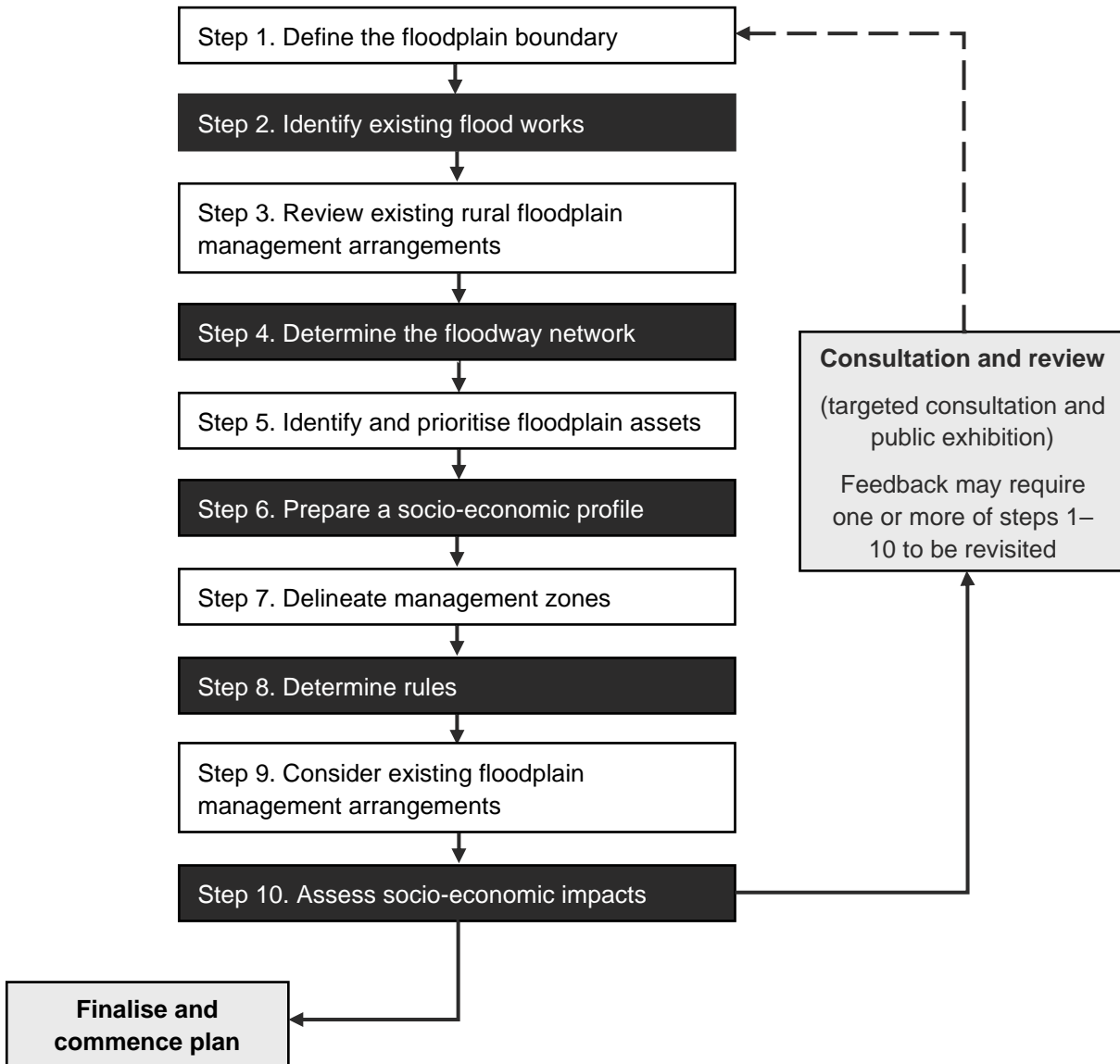


Figure 4. Ten steps to develop rural floodplain management plans under the *Water Management Act 2000*

Appendix 1 contains a detailed flow diagram of the ten steps, including the input/process and output/outcome related to each step.

Step 1: Define the floodplain boundary

Floodplains are essentially areas of land subject to inundation by flooding. The Lower Namoi Valley Floodplain covers 570,700 ha.

The boundary of the Lower Namoi Valley Floodplain was defined to capture the floodplain areas inundated during flooding of the major rivers running between Narrabri and Walgett and to include any works that may affect flooding.

The following existing floodplains, designated under section 166 of Part 8 of the *Water Act 1912* and by publication in the NSW Government Gazette, formed the basis for capturing existing and potential floodplain developments within the floodplain:

- the Lower Namoi Valley Floodplain, which was designated as a floodplain on 18 September 1984 (and later amended by the Narrabri to Wee Waa Floodplain)
- the Narrabri to Wee Waa Floodplain, which was designated as a floodplain on 23 December 2005.

The overall extent of boundary change when compared to the existing designated floodplain areas was the addition of 57,400 ha in some areas and the subtraction of 175,600 ha in other areas (Figure 5). Table 1 and Figure 5 highlight the changes made to the existing floodplain areas to delineate the new Lower Namoi Valley Floodplain boundary.

Where appropriate, the boundary was adjusted to align with significant cadastral features, such as the Walgett to Pilliga Road, to ease administration and provide clarity to floodplain users.

The largest change is at the northern boundary, where 174,000 ha of the existing floodplain were removed when delineating the new floodplain boundary. This change aligns with the *Water Sharing Plan for the Gwydir Unregulated and Alluvial Water Sources 2012*. Flood work applications in these areas are now assessed under the Gwydir Valley FMP 2016.

In urban areas such as Narrabri, the boundary was expanded in consultation with local government authorities to include the area where council manages flood risk.

Expressions of interest for the licensing of floodplain harvesting structures received as part of the NSW Healthy Floodplains Project (floodplain harvesting) were also considered when delineating the boundary. However, no changes were required.

Table 1. Changes made to the Lower Namoi Floodplain designated under Part 8 of the *Water Act 1912* when delineating the Lower Namoi Valley Floodplain boundary

Number	Map point in Figure 5	Change type from existing floodplain	Alignment	Rationale
1	A–B	Subtraction	WSP for the Gwydir Unregulated and Alluvial Water Sources 2012/Gwydir Valley Floodplain boundary for the Gwydir Valley FMP 2016	Consistency with existing plan boundaries
2	C	Addition	WSP for the Gwydir Unregulated and Alluvial Water Sources 2012/Gwydir Valley Floodplain boundary for the Gwydir Valley FMP 2016	Consistency with existing plan boundaries
3	D	Addition	Bald Hill Road	Cadastral and administrative relevance
4	E	Addition	Bald Hill Road	Cadastral and administrative relevance
5	F	Addition	Narrabri urban area managed by Council	To include the urban area in the FMP

Number	Map point in Figure 5	Change type from existing floodplain	Alignment	Rationale
6	G	Addition	Wee Waa urban area managed by Council	To include the urban area in the FMP
7	H-I	Addition	Extent of flood water using an envelope of flooding	Flood history
8	I-J	Addition	Pilliga Road	Cadastral and administrative relevance
9	J-K	Addition	Walgett to Pilliga Road	Cadastral and administrative relevance
10	L-M	Addition	Extent of flood water using an envelope of flooding	Flood history
11	M-N	Addition	Castlereagh Highway	Cadastral and administrative relevance
12	O	Subtraction	Walgett urban area managed by council	To move the urban area to the Barwon-Darling Valley FMP 2017
13	P	Subtraction	A shire road	Cadastral and administrative relevance
14	Q-A	Subtraction	A shire road and local track/ Gwydir Valley Floodplain boundary for the Gwydir Valley FMP 2016	Consistency with existing plan boundaries
15	Central green areas	Addition	Landscape features identified through ADS40 DEM and satellite imagery	ADS40 DEM and flood history was used

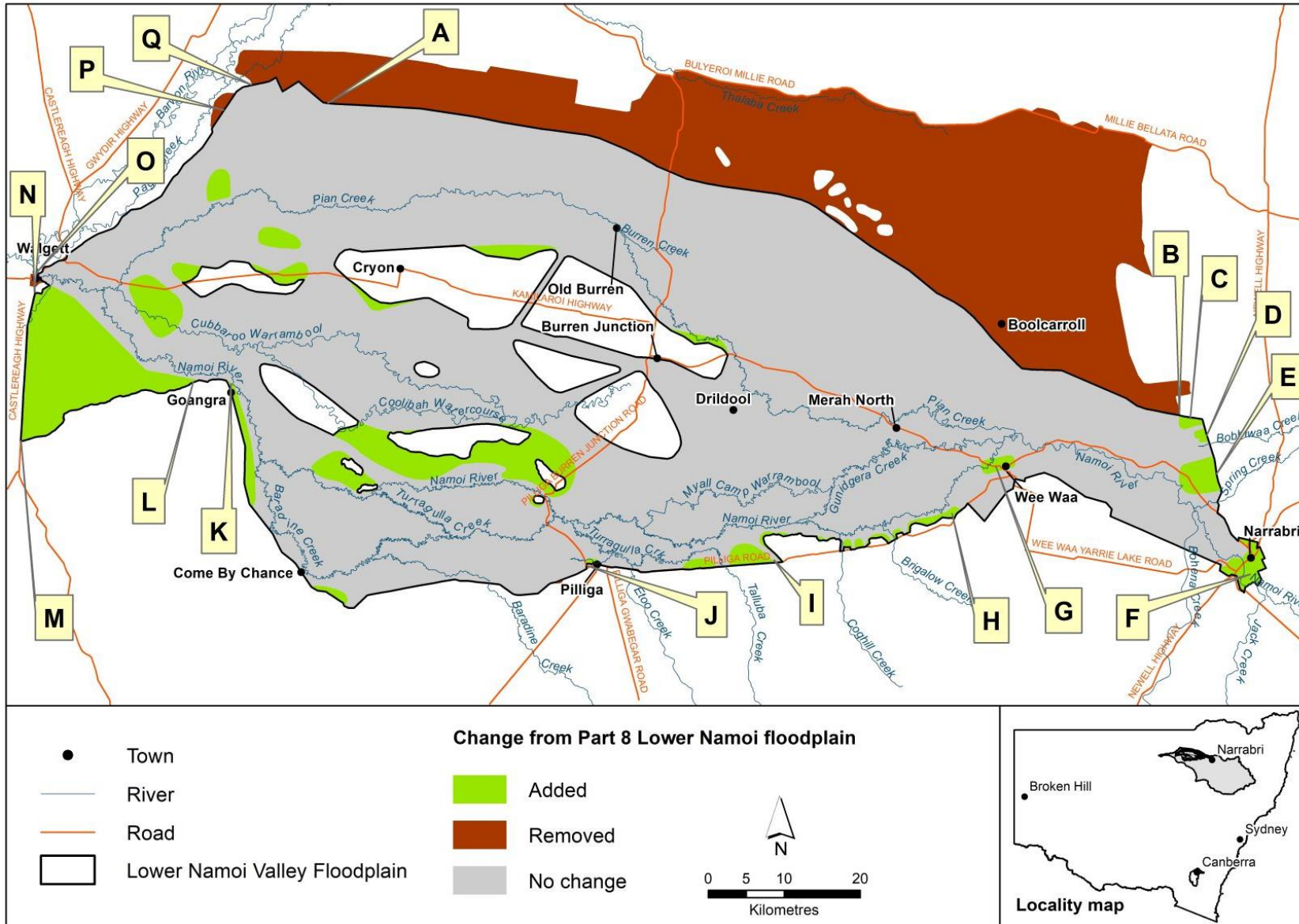


Figure 5. Changes made to the existing designated floodplain boundary when delineating the Lower Namoi Valley Floodplain boundary

Note. The boundary of the Lower Namoi Valley Floodplain is available on the Floodplain Management Plan Map published on the NSW legislation website.

Step 2: Identify existing flood works

As of March 2020, approximately 107,400 ha (20%) of floodplain area are enclosed by flood works in the Lower Namoi Valley Floodplain (Figure 6).

Individual works are not shown in the footprint areas but may include:

- infrastructure protection works
- levees
- private access roads
- storages
- supply channels
- stock refuge works
- other earthworks and embankments.

Limited-height works are also included in the existing work footprint areas. Instream works are not identified as flood works but are generally identified as controlled activities under the WM Act. Supply channels and storages may be identified as water supply works and flood works.

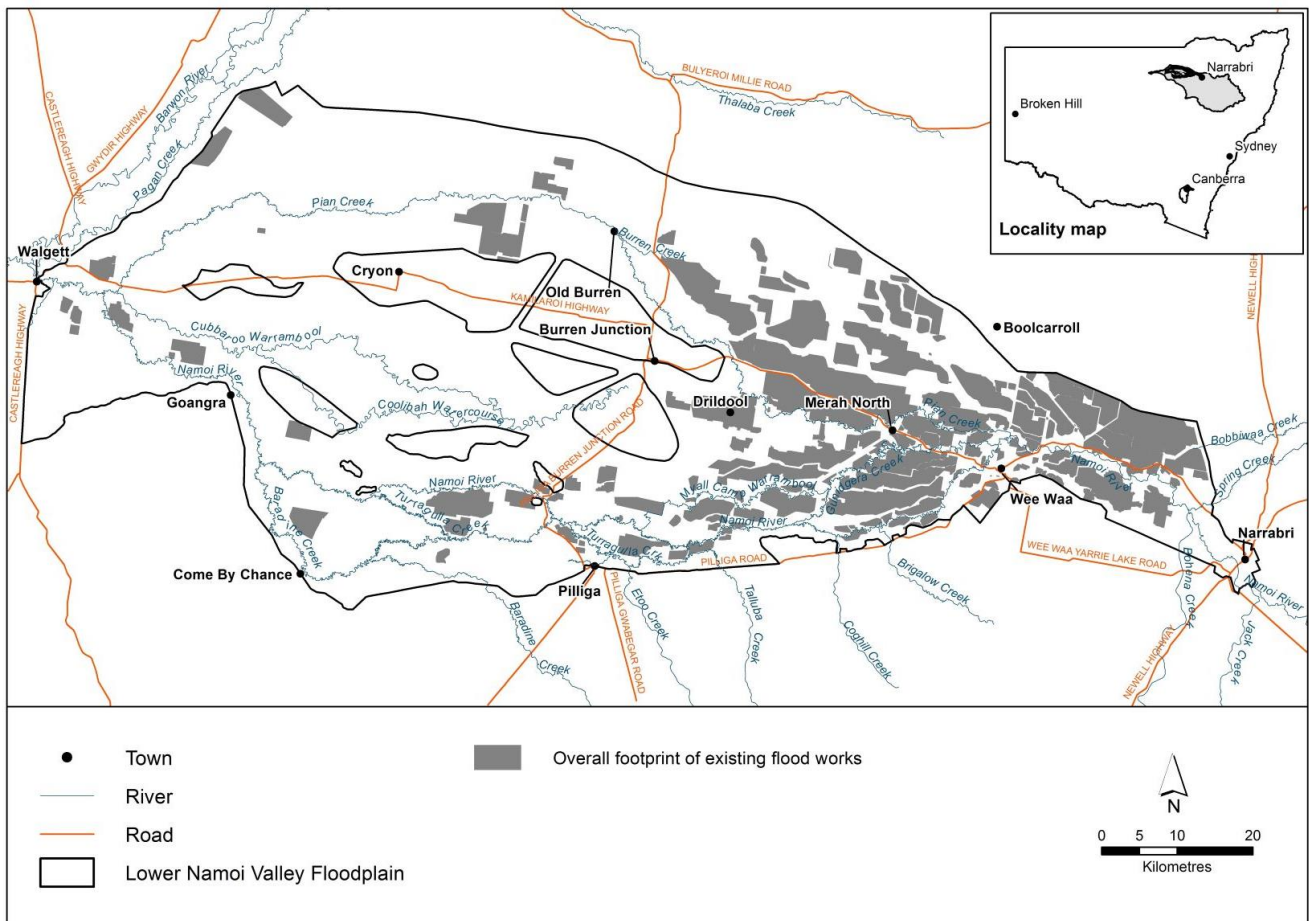


Figure 6. Overall footprint of existing flood works in the Lower Namoi Valley Floodplain

Note. The boundaries of the area enclosed by existing flood works are shown on the Existing Flood Works Map published on the NSW legislation website.

Step 3: Review existing rural floodplain management arrangements

Existing (now previous) rural floodplain management arrangements in the Lower Namoi Valley Floodplain included four first-generation rural floodplain development guidelines that were non-statutory, and one second-generation statutory rural FMP made under Part 8 of the *Water Act 1912*. In 2016, when Part 8 of the *Water Act 1912* was repealed, rural FMPs were transitioned over as Minister's Plans under the WM Act.

Three of the four first-generation rural floodplain development guidelines published in the Lower Namoi Valley Floodplain were still used prior to commencement of the Lower Namoi Valley FMP 2020. These guidelines covered the areas between Boolcarrol and Bulyeroi; Gardens and Drilool; and Merah North and Burren Junction. The fourth guideline covering the Narrabri to Wee Waa area was replaced by the Narrabri to Wee Waa Floodplain Management Plan in 2005.

Of the new Lower Namoi Valley Floodplain, approximately (Figure 7):

- 15% was covered by the Narrabri to Wee Waa Floodplain Management Plan 2005—hereafter referred to as the Narrabri to Wee Waa FMP 2005
- 15% was covered by the three first-generation rural floodplain development guidelines—hereafter referred to as managed areas (guidelines)
- 60% was designated as the Lower Namoi Valley Floodplain (the 1984 designated floodplain, as amended by the Narrabri to Wee Waa Floodplain in 2005) and flood works needed to be assessed against the relevant legislation—hereafter referred to as Part 8 areas
- 10% was not part of a guideline, rural FMP or designated floodplain—hereafter referred to as new areas.

The Lower Namoi Valley FMP 2020 supersedes all previous plans and guidelines in the Lower Namoi Valley Floodplain. A detailed history of floodplain management in the floodplain is outlined in Appendix 2. Existing rural floodplain management arrangements were reviewed to determine (see Appendix 3 for outcomes):

- flood management principles
- ecological and cultural heritage considerations
- floodway networks
- hydraulic models
- design flood events
- types of works considered for approval
- advertising requirements for applications
- assessment process for flood work applications, including any assessment criteria used.

Rural floodplain development guidelines and floodplain management studies

Non-statutory floodplain development guidelines (also referred to as guidelines) that have been prepared in the Lower Namoi Valley Floodplain include:

- *Guidelines for Boolcarrol to Bulyeroi floodplain development* (1980) NSW Water Resources Commission
- *Guidelines for Gardens to Drilool floodplain development* (No date) NSW Water Resources Commission

- *Guidelines for Merah North to Burren Junction floodplain development* (1978) NSW Water Resources Commission
- ²*Restoration of Namoi River Floodplain Waterways: Final Proposal* (1976) NSW Water Resources Commission (superseded).

Non-statutory floodplain management studies that have been prepared in the Lower Namoi Valley Floodplain include:

- Wee Waa Area Floods report following the 2–11 February 2012 flood (March 2012) by Frank Hadley

Water Act 1912 rural floodplain management plans

The Narrabri to Wee Waa Floodplain Management Plan (adopted September 2005) by the then Department of Natural Resources was the only second-generation rural FMP to be made under Part 8 of the *Water Act 1912* in the Lower Namoi Valley Floodplain. Part 8 of the *Water Act 1912* has since been repealed and the plan was transitioned over as a Minister's Plan under the WM Act.

The Lower Namoi Valley FMP 2020 replaces the Narrabri to Wee Waa FMP 2005, which was repealed as part of the process to commence the new plan.

² A report recommending strategies to improve this scheme was released in 1984 by the NSW Water Resources Commission titled 'Proposed modifications to Narrabri – Wee Waa Floodway Restoration Scheme'. In 2005, this scheme was superseded by the Narrabri to Wee Waa FMP.

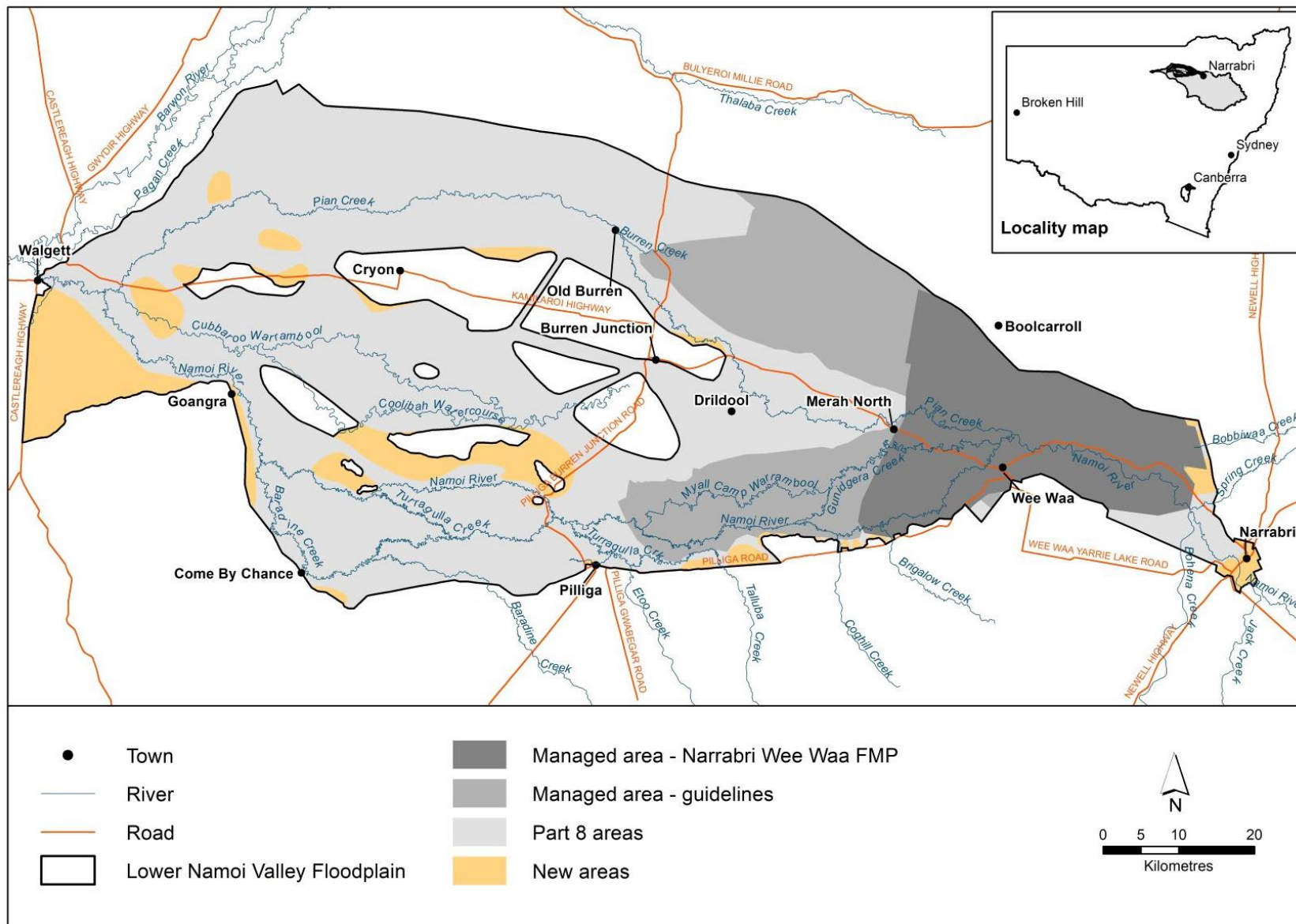


Figure 7. History of floodplain management in the Lower Namoi Valley Floodplain

Step 4: Determine the floodway network

In step 4, hydraulic criteria were determined to map the floodway network. Design floods of different magnitudes were selected and hydraulic models were constructed to simulate the movement of these design floods through the river channels and floodplain. This modelling data, as well as additional information, such as flood imagery, was used to map the floodway network.

Two-dimensional modelling was undertaken across more than 97% of the floodplain where high-resolution digital elevation modelling (DEM) and LiDAR were available.

The Lower Namoi floodway network (Figure 8 and Figure 9) includes the following hydraulic categories:

- major discharge areas:
 - defined floodways (127,937 ha or 22% of the floodplain), which are areas where a significant discharge of floodwater occurs during design floods and are important for the continuity of flood flows over the floodplain. They are general characterised by defined channels and banks.
 - ill-defined floodways (21,402 ha or 4% of the floodplain), which are areas where a significant discharge of floodwater occurs during design floods. They are overland flow paths with no defined channels or riverbanks that are important for the continuity of flood flows over the floodplain.
- inundation extent (228,526 ha or 40% of the floodplain), which includes areas of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood and for secondary flood discharge. Approved flood works that are limited height are included in the inundation extent, whereas those that are not overtopped by flooding are excluded.

The remaining 192,217 ha or about 34% of the floodplain was outside of the inundation extent of the large design flood and was not included as part of the floodway network.

The floodway network was the hydraulic basis for determining the extent of the management zones in the Lower Namoi Valley FMP 2020. Further information on design floods and hydraulic criteria is provided below.

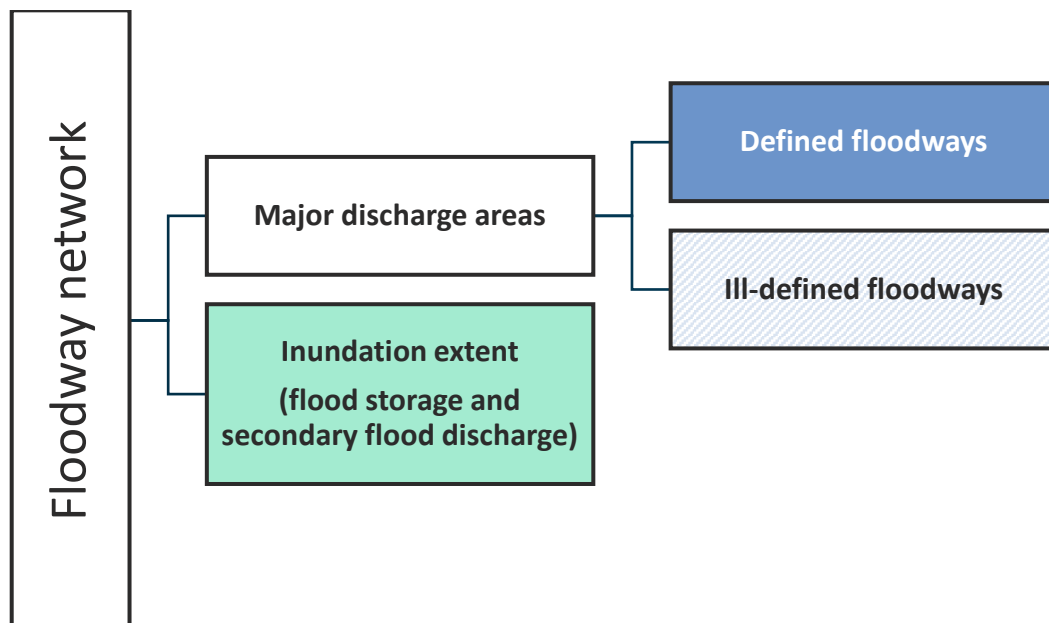


Figure 8. Finger diagram of hydraulic categories comprising the floodway network

Design floods

A design flood is a flood of known magnitude or annual exceedance probability (AEP) that can be modelled. For the Lower Namoi Valley FMP 2020, design floods were used to delineate the floodway network, which was then used as the hydraulic basis for developing the management zones. Design floods were selected based on an understanding of flood behaviour and associated flood risk. Two design floods were selected to account for the social, economic and ecological consequences associated with floods of different magnitudes.

The following design floods were selected for the Lower Namoi Valley FMP 2020:

- the design flood of February 1971 (4% AEP or 1 in 25 annual recurrence intervals at the Namoi River at the Mollee gauge GS 419039), known as the large design flood
- the design flood of December 2004 (13% AEP or 1 in 8 annual recurrence intervals at the Namoi River at the Mollee gauge GS 419039), known as the small design flood.

A flood frequency analysis was undertaken to understand the relative size of the historic floods in terms of their AEP (Table 2 for large floods and Table 3 for small floods). The flood frequency analysis was used to determine the relationship between peak flood discharge at a location of interest and the likelihood that a flood event of that size or greater would occur (see Appendix 4 for more details on how the flood frequency analysis results were obtained). This analysis uses available flow records, which may include records from when the flooding regime was relatively natural, as well as information that encompasses the existing flooding regimes.

Table 2. Annual exceedance probability (AEP) for large historic flood events at selected locations in the Lower Namoi Valley Floodplain

Location	1971 flood event AEP (%)	1974 flood event AEP (%)	1984 flood event AEP (%)	1998 flood event AEP (%)
Narrabri Creek at Narrabri (GS 419003)	3	6	7	7
Namoi River at Mollee (GS 419039)	4	6	6	6
Namoi River at Bugilbone (GS 419021)	4	5	6	4

Table 3. Annual exceedance Probability (AEP) for small historic flood events at selected locations in the Lower Namoi Valley

Location	2004 flood event AEP (%)	2012 flood event AEP (%)
Narrabri Creek at Narrabri (GS 419003)	20	14
Namoi River at Mollee (GS 419039)	13	10
Namoi River at Bugilbone (GS 419021)	10	7

The large design flood (February 1971) was used to delineate the floodway network. The large design flood was selected because:

- it is the most recent large flood and therefore likely to be in the collective memory of floodplain users
- it is representative of large floods in the valley
- it was used for the development of the Narrabri to Wee Waa FMP 2005

- there is a significant amount of information available for the event.

The small design flood (December 2004) was selected to ensure that critical flow paths to ecological and cultural assets that are dependent on flooding are considered in the management zones and during the technical assessment of flood work applications.

Modelling

Hydrologic models

Hydrologic models simulate rainfall-runoff on a catchment by converting storm rainfall to flow hydrographs. This is done using a procedure known as run-off routing, which subtracts losses, such as from soil infiltration, from the total rainfall. The rainfall excess is then routed through the catchment storage to produce flow hydrographs at specified locations (Laurenson, Mein and Nathan 2010).

In the Lower Namoi Valley Floodplain between Narrabri and Walgett, most floodwater originates from the upper Namoi Valley catchments. These flows are well gauged at Mollee and these flows are used as inflow to the Lower Namoi River model.

There are a number of other smaller ephemeral tributaries, which drain the southern side of the Lower Namoi Valley Floodplain, to the south of Pilliga including Carbeen, Friday and Baradine creeks. The inflows for these ungauged tributaries were estimated using the Probabilistic Rational Method outlined in the Australian Rainfall and Runoff (ARR, 2011).

Hydraulic models

The Lower Namoi Floodplain was divided into five sections for hydraulic modelling purposes (Figure 10). The hydraulic models built for the Lower Namoi Valley FMP 2020 were a combination of one-dimensional river systems, which model channel flow, and two-dimensional grids, which simulate water flowing over floodplains (Table 4).

Table 4. Hydraulic models in each floodplain section

Floodplain model	Size (ha)	Model description
Narrabri	15,000	A *MIKE FLOOD Flexible Mesh (FM) model was built for the town of Narrabri. It encompasses an area approximately 10 km upstream and 12 km downstream of the town and includes the two main branches of the Namoi River as well as several smaller side branches and overland flow paths within the town.
Mollee	68,000	A *MIKE 21 FM model built between Mollee Weir and Merah North and includes the towns of Merah North and Wee Waa.
Merah	237,000	A MIKE 21 FM model built between Merah North and Burren Junction. The model extends 37 km to the north and 15 km to the south of Merah North and 8 km to the west of Burren Junction.
Burren	370,000	A MIKE 21 FM model from Burren Junction to Goangra. The midpoints of the eastern and western model borders are located approximately 4 km and 59 km, respectively, downstream of Burren Junction.
Section 2 (Gomilaroi Weilan and Youularoi section)	398,000	A MIKE 21 FM model was built from Tara to Geera. The major tributary inflows included Pian Creek, Barwon and Namoi rivers. All major areas were excluded from the mesh, including the township of Walgett.
Total	^1,088,000	

*For more information on model software see Appendix 5.

^This area is larger than the Lower Namoi Valley Floodplain as the model boundaries extend outside the floodplain.

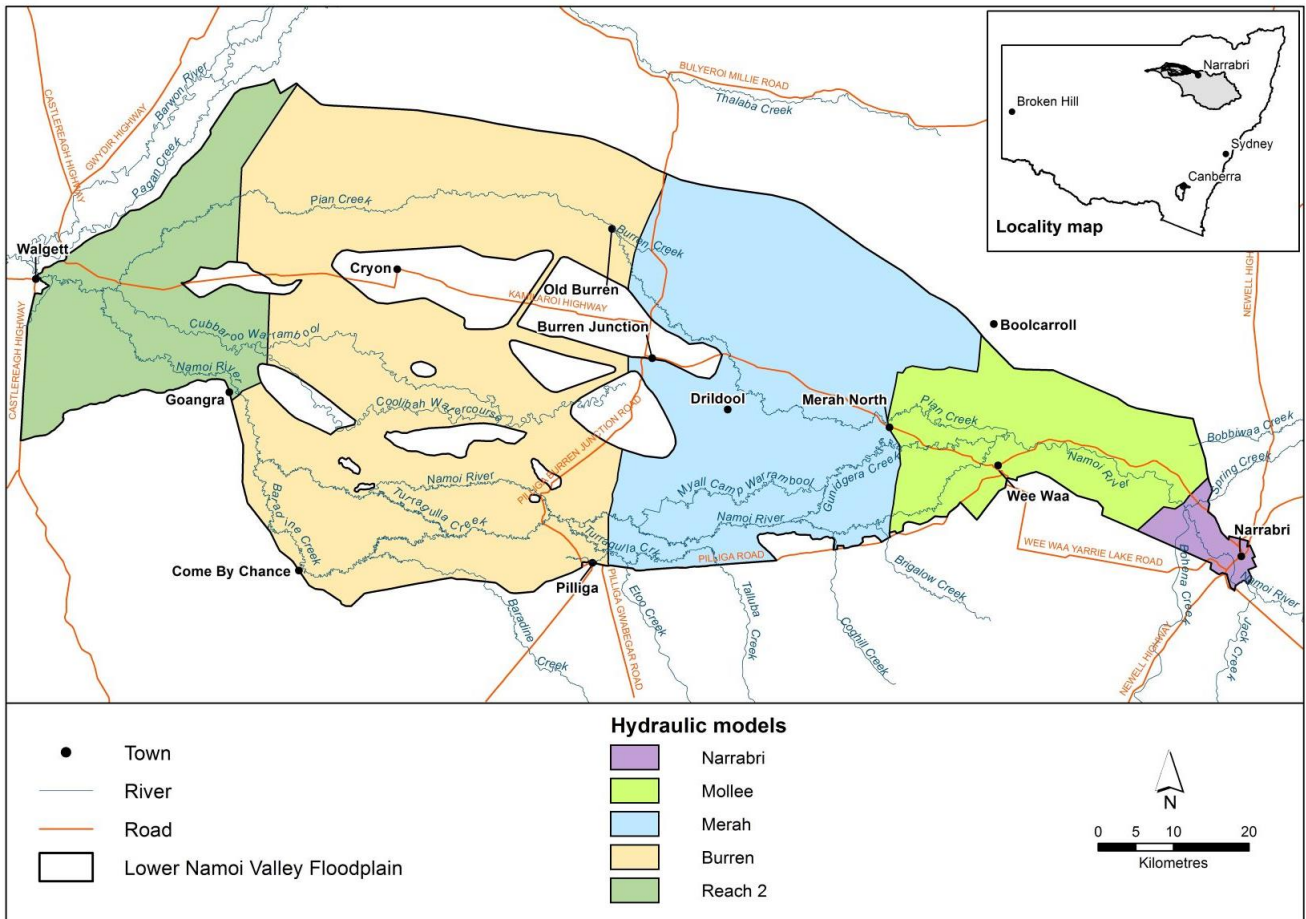


Figure 10. The approximate extent of the five hydraulic models within the Lower Namoi Valley Floodplain

Hydraulic model outputs used include a depth-velocity product map from the large design flood (Figure 11) and inundation extents of the small and large design floods.

These outputs were used to determine whether an area of flooding was a floodway and the appropriate width of identified floodways. The location of flow paths in the models were determined using DEMs, flood aerial photography, satellite imagery, watercourse layers, flood marks and local knowledge.

The overall footprint of constructed works was determined in Step 2. Floodplain areas enclosed by existing flood works, that are not limited height, were generally excluded from the model’s computational grid, as they were assumed to not be overtopped by floodwater. Areas protected by limited height works (as indicated by licence files) were assumed to be overtopped by floodwater and were represented in the models as indicated by their licence files.

The hydraulic models cover almost all the floodplain (97%), including the area of floodplain between Mollee Weir near Narrabri and the confluence of the Barwon–Darling and Namoi River immediately downstream of Walgett. These models were built in MIKE21FM, which is the finite volume version of MIKE21, to allow for finer mesh resolution along the flow paths and floodplain areas where more detail is required and a coarser mesh resolution in the wider floodplain. The model mesh was developed using triangular elements of different sizes, allowing for different mesh resolutions across the study area.

Following public exhibition of the Draft Lower Namoi Valley FMP, a local industry group requested that a peer review of the hydraulic modelling be undertaken to determine if the modelling was fit for the purpose for delineating the extent of the management zones. In response to the peer review

report and following internal review of the draft Lower Namoi Valley FMP, updates were made to the modelling which was then re-run with amended inputs.

For the Merah model, the envelope of the following two events were used to delineate the final extent of the management zones:

- large design flood (1971—4% AEP) at the Namoi River + 50% of 1 in 20-year flows from the Pilliga Forest
- small design flood (2004—13% AEP) at the Namoi River + 100% of the 1 in 20-year flows from the Pilliga Forest.

This approach was based on gauges in Brigalow Creek and the Namoi River and the joint probability of the occurrence of these floods. This approach was deemed appropriate to account for the variation in timing between the Namoi River and Brigalow Creek inflows.

For more information on model software, extents, mesh, boundary conditions, initial conditions, roughness maps, setup parameters, calibration, and updates applied following public exhibition, see Appendix 5.

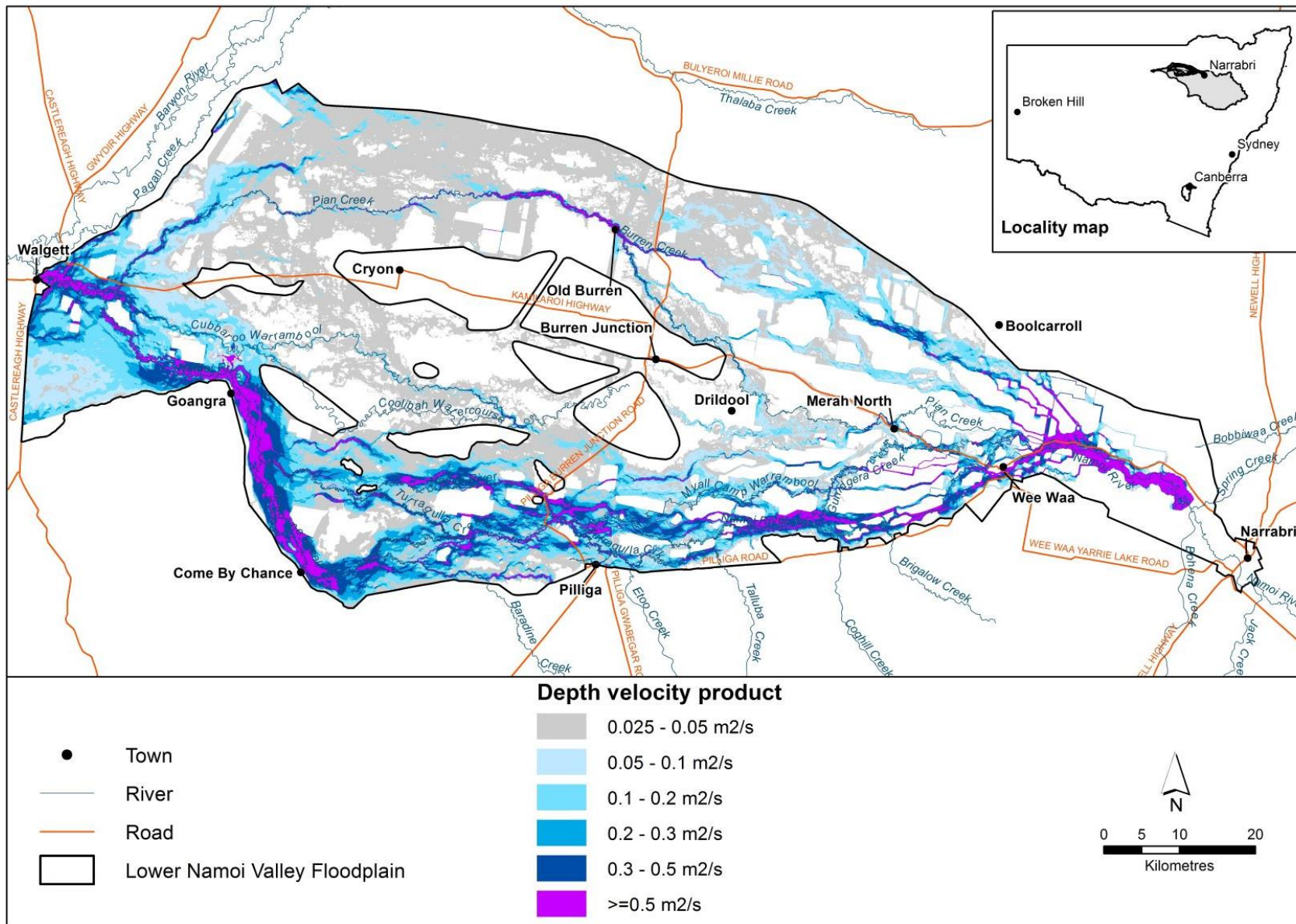


Figure 11. Hydraulic modelling results (depth-velocity product) from all five models for the large design flood event (February 1971—4% AEP at the Namoi River Mollee gauge GS 419039)

Hydraulic criteria for the floodway network

There are no industry-specific procedures for identifying floodways or for defining their extent; however, the advancement of tools used to simulate flooding (such as two-dimensional hydrodynamic models) and improved topographic data (such as LiDAR) allows practitioners to more rigorously interrogate flood characteristics (Thomas and Golaszewski 2012). Improvements to models and input data has enabled quantitative approaches for delineating floodways to be used such as depth-velocity product thresholds and extents of design floods. Nevertheless, there is no definitive flood modelling procedure that can be applied to automate the process of generating floodway extents and the methodology should involve iterative assessments (Thomas and Golaszewski 2012).

Through consultation with the Technical Advisory Group and with local stakeholders, criteria to interpret two-dimensional flood modelling outputs were determined, including deciding on appropriate depth-velocity product thresholds and use of small design flood extents. The outcomes are described in detail below. Once the thresholds were selected, applying the criteria remained a complex and iterative process requiring specialist input from practitioners with skills in interpreting flood data and floodplain geomorphology, and in understanding the importance of hydraulic controls and conveyance.

Floodways

Hydraulic criteria were determined for defined floodways and ill-defined floodways through consideration of existing floodplain management arrangements, the Upper Namoi Valley FMP 2019, feedback from targeted consultation, and in discussion with the Technical Advisory Group. The criteria are described in detail below.

Defined floodways

Defined floodways were identified as floodways with a depth-velocity product of greater than or equal to $0.2 \text{ m}^2/\text{s}$ for the large design flood (1971—4% AEP).

In the southern part of the floodplain, the envelope of the following two events was also used to delineate the extent of the management zones:

- large design flood (1971—4% AEP) plus 50% of 1 in 20-year flows from the Pilliga Forest
- small design flood (2004—13% AEP) plus 100% of 1 in 20-year flows from the Pilliga Forest.

This approach was based on gauges in Brigalow Creek and on the Namoi River and joint probability of the occurrence of these floods and was deemed appropriate to account for the variation in timing between the Namoi River and Brigalow Creek inflows.

In ArcGIS ArcMap 10.4, the depth-velocity product model outputs of greater than or equal to $0.2 \text{ m}^2/\text{s}$ were converted to polygon format, dissolved and smoothed using the Smoothing Polygon tool and the PAEK (Polynomial Approximation with Exponential Kernel) method with a tolerance of 400 m in the Burren and Reach 2 areas and of 200 m in other areas. Smoothing was undertaken to produce a more practical product. Small refinements were also made to:

- remove 'arms' that branch from a floodway that do not have connectivity and are not important for drainage
- remove isolated floodways that would not be able to be connected to the floodway network
- ensure all floodways are a minimum width of 80 m unless a feature on the landscape makes this impractical
- make gaps of less than or equal to 5 ha in the floodways part of the floodways.

Floodplain connectivity was provided for by incorporating areas connecting floodways that had:

- a depth-velocity product of greater than or equal to $0.05 \text{ m}^2/\text{s}$, and/or

- coincided with the small design flood extent (2004—13% AEP) (Figure 12).

The width of these connectors was a combination of the width of the upstream and downstream floodways as well as the modelling results. Additional data was used to guide the location of the floodway connectors, including:

- satellite and aerial flood imagery (see Appendix 6)
- ADS40 DEM (Land and Property Information 2013) and ADS40 aerial imagery
- LiDAR DEM
- *NSW water count and water prevalence* (1988-2012) (Fisher et al. 2016; Danaher & Collett 2006; Auscover Remote Sensing Data Facility 2016)—provides a measure of the relative persistence of water in the landscape (for example from always present to rarely and never present).

Rivers and creeks identified in two stream layers were also included as defined floodways. Specifically, streams were included as defined floodways if they were classified as greater than or equal to three in the *NSW Strahler Stream Order Hydroline* (2013) spatial layer and the *Stream Ordering* (Revised in 2011; ANZNS0359100076) spatial layer. These streams were checked against ADS40 and other imagery. During this process, if they were found to be man-made channels or roads; perched streams or only significant for local drainage they were not included as a defined floodway. The selected stream orders were line features and were buffered by 40 m to be a total width of 80 m.

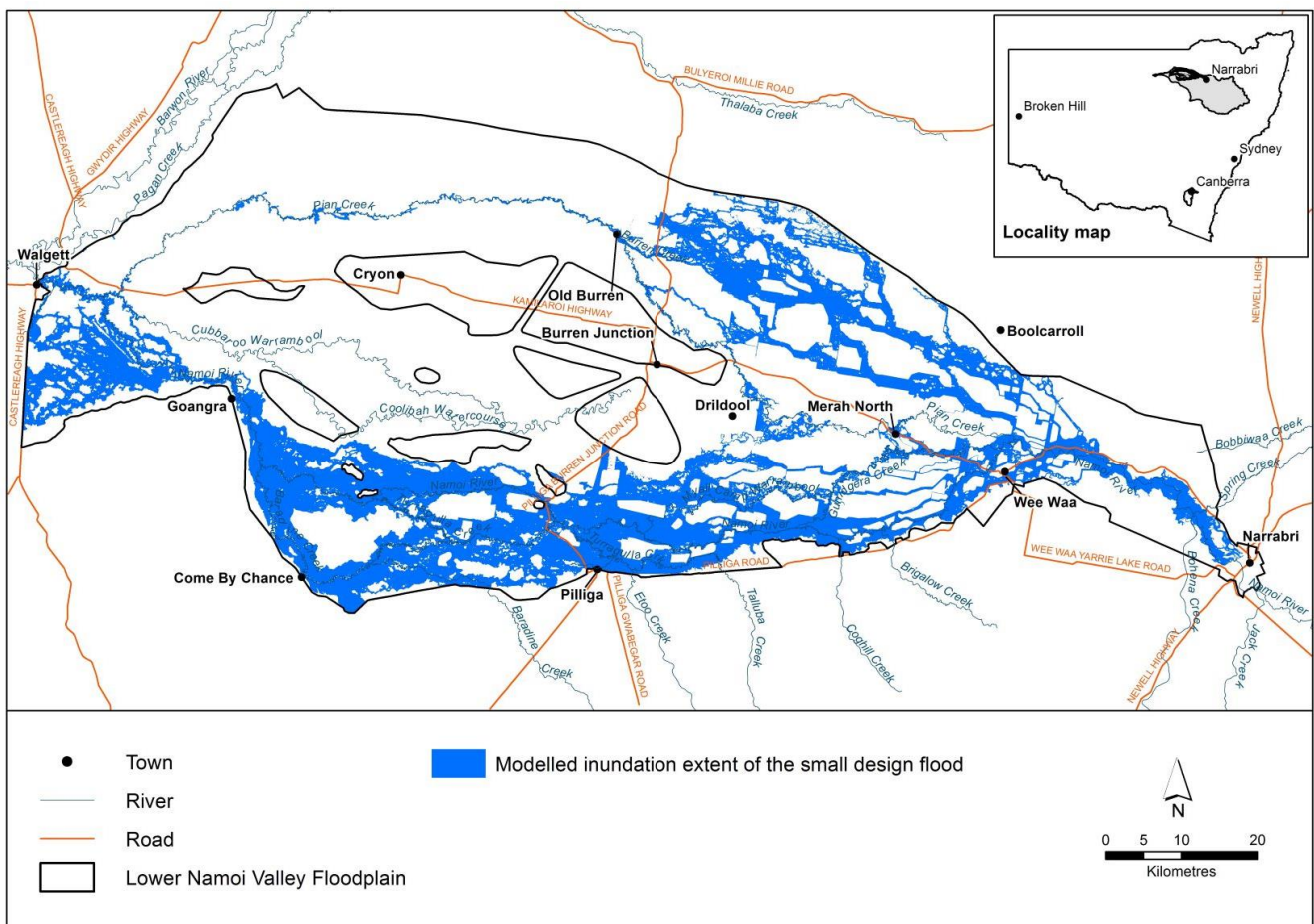


Figure 12. Modelled inundation extent of the small design flood (December 2004—13% AEP at the Namoi River Mollee gauge GS 419039)

Ill-defined floodways

During targeted consultation, a local industry group requested that ill-defined floodways be applied to the Lower Namoi Valley Floodplain in place of defined floodways in areas where a flow path was known to be located but where the depth-velocity product threshold was less than 0.2 m²/s for the large design flood.

The centreline of the ill-defined floodways was guided by flood imagery, local knowledge, extent of the small design flood and areas with a depth-velocity product of less than 0.05 m²/s. The final width was determined as the width of the upstream floodway plus a maximum 500 m buffer either side of the original floodway.

Ill-defined floodways have a minimum width of 1 km to complement the rule that prescribes a flood flow corridor of at least 80 m must be maintained through any ill-defined floodway. The ill-defined floodways are purposefully made wide to give landholders who apply for a flood work in the area the opportunity to meaningfully negotiate the location of the flood flow corridors, which are not mapped in the plan. Further detail is provided in Step 8. An 80 m flood flow corridor in most cases would allow for the conveyance of major discharge of flood water during a flood.

Ill-defined floodways were first delineated in the Upper Namoi Valley FMP 2019 using a different methodology. Two-dimensional modelling was not available in most of the Upper Namoi Valley Floodplain, so ill-defined floodways were identified where topographical data indicated floodways did not have a defined channel or bank.

In the Lower Namoi Valley Floodplain, some floodways that do not have a defined channel or bank may have been identified as a defined floodway where the depth-velocity product thresholds were met. Ill-defined floodways in both the Lower and Upper Namoi Valley FMPs are areas of major flood discharge.

Inundation extent

Hydraulic modelling produced the inundation extent of the large design flood across the floodplain. Where the flood extent was reliable, its outer limits were used to determine the extent of the floodway network. However, where topographic data was not sufficient to accurately map the extent of the flood, the limits to the floodway network were determined by using aerial and satellite flood imagery captured for the design event or another flood event of similar size.

Using ArcGIS ArcMap 10.4, the model outputs for the areas inundated were converted to polygon format, dissolved and smoothed using the Smooth Polygon tool and the PAEK method with a tolerance of 200 m. Isolated polygons less than or equal to 10 ha were then removed. The layer was again smoothed with the PAEK tool using a tolerance of 600 m. After this, polygons less than or equal to 30 ha were removed. Gaps were then manually filled in or widened in consultation with flood imagery and experts. This resulted in a product that was practical as well as indicative of the inundation extent of the large design flood.

Areas within the extent of the design flood are considered important for providing temporary pondage during large floods. Areas beyond the extent of the design flood may also be flood-prone but would only become inundated during larger floods including extreme events and would generally have low conveyance or pondage capacity.

Areas of the floodplain that are protected by existing flood works that are limited height and overtopped during moderate to large floods were included in the inundation extent. Those areas of the floodplain that are protected by existing flood works and are not overtopped during moderate to large floods were excluded from the inundation extent (step 2).

Summary

Hydraulic criteria for mapping the floodway network are summarised in Table 5 below. To ensure that conditions on the ground are adequately represented, the criteria were checked against the following additional data:

- flood aerial photography and satellite imagery
- spatial watercourse layers, topographical mapping, ADS40 DEM and LiDAR
- previous floodplain management plans and development guidelines
- local knowledge obtained from floodplain communities and floodplain/environmental managers.

Table 5. Summary of criteria used to delineate the hydraulic categories in the floodway network

Hydraulic category	Criteria
Major discharge areas, Defined floodways	<p>Major discharge areas that have a depth-velocity product of greater than or equal to 0.2 m²/s for the large design flood (1971—4% AEP).</p> <p>Floodplain connectivity was provided for by incorporating:</p> <ul style="list-style-type: none"> • parts of the small design flood extent (2004—13% AEP) and/or • floodplain areas that have a depth-velocity product of greater than or equal to 0.05 m²/s for the large design flood (1971—4% AEP).
Major discharge areas, Ill-defined floodways	<p>Major discharge areas that have a depth-velocity product of <0.05 m²/s for the large design flood (1971—4% AEP).</p> <p>The location of ill-defined floodways is guided by:</p> <ul style="list-style-type: none"> • areas with a depth-velocity product of less than 0.05 m²/s for the large design flood (1971 —4% AEP) and/or • flood imagery and/or • local knowledge and/or • parts of the small design flood extent (2004—13% AEP). <p>The width of ill-defined floodways is determined by the width of the upstream defined floodway and a maximum 500 m buffer either side of this floodway (minimum width is 1 km).</p>
Flood storage and secondary flood discharge areas	<p>Flood storage and secondary flood discharge areas of the floodplain are:</p> <ul style="list-style-type: none"> • areas not already identified as an ill-defined or defined floodway, and • included within the extent of the large design flood (1971—4% AEP), or • enclosed by existing Part 8 approved flood works that are overtopped during moderate to large floods.
Areas outside floodway network (known as flood fringe and flood-protected areas)	<p>Areas outside of the floodway network include the flood fringe areas of the floodplain, which have not been mapped as floodways or flood storage and secondary flood discharge areas. These areas of the floodplain are:</p> <ul style="list-style-type: none"> • outside the extent of the large design flood (1971—4% AEP), and/or are • enclosed by existing Part 8 approved flood works that are not designed to be overtopped during flooding.

Step 5: Identify and prioritise floodplain assets

Step 5 was undertaken to identify and prioritise the many unique and diverse floodplain assets found on the Lower Namoi Valley Floodplain. This informed the design of the management zones, rules and assessment criteria in later steps.

Ecological assets

During step 5, ecological assets were:

- identified using best-available spatial data
- grouped using information on their optimum watering requirements
- prioritised to select the assets that best represent biodiversity on the floodplain.

Identifying ecological assets

The Lower Namoi Valley FMP considered three types of ecological asset including wetlands, other floodplain ecosystems (Figure 13) and areas of groundwater recharge. Note that areas of groundwater recharge were not mapped due to data limitations.

Native vegetation mapping was predominantly used to identify wetlands and other floodplain ecosystems. Approximately 112,136 ha (or 20%) of the floodplain was identified as native vegetation that is flood-dependent, and which were considered in the application of the ecological criteria in the delineation of the management zones (see ecological criteria below for further information). Several regional vegetation maps sourced from the NSW Vegetation Information System (VIS) and previous studies were utilised to identify flood-dependent vegetation and wetlands, including:

- Non-woody (wetland) vegetation communities mapped by:
 - Eco Logical Australia (2008) *Vegetation Mapping for the Namoi and Border Rivers-Gwydir CMA's. Compilation of API Datasets and Preparation of a Hierarchical Vegetation Classification. Project Numbers 125-002 & 129-002. Report prepared for Namoi and Border-Rivers-Gwydir CMAs (VIS ID: 3842)*
 - Eco Logical Australia (2009) *A vegetation map for the Namoi Catchment Management Authority. (Project No. 125-004). Report prepared for Namoi CMA June 2009 (VIS ID: 3851)*
 - Eco Logical Australia (2013) *Refinement of vegetation mapping in the Namoi Catchment: Extant and pre-European. Prepared for Namoi CMA. May 2013 (VIS ID: 4028)*
 - OEH (2015) *BRG-Namoi Regional Native Vegetation Mapping. Technical Notes, NSW Office of Environment and Heritage, Sydney, Australia (VIS ID: 4467)*
- Wetlands identified in previous studies:
 - The Narrabri to Wee Waa FMP 2005 which identified several wetland depressions and lagoons where low connectivity to these wetlands was maintained within the FMP floodway limits
 - Eco Logical Australia (2008a) *Namoi Wetland Assessment and Prioritisation Project. Project No. 125-005. Report prepared for Namoi Catchment Management Authority, PO Box 1927, Armidale, NSW 2350*
 - Green, D and Dunkerley, G (1992) *Wetlands of the Namoi Valley: Progress Report. Department of Water Resources Technical Services Division. A progress Report to the Murray–Darling Basin Commission for the Barwon–Darling Wetland Survey, funded under the Natural Resources Management Strategy*

- Wetland features from HydroArea (Land and Property Information 2012) Hydro area defines the hydrography feature types as water body area and water course. It is a polygon feature class of the NSW Digital Topographic Database (DTDB), within the Hydrography theme.
- Woody vegetation communities mapped by:
 - OEH (2015) BRG-Namoi Regional Native Vegetation Mapping. Technical Notes, NSW Office of Environment and Heritage, Sydney, Australia (VIS ID: 4467).

The BRG-Namoi Regional Native Vegetation Mapping (OEH 2015) forms part of the OEH State Vegetation Type Map (SVTM) and was used to identify regional scale Plant Community Types (PCTs) in the Lower Namoi Valley Floodplain. This map was developed by OEH in 2015 using vegetation surveys, remote sensing derivations, visual interpretations of high-resolution imagery and spatial distribution models. The NSW PCT classification provides an unambiguous community-level classification for use in vegetation mapping programs, BioMetric-based regulatory decisions, and as a standard typology for other planning and data gathering programs.

Semi-permanent wetland vegetation communities were identified from the BRG-Namoi Regional Native Vegetation Mapping (OEH 2015) and several additional sources including the regional vegetation maps of Eco Logical Australia 2008, Eco Logical Australia 2009 and Eco Logical Australia 2013.

Ecological asset type—wetlands

The ecological asset, *wetlands*, is comprised of floodplain watercourses, semi-permanent wetlands and floodplain wetlands (flood-dependent shrubland wetlands) (Figure 13).

Semi-permanent (non-woody) wetlands (3712 ha) require annual or a higher frequency of inundation to maintain structure and community composition. Semi-permanent wetlands contain the following vegetation communities (PCT, plant community types; RVC, regional vegetation types):

- shallow freshwater wetland sedgeland in depressions on floodplains on inland alluvial plains and floodplains (PCT 53)
- water Couch marsh grassland wetland of frequently flooded inland watercourses (PCT 204)
- riparian sedgeland rushland wetland of the Pilliga to Goonoo sandstone forests, Brigalow Belt South Bioregion (PCT 400)
- tall rushland, reedland or sedgeland of inland rivers, Darling Riverine Plains and Brigalow Belt South (RVC 69)
- wetlands and marshes, Darling Riverine Plains, Brigalow Belt South and Nandewar (RVC 70)
- tall rushlands, reedlands or sedgelands of inland river systems, Darling Riverine Plains, Brigalow Belt South and Nandewar (RVC 95).

Floodplain wetlands (flood-dependent shrubland wetlands) (4650 ha) requires flooding at intervals of one to five years (Roberts and Marston 2011; Rogers and Ralph 2011). Floodplain wetland contains the following vegetation communities:

- Eurah shrubland of inland floodplains (PCT 115)
- River coobah swamp wetland on the floodplains of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion (PCT 241)
- Lignum shrubland wetland on regularly flooded alluvial depressions in the Brigalow Belt South Bioregion and Darling Riverine Plains Bioregion (PCT 247).

Wetlands can provide habitat for a variety of flood-dependent fauna such as nesting waterbirds, fish, amphibians and turtles.

Ecological asset type—other floodplain ecosystems

The ecological asset, *other floodplain ecosystems*, is comprised of flood-dependent forest/woodland (wetlands) and flood-dependent woodlands (Figure 13).

Flood-dependent forest/woodland (wetlands) (5140 ha) requires flooding at intervals of between one and three years (Roberts & Marston 2011) or up to every five years (Roberts and Marston 2011). Flood-dependent forest/woodland (wetlands) contains the following vegetation communities:

- river red gum tall to very tall open forest/woodland wetland on rivers on floodplain mainly in the Darling Riverine Plains Bioregion (PCT 36)
- river red gum riparian tall woodland/open forest wetland in the Nandewar Bioregion and Brigalow Belt South Bioregion (PCT 78)
- red gum–rough-barked apple +/- tea tree sandy creek woodland (wetland) in the Pilliga–Goonoo sandstone forests, Brigalow Belt South Bioregion (PCT 399).

Flood-dependent woodland (97,196 ha) contains the following vegetation communities:

- black box woodland wetland on NSW central and northern floodplains including the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion (PCT 37)
- coolibah–river coobah–Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion (PCT 39)
- coolibah open woodland wetland with chenopod/grassy ground cover on grey and brown clay floodplains (PCT 40)
- poplar box–coolibah floodplain woodland on light clay soil mainly in the Darling Riverine Plains Bioregion (PCT 87)
- carbeen +/- coolibah grassy woodland on floodplain clay loam soil on north-western NSW floodplains, mainly Darling Riverine Plain Bioregion (PCT 628).

Non flood-dependent vegetation or dryland species of vegetation may occur adjacent to flood-dependent vegetation in response to rainfall events and may tolerate infrequent small floods. There are 14 non-flood-dependent PCTs identified in the study area (Appendix 7). Non flood-dependent vegetation as well as vegetation classes identified by OEH (2015) as Non-Native (PCT 0) (Figure 14) or Candidate Native Grasslands (PCT 1) were not considered in the design of the management zones.

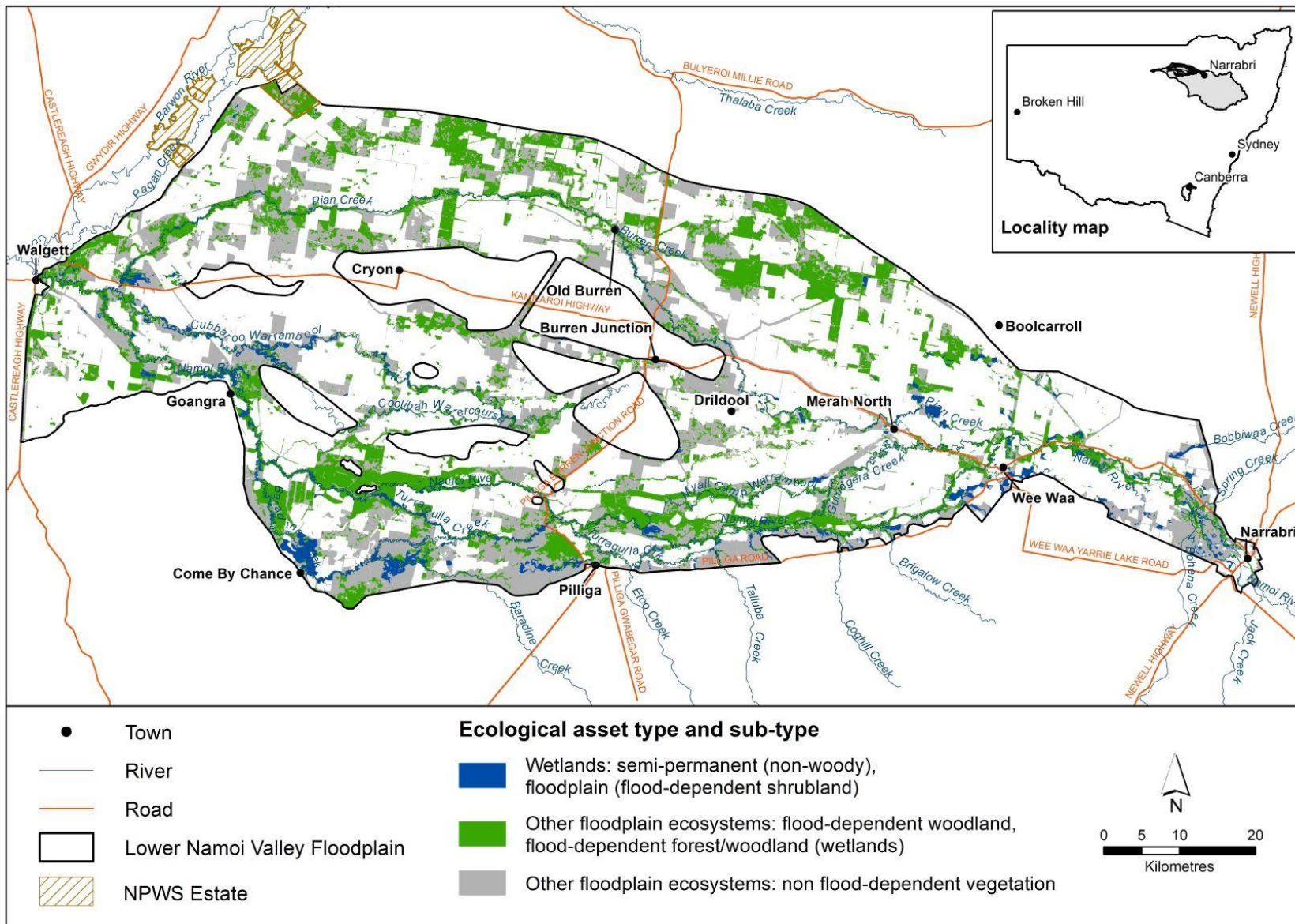


Figure 13. Overview of the ecological assets identified in the Lower Namoi Valley Floodplain

Note. The boundaries of the ecological assets are shown on the Ecological Assets Map published on the NSW Legislation website.

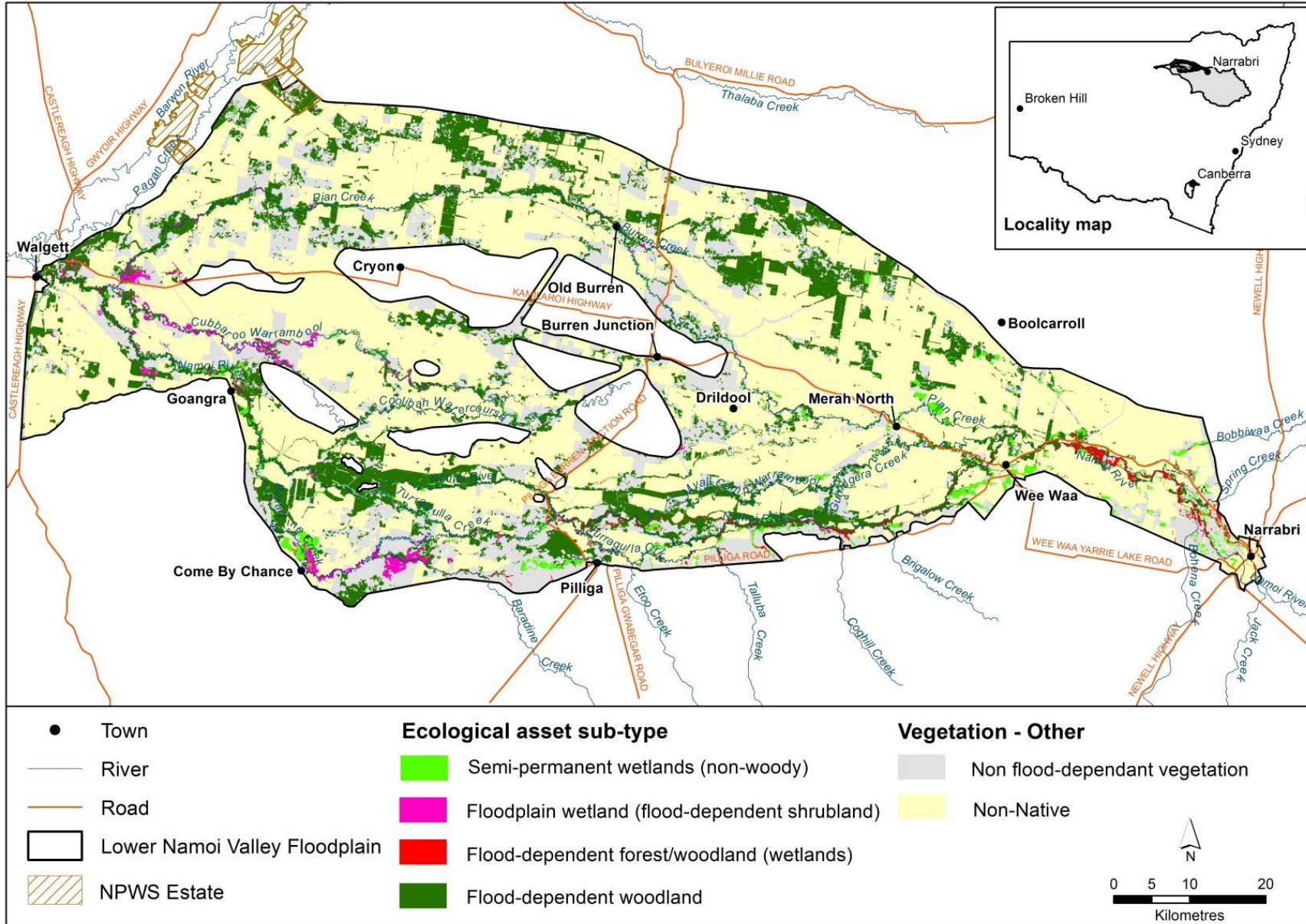


Figure 14. Ecological asset sub-types identified in the Lower Namoi Valley Floodplain

Ecological asset type—groundwater recharge

Groundwater recharge areas are sites where water from a flood event leaks through the soil profile into underlying aquifers. The scale of groundwater recharge mapping in the Lower Namoi Valley Floodplain is not appropriate for making management decisions, such as where management zones should be located on the floodplain. Nevertheless, flooding is an important source of groundwater recharge on floodplains and changes to flood connectivity may impact on groundwater storage. Therefore, to minimise harm to groundwater reserves and groundwater-dependent ecosystems that are either partially reliant on surface floodwaters or rely wholly on groundwater sourced by floods, the Lower Namoi Valley FMP 2020 aims to achieve a natural flood-flow distribution where practicable and to maintain core floodplain inundation. This will improve the likelihood and duration of groundwater recharge areas being subjected to flood inundation.

If further information on flood-sourced groundwater recharge areas becomes available, the Lower Namoi Valley FMP 2020 may need to be reviewed to ensure that they are adequately considered in the design of the management zones and rules.

Appendix 8 provides further detail on groundwater recharge in the Lower Namoi Valley Floodplain.

Flood dependency of wetlands and other floodplain ecosystems

The flood dependency of ecological assets in the Lower Namoi Valley Floodplain was a key consideration informing the delineation of the management zones. This aims to protect the passage of floodwater to ecological assets dependent on flooding to maintain their long-term persistence, structural integrity and community condition.

The distribution of vegetation across a floodplain may reflect the water regime (Casanova and Brock 2000). Vegetation communities in the immediate vicinity of the Namoi River are in contrast to those found in drier environments beyond the extensive alluvial floodplain where non-flood-dependent species are likely to occur. The timescales of flooding and the spatial extent of wet/dry ecotone may influence the types of plants that can germinate, grow and reproduce (Brock and Casanova 1997, Capon and Brock 2006).

The many lagoons and semi-permanent wetland vegetation communities that occur on the Lower Namoi Valley Floodplain downstream of Narrabri are connected with major watercourse channels by over-bank flooding. Their vegetation composition and condition reflect differences in flood frequency, timing and duration. Foster (1999) surveyed a number of key locations along the lower Namoi river as part of a preliminary assessment of the commence-to-flow levels of wetlands and in channel features of the lower Namoi Valley.

The creek banks and floodplain swamps near Wee Waa support wetland plant species such as water primrose (*Ludwegia peploides*), which provide important habitat for aquatic fauna (Namoi CMA 2008). Other wetlands and moist sites in the Walgett and Wee Waa area support emergent sedges which favour moist conditions including small spike-rush (*Eleocharis pusilla*), submerged aquatic species such as striped water milfoil (*Myrophyllum striatum*) and aquatic ferns such as *Marsilea* spp. (nardoo) which prefer moist water-logged soils and have growth traits such as flexible stems to cope with changes in water levels (Capon 2016; Namoi CMA 2008). Riverine vegetation such as river red gum (PCT 36, PCT 78) align the immediate banks of Namoi river (OEH 2015) and overbank flooding from main river channels is important for maintaining its condition and for the provision of dissolved organic carbon and other nutrients to downstream reaches and wetlands.

Further away from the banks of the Namoi River, the flood-dependent vegetation is distributed laterally across the floodplain in response to over-bank flooding, where coolibah–river coobah–lignum and black box–coolibah woodlands occur (Foster 1999; Lambert and Short 2004; OEH 2015). The sparse to open flood-dependent woodland communities of the Lower Namoi Valley Floodplain have been extensively cleared for cropping and grazing and the remaining flood-

dependent woodlands are now limited to areas where cropping is restricted. Green and Dunkerley (1992) provide additional detail regarding the spatial extent of key water-dependent species.

Beyond the extent of major flooding, a range of different dryland vegetation communities occur on the margins of the Lower Namoi Valley Floodplain that do not rely on surface water flooding to grow and reproduce. These communities include poplar box (*Eucalyptus populnea* subsp. *bimbil*) and white cypress pine (*Callitris glaucophylla*) communities of the Pilliga region (PCT 397) and narrow-leaved ironbark (*Eucalyptus crebra*)–white cypress pine (PCT 398) (OEH 2015).

In step 5, wetlands and other floodplain ecosystems of the Lower Namoi Valley Floodplain were categorised into hydro-ecological functional groups according to the surface water requirements of the dominant or canopy species in a floodplain vegetation community to maintain their ecological character using information sourced from the reviews of Roberts and Marston (2011) and Rogers and Ralph (2011), which provide a synthesis of the best available knowledge (Table 6 and Table 7).

Any mapped vegetation classes that were described as non-native were discarded from the analysis.

Table 6. Hydro-ecological functional groups that comprise wetlands¹ in the Lower Namoi Valley Floodplain

HEF ² group	Vegetation/watercourse class	Ideal watering frequency
Semi-permanent wetlands	Shallow freshwater wetland sedgeland in depressions on floodplains on inland alluvial plains and floodplains (PCT 53)	Annual or near annual
Semi-permanent wetlands	Water Couch marsh grassland wetland of frequently flooded inland watercourses (PCT 204)	Annual or near annual
Semi-permanent wetlands	Riparian sedgeland rushland wetland of the Pilliga to Goonoo sandstone forests, Brigalow Belt South Bioregion (PCT 400)	Annual or near annual
Semi-permanent wetlands	Tall rushland, reedland or sedgeland of inland rivers, Darling Riverine Plains and Brigalow Belt South (RVC 69)	Annual or near annual
Semi-permanent wetlands	Wetlands and marshes, Darling Riverine Plains, Brigalow Belt South and Nandewar (RVC 70)	Annual or near annual
Semi-permanent wetlands	Tall rushlands, reedlands or sedgelands of inland river systems, Darling Riverine Plains, Brigalow Belt South and Nandewar (RVC 95).	Annual or near annual
Floodplain wetlands (flood-dependent shrubland wetlands)	River coobah swamp wetland on the floodplains of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion (PCT 241)	Every year to 1 in 5 years
Floodplain wetlands (flood-dependent shrubland wetlands)	Lignum shrubland wetland on regularly flooded alluvial depressions in the Brigalow Belt South Bioregion and Darling Riverine Plains Bioregion (PCT 247)	Every year to 1 in 5 years

HEF ² group	Vegetation/watercourse class	Ideal watering frequency
Floodplain wetlands (flood-dependent shrubland wetlands)	Eurah shrubland of inland floodplains (PCT 115) ³	Every year to 1 in 5 years

(Source: Optimum watering requirements adapted from Roberts and Marston 2011 and Rogers and Ralph 2011)

¹Examples of wetlands include lakes, lagoons, rivers (including watercourses), floodplains, swamps, billabongs and marshes.

²HEF—Hydro-ecological functional; PCT—plant community type; RVC—regional vegetation communities

³Eurah (*Eremophila bignoniiflora* (Benth.) F.Muell.) generally occurs in periodically flooded areas of floodplains and drainage lines (Cunningham et al. 1981) chiefly in black box, and river red gum communities. No specific watering requirements have been documented by Rogers and Ralph (2011) or Roberts and Marston (2011) for this floodplain shrubland vegetation community, however, is likely to require periodic flooding for maintenance and persistence.

Table 7. Hydro-ecological functional groups that comprise other flood-dependent ecosystems in the Lower Namoi Valley Floodplain

HEF ¹ group	Vegetation/watercourse class	Ideal watering frequency
Flood-dependent forest/woodland (wetlands)	River red gum tall to very tall open forest/woodland wetland on rivers on floodplain mainly in the Darling Riverine Plains Bioregion (PCT 36)	1 in 3 to 1 in 5 years
Flood-dependent forest/woodland (wetlands)	River red gum riparian tall woodland/open forest wetland in the Nandewar Bioregion and Brigalow Belt South Bioregion (PCT 78)	1 in 3 to 1 in 5 years
Flood-dependent forest/woodland (wetlands)	Red gum–rough-barked apple +/- tea tree sandy creek woodland (wetland) in the Pilliga–Goonoo sandstone forests, Brigalow Belt South Bioregion (PCT 399)	1 in 3 to 1 in 5 years
Flood-dependent woodland	Black box woodland wetland on NSW central and northern floodplains including the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion (PCT 37)	1 in <10 years
Flood-dependent woodland	Coolibah–river coobah–Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion (PCT 39)	1 in <10 years
Flood-dependent woodland	Coolibah open woodland wetland with chenopod/grassy ground cover on grey and brown clay floodplains (PCT 40)	1 in <10 years
Flood-dependent woodland	Poplar Box–Coolibah floodplain woodland on light clay soil mainly in the Darling Riverine Plains Bioregion (PCT 87)	1 in <10 years
Flood-dependent woodland	Carbeen +/- Coolibah grassy woodland on floodplain clay loam soil on north-western NSW floodplains, mainly Darling Riverine Plain Bioregion (PCT 628)	1 in <10 years

(Source: Optimum watering requirements adapted from Roberts and Marston 2011 and Rogers and Ralph 2011)

¹ HEF—Hydro-ecological functional; PCT—plant community type; RVC—regional vegetation communities

² +/- means 'with or without'.

Prioritisation of ecological assets

Ecological assets were prioritised to determine which assets best represent biodiversity in the Lower Namoi Valley Floodplain. The prioritisation process was undertaken for the Lower and Upper Namoi Valley Floodplains combined. Ecological assets were predominantly prioritised by the TAG during a meeting in February 2014.

Due to progress of floodplain development in the Namoi River floodplains, the TAG recommended that 100% of the remaining flood-dependent vegetation should be a priority for protection to ensure their future persistence. A target of 100% was considered reasonable due to only a small percentage of assets remaining relative to pre-1750 vegetation reconstruction extents (Eco Logical Australia 2013).

As outlined in the Technical Manual, targets determined by a TAG are used to drive the selection of priority assets for protection and are used in the conservation planning decision-software, Marxan. Marxan is a decision-support tool used to assist the determination of areas of high conservation significance where floodplain connectivity should be secured (Ball & Possingham 2000; Possingham et al. 2000; Ball et al. 2009). Conservation targets are prescribed in Marxan to determine the amount of each feature the program is instructed to select. In conservation planning, variable targets are often prescribed for ecological surrogates based on ecological objectives to determine relative conservation priority (higher and lesser priority areas). In the Namoi floodplains, the TAG endorsed conservation targets of 100% for each asset type to ensure their future persistence. As a result, the Marxan analysis determined that all ecological assets were a high priority. Nevertheless, the prioritisation method was undertaken in full for completeness. The method was to:

- partition the floodplains into *planning units* (Appendix 9)
- use local and expert knowledge to set *targets for ecological surrogates*, which are spatially definable components of biodiversity patterns, (Appendix 10), including:
 - fauna habitat—species distribution models for fish, frogs, turtles and a snake and modelled fish biodiversity hotspots
 - vegetation communities—wetlands and other floodplain ecosystems
 - fauna observations for fish, frogs, amphibious reptiles and mammals
 - wetlands identified in current FMPs and studies—*Wetlands of the Namoi Valley* (Green and Dunkerley 1992)
- develop a *constraint surface* to constrain the selection of priority planning units (Appendix 11)
- run Marxan to *identify priority ecological assets* (section below).

The project used Marxan to analyse key ecological surrogates to represent biodiversity patterns and identify floodplain areas that complement each other. This produced an efficient, well-connected system with the aim of ensuring the future persistence of flood-dependent ecological assets.

Marxan was run to select the planning units that achieve targets and minimise constraints. Planning units were either in or out of a solution. Marxan was run with one million iterations

Cultural assets

The Lower Namoi Valley FMP 2020 identifies and prioritises two types of cultural assets:

- **Aboriginal cultural values**—sites, objects, landscapes, resources and beliefs that are important to Aboriginal people as part of their continuing culture. Aboriginal cultural values also include functions, services and features that benefit Aboriginal people that are listed in federal, state and local government registers
- **heritage sites**—cultural heritage objects and places as listed on Commonwealth, state and local government heritage registers.

In some cases, information about sensitive cultural assets are held by elders and may not be listed in a federal, state or local database or register. To accommodate this information, flexibility has been integrated into the Lower Namoi Valley FMP to accept Aboriginal cultural values and heritage sites that are derived from ‘any other source that, in the minister’s opinion, is relevant’.

Cultural asset type—Aboriginal cultural values

Aboriginal people view themselves as an inherent part of the river system. A holistic understanding of how water is connected to the land and rivers and the connection that Indigenous people feel to river systems feeds a strong feeling of responsibility for the health of rivers and floodplains. For more information on how this connection is being integrated into water planning and management via cultural flows, see Appendix 12.

The Gamilaroi Nation is the traditional owner of the entire Namoi Valley prior to colonisation. The Dunghutti and Anaiwain Nations share country⁴ at the head waters with the Gamilaroi Nation. Today, there is a Gomeroi Native Title Claim that covers 111,000 km² of the North West region of NSW and encompasses the Namoi Valley. The Gomeroi Claim represents some 50,000 Gomeroi people. There are 12 local Aboriginal Land Councils representing some 6,500 people (Namoi Catchment Management Authority 2011).

The Namoi Valley Floodplain contains many cultural sites and values that are important to the local Aboriginal community. Due to the sensitive nature of the data, specific Aboriginal cultural values cannot be listed or mapped in published documents. Identifying Aboriginal cultural values is an ongoing process that will be continued by the department.

Aboriginal cultural values include those places and knowledge located within or connected to the floodplain nominated by Aboriginal people with cultural connection to the region. They can also include places and landscapes identified through previous recording to have significant cultural importance and are dependent on or connected with the passage of floodwater during flood events. These values can include tangible (for example, an archaeological site) or intangible (for example, recognition of spiritual value) features and can be place-specific (for example, a waterhole or camp site) or nondescript spatially (such as a traditional story about the activities of ancestral beings).

A variety of connections between Aboriginal cultural values and floodwater were considered. For example, some values are dependent on the passage of floodwater (for example, a fish trap), some are maintained by floodwater (for example, the health of a living, culturally modified, flood-dependent tree), some may be enhanced by floodwater (for example, the harvesting of resources during cultural events), and some may be connected with the natural processes operating within the floodplain (for example traditional stories about ancestral beings). Each individual Aboriginal cultural value could have any combination of these features.

⁴ Country is a term that Aboriginal people often use to describe many of the facets of how they are connected with the land and sea. It concerns the physical, spiritual and cultural concept of belonging to places, along with the sense of responsibility and self-identity that these create. Country can also refer to the notion of the life-giving force that resides in the landscape and all of its elements that are recognised by Aboriginal people, which provide nourishment, and bring with them a duty of care.

Confirmed and potential Aboriginal cultural values identified in the Lower Namoi Valley Floodplain include:

- wetlands and river channels that were an important focus of settlement, and are also places of spiritual and specifically Dreaming significance
- locations of Bora (initiation) ceremonies
- core semi-permanent wetlands with iconic plants (for example, cumbungi and nardoo)
- riverine forests, woodland and grassland areas with iconic plants (for example, river coobah, river red gum, coolibah, Mitchell grass and native millet)
- sites with scarred trees
- long-lasting waterholes or swamps in wetland areas that may have been a focus of settlement
- semi-permanent waterholes and channels on the floodplain that may have been a focus of settlement.

For the Lower Namoi Valley FMP, Aboriginal cultural values were identified at a regional scale by:

- reviewing previous studies that investigated cultural values in the floodplain
- consulting with various NSW Government agencies involved with landscape management within the valley (for example, Local Land Services, National Parks and Wildlife Service, WaterNSW and the Department of Planning, Industry and Environment's Environment, Energy Science group)
- targeted consultation with members of the Aboriginal community with knowledge of values connected with the floodplain
- consultation with the ATWG, which was comprised of Aboriginal people with cultural connection to the floodplain
- context-setting using existing spatial information about the potential distribution of unidentified values using the Aboriginal Sites Decision Support Tool (ASDST) (Ridges 2010) (Appendix 13).
- Aboriginal cultural values were also identified by reviewing the values recorded within the floodplain in the following databases:
 - NSW Aboriginal Heritage Information Management System (AHIMS) (see www.environment.nsw.gov.au/topics/aboriginal-cultural-heritage/protect-and-manage/aboriginal-heritage-information-management-system), which includes:
 - information on Aboriginal objects
 - information about Aboriginal Places
 - archaeological reports
 - NSW Aboriginal Water Initiative System (AWIS) (no longer actively used; see Appendix 12 for more details)
 - Murray–Darling Basin Authority Aboriginal Submissions Database
 - NSW State Heritage Inventory (see www.heritage.nsw.gov.au/search-for-heritage/search-for-nsw-heritage/), which includes:
 - declared Aboriginal Places
 - items listed on the State Heritage Register
 - listed Interim Heritage Orders
 - items on State Agency Heritage Registers
 - items listed of local heritage significance on a local council's Local Environmental Plan.

- Australian Heritage Database (see www.environment.gov.au/heritage/publications/australian-heritage-database), which includes places in the:
 - World Heritage List
 - National Heritage List
 - Commonwealth Heritage List
 - Register of the National Estate.
- Overall, 76 scarred or culturally modified trees were identified in the floodplain and 16 places with Aboriginal cultural value were identified.

Cultural asset type—heritage sites

Heritage sites are cultural heritage objects and places as listed on federal, state and local government heritage databases. Some Aboriginal cultural values may also be heritage sites and for the purposes of the Lower Namoi Valley FMP, heritage sites were divided into historic heritage sites and Aboriginal heritage sites.

Federal, state and local government heritage databases include the:

- Commonwealth Heritage List
- Historic Heritage Information Management System (HHIMS)
- Murray–Darling Basin Authority Aboriginal Submissions Database
- NSW State Heritage Register
- NSW State Heritage Inventory
- Aboriginal Heritage Information Management System (AHIMS).

Flood dependency of Aboriginal cultural values and heritage sites

During the development of the Lower Namoi Valley FMP, the flood dependency of cultural assets was established so that consideration could be given to how changes to the flooding regime may impact Aboriginal cultural values across the floodplain.

Flood dependency—Aboriginal cultural values

Flood dependency of the Aboriginal cultural values nominated by the Aboriginal community was determined through direct discussion with knowledge holders about the nature of the value, and how it is connected with floodwater. Eleven of the 16 places nominated as having significant Aboriginal cultural value were found to have a strong connection or dependency on flooding on the floodplain, including:

- waterholes associated with important stories
- areas with scarred trees
- fishing lagoons
- lignum swamp that is a significant local resource
- areas that historically had fish traps
- areas that were historically Aboriginal camps
- areas of considerable local use and resources.

Flood-dependent Aboriginal cultural values are complicated because of the nature of association between cultural value or feature and flooded area. For example, some Aboriginal cultural values are not straightforwardly flood-dependent but exist because of the close proximity or association with flooding. For instance, ceremonial locations connected with intact flood-dependent vegetation and camp sites near wetlands may persist regardless of flooding. However, they are considered to be flood-dependent in the Lower Namoi Valley FMP because

they may not be utilised until the landscape is flooded, and resources only abundant during flood events are available. Wherever possible, the nature of these cultural relationships was considered in the design of the management zones.

Flood dependency—historic heritage sites

Flood dependency was assessed by reviewing the heritage listing records to establish the nature of the heritage theme and value of the site to determine if this was dependent on or connected with floodwater. In the Lower Namoi Valley Floodplain, none of the listed floodplain historic assets that were reviewed were found to have flood-dependent values.

Flood dependency—Aboriginal cultural heritage sites

The following Aboriginal cultural heritage site types occurring within the region were identified as having flood-dependent values associated with them:

- cultural modifications (for example Coolamon scars) to living trees that are flood-dependent species
- fish traps
- ceremony sites located within or surrounded by floodplain vegetation⁵.

Some Aboriginal cultural heritage sites were identified as being sensitive to:

- the effect of erosion associated with the redistribution of flood flow, or
- ground disturbance caused by the construction of new flood works, or
- the modification of existing flood works.

For instance, thin elevated ridges known as ‘red country’, which were inhabited in floods when ‘black country’ (floodplains and wetlands) was too wet to live in, contain stone artefact sites and plants with cultural values. Such plants include belah, quandong and boobialla that may be vulnerable to changes in flood flows.

Prioritisation of cultural assets

High-priority cultural assets that are dependent on flooding were considered in the design of the management zones to protect their flood connectivity. The process for identifying these high-priority cultural assets is outlined below.

Cultural assets vulnerable to the:

- effect of erosion associated with the redistribution of flood flow, or
- direct impacts of the installation of new flood works, or
- modification of existing flood works

are not dealt with in the design of the management zones. Therefore, these cultural assets were not prioritised. Where identified, these cultural assets will be an additional consideration in the assessment of flood work applications.

Prioritisation of Aboriginal heritage sites

Scarred trees

Scarred trees were investigated using AHIMS records and by inspecting the original site cards. Those scarred trees where it was clear that the tree was dead at the time of the recording, were excluded from the prioritisation. The location of each tree was also compared to current 2009 SPOT imagery to ensure that there was a reasonable likelihood the tree still existed (some

⁵ While it is recognised the ceremony site itself may not be flood-dependent, based on advice received from the ATWG, it was noted that many ceremonies were connected with the surrounding flood-dependent landscape, and were undertaken when many floodplain resources were abundant.

recordings were over 30 years old). As a result of the comparison with SPOT, some recordings were found to have locations recorded that were inconsistent with information in the original site card and were corrected when found.

Fish traps

There are no records of existing fish traps within the study region, although there are sites where they were known to be historically. The possibility of fish traps being used was noted by the ATWG.

Prioritisation of Aboriginal values

Targeted consultation was undertaken with members of the Aboriginal community throughout the region who have knowledge on flood-dependent Aboriginal cultural values. Given available timeframes, this was not an exhaustive consultation process, and the incorporation of Aboriginal cultural values into the plan should be considered an ongoing process.

Discussions were held in person with community members with printed maps that could be annotated. The maps were left with community members to allow time to consider the requirements of the plans, and follow-up discussions were held a week or so later.

The consultation process identified areas where the significance of Aboriginal cultural values warranted an exclusion of further flood works. In some cases, this was because of the sensitivity of important and largely intact ceremony grounds. In other cases, this was due to the occurrence of relatively intact land that was rich with sites associated with living in the floodplain.

These areas were digitised and used to inform the design of the management zones. The areas identified and their associated values were submitted to AHIMS and will be used by staff as part of the process to assess flood work applications.

Step 6: Prepare a socio-economic profile

To develop options for future floodplain management, the floodplain area must be understood and the ability of the community to absorb change appreciated. A socio-economic profile of the Lower Namoi Valley Floodplain area is required so that the social and economic impact of development controls in the floodplain and flood risk to life and property from the effects of flooding can be effectively considered. The socio-economic profile is detailed in Appendix 14 and a summary is provided below.

The profile is an assembly of existing key socio-economic data, which provide a general picture of the catchment in terms of its socio-demographic and economic structures. Key socio-economic data that inform the baseline profile include: Key socio-economic information that informs the baseline profile include:

- geographies that are relevant to the socio-economic discussion of the floodplain
- demographic profiles
- household income statistics
- employment statistics
- economic wellbeing indicators
- agricultural production statistics.

Information from this assessment was used in the socio-economic impact analysis of the FMP, which is outlined in step 10. The socio-economic impact analysis is undertaken in coordination with the development of management zones and rules for a valley and informs steps 7, 8 and 9 of this process.

Study area geography

There are several geographies that are relevant to the socio-economic discussion of water management within the Lower Namoi Valley Floodplain (see Table 8 for a description and Appendix 14 for figures of the areas).

Table 8. Description of study area geographies used the socio-economic profile

Geography	Size (hectares)	Description
Lower Namoi Valley Floodplain Economy (and within the defined area of the Floodplain Economy)	1,103,400	The Lower Namoi Valley Floodplain Economy area includes the Lower Namoi Rural and Urban Floodplains as well as the adjacent areas that engage with the economy of the region. This area extends from Narrabri in the east across to Walgett in the west. Most goods and services consumed in the Lower Namoi Valley Floodplain Economy area are sourced from the regional centre of Narrabri, or the small townships in this area.
Lower Namoi rural floodplain	759,200	The Lower Namoi rural floodplain is the rural area that follows the Namoi River from near the town of Narrabri across to Walgett. This area is the Lower Namoi rural floodplain and will be directly impacted by the Lower Namoi Valley FMP 2020. The community residents who live and work in this area are predominantly agriculture-based, but the community does include people who live in small rural towns. There are limited community services and infrastructure in this area; most of the required farm inputs and human services are provided from the local towns and the three regional centres.

Geography	Size (hectares)	Description
Lower Namoi urban floodplain	N/A	The regional centre of Narrabri and the township Wee Waa constitute the third area, the Lower Namoi urban floodplain. While this area is situated on or adjacent to the floodplain and is affected by floodwater, floodwater management is provided for under the <i>Local Government Act 1993</i> . The communities that live in these towns are reliant upon the surrounding rural floodplain areas both as a source of employment and as a consumer of services.

Data sources

Data for the Lower Namoi Valley Floodplain Economy, the Lower Namoi Rural Floodplain, and the Lower Namoi Urban Floodplain is drawn from the ABS Census of Population and Housing 2011 SA1 level data (ABS 2011b). This includes data on population including Indigenous community, sex and age ratios; household weekly incomes; and employment, labour participation rates, and employment by industry sector. The SA1 areas are the smallest unit for release of census data⁶. The boundaries closely align with the boundary of the Lower Namoi Valley Floodplain Economy area and of the Rural and Urban Floodplain areas. The SA1 areas referenced to calculate values for the Lower Namoi Rural Floodplain are presented in Appendix 14. Regional population trends for the Narrabri and the Walgett Local Government Areas have been drawn from the ABS Regional Population Growth 2013 data (ABS 2016).

Information on the relative socio-economic advantage and disadvantage for the SA1 areas of the floodplain area is drawn from the ABS Census of Population and Housing 2011 Socio-economic Indexes for Areas (ABS 2011c).

Agricultural production is a significant component of the floodplain economy. The ABS Agricultural Census 2011 (ABS 2011a) provides comprehensive data on both dry land and irrigated agricultural production at the SA2 level for three regions that partially cover the Lower Namoi Valley Floodplain agricultural region: Narrabri, Narrabri Region, and Walgett-Lightning Ridge regions. SA2 areas represent a community that interacts socially and economically⁷.

⁶ Statistical Areas Level 1 (SA1s) have been designed as the smallest unit for the release of ABS Census data. SA1s generally have a population of 200 to 800 persons, and an average population of about 400 persons. They are built from whole Mesh Blocks and there are approximately 55,000 SA1s covering the whole of Australia (ABS 2014).

⁷ Statistical Areas Level 2 (SA2s) are a general-purpose medium sized area built from whole SA1s. Their aim is to represent a community that interacts together socially and economically. SA2s generally have a population range of 3,000 to 25,000 persons and have an average population of about 10,000 persons. There are 2,196 SA2s covering the whole of Australia (ABS 2014).

Demographic profiles

Regional populations have stabilised over recent years with the estimated population for the Narrabri Local Government Area recovering slightly. Regional population trends since 2004 for the Narrabri and Walgett Local Government Areas are presented in Figure 16.

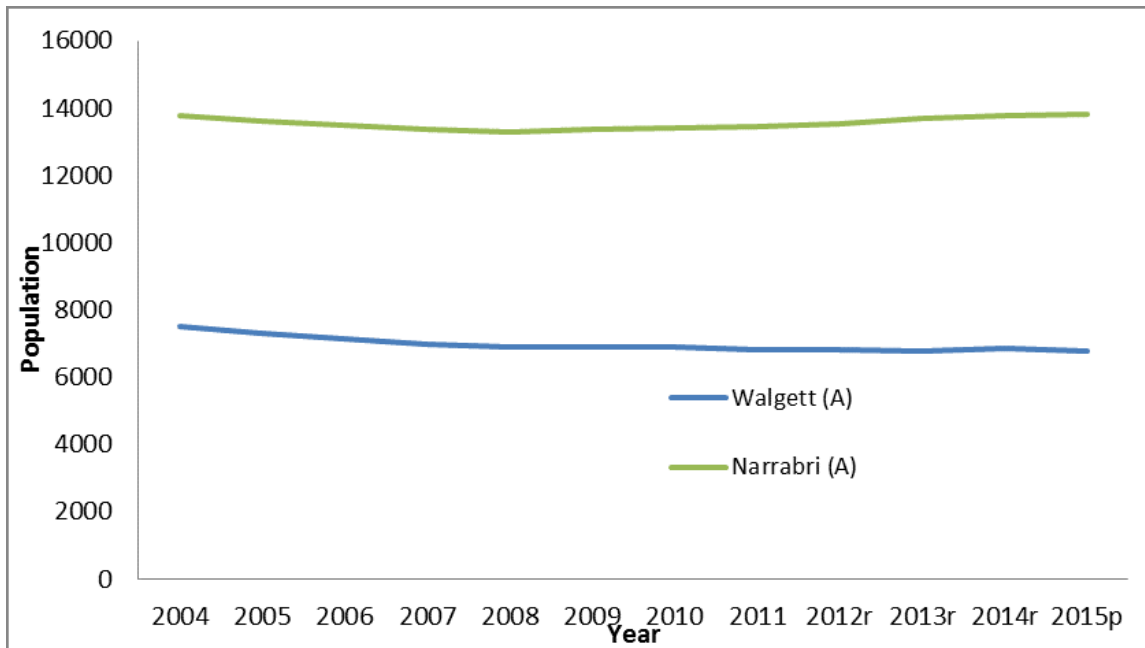


Figure 16. Regional population trend by Local Government Area 2004–14 (Source: Based on ABS data, ABS 2016)

Household income

Lower Namoi Valley Floodplain Economy

The weekly household income in the Lower Namoi Valley Floodplain Economy closely correlates with that of the Lower Namoi urban floodplain, with 72% of the population living in the townships. The proportion of low-income households in the Lower Namoi Valley Floodplain Economy, at 31%, is greater than the NSW state proportion of 23%. The medium-income proportion of 59% in the Lower Namoi Valley Floodplain Economy is marginally greater than the NSW proportion of 56%. Consequently, the high-income household proportion of 10% is lower than the NSW state proportion of 22%.

Employment by industry

Lower Namoi Valley Floodplain Economy

The labour force of the Lower Namoi Valley Floodplain Economy is 4,100 people. The number of people 15 years and above is 7,230. The labour force participation rate, which is the number of persons in the labour force as a percentage of persons aged 15 years and over, is 57.1% and is slightly lower than the NSW participation rate of 56.2%.

Employment in the Lower Namoi Valley Floodplain Economy is predominantly within the agricultural, forestry and fishing sector with 25% of employment (1,038 people). In contrast, the NSW state agriculture sector engages 2% of the workforce. There is a relatively even distribution of the remaining 75% of employment among the remaining sectors. The next most significant employment sectors are retail trade and healthcare, with 9% of employment.

Estimated employment of the Lower Namoi Valley Floodplain

Given the location of the townships, it is likely that at least half of the 1,000 Lower Namoi urban floodplain residents employed in the agriculture sector work in the adjacent rural floodplain, while the other half would be working in the areas of agriculture outside the floodplain area.

The estimated total employment in the agricultural sector potentially impacted by the Lower Namoi Valley FMP 2020 is around 650 people, counting the 510 agriculture workers from the Rural Floodplain and half of the 300 agriculture workers from the urban floodplain.

Economic wellbeing indicators

Socio-Economic Indexes for Areas (SEIFA) is a product developed by the ABS that ranks areas in Australia according to relative socio-economic advantage and disadvantage (ABS 2011c). The indexes are based on information from the five-yearly Census. The index scores are on an arbitrary numerical scale; the scores do not represent some quantity of advantage or disadvantage. As measures of socio-economic level, the indexes are best interpreted as ordinal measures. They can be used to rank (order) areas and are also useful to understand the distribution of socio-economic conditions across different areas.

The Index of Relative Socio-economic Advantage and Disadvantage (IRSAD) ranks areas in terms of relative socio-economic advantage and disadvantage. The IRSAD summarises 25 variables that indicate either relative advantage or disadvantage. This index ranks areas on a continuum from most disadvantaged to most advantaged. An area with a high score on this index has a relatively high incidence of advantage and a relatively low incidence of disadvantage.

The IRSAD scores for key regions are (see Appendix 14):

- Local Government Areas of Narrabri, Narrabri Region and Walgett are in the 4th and 1st decile of NSW, reasonably to most disadvantaged.
- The lowest SA1 area score is 685 (decile 1 in the state) which is the SA1 of Walgett.
- The highest-scoring area has a score of 1,092 (decile 9 in the state), which is the town of Narrabri (ABS 2011c).

Agricultural production

The economy of the Lower Namoi Valley Floodplain is interwoven with the economy of the adjacent communities, drawing inputs from, passing outputs through and using services from the same business centres as the floodplain. It is appropriate therefore to consider the socio-economic profile of the wider Lower Namoi Valley Floodplain Economy.

Agricultural production is the significant production activity of the region's economy. Agricultural production is predominantly cropping, which is dominated by cotton and to a lesser extent wheat. Irrigation on the Lower Namoi Valley Floodplain is dominated by irrigated cotton production. The regional economy is structured to process the inputs and outputs of these industries and provide the services they require. The performance of the regional economy responds in large part to the fortunes of the cotton and wheat industries.

The ABS Agricultural Census 2011 provides agricultural production statistics for the Narrabri, Narrabri region and Walgett–Lighting Ridge regions that cover the majority of the Lower Namoi Valley Floodplain and the Lower Namoi Floodplain Economy area (ABS 2011a). The combined area of these three regions is different to the FMP area, with the boundaries of the FMP area within the boundaries of these combined regions.

The Gross Value of Agricultural Production (GVAP) in 2010–11 in the Lower Namoi Valley Floodplain, using a farm holding area of 445,483 ha, is estimated to be \$116.1 million or 1% of total NSW GVAP. Broadacre cropping constitutes 89% of the GVAP (\$103.8 million) of the FMP

area production, using 189,930 ha or 30% of the area. The highest value-producing individual broadacre crops are cotton, yielding \$50 million or 3%, and wheat, yielding \$39 million or 17%, of the total Lower Namoi Valley Floodplain GVAP. Livestock and livestock products yield \$12 million, accounting for 10% of GVAP while using 66% of the area.

There was an estimated total of 9,692 ha of irrigated land in the Lower Namoi Valley Floodplain in 2010–11. This area of irrigated land constitutes approximately 2% of the area of the FMP farm holding area. It is estimated that 50,200 megalitres of water was extracted for agricultural irrigation across the Narrabri, Narrabri Region and Walgett–Lighting Ridge regions in 2010–11. The majority of the irrigation water used in 2010–11 was applied to cotton (47,700 megalitres, 95%). Irrigation for cotton used an estimated 8,900 ha or 92% of the estimated Lower Namoi Floodplain irrigated area.

Step 7: Delineate management zones

In Step 7, the nature and location of the management zones for the Lower Namoi Valley Floodplain was determined using hydraulic, ecological and cultural criteria as well as criteria to ensure the plan reflects current floodplain management arrangements.

The Lower Namoi Valley FMP 2020 contains six different management zones (Figure 17 and Figure 18):

- MZ AD— major discharge areas, defined floodways (133,530 ha or 23% of the floodplain)
- MZ AID—major discharge areas, ill-defined floodways (21,398 ha or 4% of the floodplain)
- MZ B—flood storage and secondary flood discharge (221,491 ha or 39% of the floodplain)
- MZ C—flood fringe and flood protected developed areas (189,439 ha or 33% of the floodplain)
- MZ CU— urban areas managed by Local Council (2,789 ha or less than 1% of the floodplain)
- MZ D—special protection zone (1,447 ha or less than 1% of the floodplain).

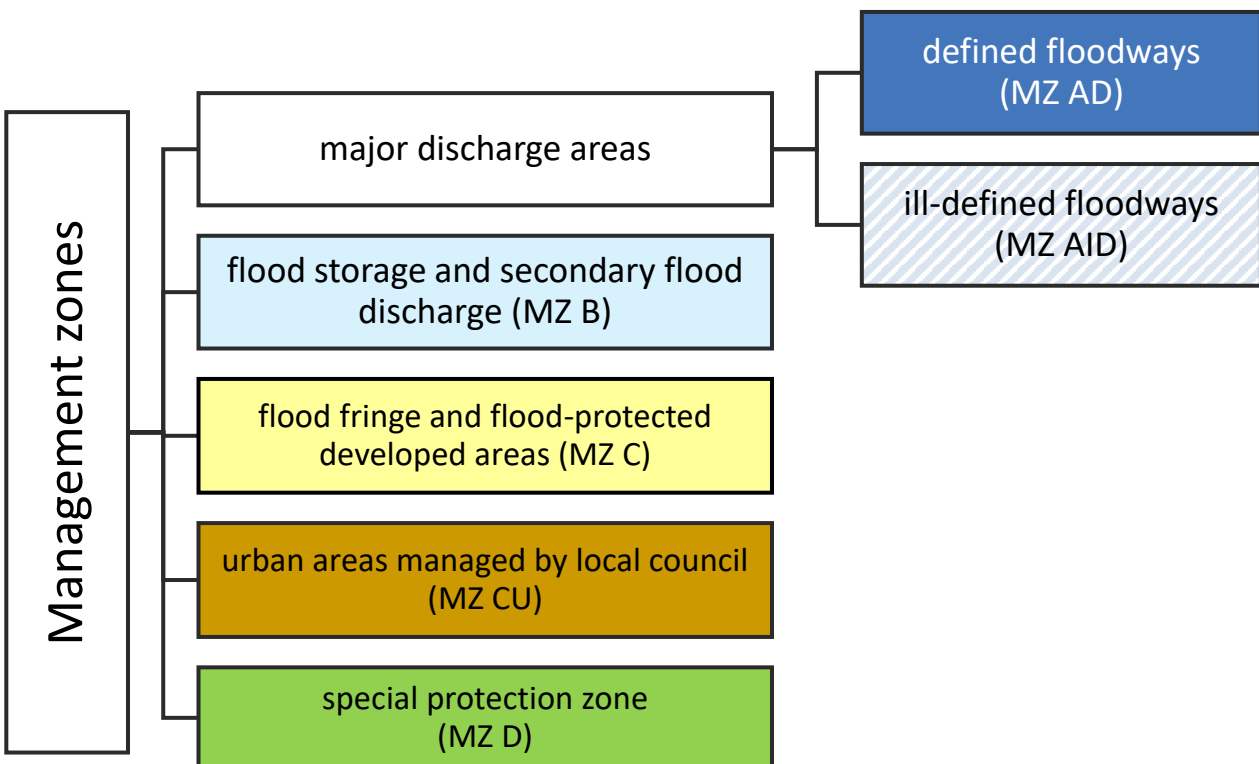


Figure 17. Finger diagram of management zones in the Lower Namoi Valley FMP 2020

The approach for developing the management zones considered the impact of existing and future development on flooding in rivers and floodplains; the flood risk to life and property; the flood connectivity of floodplain assets and the social and economic impacts of restricting flood work development.

Part 10 'Amendment of this Plan' in the Lower Namoi Valley FMP 2020 provides the opportunity modify to the management zones in response improvements in knowledge and technology. More information about modifying the management zones is provided at the end of this step. The Lower Namoi Valley Floodplain management zones are displayed in more a detailed series of maps in Appendix 15.

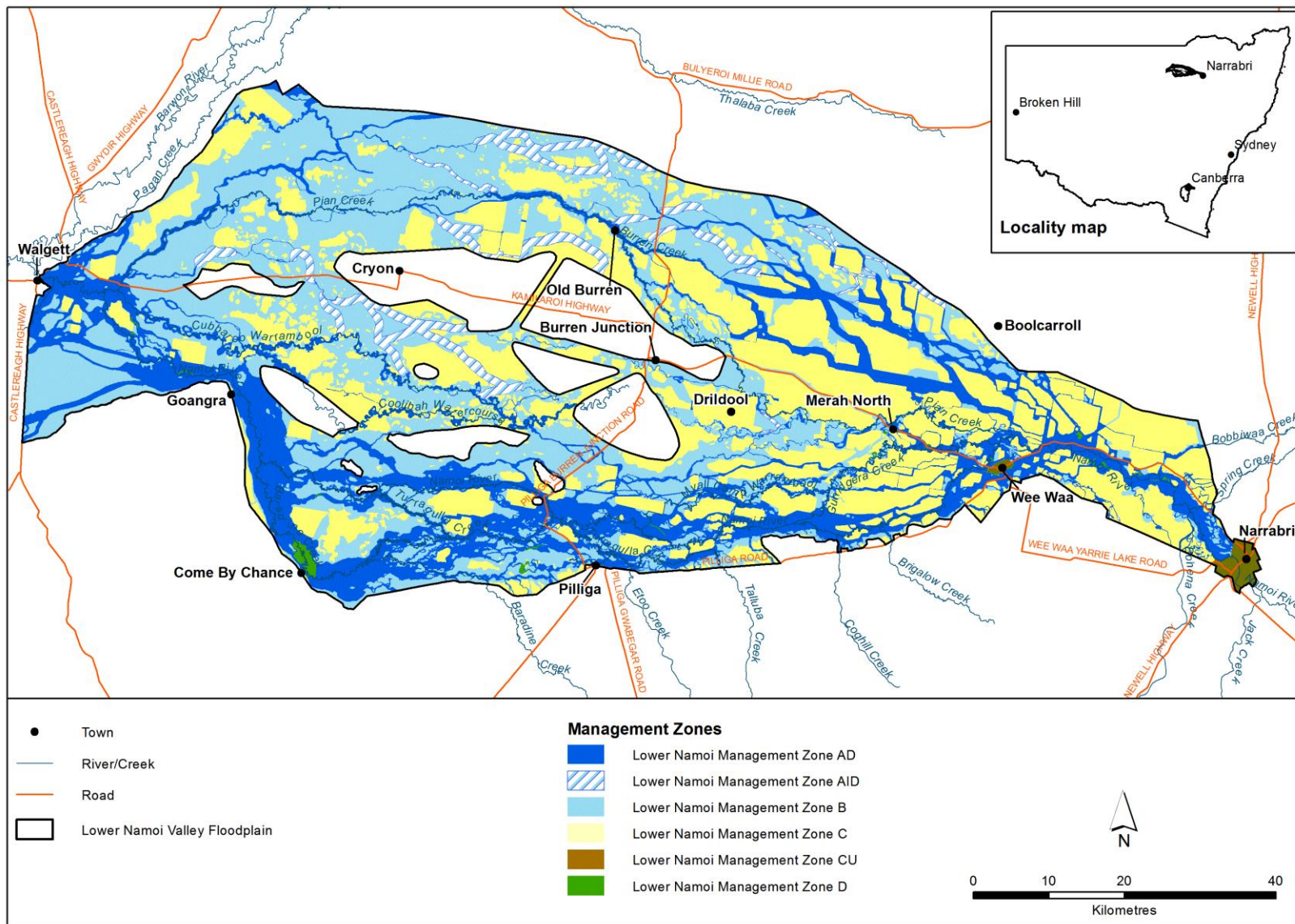


Figure 18. Overview of the management zones in the Lower Namoi Valley Floodplain

Note. The Management Zones Map is published on the NSW legislation website.

Description of management zones

Management Zone AD—major discharge areas, defined floodways (MZ AD)

Management Zone AD covers 133,530 ha or 23% of the floodplain. It includes areas of the floodplain where a significant discharge of floodwater occurs during floods, with relatively high flood flow velocity and depth. These areas are generally characterised by defined channels and banks.

In the Lower Namoi Valley Floodplain, Management Zone AD includes floodways that have a depth-velocity product of greater than or equal to $0.2 \text{ m}^2/\text{s}$ for the large design flood (1971—4% AEP). Floodplain connectivity was provided for by incorporating areas connecting floodways that had:

- a depth-velocity product of greater than or equal to $0.05 \text{ m}^2/\text{s}$, and/or
- coincided with the small design flood extent (2004—13% AEP).

Management Zone AD includes areas where uncoordinated flood work development may have a high adverse impact on flood behaviour. The zone was designed to ensure a reduction in the risk to life and property by limiting flood work developments to prevent flood flow redistribution, increased flood velocities and flood levels. Management Zone AD provides for continuity of flow and flow paths and assists in maintaining the overall flow distribution on the floodplain.

Management Zone AD is important for the conveyance of floodwater to ecological assets that depend on the water for survival. The zone includes the extent of semi-permanent wetland; key fish passage areas; connections to floodplain wetland (flood-dependent shrubland wetlands) and flood-dependent forest/woodland (wetlands); and the low-lying areas bordering a watercourse that contain floodplain wetland (flood-dependent shrubland wetlands) and flood-dependent forest/woodland (wetlands).



Figure 19. Namoi River near Pilliga is an example of Management Zone AD. Joanna Taylor, 2015.

Management Zone AD is also important for the conveyance of floodwater to Aboriginal cultural values that are highly flood-dependent. Wherever possible, flood-dependent Aboriginal cultural

values have been incorporated in Management Zone AD where those values can be identified in a cultural database or register. Certain trees that have been modified by Aboriginal people have also been included in Management Zone AD. Modified trees were incorporated into Management Zone AD if the trees are living scarred or carved trees and found in close proximity to floodways.

Where the Lower Namoi Valley FMP 2020 joins other FMPs, including the Gwydir Valley FMP 2016 (north), Barwon–Darling Valley FMP 2017 (west) and the Upper Namoi Valley FMP 2020 (south east), floodways in the Lower Namoi Valley Floodplain have been aligned where appropriate to ensure floodway continuity and protection between adjacent floodplains.

An additional rule in Management Zone AD provides a pathway for the approval of certain other flood works that are not minor or existing, provided that a flood flow corridor with adequate hydraulic capacity is maintained (as determined by hydraulic modelling results) and the flood work meets the assessment criteria for Management Zone B. This pathway for the potential reduction in the width of Management Zone AD is only applicable to areas of *hydraulic Management Zone AD*. Applications for flood works that meet the requirements of this clause must be advertised. The flexibility provided in this clause is anticipated to ease the socio-economic impacts of Management Zone AD.

Management Zone AID—major discharge areas, ill-defined floodways (MZ AID)

Management Zone AID covers 21,398 ha or 4% of the floodplain. It includes areas of the floodplain where a significant discharge of floodwater occurs during floods, with relatively high flood flow velocity and depth. These areas are generally characterised by overland flow paths without defined channels and banks.

In the Lower Namoi Valley Floodplain, ill-defined floodways are floodways identified through flood imagery, local knowledge and the extent of the small design flood (2004—13% AEP). Ill-defined floodways must have a depth-velocity product of at least 0.05 m²/s for the large design flood (1971—4% AEP). Ill-defined floodways are the width of the upstream hydraulic floodway (Management Zone AD) and a maximum 500 m buffer either side of this floodway.

Ultimately, Management Zone AID functions much like Management Zone AD but it provides landholders with the opportunity to negotiate the location of a flood flow corridor that will be a minimum of 80 m wide. Within the flood flow corridor, the construction or modification of flood works will be subject to the rules and assessment criteria for Management Zone AD. Outside of the flood flow corridor, the construction or modification of flood works will be subject to the rules and assessment criteria for Management Zone B.

Management Zone B—flood storage and secondary flood discharge (MZ B)

Management Zone B covers 221,491 ha or 39% of the floodplain. It is important for the conveyance of floodwater during large flood events and for the temporary pondage of floodwaters during the passage of a flood.

Management Zone B is defined by the modelled inundation extent of the large design flood (1971—4% AEP). Management Zone B was designed to include ecological assets that have a moderate level of flood dependency, including areas of flood-dependent woodland. Management Zone B also includes cultural assets such as modified trees that are likely to only be flood-connected during moderate and large floods.

Management Zone B includes areas where coordinating flood work development is important to manage the cumulative and local impact of works on flood behaviour.

In floodplain areas covered by a historical guideline, the depth-velocity product threshold for determining Management Zone AD was relaxed from greater than or equal to 0.2 m²/s to greater than or equal to 0.3 m²/s in areas outside the guidelines' floodway networks. This increased the

area of Management Zone B. Consistency with current flood work development levels in the floodplain was also verified.

Management Zone C—flood fringe and flood-protected developed areas (MZ C)

Management Zone C covers 189,439 ha or 33% of the floodplain. It includes flood fringe and flood-protected developed areas. Management Zone C also includes areas protected by flood works of unlimited height and are not overtopped by floodwater during moderate to large floods.

Management Zone C was not specifically designed to include ecological assets that are flood-dependent. However, ecological assets still occur in Management Zone C and are likely to include those that tolerate infrequent flooding. Management Zone C also includes some cultural assets, such as scarred trees. However, the basis of Management Zone C was not cultural. Any cultural assets that are recorded in Management Zone C will still be required to be considered during the assessment of flood work applications.

The rules and assessment criteria of Management Zone C are less restrictive than other management zones as Management Zone C includes areas where flood work development is unlikely to have a significant effect on flood behaviour. Nevertheless, flood works still require an assessment and approval to protect the health of the floodplain environment.

Management Zone CU—urban areas management by local council (MZ CU)

Management Zone CU covers 2,789 ha, which is less than 1% of the floodplain. It includes parts of Narrabri and Wee Waa that are urban areas where flood risk is managed by local councils through flood risk management plans and studies developed in accordance with the *Floodplain Development Manual* (NSW Government 2005).

In Management Zone CU, flood works undertaken by councils and private landholders are generally exempt from approval under the WM Act. In accordance with statewide exemptions, in Management Zone CU, flood works that would require a flood approval under the WM Act include flood works on private landholdings where the landholding is greater than 0.2 ha, unless that flood work is a:

- ring embankment that protects infrastructure and encloses an area less than 2 ha or less than 10% of the land area, whichever is lesser, or
- earthwork (for example farm track, check bank) and less than 15 cm above (but not below) ground level.

Management Zone D—special protection zone (MZ D)

Management Zone D covers 1,447 ha, which is less than 1% of the floodplain. It is a special protection zone for areas of ecological or cultural significance, or both. These areas are subject to very frequent inundation and have high ecological and/or cultural value.

The largest area of Management Zone D is Bungle Gully Dam, which is on Baradine Creek and is surrounded by coolibah with river coobah and lignum that is inundated during floods. To maintain flood connectivity to these significant assets, only works that enhance an Aboriginal cultural value, ecological asset or heritage site will be considered. There are 18 Management Zone D areas including:

- Baraneal Lagoons
- Bungle Gully
- Camp Pool
- Coolibah Swamp
- Eulah Lagoon

- Gurleigh Lagoon (Sheep Station Creek)
- Krui Swamp
- Locharba Lagoons
- un-named lagoon A
- un-named lagoon B
- un-named lagoon C
- un-named lagoon D
- Warriar Lagoon
- Wee Waa Lagoon
- Weeta Waa Lagoon
- Wirebrush Lagoon
- Woodlands Billabong
- Yarral Lagoon.

Further information on Management Zone D is provided in Appendix 16.

Hydraulic criteria

Management zones were established based on hydraulic criteria, which were developed from information on flood behaviour within the floodway network (Table 5 in step 4). The three hydraulic categories in the floodway network and the area outside of the floodway network identified during step 4 were the basis for four different management zones, so that the:

- defined floodways are the hydraulic basis for Management Zone AD
- ill-defined floodways are the hydraulic basis for Management Zone AID
- inundation extent is the hydraulic basis for Management Zone B
- flood fringe (that is area outside the floodway network) is the hydraulic basis for Management Zone C

Management Zone CU and Management Zone D do not have a hydraulic basis.



Figure 20. Bungle Gully Dam. J. Taylor, OEH 2015

Ecological criteria

In the Lower Namoi Valley Floodplain, there are a wide range of aquatic habitats of ecological importance, including:

- oxbow lagoons
- wetlands
- the coolibah–black box woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions endangered ecological community
- flood-dependent species protected under the *Biodiversity Conservation Act 2016*, the *Fisheries Management Act 1994* and the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth).

Floodplain water flows are crucial to maintain the structure and function and long-term survival of flood-dependent communities in the Lower Namoi Valley Floodplain.

The purpose of the ecological criteria is to ensure that ecological assets are not impacted by changes to the passage of floodwater caused by new flood works or modifications to existing flood works. To this end, refinements were made to Management Zone AD and Management Zone AID and Management Zone D was created as a new management zone. Overall, almost 6,992 ha were added to Management Zone AD and 1,446 ha were added to Management Zone D, based on ecological criteria. No other management zones were directly changed as a result of ecological criteria.

The ecological criteria were based on hydro-ecological functional groups determined in step 5 as well as key fish passage information and floodplain topography. Ecological criteria were finalised in discussion with TAG members and local experts. Table 9 shows the recommended management zones for each type of ecological asset determined.

Table 9. Management zone recommendations for ecological asset types

Ecological asset	Hydro-ecological functional group	Ideal frequency of watering	Management zone recommendation	Change made?
Wetland	Semi-permanent wetland	Annual or near annual	MZ AD (entire record or polygon)	Yes
Wetland	Floodplain wetland (Flood-dependent shrubland wetlands)	Every year to 1 in 5 years	MZ AD or MZ AID (polygon at least connected)	Yes
Other floodplain ecosystem	Flood-dependent forest/woodland (wetlands)	1 in 3 to 1 in 5 years	MZ AD or MZ AID (polygon at least connected)	Yes
Another floodplain ecosystem	Flood-dependent woodland	1 in less than 10 years	MZ D or MZ AD or MZ AID or MZ B (polygon at least connected)	Yes

Ecological refinements to Management Zone AD

Where there was hydraulic justification, the following six ecological amendments were made to Management Zone AD, Management Zone AID, and Management Zone D (Figure 21):

1. inclusion of semi-permanent wetland vegetation communities as Management Zone AD (approximately 1,686 ha were added to Management Zone AD based on this recommendation)
2. Management Zone AD or Management Zone AID connections to floodplain wetland (flood-dependent shrubland wetlands) and flood-dependent forest/woodland (wetlands) (approximately 634 ha were added to Management Zone AD based on this recommendation. No additions were made to Management Zone AID)
3. inclusion of tracts of floodplain land within the low-lying areas bordering a watercourse (identified at a scale of 1:10,000 using LiDAR or ADS40 DEM) that contained flood-dependent woodland as Management Zone AD (approximately 1,557 ha were added to Management Zone AD based on this recommendation)⁸
4. inclusion of key fish passage areas identified using NSW Fish Community Status and Threatened Fish Species Data (Aquatic Biodiversity Value Mapping Project) (NSW DPI 2015) as Management Zone AD using the predicted current distributions of the following species (no additions were made to Management Zone AD):
 - Silver Perch (*Bidyanus Bidyanus*)
 - Purple Spotted Gudgeon (*Mogurnda adspersa*)
 - Olive Perchlet (*Ambassis agassizii*)
 - Flathead Galaxias (*Galaxias rostratus*)
 - Eel Tailed Catfish (*Tandanus tandanus*)

⁸ This low-lying riparian land broadly aligns with e-water outcomes in the Commonwealth Environmental Water Portfolio Management Plan: Namoi River Valley 2016-17, Commonwealth of Australia, 2016 report. For instance, the outcome to maintain riparian vegetation and support connectivity and movement for fish.

5. zoning of ecological assets as Management Zone D where the asset is a location or landscape feature with (1,447 ha were added as Management Zone D based on this recommendation):

- a high degree of floodwater dependency
- a high degree of habitat complexity
- a history of supporting a diversity or abundance of waterbird, native fish or frog populations, or
- the functional capacity to act as an aquatic drought refuge, or
- recognition in or protection by a local, state or federal environmental policy.

If there was a lack of hydraulic justification to amend the management zones, then there were opportunities for developing rules to protect flood connectivity to the ecological asset in Step 8.

A spatial analysis was undertaken to determine if the ecological assets were captured in the recommended management zones. High-priority ecological assets were largely aligned with hydraulic floodways (MZ AD or MZ AID). This finding was expected because flood-dependant forest/woodland (wetlands), including river oak (*Casuarina cunninghamiana subsp. cunninghamiana*) and river red gum (*Eucalyptus camaldulensis*) are predominately inner floodplain vegetation communities found on stream banks of major rivers and creeks. Connecting over 90% of semi-permanent wetland to floodways will help to protect flood connectivity to these assets and to conserve these significant ecological areas into the future.

The objective of the ecological criteria for floodplain wetland, flood-dependent forest/woodland (wetlands) and flood-dependent woodland was to connect the assets to floodways (not to wholly incorporate them into Management Zone AD). Minor changes were made to the management zones to connect additional isolated assets in these sub-group categories.

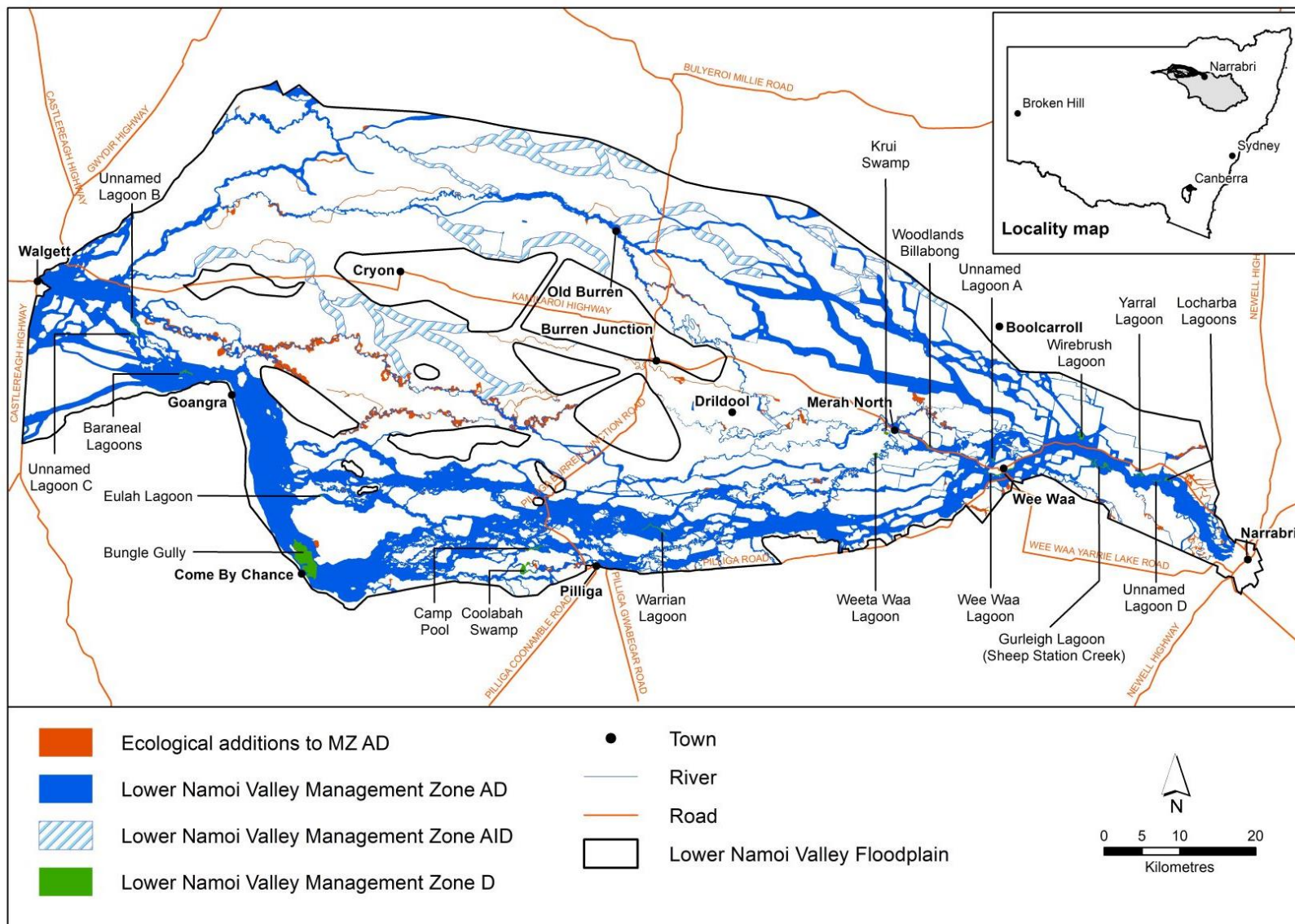


Figure 21. Refinements to management zones based on ecological criteria.

Note. Amendments based on ecological flow corridors and key fish passage are not shown due to map scale.

Cultural criteria

Cultural criteria were developed to ensure that flood-dependent Aboriginal cultural values and heritage sites are not impacted by flood behaviour changes caused by flood work development. Historic heritage sites that are not flood-dependent were not included as part of the cultural criteria for management zone delineation.

Cultural criteria were based on flood dependency of Aboriginal values and heritage sites determined in step 5. Cultural criteria were finalised in discussion with TAG members and local Aboriginal heritage experts. Three criteria were to map, where there was hydraulic justification, the following as either Management Zone AD or Management Zone AID (depending on the hydraulic conditions):

- Aboriginal values (excluding scarred/carved trees) that are highly flood-dependent if they:
 - were identified by the department's Aboriginal Water Initiative, or
 - are listed on the NSW AHIMS, or
 - were identified during direct community consultation with the local Aboriginal community
- scarred/carved tree locations where the trees are:
 - living flood-dependent vegetation that generally requires flooding at least every five years to maintain their ecological character and cultural value
 - within 100 m of hydraulic Management Zone AD
 - within 100 m to 500 m of hydraulic Management Zone AD and the site card has been evaluated
- Heritage sites that are flood-dependent and are cultural heritage objects and places as listed on federal, state and local government heritage registers.

An additional cultural criterion was to map as Management Zone D, those areas of the floodplain that are a location or landscape feature that have a high degree of:

- flood water dependency, such as swamps, marshes, lagoons, billabongs, rocky bars or warrumbools that are strongly dependent on the passage of floodwater
- cultural significance to the Aboriginal community, including spiritual, archaeological or resource use-values and are listed on a heritage register or are a place that is recognised for its cultural significance by several senior knowledge holders in the Aboriginal community.

Overall, less than 100 ha were added to Management Zone AD based on cultural criteria alone. These additions were to better connect scarred/carved trees to hydraulic floodways. More extensive changes based on cultural criteria were not required due to the good correlation of the management zones with the identified assets. Direct changes were not made to Management Zone AID, Management Zone B, Management Zone C, Management Zone CU or Management Zone D.

To ensure management zone refinements represent on-ground conditions, the above criteria were field-validated against expert recommendations and to account for data accuracy and confidence. Where hydraulic justification could not be made to amend the management zones, there were opportunities for developing rules to protect flood connectivity to the assets in step 8.

Non-flood-dependent cultural assets

Cultural assets vulnerable to the:

- effect of erosion associated with the redistribution of flood flow, or
- direct impacts of the installation of new flood works, or
- modification of current works

are not dealt with in the design of the management zones. Where identified, these cultural assets will be an additional consideration as part of the process to assess flood work applications.

Criteria to better reflect existing floodplain management arrangements

Prior to commencement of the new FMP, existing floodplain management arrangements in the Lower Namoi Valley Floodplain were generally accepted. During meetings with the TAG, it was recommended that existing management arrangements be a major consideration when delineating management zones.

The outcomes from the hydraulic, ecological and cultural criteria above were made to be as consistent with existing floodplain management arrangements as possible. Nevertheless, upon review there was scope to increase consistency between the proposed management zones and the Narrabri to Wee Waa FMP (2005) and the three current guidelines in the floodplain:

- *Guidelines for Boolcarrol to Bulyeri floodplain development* (NSW Water Resources Commission 1980)
- *Guidelines for Gardens to Drilool floodplain development* (NSW Water Resources Commission no date)
- *Guidelines for Merah North to Burren Junction floodplain development* (NSW Water Resources Commission 1978).

New criteria were developed at the scale of existing FMP, guidelines and approved flood works. A new criterion was also developed to account for urban areas where local council is responsible for granting approvals for the majority of flood works under the *Environmental Planning and Assessment Act 1979*. Management zones developed in neighbouring rural FMPs were also considered.

Five criteria to better reflect existing floodplain management arrangements were developed:

1. amendments to make Management Zone AD and Management Zone AID congruent with neighbouring floodways in the Gwydir Valley FMP 2016, the Barwon–Darling Valley FMP 2017 and the Upper Namoi Valley FMP 2019
2. amendments to make Management Zone AD floodways more consistent with existing mapped floodways and approved development. Where existing floodways differed to approved flood work developments, consistency with the approved development was a priority
3. amendments to relax the depth-velocity product threshold for Management Zone AD in current guideline areas from greater than or equal to 0.2 m²/s to greater than or equal to 0.3 m²/s in areas outside the guidelines' floodway networks. This increased the area of Management Zone B. Consistency with existing flood work development levels in the floodplain was also checked, with areas enclosed by existing Part 8 approved flood works that are designed to be overtopped during flooding included in Management Zone B
4. inclusion in Management Zone C areas of the floodplain enclosed by existing Part 8 approved flood works that are not designed to be overtopped during flooding
5. zoning as Management Zone CU of floodplain areas that are included within existing urban flood studies, floodplain risk management studies or floodplain risk management plans (2,400 ha of Narrabri and 400 ha of Wee Waa become Management Zone CU).

Modifying the management zones

Part 10 of the Lower Namoi Valley FMP 2020 (Amendment of this Plan) is the mechanism by which modifications may be made to the management zones.

Amendments may be made to modify the area to which the plan applies or any management zone using any of the following information, or supporting information as determined by the minister:

- an aerial photograph or equivalent satellite image showing flood inundation at the property scale of either the small design flood or the large design flood
- oblique photos showing flood inundation of either the small design flood or the large design flood that contain verifiable landmarks
- oblique photos of flood survey marks that can be verified for either the small design flood or the large design flood.

Note that a hydraulic study which provides velocity and depth information for the large design flood may be used to support this information.

Summary of management zone criteria

The overall configuration of management zones in the Lower Namoi Valley Floodplain was based on four categories of management zone criteria (Figure 22):

- hydraulic criteria
- ecological criteria
- cultural criteria
- criteria to better reflect existing floodplain management arrangements.

The area contribution of each criteria to each management zone is shown in hectares in Table 10 and as a percentage of each zone in Table 11.

Table 10. Contribution of each criteria to each management zone in hectares (rounded to the nearest 100 ha)

Management zone	Hydraulic	Ecological	Cultural	Existing planning	Total
AD	120,800	7,000	<100	5,800	133,600
AID	21,400	-	-	-	21,400
B	221,400	-	-	300	221,700
C	80,500	-	-	109,200	189,700
CU	-	-	-	2,800	2,800
D	-	1,400	-	-	1,400
Total	444,100	8,400	<100	118,100	570,700

Table 11. Percentage contribution of each criteria to each management zone

Management zone	Hydraulic	*Ecological	Cultural	Existing planning
AD	90	5	<1	4
AID	100	-	-	-
B	>99	-	-	<1
C	42	-	-	58
CU	-	-	-	100
D	-	100	-	-

* Where cultural and ecological criteria both contributed to the zoning decision, the proportion was added to the 'ecological' total

Between 90% and 100% of Management Zone AD, Management Zone AID and Management Zone B was based on hydraulic criteria. Approximately half of Management Zone C was based on the flood fringe mapped as part of the floodway network and the other half was based on Part 8 approved flood works as part of criteria to better reflect current floodplain management arrangements. All of Management Zone CU was based on towns managed by local councils identified as part of the criteria to better reflect current floodplain management arrangements. All of Management Zone D was based on ecological assets identified using the ecological criteria.

The breakdown of each category's contribution to each management zone is provided in Figure 22.

The proportion of the floodplain mapped as each of the six management zones is shown in Figure 23 and a summary of the criteria for delineating management zones is provided in Tables 12 to 17 below.

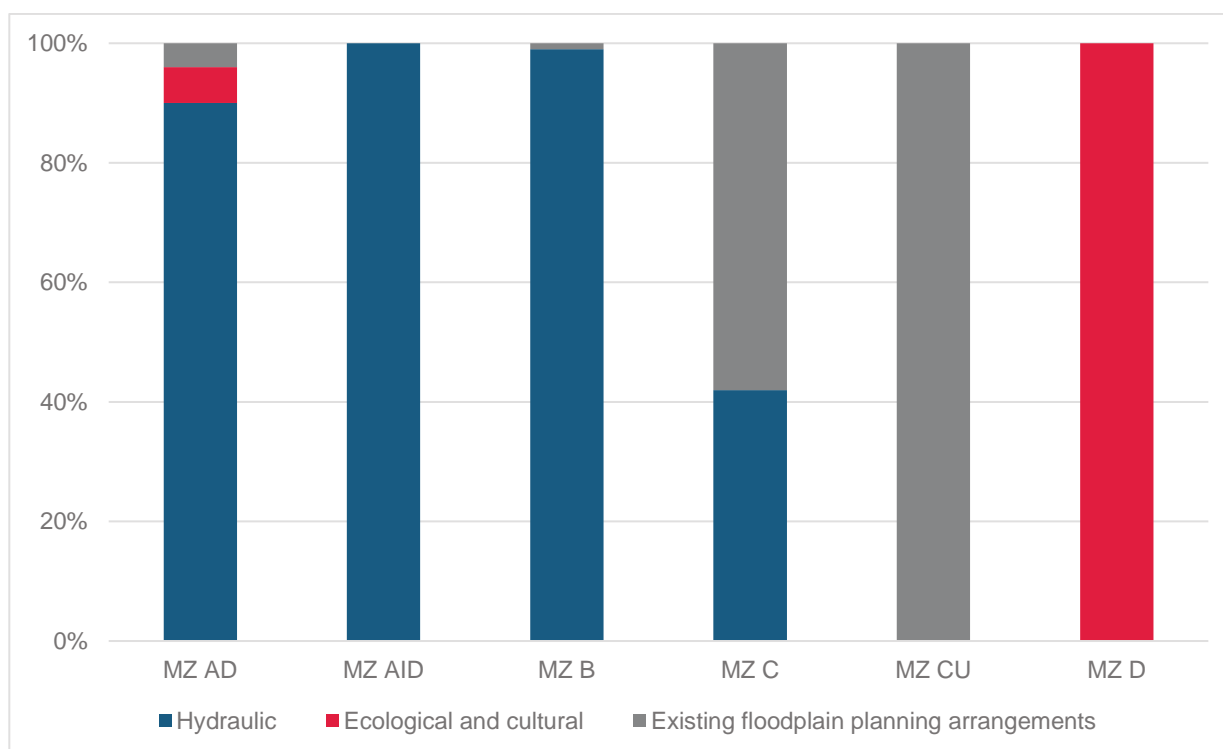


Figure 22. Bar graph showing the contribution of each of the criteria (hydraulic, ecological, cultural, existing floodplain planning arrangements) to each management zone.

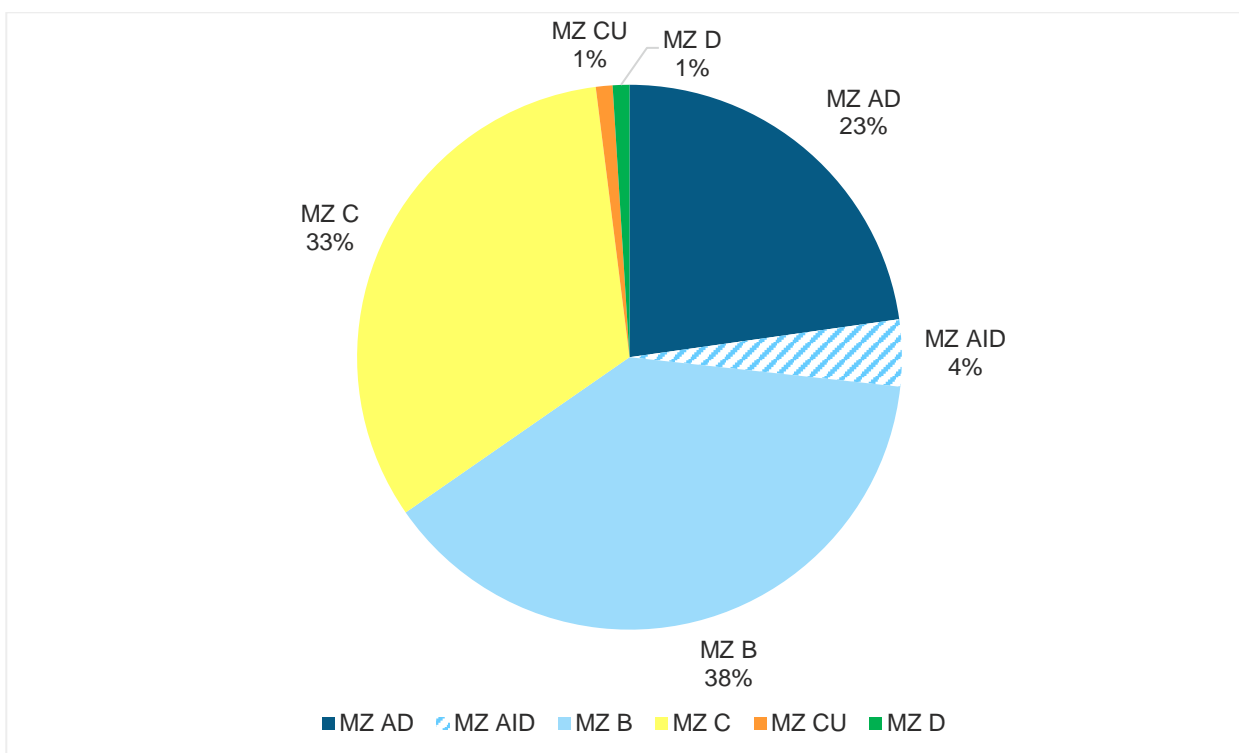


Figure 23. Pie graph showing the proportion of the Lower Namoi Valley Floodplain mapped as each of the six management zones.

Table 12. Criteria for Management Zone AD (133,600 ha)

Criteria	Description
Hydraulic (120,819 ha)	<p>Management Zone AD includes major discharge areas that have a depth-velocity product of greater than or equal to 0.2 m²/s for the large design flood (1971—4% AEP). Floodplain connectivity was provided for by incorporating:</p> <ul style="list-style-type: none"> parts of the small design flood extent (2004—13% AEP) and/or floodplain areas that have a depth-velocity product of greater than or equal to 0.05 m²/s for the large design flood (1971—4% AEP). <p>To ensure that conditions on the ground are adequately represented, the above criteria were road tested against the following additional data:</p> <ul style="list-style-type: none"> flood aerial photography and satellite imagery spatial watercourse layers, topographical mapping, ADS40 DEM and LiDAR previous floodplain management plans and development guidelines local knowledge obtained from floodplain communities and floodplain/environmental managers.
Ecological criteria (~7,000 ha) (6,992 ha)	<p>Management Zone AD includes, where there is hydraulic justification:</p> <ul style="list-style-type: none"> semi-permanent wetland connections to/through floodplain wetland (flood-dependent shrubland wetlands) and flood-dependent forest/woodland (wetlands) tracts of floodplain land within low-lying areas bordering a watercourse that contain floodplain wetland (flood-dependent shrubland wetland) or flood-dependent forest/woodland (wetlands) key fish passage areas (DPI 2015).
Cultural criteria (<100 ha) (27 ha)	<p>Management Zone AD includes, where there is hydraulic justification:</p> <ul style="list-style-type: none"> floodplain areas with Aboriginal values that are highly flood-dependent that were identified during direct community consultation with the local Aboriginal community and/or are listed on the: <ul style="list-style-type: none"> Aboriginal Water Initiative System (AWIS) database (now inactive)

Criteria	Description
	<ul style="list-style-type: none"> ○ Aboriginal Heritage Information Management System (AHIMS). • locations for scarred/carved trees that are living flood-dependent vegetation that generally require flooding at least every five years to maintain their ecological character and cultural value • locations for heritage sites that are flood-dependent and are cultural heritage objects and places as listed on federal, state and local government heritage registers.
Existing floodplain management arrangements criteria (5,799 ha)	Management Zone AD was made congruent with the Management Zone A of the bordering Gwydir, Barwon–Darling and Upper Namoi Valley FMPs. Management Zone AD was also reviewed for consistency with existing FMPs and floodplain development guidelines. During the review, Management Zone AD floodways were matched to historical floodways. If the historical floodways were inconsistent with current flood work development, the floodways were designed to match current development conditions. Importantly, Management Zone AD was not made more restrictive than the historic floodways.

Table 13. Criteria for Management Zone AID (21,400 ha)

Criteria	Description
Hydraulic criteria (20,427 ha)	<p>Management Zone AID includes major discharge areas that have a depth-velocity product of $<0.05 \text{ m}^2/\text{s}$ for the large design flood (1971—4% AEP).</p> <p>The location of ill-defined floodways is guided by:</p> <ul style="list-style-type: none"> • areas with a depth-velocity product of $<0.05 \text{ m}^2/\text{s}$ for the large design flood (1971—4% AEP) and/or • flood imagery and/or • local knowledge and/or • parts of the small design flood extent (2004—13% AEP). <p>The width of ill-defined floodways is determined by the width of the upstream defined floodway and a maximum 500 metre buffer either side of this floodway (minimum width is 1 km).</p> <p>To ensure that conditions on the ground are adequately represented, the above criteria were road tested against the following additional data:</p> <ul style="list-style-type: none"> • flood aerial photography and satellite imagery • spatial watercourse layers, topographical mapping, ADS40 DEM and LiDAR • previous floodplain management plans and development guidelines • local knowledge obtained from floodplain communities and floodplain/environmental managers.
Ecological criteria (0 ha)	Management Zone AID includes, where there is hydraulic justification connections to/through floodplain wetland (flood-dependent shrubland wetlands) and flood-dependent forest/woodland (wetlands).
Cultural criteria (0 ha)	<p>Management Zone AID includes, where there is hydraulic justification:</p> <ul style="list-style-type: none"> • floodplain areas with Aboriginal values that are highly flood-dependent that were identified during direct community consultation with the local Aboriginal community and/or are listed on the: <ul style="list-style-type: none"> ○ DPI Water Aboriginal Water Initiative System (AWIS) database (now inactive) ○ Aboriginal Heritage Information Management System (AHIMS). • locations for scarred/carved trees that are living flood-dependent vegetation that generally require flooding at least every five years to maintain their ecological character and cultural value • locations for heritage sites that are flood-dependent and are cultural heritage objects and places as listed on federal, state and local government heritage registers.
Existing floodplain management arrangements criteria (0 ha)	Management Zone AID was made congruent with Management Zone A of the bordering Gwydir, Barwon–Darling and Upper Namoi Valley FMPs. Management Zone AID was also reviewed for consistency with existing FMPs and floodplain development guidelines.

Table 14. Criteria for Management Zone B (221, 700 ha)

Criteria	Description
Hydraulic criteria (221,397 ha)	<p>Flood storage and secondary flood discharge areas of the floodplain:</p> <ul style="list-style-type: none"> not already identified an ill-defined or defined floodway and are included within the extent of the large design flood (1971—4% AEP) or are enclosed by existing Part 8 approved flood works that are overtopped during moderate to large floods. <p>To ensure that conditions on the ground are adequately represented, the above criteria were road tested against the following additional data:</p> <ul style="list-style-type: none"> flood aerial photography and satellite imagery spatial watercourse layers, topographical mapping, ADS40 DEM and LiDAR previous floodplain management plans and development guidelines local knowledge obtained from floodplain communities and floodplain/environmental managers.
Ecological criteria (0 ha)	Management Zone B includes, where there is hydraulic justification, flood-dependent woodland.
Cultural criteria (0 ha)	Management Zone B includes, where there is hydraulic justification, locations for scarred/carved trees that are living and located within flood-dependent woodland.
Existing floodplain management arrangements criteria (368 ha)	<p>Management Zone B includes areas that were initially mapped as Management Zone AD (based on hydraulic criteria) where the depth-velocity product was less than 0.3 m²/s for the large design flood. These areas also had to be outside of the original floodway networks described in the floodplain development guidelines. Before being made Management Zone B, these areas were checked for consistency with current flood work development levels in the floodplain.</p> <p>Management Zone B may include areas of the floodplain that are enclosed by existing Part 8 approved flood works that are designed to be overtopped during moderate to large floods. Although these areas were generally part of Management Zone C.</p>

Table 15. Criteria for Management Zone C (189,700 ha)

Criteria	Description
Hydraulic criteria (80,496 ha)	<p>Management Zone C includes flood fringe areas of the floodplain that are:</p> <ul style="list-style-type: none"> outside the extent of the large design flood (1971—4% AEP) enclosed by existing Part 8 approved flood works that are not designed to be overtopped during flooding. <p>To ensure that conditions on the ground are adequately represented, the above criteria were road tested against the following additional data:</p> <ul style="list-style-type: none"> flood aerial photography and satellite imagery spatial watercourse layers, topographical mapping, ADS40 DEM and LiDAR previous floodplain management plans and development guidelines local knowledge obtained from floodplain communities and floodplain/environmental managers.
Ecological criteria (0 ha)	The basis of Management Zone C was not ecological
Cultural criteria (0 ha)	The basis of Management Zone C was not cultural.
Existing floodplain management arrangements criteria (109,198 ha)	<p>Management Zone C was reviewed for consistency with existing plans.</p> <p>Management Zone C includes areas of the floodplain that are enclosed by existing Part 8 approved flood works that are not designed to be overtopped during flooding.</p>

Table 16. Criteria for Management Zone CU (2,800 ha)

Criteria	Description
Hydraulic criteria (0 ha)	The basis of Management Zone CU was not hydraulic.
Ecological criteria (0 ha)	The basis of Management Zone CU was not ecological. If any assets fall within Management Zone CU, ecological asset mapping will be provided to the relevant local government authority for consideration in land-use planning and assessment of development applications.
Cultural criteria (0 ha)	The basis of Management Zone CU was not cultural. If any assets fall within Management Zone CU, the relevant local government authority will be notified and provided with relevant contact details.
Existing floodplain management arrangements criteria (2,788 ha)	Management Zone CU was mapped as floodplain areas that are included within existing urban flood studies, floodplain risk management studies, or floodplain risk management plans or that are protected by flood mitigation works such as town levees.

Table 17. Criteria for Management Zone D

Criteria	Description
Hydraulic criteria (0 ha)	The basis for Management Zone D was not hydraulic.
Ecological criteria (1,448 ha)	Management Zone D includes assets that are a location of landscape feature, such as a swamp, marsh, lagoon, anabranch or billabong with a high degree of floodwater dependency, and: <ul style="list-style-type: none"> • a high degree of habitat complexity • a history of supporting a diversity or abundance of waterbird, native fish or frog populations • the functional capacity to act as an aquatic drought refuge • recognition in, or protected by a local, state or federal environmental policy.
Cultural criteria (0 ha)	Management Zone D includes areas of the floodplain that are a location or landscape feature that were identified as having a high degree of: <ul style="list-style-type: none"> • floodwater dependency, such as swamps, marshes, lagoons, billabongs, rocky bars or warrumbools that are strongly dependent on the passage of floodwater • cultural significance to the Aboriginal community including spiritual, archaeological or resource use-values and are listed on a heritage register or are a place that is recognised for its cultural significance by several senior knowledge holders in the Aboriginal community.
Existing floodplain management arrangements criteria (0 ha)	Management Zone D was reviewed for consistency with existing plans. However, the basis for Management Zone D did not include existing floodplain management planning arrangements.

Step 8: Determine rules

The management zones and rules (including assessment criteria) together provide the legal framework for the granting and amending of flood work approvals in the Lower Namoi Valley Floodplain. Step 8 was undertaken to develop specific rules to define the type, nature, construction, and advertising requirements of flood works for each management zone. The rules vary between management zones to reflect differences in flooding behaviour and the floodplain environment. Step 8 was also undertaken to develop rules to facilitate the approval or amendment of existing flood works in MZ AD (including identified flood flow corridors in MZ AID) and MZ D.

The rules can be split into five general types, including those that:

- specify the physical nature of permissible flood works
- maintain flood flow corridors through Management Zone AID
- specify advertising requirements
- are assessment criteria to determine the acceptable impacts of flood works
- relate to existing flood works in Management Zone AD and Management Zone D.

The Lower Namoi Valley FMP 2020 is supported by assessment guidelines to assist with applying the rules to assess flood work applications.

The rules outlined in step 8 should be considered in conjunction with the statewide exemptions as set out in the Water Management (General) Regulation 2018 (see 'Exemptions to flood work approvals' below for further information).

Permissible flood works

Permissible flood works are works for which an application for an approval will be accepted. Applications for permissible flood works must still go through the assessment process to receive an approval. Applications for non-permissible flood works will not be approved.

The types of flood works that can be applied for in each management zone (permissible flood works) are determined by considering the optimal balance between hydraulic, ecological, cultural and socio-economic considerations on the floodplain. Rules relating to the physical nature of flood works are used to specify the types of permissible flood works and are easy to interpret and do not require technical assessment.

Types of flood works

The following types of flood works are present in the Lower Namoi Valley Floodplain:

- (a) infrastructure protection works—to minimise risk to life and property
- (b) private access roads—to ensure landholders have basic provisions to access property
- (c) supply channels—to ensure supply channels reach water sources so landholders can access water rights
- (d) stock refuges—to account for animal welfare and to minimise a landholder's potential to lose stock to floodwaters
- (e) ecological, Aboriginal cultural value and heritage site enhancement works—to provide a positive outcome for an ecological or cultural asset that is listed in any of the sources identified in the plan
- (f) levees
- (g) storages
- (h) other earthworks and embankments.

Permissible flood works by management zone

In Management Zone AD (including identified flood flow corridors) and Management Zone D there is a high risk that flood works may impact flood behaviour. To minimise this risk, restrictions have been placed on the types of flood works that could be applied for in these zones. These restrictions on permissible flood works were made to be sympathetic to landholder needs and decisions were checked against:

- works likely to be approved under existing floodplain management planning arrangements (step 9 and step 10: phase 1)
- consultation with the community and interagency officers.

The rules specify that the types of flood works in Management Zone AD (and identified flood flow corridors) are:

- access roads
- supply channels
- infrastructure protection works
- stock refuges
- ecological enhancement works
- Aboriginal cultural value enhancement works
- heritage site enhancement works.

The rules that apply to ecological, Aboriginal cultural value and heritage site enhancement works are the only type of permissible flood works in Management Zone D.

In Management Zone B, Management Zone C and Management Zone CU all types of flood works are permissible.

The rules that specify the physical nature of permissible flood works in Management Zone AD (and identified flood flow corridors) and Management Zone D are described in detail below.

Flood flow corridors

A flood flow corridor is a hydraulic corridor that conveys flood flow through a management zone.

There are two types of flood flow corridors used in the Lower Namoi Valley FMP 2020:

1. In Management Zone AID, flood flow corridors are not mapped as the floodways are not well defined. This means that, although the evidence shows that a floodway goes through an area, the exact width of the floodway is unknown at the scale that the management zones were mapped (step 4).

Rather than mapping all floodways with the same management zone and applying the same restrictive rules as Management Zone AD, ill-defined floodways were appointed their own management zone (Management Zone AID) and the uncertainty regarding the location of the major discharge area could be negotiated by the landholder applying for a flood work approval.

As such, the location of the flood flow corridor within Management Zone AID is somewhat flexible and a landholder can negotiate a corridor that best suits their flood work application while also maintaining flood connectivity. The final location and width of the flood flow corridor will depend on the location of flood flow corridors (if identified) and Management Zone AD on adjacent properties, technical flood studies as well as consideration of the proposed location included in the flood work application.

The rules for flood flow corridors in Management Zone AID are provided in more detail on page 75.

2. In some areas of Management Zone AD, the depth-velocity product threshold of 0.2 m²/s has produced areas of *hydraulic Management Zone AD* that may be considered conservatively wide and therefore unnecessarily restrictive.

The inclusion of a rule for certain other flood works in Management Zone AD provides flexibility by allowing landholders to apply for flood works in localised areas of Management Zone AD by identifying flood flow corridors (whose width is justified by hydraulic modelling depth-velocity product results) that effectively reduce the width of Management Zone AD. This rule will maintain the hydraulic integrity of Management Zone AD by using the required flood flow corridors to convey flood flow through a management zone whilst maintaining flood-connectivity to flood-dependent ecological and cultural assets and facilitating fish passage.

The rules for certain other flood works in Management Zone AD are provided in more detail on page 73.

Specific requirements for permissible flood works

Access roads

In Management Zone AD (including identified flood flow corridors), the granting or amending of a flood work approval for an access road is only permitted if, in the minister's opinion, all of the following apply:

- (a) the height of the access road at any point of the road is no more than:

- (i) 15 cm above the natural surface level if it is not a primary access road, or

Note. *Natural surface level* is the average undisturbed surface level in the immediate vicinity of a flood work. A ***primary access road*** is a road providing access from a public road to a permanently occupied fixed dwelling via a direct route.

- (ii) 50 cm above the natural surface level if it is a primary access road,

- (b) the access road is constructed:

- (i) with causeways that:

(A) are no higher than the natural surface level, and

(B) are located at low points of the floodway, and

(C) occur at least once every 200 metres, and

(D) total at least 10% of the total length of the access road that is in the Lower Namoi Management Zone AD, and

Note. This applies to access roads that span a single property or multiple properties.

- (ii) with any borrow associated with the construction and maintenance of the access road located on the downstream side of the access road and no deeper than 15 cm below the natural surface level.

Justification for specifications

There are provisions for different kinds of access roads. The first part of the rule allows floodplain access with minimal impact on flood behaviour by limiting access roads to 15 cm in height above the natural surface level. The second part of the rule limits primary access roads to 50 cm in height above the natural surface level where those roads provide access from a public road to a permanently occupied fixed dwelling via a direct route.

The height limit of 15 cm for general access roads was selected as the threshold for the Gwydir Valley FMP 2016 and was also the height allowable for access roads in the Caroon to Breeza FMP (DNR 2006a) in the Upper Namoi Valley Floodplain. The Narrabri to Wee Waa FMP 2005

allowed access roads up to 30 cm. However, this was considered too high and could be used to facilitate the illegal interception, conveyance or storage of overland flow during times of flood. The construction of general access roads of up to 15 cm in height above the natural surface level will be overtopped by most floods and will have minimal impact on flood flows.

Primary access roads of 50 cm are permissible, by application, to provide improved reliability of road access to permanently occupied fixed dwellings during times of small to medium flood. This rule acknowledges that the demand for the use of such access roads during times of flood is of higher priority than the demand for the use of general access roads. Fifty centimetres is an appropriate compromise between providing reliable access and providing for the adequate passage of floodwater and local drainage during small to medium flood events.

The causeway requirements are to allow unimpeded flood flow during small flood events. The causeways also allow for connectivity that is important for fish passage. The requirements for causeways are modelled on the Gwydir Valley FMP 2016, which were originally adopted from the Lower Gingham Watercourse FMP 2006 (DNR 2006d). Causeways are included to ensure that access roads will not block or divert flow flows, which are important for flood-dependent ecological and cultural assets.

Rules relating to borrow pits were developed for the Gwydir Valley FMP 2016 and represent current best practice principles. The positioning of the borrow pit on the downstream side and limiting the depth to 15 cm below the natural surface level was selected to facilitate the passage of floodwater, prevent diversion of floodwater, minimise soil erosion and reduce disruption to access by maintaining the stability of the roadway.

Supply channels

In Management Zone AD (including identified flood flow corridors), the granting or amending of a flood work approval for a supply channel is only permitted if, in the minister's opinion, all of the following apply:

- (a) the height of the supply channel is below the natural surface level,
- (b) the supply channel is constructed to ensure:
 - (i) the adequate passage of floodwater and prevention of diversion of floodwater from natural flow paths, and

Note. The minister may require that a structure be put in place at a low point of the supply channel to meet the requirements of this subparagraph.

the spoil associated with the construction and maintenance of the supply channel:

- (A) forms a windrow parallel to the direction of flow so that it does not block more than 5% of the width of the Lower Namoi Management Zone AD, as measured at the location of the supply channel and perpendicular to the flood flow direction, or

Note. Width is measured perpendicular to flood flow direction.

- (B) is levelled to a height of 10 cm or less above the natural surface level at any point of the spoil.

Note. *Spoil* refers to waste material (such as dirt or soil) that is produced during the construction or modification of a flood work. *Windrow* refers to a row or line of cut vegetation or other material.

Justification for specifications

Ensuring that supply channels are below the natural ground level reduces the potential for the work to affect the distribution or flow of floodwater during flood events. It is still a requirement to construct the supply channel so that there is adequate passage of floodwater and to adequately prevent the diversion of floodwater. This is because, during small floods, a supply channel could

potentially capture and divert flow from its natural flow path. It may be required that a siphon or gate be put in place at a low point of the supply channel to enable timely floodwater passage and/or drainage on the floodplain. Construction of siphons or equivalent structures will enable floods to pass through or under these works.

Spoil from the construction and maintenance of a supply channel may act as an above-ground flood work. To minimise the chance of spoil influencing flood flow, it is required to windrow the spoil to the specifications in the rules or to ensure it is levelled to no more than 10 cm in height. It is also required that the encroachment of spoil into active discharge areas is limited to minimise any impacts on flooding. Previously, in the Narrabri to Wee Waa FMP 2005, spoil had to be removed from the floodways identified in the plan. The new rules are considered sufficient for managing the risk that spoil will act as an above-ground flood work.

In the Narrabri to Wee Waa FMP 2005, supply channels were allowed to be at ground level as well as below ground level. Supply channels must now be below ground level to minimise the potential for negative impacts on flood behaviour.

These rules are consistent with rules in the Gwydir Valley FMP 2016 and the Barwon–Darling Valley FMP 2017.

In other areas of the Lower Namoi Valley Floodplain, below-ground supply channels did not require approval if they had an existing approval under Part 2 of the *Water Act 1912*. During the preparation of the Gwydir Valley FMP 2016, it was proposed to assess below-ground supply channels as a flood work because of their potential to impact on flooding behaviour. This assessment would be consistent with Part 2 practice, which would place a condition that water supply works could not impact flooding. The regulation of this type of work as a flood work better ensures flood connectivity during small flood events.

Stock refuges

In Management Zone AD (including identified flood flow corridors), the granting or amending of a flood work approval for a stock refuge is only permitted if, in the minister's opinion, all of the following apply:

- (a) the area of the stock refuge is 10 ha or less and no other stock refuge is in that area,

Note. *Stock refuge* refers to a flood work for the purpose of protecting stock in times of flooding.

- (b) the total area of stock refuges on the landholding on which the stock refuge is located is no more than 5% of the total area of the landholding,
- (c) the stock refuge blocks 5% or less of the width of the Lower Namoi Management Zone AD, as measured at the location of the stock refuge and perpendicular to the flood flow direction.

Note. For example, if the Lower Namoi Management Zone AD is 200 m in width, the stock refuge must not extend more than 10 m into the Lower Namoi Management Zone AD.

Justification for specifications

Stock refuges are an important consideration for the protection of life and property from the effects of flooding. It is important to have a safe place for stock to take refuge during times of flood. For this reason, there are no height restrictions on stock refuges so that a landholder can ensure stock are not overcome by flood waters. However, to ensure that flooding behaviour is not significantly affected, there are limitations on the size and location of the work.

A stock refuge can be no more than 10 ha in any single location and can take up no more than 5% of the total area of the landholding. For example, if a landholding is 400 ha in area, the total area of stock refuges may be 20 ha in area, but it must be divided into at least 2 parcels with a maximum of 10 ha each.

These refuges would also have to be located so as not to take up more than 5% of the width of MZ AD. For example, if the Lower Management Zone AD is 200 m in width, the stock refuge must not extend more than 10 m into the MZ AD.

These rules are similar in nature to the previous policy that allowed stock refuges of 10 ha in size in any single location or up to 5% of the property in total area. These rules bring greater clarity to landholders by bringing the intention of an existing policy within a single governing FMP. These rules are also consistent with the Gwydir Valley FMP 2016 and the Barwon–Darling Valley FMP 2017.

The previous policy did not allow stock refuges to be built in sensitive areas or observed major flow paths. Such areas are essentially equivalent to Management Zone AD areas. Therefore, the new rules are a relaxation from current policy.

Infrastructure protection works

The granting or amending of a flood work approval for an infrastructure protection work is only permitted if, in the minister's opinion, the following apply:

- (a) the infrastructure protection work is on a landholding:
 - (i) where 20 ha or less of the landholding is in the Lower Namoi Management Zone AD and 10% or less of the total area of the landholding is enclosed by the work, or
 - Note.** For example, if a landholding is 10ha in area, the infrastructure protection work must enclose no more than 1ha.
 - (ii) where more than 20 ha of the landholding is in the Lower Namoi Management Zone AD and no more than 2 ha or 1% (whichever is greater) of the total area of the landholding is enclosed by the work,
 - Note.** For example, if a property is 25 ha in area, the area enclosed by infrastructure protection works must not exceed 2 ha in area. Alternatively, if a property is 300 ha in area, the area enclosed by infrastructure protection works must not exceed 3 ha in area.
- (b) the infrastructure protection work blocks 5% or less of the width of the Lower Namoi Management Zone AD, as measured at the location of the infrastructure protection work and perpendicular to the flood flow direction.

Justification for specifications

Infrastructure protection works are important flood works that provide for the protection of life and property from the effects of flooding. The thresholds selected for the works ensures that flood behaviour is not significantly affected by a work of this nature.

Infrastructure protection works can be built in different areas depending on the total size of the landholding where the work is being built. This is to cater for the practicality of larger properties being likely to have more infrastructure servicing their land.

On properties no larger than 20 ha, infrastructure protection works can cover an area that is up to 10% of the area of the property. For example, if a property is 10 ha in area, the proposed infrastructure protection works must enclose no more than 1 ha. This rule is consistent with the Gwydir Valley FMP 2016, the Barwon–Darling Valley FMP 2017 and the Upper Namoi Valley FMP 2019.

On properties larger than 20 ha, infrastructure protection works can be whichever is the larger of the following two options (a) either 2 ha in size or (b) 1% of the total area of the property. For example, if a property is 25 ha in area, the area enclosed by infrastructure protection works must not exceed 2 ha in area. Alternatively, if a property is 300 ha in area, the area enclosed by infrastructure protection works must not exceed 3 ha in area. This rule is consistent with the Gwydir Valley FMP 2016, the Barwon–Darling Valley FMP 2017 and the Upper Namoi Valley FMP 2019.

The rules requiring infrastructure protection works not block more than 5% of the width of Management Zone AD at the location of the works was referenced from the Gwydir Valley FMP 2016 and was used in interim working policies adopted by the department prior to this. This rule provides greater certainty to landholders wishing to construct an infrastructure protection work by specifying a threshold for how much of Management Zone AD can be blocked.

Generally, in the Lower Namoi Valley Floodplain, the previous policy was to allow infrastructure protection works of 10 ha in size or up to 5% of the property's total area. Although, the rules have reduced these thresholds, it is important to note that previously, infrastructure protection works were not allowed in sensitive areas or observed major flow paths. Such areas are essentially equivalent to Management Zone AD areas. Therefore, the new rules are a relaxation from the previous policy.

Ecological enhancement work

In Management Zone AD (including identified flood flow corridors) and Management Zone D, the granting or amending of a flood work approval for an ecological enhancement work is only permitted if, in the minister's opinion, the work is for the purpose of providing a positive outcome for a flood-dependent ecological asset or any other ecological asset specified in local, state or federal environmental plans, policy or legislation, including any of the following:

- (a) *Basin Plan 2012* (Cwlth),
- (b) *Biodiversity Conservation Act 2016*,
- (c) *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth),
- (d) the long-term watering plan for the Namoi water resource plan area under the *Basin Plan 2012* (Cwlth),
- (e) *National Parks and Wildlife Act 1974*,
- (f) *Fisheries Management Act 1994*,
- (g) NSW Wetland Policy 2010,
- (h) *Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management* (2013 update),
- (i) any other source that, in the minister's opinion, is relevant.

Justification for specifications

An ecological enhancement work is an important new type of work that is constructed only to benefit flood-dependent ecological assets, or any other ecological asset specified in local, state or federal environmental plans, policy or legislation.

These types of works are permissible in sensitive Management Zone AD and Management Zone D areas as they will provide a positive outcome for the environment. This rule is consistent with the WM Act additional provision 30(c) which allows for an FMP to deal with the restoration or rehabilitation of land, water sources or their dependent ecosystems, in particular in relation to the following:

- the passage, flow and distribution of flood water
- existing dominant floodways and exits from floodways
- rates of flow, floodwater levels and duration of inundation
- downstream water flows
- natural flood regimes, including spatial and temporal variability.

Aboriginal cultural value enhancement works

In Management Zone AD (including identified flood flow corridors) and Management Zone D, the granting or amending of a flood work approval for an Aboriginal cultural value enhancement work is only permitted if, in the minister's opinion, the work is for the purpose of providing a positive outcome for a flood-dependent Aboriginal cultural value or any other Aboriginal cultural value listed in any of the following:

- (a) Aboriginal Heritage Information Management System,
- (b) Murray–Darling Basin Authority Aboriginal Submissions Database,
- (c) NSW State Heritage Register,
- (d) Commonwealth Heritage List,
- (e) any other source that, in the minister's opinion, is relevant.

Justification for specifications

An Aboriginal cultural value enhancement work is an important new type of work that is constructed only to benefit Aboriginal cultural values that are listed in the Aboriginal Heritage Information Management System (AHIMS), Murray–Darling Basin Authority Aboriginal Submissions Database, NSW State Heritage Register or Commonwealth Heritage Register, or any other source that, in the minister's opinion, is relevant.

These types of works are authorised in Management Zone AD and Management Zone D as they will provide a positive outcome for, locations or landscapes that contain Aboriginal cultural values and cultural areas. This rule is consistent with the objects of the WM Act, clause 3(c)(iii) and (iv), which ensure that culture and benefits to Aboriginal people in relation to their spiritual and customary use of land and water are recognised and incorporated into sustainable water resource management. As Aboriginal values are often linked with ecological assets this rule is also consistent with the WM Act additional provision 30(c) which allows for an FMP to deal with the restoration or rehabilitation of land, water sources or their dependent ecosystems.

Heritage site enhancement works

In Management Zone AD (including identified flood flow corridors) and Management Zone D, the granting or amending of a flood work approval for a heritage site enhancement work is only permitted if, in the minister's opinion, the work is for the purpose of providing a positive outcome for a heritage site that is a flood-dependent heritage site or any other heritage site that is listed in any of the following:

- (a) Aboriginal Heritage Information Management System,
- (b) Murray–Darling Basin Authority Aboriginal Submissions Database,
- (c) NSW State Heritage Register,
- (d) NSW State Heritage Inventory,
- (e) Historic Heritage Information Management System,
- (f) Commonwealth Heritage List,
- (g) any other source, that in the minister's opinion, is relevant.

Justification for specifications

Heritage site enhancement work is an important new type of work that is constructed only to benefit heritage site assets that are listed in the Aboriginal Heritage Information Management System (AHIMS), Murray–Darling Basin Authority Aboriginal Submissions Database, NSW State Heritage Register, NSW State Heritage Inventory, Historic Heritage Information Management System, Commonwealth Heritage List or any other source, that in the minister's opinion, is relevant.

A heritage site enhancement work enables the protection of Aboriginal or heritage locations in the floodplain that have recognised significance. These types of works are authorised in Management Zone AD and Management Zone D areas as they will provide positive outcomes to heritage sites. This rule is consistent with the objects of the WM Act, clause 3(c)(iii) and (iv), which ensure that culture and heritage, and benefits to Aboriginal people in relation to their spiritual and customary use of land and water are recognised and incorporated into sustainable water resource management. As some heritage sites are linked with ecological assets this rule is also consistent with the WM Act additional provision 30(c) which allows for an FMP to deal with the restoration or rehabilitation of land, water sources or their dependent ecosystems.

Certain other flood works in Management Zone AD—flood flow corridors

This clause applies to a flood work or proposed flood work, or part of a flood work or proposed flood work, that is in Management Zone AD and for which the granting or amending of a flood work approval is not permitted under the rules and specifications for flood works in Management Zone AD (clauses 36 and 37).

In Management Zone AD, the granting or amending of a flood work approval for a flood work to which this clause applies is not permitted unless, in the minister's opinion:

- (a) the flood work is, or is proposed to be located within the *Hydraulic Management Zone AD* of the Lower Namoi Management Zone AD,

Note. *Hydraulic Management Zone AD* refers to areas of the floodplain with floodways that have a depth-velocity product of greater than $0.2\text{m}^2/\text{s}$; it does not refer to areas of the floodplain that were determined to be Management Zone AD based on ecological, cultural or existing planning arrangements criteria as part of the application of the method for delineating the extent of the management zones.

- (b) a flood flow corridor within the Lower Namoi Management Zone AD on the landholding on which the work is located is identified, and maintained, within the following range of maximum depth-velocity products across the width of the flood flow corridor (*required flood flow corridor for the Lower Namoi Management Zone AD*):
 - (i) where there is an area of the landholding with an existing maximum depth-velocity product greater than or equal to $0.7\text{m}^2/\text{s}$, from that maximum depth-velocity product to a depth-velocity product of at least $0.5\text{m}^2/\text{s}$ or less, or
 - (ii) where there is an area of the landholding with an existing maximum depth-velocity product greater than or equal to $0.6\text{m}^2/\text{s}$ but less than $0.7\text{m}^2/\text{s}$, from that maximum depth-velocity product to a depth-velocity product of at least $0.4\text{m}^2/\text{s}$ or less, or
 - (iii) where there is an area of the landholding with an existing maximum depth-velocity product greater than or equal to $0.5\text{m}^2/\text{s}$ but less than $0.6\text{m}^2/\text{s}$, from that maximum depth-velocity product to a depth-velocity product of at least $0.3\text{m}^2/\text{s}$ or less,

Note. Width is measured perpendicular to flood flow direction.

- (c) to ensure a continuing flood flow corridor in the Lower Namoi Management Zone AD, the required flood flow corridor for the Lower Namoi Management Zone AD directly joins:
 - (i) other required flood flow corridors for the Lower Namoi Management Zone AD or the Lower Namoi Management Zone AID (which have been identified for the purposes of other flood work approvals) on the landholding on which the flood work is located or adjacent landholdings, or
 - (ii) if directly joining with other required flood flow corridors on adjacent landholdings is not possible, that part of an adjacent landholding that is in the Lower Namoi Management Zone AD,

Note. *Flood flow corridor* is a hydraulic corridor that conveys flood flow through a management zone.

- (d) if the flood work, or any part of the flood work, is located, or is proposed to be, *located outside* of the required flood flow corridor for the Lower Namoi Management Zone AD:
- (i) the application for the flood work approval is advertised in accordance with the rules for the Lower Namoi Management Zone B, and
 - (ii) the flood work, or that part of the flood work, satisfies the assessment criteria for the Lower Namoi Management Zone B, where references to the Lower Namoi Management Zone B are taken to be references to the Lower Namoi Management Zone AD,
- (e) if any part of the flood work is located, or is proposed to be, located *within* the required flood flow corridor, the granting or amending of the approval must be in accordance with the rules and specific requirements (clauses 36 and 37) for the Lower Namoi Management Zone AD (including the assessment criteria and cumulative impact assessment for the Lower Namoi Management Zone AD).

Justification for specifications

This is a new rule in the Lower Namoi Valley Floodplain. The flexible flood flow corridor approach provides localised flexibility to flood work applicants in areas of the floodplain where the depth velocity product and threshold of $0.2\text{m}^2/\text{s}$ produces areas of Management Zone AD that are conservatively wide and may be considered unnecessarily restrictive. The intent of this rule is to provide flexibility to landowners, allowing flood work applicants to reduce the width of Management Zone AD in localised areas (where the variation in width is justified by hydraulic modelling depth-velocity product results) while maintaining the hydraulic integrity of the floodway network and maintaining flood connectivity to flood-dependent ecological and cultural assets and facilitating fish passage.

The rule only applies to areas of Management Zone AD where hydraulic modelling results indicate maximum depth velocity products within the range $0.5\text{ m}^2/\text{s}$ to $0.7\text{ m}^2/\text{s}$ (or greater) and which were determined under the methodology as hydraulic Management Zone AD. It does not apply to areas of Management Zone AD determined under the ecological, cultural or existing planning arrangement criteria of the methodology applied for delineating the extent of the management zones.

Undetermined flood work applications in Management Zone AD

A transitional provision has been included in the Lower Namoi Valley FMP 2020 that applies to applications for flood work approvals that:

- were lodged prior to 31 December 2019, and
- are for works that are located or proposed to be located in Management Zones A, AD, AID or D (including applications to amend an existing approval), and
- were yet to be assessed and determined at the time of commencement of the FMP.

For these applications, the transitional provision allows for the assessment to be undertaken against the comprehensive and comparatively less restrictive assessment criteria specified for Management Zone B, subject to the application being advertised.

All other applications, including those applications for flood works located or proposed to be located in other management zones or those applications lodged after the 31 December 2019 will be assessed against the relevant rules and assessment criteria in the commenced Lower Namoi Valley FMP 2020.

Once all of the outstanding applications have been assessed and determined, the transitional provision will no longer be used.

Justification for the transitional provision

A transitional provision has been included in the Lower Namoi Valley FMP 2020 to mitigate any disadvantage applicants may face as a result of significant delays in the assessment of the flood work applications while ensuring that a comprehensive set of assessment criteria is applied to the application. The latter providing for the long-term protection of the floodplain, environmental assets, cultural values and flood flow paths.

Prior to commencement of the FMP, there were significant delays in assessing applications for flood work approvals in the Lower Namoi Valley Floodplain. These delays were the result of WaterNSW focusing on applications for works relating to critical water needs during the recent drought.

There was a potential for some applicants to face disadvantage as a result of these delays, specifically in areas where the rules have become more restrictive with the start of the FMP.

This is because the rules and assessment criteria of an FMP in force **when the application is determined** that apply. This is clarified by section 95(3) of the *Water Management Act 2000*, which prevents an approval being granted if it contravenes the provisions in a relevant management plan.

This transitional provision also ensures that a comprehensive set of assessment criteria applies, and applications are advertised. This results in the long-term protection of the floodplain, environmental assets, cultural values and flood flow paths, which contributes to the protection of life and property from the effects of flooding.

Flood flow corridors in Management Zone AID

In Management Zone AID, the granting or amending of a flood work approval for a flood work to which this clause applies is only permitted if, in the minister's opinion, all of the following apply:

- (a) a flood flow corridor within the Lower Namoi Management Zone AID on the landholding on which the flood work is located is identified and is to be maintained with a width of no less than 80 m (*required flood flow corridor for the Lower Namoi Management Zone AID*),
- (b) the required flood flow corridor links to:
 - (i) other required flood flow corridors for the Lower Namoi Management Zone AID or the Lower Namoi Management Zone AD (which have been identified for the purposes of other flood work approvals) on the landholding or adjacent landholdings, or
 - (ii) if linking to other required flood flow corridors is not possible, that part of the Lower Namoi Management Zone AD on the landholding or adjacent landholdings.
- (c) the flood work satisfies the assessment criteria for the Lower Namoi Management Zone AID,
- (d) a cumulative impact assessment for the Lower Namoi Management Zone AID of the flood work has been completed,
- (e) if the flood work or any part of the flood work is, or is proposed to be, located *within the required flood flow corridor*, the granting or amending of the flood work approval is permitted for the flood work, or that part of the flood work, in accordance with the rules for the Lower Namoi Management Zone AD where references to the Lower Namoi Management Zone AD in those clauses are taken to be references to the Lower Namoi Management Zone AID, and
- (f) if the flood work or any part of the flood work is, or is proposed to be, located *outside of the required flood flow corridor*, the application for the flood work approval is advertised,

where references to the Lower Namoi Management Zone B in the clause are taken to be references to the Lower Namoi Management Zone AID.

Justification for specifications

Management Zone AID includes areas of the floodplain where a significant discharge of floodwater occurs during floods, with relatively high flood flow velocity and depth. These areas are generally characterised by overland flow paths without defined channels or banks. This means that, although the evidence shows that a floodway goes through an area, the exact location and width of the floodway is unknown at the scale that the management zones were mapped (step 4).

Management Zone AID was created so that the uncertainty regarding the location of the significant discharge area could be negotiated by the landholder applying for a flood work approval.

As such, the location of the flood flow corridor within Management Zone AID is flexible and a landholder can negotiate a corridor that best suits their flood work application while also maintaining flood connectivity. The final location and width of the flood flow corridor will depend on the location of other flood flow corridors (if identified) and Management Zone AD on adjacent properties, technical flood studies as well as consideration of the proposed location included in the flood work application.

Applications for new or amended flood works in Management Zone AID that are *located within a flood flow corridor* must comply with the rules and assessment criteria for flood works in Management Zone AD.

Applications for new or amended flood works in Management Zone AID that are located outside of a flood flow corridor must comply with the rules (advertising requirements) and assessment criteria for Management Zone B.

Advertising requirements

The Lower Namoi Valley FMP 2020 does not require advertising for works deemed to be minor in nature in most management zones. Advertising requirements were determined by considering the level of impact flood works would likely have on flood behaviour, floodplain connectivity and on neighbouring properties.

For the purposes of clause 26 (1) (c) of the *Water Management (General) Regulation 2018*, an application for a new or amended flood work approval for a flood work in Management Zone B must be advertised if, in the minister's opinion, any of the following applies:

- (a) the flood work is greater than 40 cm above the natural surface level at any location,
- (b) the flood work is a stock refuge:
 - (i) with an area that is greater than 10 ha and no other stock refuge is within that area, and
 - (ii) on a landholding of which the total area of stock refuges is greater than 5% of the total area of the landholding,
- (c) the flood work is an infrastructure protection work with an area that is greater than 1% of the total area of the landholding on which it is located.

Justification for specifications

Advertising gives interested parties the opportunity to comment on a flood work application and for that comment to be considered during the assessment process.

Flood work applications do not need to be advertised in Management Zone AD or Management Zone D (unless specified by the transitional provision). This is because works in these zones are

minor in nature and the cost of advertising is likely to outweigh any potential benefits gained from advertising.

The incremental increase in the risk of unsuitable development in Management Zone AID is mitigated by the requirement for flood works outside of a required flood flow corridor to be advertised in accordance with the rules for Management Zone B and to meet the assessment criteria for Management Zone B, which are more comprehensive than the assessment criteria for Management Zone AD.

Management Zone B includes areas of flood storage and secondary flood discharge. As all works are authorised works in this zone there is an increased likelihood that some flood works applied for will impact on flood behaviour and floodplain connectivity. Although the suite of assessment criteria in the Lower Namoi Valley FMP 2020 mitigates this risk, it was considered prudent to advertise works that may have an increased risk of impacting flood behaviour. As a result, all flood works in Management Zone B must be advertised except for those that are minor in nature. Works that are minor in nature are defined in the rules to include works less than 40 cm in height, stock refuges and infrastructure protection works.

Flood works in Management Zone C do not need to be advertised. This is because in Management Zone C there is a low risk that flood works will impact third parties in the flood fringe and existing developed areas.

Flood works in Management Zone CU will be assessed under the assessment criteria for Management Zone C and do not need to be advertised. The majority of flood works likely to be applied for in Management Zone CU will be exempt from requiring a flood work approval under the WM Act (see 'Exemptions to flood work approvals').

Assessment criteria

Assessment criteria relating to the acceptable impacts of flood works have been designed to consider the potential for a flood work to have:

- ecological, Aboriginal cultural value, and heritage site impacts
- social (drainage) impacts
- local hydraulic impacts
- cumulative hydraulic impacts.

The above categories of impacts are considered in the assessment criteria in different ways depending on the management zone that a flood work application is made for (Table 18).

Table 18. Categories of impacts that flood work applications must be assessed against to be approved by management zone

Assessment criteria	Type	MZ AD	MZ AID	MZ B	MZ C/CU	MZ D
Ecological and cultural impacts	Flood connectivity to ecological assets (Including facilitating fish passage), heritage sites	✓	*	✓	✓	✓
Ecological and cultural impacts	Flood connectivity to Aboriginal cultural values	✓	*	✓	✓	✓
Ecological and cultural impacts	Heritage site impacts	✓	*	✓	✓	✓
Social (drainage) impacts	Drainage impacts	✓	*	✓	✓	✓
Local hydraulic impacts	Redistribution	N/A	*	✓ [#]	∧	N/A

Assessment criteria	Type	MZ AD	MZ AID	MZ B	MZ C/CU	MZ D
Local hydraulic impacts	Flood levels	N/A	*	☑#	^	N/A
Local hydraulic impacts	Velocity	N/A	*	☑#	^	N/A
Cumulative hydraulic impacts	Redistribution	☑	*	☑#	^	☑

*Flood works inside a flood flow corridor will be assessed as Management Zone AD. Flood works outside of a flood flow corridor will be assessed as Management Zone B. Also, see 'Certain other flood works in Management Zone AD—flood flow corridors' for flood works that do not comply with the rules of Management Zone AD.

^ Assessment criteria are discretionary

Assessment criteria are discretionary for minor works that do not require advertising. For flood works that require advertising, all assessment criteria are mandatory.

Assessment criteria relating to the acceptable impacts of flood works follow a merit-based assessment approach and require technical assessment to interpret and apply. Flood work applications may require supporting information to assist with interpretation during the determination. Flood events (known as 'flood scenarios' in the Lower Namoi Valley FMP 2020) are considered when applying the assessment criteria. The types of flood scenarios depend on the management zone and the type of assessment criteria as outlined in the plan. More information on each of the four assessment criteria categories is described below.

Ecological and cultural impacts

Description of the criteria

The ecological and cultural impacts assessment criteria are designed to ensure that flood connectivity to ecological and cultural assets is considered when determining a flood work approval. Criteria were also developed to ensure that areas of cultural heritage significance are not disturbed during construction of flood works.

In all management zones, a flood work must, in the minister's opinion:

- (a) maintain adequate flood connectivity to the following under a range of flood scenarios including, at a minimum, scenarios for the large design flood and small design flood:
 - (i) flood-dependent ecological assets,
 - (ii) facilitation of fish passage, and
- (b) maintain adequate flood connectivity to the following under a range of flood scenarios including, at a minimum, scenarios for the large design flood and small design flood:
 - (i) flood-dependent Aboriginal cultural values,
 - (ii) flood-dependent heritage sites, and
- (c) not be constructed or modified if the construction or modification is likely to disturb the ground surface of a heritage site or cause more than minimal erosion to a heritage site.

Why are ecological and cultural impacts considered?

The ecological and cultural impacts assessment criteria were developed to ensure that floodplain assets are specifically considered during the assessment of flood work applications. The management zones were designed at a strategic scale and may not always account for the complex network of flow paths at the property scale. Many of these smaller flow paths are important for maintaining the ecological or cultural character of flood-dependent ecological

assets, Aboriginal cultural values, heritage sites and for facilitating fish passage. This assessment criteria ensures that flood works will not block these critical flow paths.

The first two assessment criteria were in line with the requirements of the Narrabri to Wee Waa FMP 2005 and Part 8 of the *Water Act 1912*. For instance, the Narrabri to Wee Waa FMP 2005 considered wetland connectivity, floodplain flora and fauna, soil condition and structure, fish passage, groundwater recharge and cultural sites. For other areas assessed under Part 8, the matters for general consideration (166C) required regard of the need to maintain the natural flood regimes in wetlands and related ecosystems and the preservation of any habitat, animals (including fish) or plants that benefit from flooding; any geographical features, or other matters of Aboriginal interest that may be affected by a controlled work; and the protection of the environment.

TAG and agency experts determined that fish habitat on the floodplain is a significant asset that requires additional protection measures. Therefore, flood connectivity that facilitates fish passage are specifically dealt with in the assessment criteria. Regulatory structures and flow alteration have contributed to a significant decline in the abundance and distribution of native fish in the Murray–Darling Basin (Cadwallader 1978; Horwitz 1999; Thorncraft & Harris 2000; Humphries et al. 2002).

The potential for a flood work to disturb the ground surface of a heritage site or cause more than minimal erosion to a heritage site was also considered. Consultation with the ATWG and agency experts identified that some heritage sites are at risk from being impacted during the construction of a flood work or as a result of erosion from changes to flood behaviour caused by a flood work. If a flood work is proposed in the vicinity of such a site, the *National Parks and Wildlife Act 1974* will be triggered, and a due diligence assessment will be required to be undertaken to ensure the sites are not impacted by the proposal.

How were the criteria determined?

The criteria were determined by considering current floodplain management arrangements and after discussions with the Fisheries NSW representative of the TAG and the ATWG. Equivalent assessment criteria are also included in the Gwydir Valley FMP 2016, Barwon–Darling Valley FMP 2017 and the Upper Namoi Valley FMP 2019.

How will the criteria be applied?

Ecological and cultural impacts assessment criteria will be assessed using spatial floodplain asset datasets and site observation data. State and federal heritage registers will also be checked to identify any heritage sites within the local area of a flood work application. Flow paths across a range of flood scenarios may be considered to ensure flood connectivity is maintained to ecological and cultural assets.

There may be instances where the flood work proposal triggers the need for the applicant or the assessing officer to seek advice, permits or to notify external agencies of a flood work application. Referrals will be an integral part of meeting these assessment criteria due to the overlap of the assessment requirements of the WM Act and other legislation relevant to flood work approvals, including the *Environmental Planning and Assessment Act 1979*, the *Fisheries Management Act 1994*, the *National Parks and Wildlife Act 1974* and the *Biodiversity Conservation Act 2016*.

Referrals will improve the assessment of flood work applications against the assessment criteria by strengthening links with other agencies or groups that have a responsibility or function to contribute to the assessment of the impacts under related legislation.

In some cases, additional detailed ecological and cultural assessments may be required to support a flood work application.

If an application is required to be supported by a flood study, there will be specific requirements that the applicant (or consultant on behalf of the applicant) will be required to address to

demonstrate that flood connectivity is adequately maintained to flood-dependent ecological and cultural assets.

Social (drainage) impacts

Description of the criterion

In all management zones, a flood work must, in the minister's opinion, maintain adequate drainage on landholdings (including adjacent landholdings) that may be affected by the proposed flood work.

The drainage impacts assessment criterion was designed to ensure that local drainage on neighbouring properties is maintained.

Why are drainage impacts considered?

Drainage impacts are considered because the management zones were designed on a strategic scale that may not account for a flood work impacting on local drainage in such a way as to cause a significant disruption to the daily life of surrounding landholders. For instance, changes to local drainage may cause considerable local issues, nuisance or conflict, or property access may be disrupted.

Local drainage and drainage time were a consideration in the Narrabri to Wee Waa FMP 2005 and was a matter for consideration under Part 8 of the *Water Act 1912*.

How was the criterion determined?

The criterion was determined by considering previous floodplain management arrangements. There are also equivalent assessment criteria in the Gwydir Valley FMP 2016, the Barwon–Darling Valley FMP 2017 and the Upper Namoi Valley FMP 2019.

How will the criterion be applied?

The flood work applicant will need to demonstrate that flood water will not remain in the local area for an excessively long time compared to existing floodplain conditions. Consideration will also need to be given to avoiding peak travel time being unduly accelerated to downstream users.

Assessment of this criterion will involve giving key consideration to pondage times, peak travel time downstream and soil types that may influence permeability (that is potential waterlogging of land). A range of spatial datasets will be used to assist with this assessment, including contours, slope, soils information as well as site observation data.

If a flood study is available, information from the study will be used during the assessment. Assessment will also consider additional data such as floodplain asset datasets to ensure that changes to drainage do not have a significant effect on flood connectivity to sensitive wetland areas. Local topography will be considered to minimise the likelihood of new flood works changing local drainage lines in a disruptive manner. Local flooding patterns across a range of floods may also be considered, including the small and large design floods.

Local hydraulic impacts

Description of the criteria

The local hydraulic impacts assessment criteria were designed to ensure that within the local area, a flood work application has a minimal impact (thresholds apply) on:

- redistribution of peak flood flow
- flood levels
- flow velocity.

The 'local' area is generally defined as the adjacent landholding and other landholdings that may be affected by the proposed flood work.

The use of the assessment criteria to assess applications for minor works (that is those that do not require advertising) in Management Zone B is discretionary. The use of the assessment criteria to assess applications for all types of flood works in Management Zones C and CU is also discretionary. For flood work applications that require advertising in Management Zone B, the assessment criteria are mandatory.

In Management Zone B, applications for flood works that require advertising (that is are not minor) must not, in the minister's opinion, be likely to:

- (a) redistribute the peak flood flow by greater than 5% on adjacent landholdings and other landholdings that may be affected by the proposed flood work when compared to the peak flood flow under existing development conditions for a range of flood scenarios including, at a minimum, a scenario for the large design flood, or
- (b) increase flood levels by greater than 20 cm on adjacent landholdings and other landholdings that may be affected by the proposed flood work when compared to flood levels under pre-development and existing development conditions for a range of flood scenarios, including at a minimum, a scenario for the relevant large design flood, or
- (c) increase flow velocity by more than 50% on the landholding, adjacent landholdings and other landholdings that may be affected by the proposed flood work when compared to flow velocity under pre-development and existing development conditions for a range of flood scenarios, including at a minimum, a scenario for the relevant large design flood, unless:
 - (i) increases greater than 50% are in isolated areas on the landholding and the landholder mitigates the impact of the flood wave so that the average impact across the landholding does not exceed 50%, and
 - (ii) increases in flow velocity do not exceed 50% at the boundary of the landholding, or
- (d) increase flood levels resulting in impacts on high-value infrastructure when compared to flood levels under pre-development and existing development conditions for a range of flood scenarios, including at a minimum, a scenario for the relevant large design flood, or
- (e) increase flow velocity by an amount that, in the minister's opinion, is likely to have more than a minimal impact on soil erodibility on the landholding, adjacent landholdings and other landholdings that may be affected by the proposed flood work, taking into account the ground cover on those landholdings.

Note. *Pre-development conditions* and *existing development conditions* are defined in the plan Dictionary.

In Management Zones C and CU, the minister may require flood work applications to demonstrate that they adhere to the hydraulic assessment criteria described above for Management Zone B. The flood scenarios used to assess these applications are not prescriptive and may be determined by the minister.

Why are local hydraulic impacts considered?

Local hydraulic impacts assessment criteria were developed to ensure that flood work applications do not significantly change key hydraulic parameters in the local area and in some instances, on the landholding under application. To best assess impacts on local flood behaviour, each relevant flood work application must be assessed on a case-by-case basis. This assessment will reduce the likelihood that flood works will impact on flood behaviour, including the potential to redistribute peak flood flows, increase the flood risk and inundation extents by raising flood levels, and increase the potential for erosion and siltation by increasing flood flow velocities.

How were the criteria determined?

The criteria were determined by considering the Narrabri to Wee Waa FMP 2005 to limit the impact of future development on flood behaviour. Equivalent assessment criteria are also included in the Gwydir Valley FMP 2016, the Barwon–Darling Valley FMP 2017 and the Upper Namoi Valley FMP 2019.

How will the criteria be assessed?

Assessment against the hydraulic local impacts criteria will occur when an application is required to be supported by a flood study. In most cases, a flood study will be required to report on and be supported by hydraulic modelling. A flood study will only be accepted if the assessing officer considers that it meets appropriate reporting requirements, document standards and technical standards for hydraulic modelling. The results of the flood study must clearly demonstrate that the thresholds for the hydraulic local impacts assessment criteria are not exceeded.

Typically, the criteria will be assessed by comparing key modelled hydraulic parameters (flood flow distribution, flood levels and flow velocity) for proposed development conditions against flood study results for pre-development and/or existing development conditions, under relevant flood scenarios (such as the large design flood). Incremental changes brought by the various stages of floodplain development over time (as represented by the various modelled floodplain conditions) will need to be reported in the flood study for subsequent consideration in any final assessment of whether nominated criteria thresholds are exceeded.

For the purposes of assessing a flood work application, the following definitions apply:

- pre-development conditions—refers to natural flooding regimes and is derived from running a model of the floodplain without flood work development on the landholding under application
- existing development conditions—refers to the level of development at the commencement of the plan
- proposed development conditions—derived from running a model with the floodplain, the existing development conditions and the proposed flood work.

In regard to assessing flow velocity impacts, soil erodibility will be assessed by ensuring that maximum permissible velocities relevant to the Lower Namoi Valley Floodplain are not exceeded. This assessment criterion provides flexibility to consider ground cover when assessing the potential impact of a flood work on soil erodibility. It is likely that soil types will be a consideration—for instance, maximum permissible velocities may be relaxed for applicants who can prove that the soil type is not highly erodible.

Cumulative hydraulic impacts

Description of the criteria

Cumulative hydraulic impact assessment criteria differ between the management zones. MZ AD and MZ D share the same criteria and MZ B, MZ C and MZ CU have similar assessment criteria relating to cumulative hydraulic impacts.

In MZ AD (including inside required flood flow corridors) and MZ D, the minister must consider the cumulative effect that the proposed flood work and other existing works on the landholding may have on adjacent landholdings, other landholdings that may be affected by the flood work and the floodplain environment. No specific thresholds apply. All flood works in MZ AD and MZ D must be assessed against this criterion.

When considering the cumulative impacts of a proposal on the floodplain environment, consideration will be given to those impacts that are likely to combine with each other or with impacts of other activities to produce a beneficial or adverse effect. Impacts should be considered in terms of:

- the relationship of the activity to other proposals or developments in the area
- synergistic effects of individual developments when considered in combination
- any known environmental stresses in the affected area and the likely contribution of the proposed activity to increasing or decreasing those stresses.

In MZ B, MZ C and MZ CU, the intent of the cumulative hydraulic impact assessment criteria is to limit the redistribution of flood flows across the floodplain to acceptable thresholds. Flood flow distributions are quantified at given peak discharge calculation locations (see Appendix 17 or the *Peak Flood Flow Distribution (1971) Map* in the plan).

The use of this assessment criteria to assess applications for minor works (that is those that do not require advertising) in MZ B is discretionary. For flood work applications that require advertising in MZ B, these criteria are mandatory. Flood work applications assessed against these criteria will be done so by comparing to redistribution under existing development conditions to proposed conditions.

The use of these criteria to assess applications for all types of flood works in MZ C and CU is discretionary. If required by the minister, a flood work application in MZ C or CU must also be assessed against this criterion, which will typically be using floods larger than the design flood such as the 1% AEP flood.

Peak flood flow distribution was selected to measure cumulative impacts because distribution of flood waters is an important flood parameter and any significant changes to distribution may signify changes to other flood parameters such as velocity and depth.

Why are cumulative hydraulic impacts considered?

Current estimates are that the area protected by flood works (hereafter referred to as developed areas) makes up approximately 20% of the Lower Namoi Valley Floodplain (step 2). Typically, the developed areas are protected by levees, which will only overtop in extreme floods and so are likely to impact on flooding behaviour in small and large floods.

The hydraulic models developed as part of step 4 were used to estimate the redistribution of floodwater that may have occurred due to the current level of development. Existing flood work development has been found to have altered the flow distribution between major branches of the proposed Lower Namoi Valley Floodplain.

Further redistribution may have consequences from socio-economic, hydraulic, ecological and cultural perspectives. Therefore, the cumulative impact of current and future works must be assessed to ensure that the current flood flow distribution is maintained.

How were the thresholds for the criteria determined?

The thresholds for the hydraulic cumulative impacts have been determined by comparing the modelling results from the current floodplain conditions with a pre-development modelling scenario, where all flood works had been removed from the model bathymetry.

The two scenarios were compared at cross-sections at key locations within the floodplain. The basis for the assessment was the peak flood flow for the 1971 (4% AEP) large design flood event.

Some redistribution has likely occurred due to existing flood works, and that this redistribution is variable across the floodplain. However, limitations with representing the pre-development floodplain in the model preclude a quantitative analysis of the redistribution within the sub-floodplain areas. Therefore, a uniform threshold has been set across the entire floodplain.

How will the criteria be assessed?

Typically, assessment against hydraulic cumulative impacts assessment criteria will differ depending on if the application is required to be supported by a flood study or not.

Where a flood study is not required, the applicant must demonstrate that the proposed flood work has considered cumulative impacts of the proposal and other existing works by considering development in the surrounding area. Consideration may need to be given to if existing development is concentrated on one side of the floodplain or if there is any existing blockage to floodways or smaller flow paths important for flood connectivity to flood-dependent assets. It should be noted that the rules for MZ AD (including inside required flood flow corridors) and MZ D alleviate the potential for cumulative impacts in these zones.

Where a flood study is required, the applicant (or consultant on behalf of the applicant) will be required to report on changes to peak flood flow distribution at specific locations by comparing proposed development conditions against existing development conditions.

Existing flood works and structures

Rules to grant flood work approvals for existing unlicensed works or to modify existing flood work approvals were required in MZ AD and MZ D where the Lower Namoi Valley FMP restricts the types of permissible flood works.

The inclusion of these rules allows acceptance of applications for existing works that do not comply with the rules for MZ AD (including inside required flood flow corridors) or MZ D.

Rules for existing unlicensed flood works

The granting of a flood work approval for a flood work in MZ AD or MZ D that was constructed at any time before the commencement of the plan and does not comply with the rules for MZ AD or MZ D is only permitted if, in the minister's opinion, all of the following criteria are met:

- (a) the flood work is an access road, a stock refuge, an infrastructure protection work, a supply channel,
- (b) as at the date of application, the flood work is not the subject of a previously refused application, for any of the following:
 - (i) an approval for a controlled work under Part 8 of the *Water Act 1912*, or
 - (ii) a flood work approval under the *Water Management Act 2000*.
- (c) the flood work satisfies the assessment criteria for MZ AD and MZ D, including the completion of a cumulative impact assessment of the flood work.

Amending an existing flood work approval

The amending of a flood work approval for a flood work in MZ AD or MZ D that was constructed at any time before the commencement of the plan and does not comply with the rules for the relevant management zone is only permitted if, in the minister's opinion, all of the following criteria are met:

- (a) any proposed modification to the flood work will reduce the impact of the flood work on flow patterns (including distribution of flows, drainage, depth or velocity) in the relevant management zone
- (b) the flood work satisfies the assessment criteria for MZ AD and MZ D, including the completion of a cumulative impact assessment of the flood work.

Exemptions to flood work approvals

An approval is required to construct or use a flood work under section 91D(1) of the WM Act. However, flood works that satisfy the exemption criteria outlined in the Water Management (General) Regulation 2018 do not require an approval. Statewide exemptions are for works or types of works which are considered low-risk or are necessary for public safety, or which are more appropriately overseen by another government body such as a local council.

For further information on statewide exemptions, refer to the Water Management (General) Regulation 2018.

Step 9: Consider existing floodplain management arrangements

Consideration of existing floodplain management arrangements was integrated throughout the planning process as outlined in this document. Step 9 reports on how these arrangements were considered, including the occurrence of change between existing rural floodplain management arrangements and the new Lower Namoi Valley FMP 2020.

The existing (now previous) floodplain management arrangements are first described in step 3 and shown in Figure 7. As highlighted in Figure 7, of the Lower Namoi Valley Floodplain, approximately:

- 15% of the floodplain was previously managed under the Narrabri to Wee Waa FMP 2005 (now repealed)
- 15% of the floodplain was previously managed under the three floodplain guidelines
- 60% of the floodplain was previously designated as the Lower Namoi Valley Floodplain but was not managed by an FMP or guideline
- 10% of the floodplain was not part of a rural FMP, guideline or designated rural floodplain.

Change was seen across the floodplain boundary, management zones, rules and assessment criteria. The changes reflect improvements in understanding of the floodplain, improvements in the management of flood work development and a more consistent approach to floodplain management across the whole floodplain.

Floodplain boundary

The previous Lower Namoi Floodplain designated under section 166 Part 8 of the *Water Act 1912* on 18 September 1984 was the basis for the new Lower Namoi Valley Floodplain. Overall, the new floodplain has experienced a net loss of about 120,000 ha when compared to the previous floodplain (Figure 24). The rationale for change is detailed in step 1.

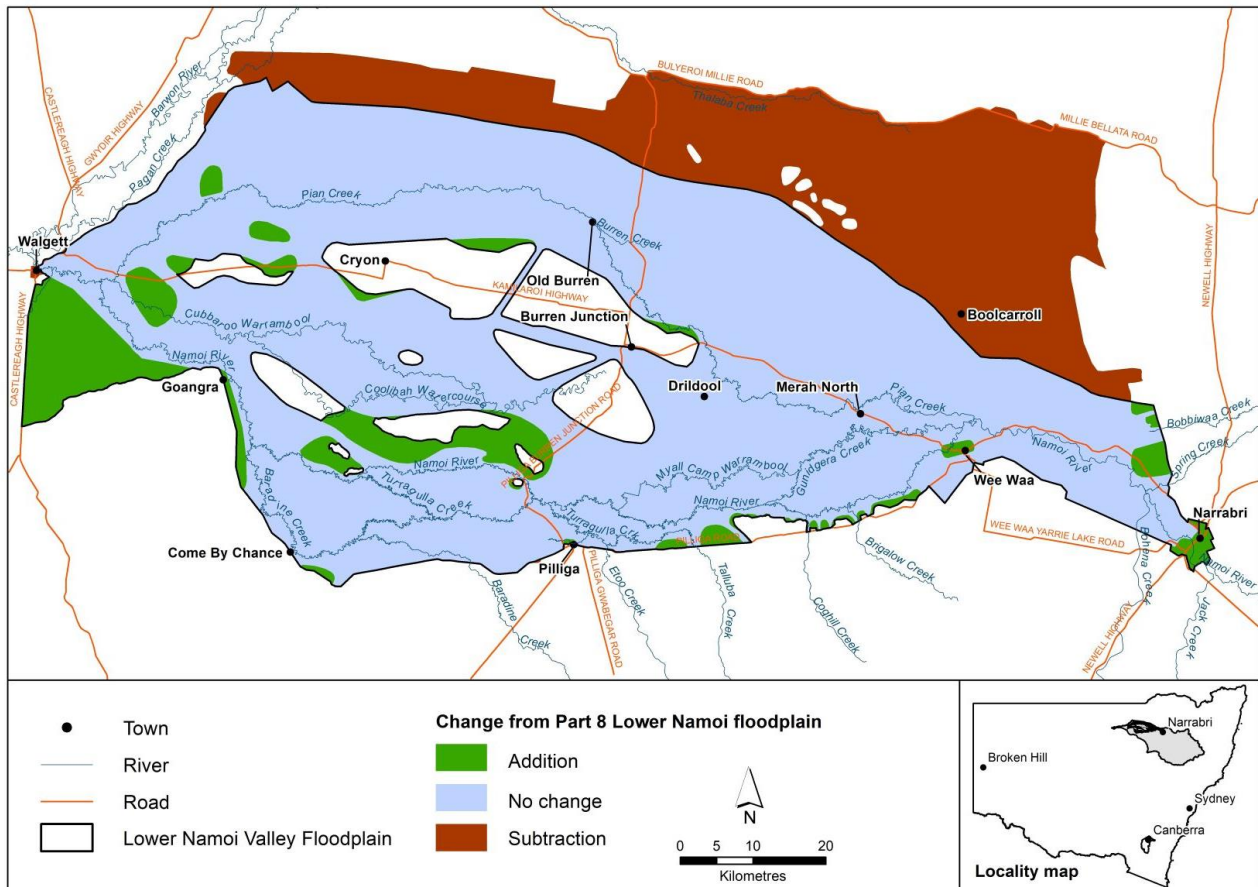


Figure 24. Change in the floodplain boundary when comparing the floodplain made under Part 8 of the *Water Act 1912* with the Lower Namoi Valley Floodplain made under the WM Act.

Management zones

The areas managed by the Narrabri to Wee Waa FMP 2005 and the three previous guidelines have mapped floodways. In these areas, the floodways were the basis for assessing applications to construct flood works and therefore function as a basic management zone. The remaining areas of the Lower Namoi Floodplain did not have mapped floodways.

The floodways were primarily based on hydraulic principles similar to the principles used to develop the floodway network in Step 4. In the Narrabri to Wee Waa FMP 2005 area, floodways were also mapped after consideration of areas of ecological and cultural significance.

As described in step 7, the Lower Namoi Valley Floodplain has six different management zones. The management zones in the Lower Namoi Valley FMP 2020 differ from existing floodplain management arrangements as a result of:

- the extension of the floodplain boundary to capture areas of major flooding
- a consistent floodplain management planning approach across the entire floodplain
- improved ecological and cultural data across a greater floodplain area
- strategic consideration of flood connectivity throughout the entire floodplain
- significantly more accurate hydraulic data (supported by new LiDAR) available from using the latest modelling techniques with new hydraulic models being developed and existing models being updated
- consideration of new rules and assessment criteria
- differences between approved flood works and floodways

- approach of mapping six management zones as opposed to individual hydraulic assessments being undertaken for each flood work application.

Rules and assessment criteria

Change has occurred between the rules in former floodplain management arrangements and the rules in the Lower Namoi Valley FMP 2020. These changes are described below.

Changes in flood flow corridors

Management Zone AD

The flexible flood flow corridor approach in Management Zone AD is a new rule and provides localised flexibility to flood work applicants in areas of the floodplain where the depth velocity product and threshold of $0.2\text{m}^2/\text{s}$ produces areas of Management Zone AD that are conservatively wide and may be considered unnecessarily restrictive.

The intent of this rule is to provide flexibility to landowners, allowing flood work applicants to reduce the width of Management Zone AD in localised areas (where the variation in width is justified by hydraulic modelling depth-velocity product results) while maintaining the hydraulic integrity of the floodway network and maintaining flood connectivity to flood-dependent ecological and cultural assets and facilitating fish passage.

There is no equivalent rule in the Narrabri to Wee Waa FMP 2005. Feedback received at public exhibition indicated that stakeholders require some flexibility in areas where the width of Management Zone AD may be conservatively wide.

Management Zone AID

When a flood work application is received in Management Zone AID, a flood flow corridor of a minimum of 80 m width must be identified through the section of Management Zone AID to which the application applies. The rules for Management Zone AD will apply inside the flood flow corridor and the rules for Management Zone B will apply in the remaining areas.

The precedent for Management Zone AID is mostly found in the Lower Coxs Creek FMP (OEH and NOW 2013), where floodways were flexible, and it was the practice for the assessing officer to ensure that floodways were congruent across property boundaries. This concept was applied in both the Upper Namoi Valley FMP 2019 and the Lower Namoi Valley FMP 2020. There is no equivalent rule in the Narrabri to Wee Waa FMP 2005. Feedback received at targeted consultation indicated that stakeholders require flexibility for the location of floodways in areas where there is less hydraulic certainty. For the Lower Namoi Valley FMP 2020, the threshold for hydraulic uncertainty was where the depth-velocity product was less than $0.05\text{m}^2/\text{s}$.

Change to permissible flood works

Under previous floodplain management arrangements, permissible flood works were restricted within the floodways of the Narrabri to Wee Waa FMP 2005. These restrictions were guidance only and not legal rules. In all other areas all types of flood works were permissible.

The Lower Namoi Valley FMP 2020 has restrictions on the types of permissible works in Management Zone AD and Management Zone D. This is generally consistent with the approach of the Narrabri to Wee Waa FMP 2005 to restrict the types of flood works permissible in areas where there is a high risk of the work affecting flood behaviour or the floodplain environment.

Permissible flood works in the floodways of the Narrabri to Wee Waa FMP 2005 included:

- access roads below 30 cm above ground
- supply channels at or below ground level.

Although generally consistent, the Lower Namoi Valley FMP 2020 has permissible flood works that differ from the Narrabri to Wee Waa FMP 2005. The change is outlined as follows:

When comparing authorised flood works in the floodways of the Narrabri to Wee Waa FMP 2005 to MZ AD:

- the allowable height for general access roads has been reduced from 30 cm to 15 cm (except primary access roads which has been increased to 50 cm)
- supply channels are authorised (no specific change, proposed work thresholds are specified)
- the following works that were not previously permissible are now permissible in Management Zone AD:
 - Aboriginal cultural value enhancement works
 - ecological enhancement works
 - heritage site enhancement works
 - infrastructure protection works
 - stock refuges.

When comparing permissible flood works in the floodways of the Narrabri to Wee Waa FMP 2005 to MZ D:

- access roads and supply channels are no longer proposed to be permissible
- the following flood works that were not previously permissible are now permissible in MZ D:
 - Aboriginal cultural value enhancement works
 - ecological enhancement works
 - heritage site enhancement works.

Generally, change has not occurred in Management Zones B, C or CU.

By limiting flood work applications to certain permissible works in Management Zone AD and Management Zone D of the Lower Namoi Valley FMP 2020, landholders will save time and money by applying only for those works likely to be approved. This also reduces the chances of inconsistency in discretionary approvals.

Changes to advertising requirements

Advertising flood works gives interested parties the opportunity to comment on a flood work application and for that comment to be considered during the assessment. The intention of the rules is for flood works not to be advertised if they are:

- minor in nature
- in an area of the floodplain where the potential for the flood work to impact on flood behaviour is minimal.

Under previous floodplain management arrangements, advertising was required in parts of the floodplain where there was not sufficient information to determine if a work would have more than minimal impact on flood behaviour. That is, all areas previously designated as the Lower Namoi Floodplain but not managed by the Narrabri to Wee Waa FMP 2005.

In the Narrabri to Wee Waa FMP 2005⁹, where there was sufficient information, advertising was required for works:

- in the floodways
- outside the floodways that trigger any issues in regard to the adopted assessment criteria.

When comparing the Lower Namoi Valley FMP 2020 to the Narrabri to Wee Waa FMP 2005, the changes to the advertising requirements reflect the new suite of management zones and the

⁹ The terminology in the Narrabri to Wee Waa FMP 2005 was that works that required advertising were 'non-complying works'.

changes made to permissible flood works. Previously works in floodways required advertising. Now, flood work applications for proposed flood works in Management Zone AD (including identified flood flow corridors) and Management Zone D do not require advertising (except where specified by the transitional provision). This is because only minor types of works are permissible in these zones.

Similarly, where flood works outside the floodways that trigger assessment criteria require advertising, minor works in Management Zone B will not require advertising. This change aims to give greater clarity around which works need advertising and to better ensure that any flood work with more than minimal potential to impact on flood behaviour is advertised.

All flood works in Management Zone C and Management Zone CU do not require advertising. This is consistent with the advertising requirements of the Narrabri to Wee Waa FMP 2005 as it is unlikely such works will impact on flood behaviour.

Previously, flood works did not require advertising in the parts of the Lower Namoi Valley Floodplain that were not part of a current rural FMP, guideline or designated rural floodplain.

Changes in assessment criteria

Under previous floodplain management arrangements, there were no assessment criteria for flood work applications in areas outside of the Narrabri to Wee Waa FMP 2005. However, assessment staff were required to consider the WM Act and in practice a set of floodplain management principles taken from other existing FMPs were applied when considering applications:

- defined floodways must possess adequate hydraulic capacity and continuity to enable the orderly passage of floodwaters through the floodplain
- any system of defined floodways should conform as closely as is reasonable to the natural drainage pattern after taking into account the existing floodplain development
- floodway areas should be equitably allocated (between adjacent landholders) consistently with natural/historical flow paths
- environmental issues related to the FMP need to be identified and investigated including developing strategies for flood-dependent ecosystems such as wetlands, riparian vegetation, and any other environmentally sensitive areas
- the exit of floodwaters from defined floodways should be at rates and depths similar to those that would have been experienced under natural/historical conditions and should discharge as close as practicable to the location of natural/historical floodways
- sufficient pondage must be retained on the developed floodplain so that the flood peak travel time is not unduly accelerated to downstream users or its height increased
- velocities of flood flow in defined floodways should be minimised and be of an order which would not cause erosion or increased siltation under various land uses
- there should be no detrimental impact from floodplain development on any individual landholder or community infrastructure including increases in peak flood levels and increased drainage times
- floodplain development should not cause significant redistribution of floodwater
- socio-economic issues relating to floodplain management need to be identified and investigated. This includes considering both tangible damages (can be readily measured in monetary terms) and intangible damages (includes increased levels of emotional stress, physical illness and disruption to daily life).

In the Narrabri to Wee Waa FMP 2005, flood works that were proposed to be located within floodways were assessed as non-complying works. Non-complying works required a detailed investigation of the hydraulic, environmental, social and economic impacts of the proposal. The cumulative impact of these proposals on flood characteristics was also required to be

comprehensively addressed. In many cases applications for non-complying works were refused or required the modification or removal of works.

Flood works outside of the Narrabri to Wee Waa FMP 2005 floodway network were assessed as complying if they did not trigger any issues regarding the adopted assessment criteria. The landholder was required to provide the necessary supporting information to demonstrate the application was a complying work.

The assessment criteria in the Narrabri to Wee Waa FMP 2005 are summarised in Table 19.

Table 19. Summary of the types of assessment criteria in previous FMPs considered in the Lower Namoi Valley FMP 2020

Historical criteria	Socio-economic criteria	Ecological criteria	Flooding criteria
<ul style="list-style-type: none"> Old guidelines Concerns and objections 	<ul style="list-style-type: none"> Disruption to daily life Health impact Cost of the works Infrastructure damage Equity 	<ul style="list-style-type: none"> Wetland connectivity Floodplain flora and fauna Soil condition and structure Fish passage Cultural sites Groundwater recharge 	<ul style="list-style-type: none"> Natural flooding characteristics Hydraulic capacity Pondage and flow duration Redistribution Flow velocities Works in floodways

The intention of many of the assessment criteria within the Narrabri to Wee Waa FMP 2005 and the (now repealed) Part 8 of the *Water Act 1912* (166 C Matters for general consideration) have been captured in the Lower Namoi Valley FMP 2020. However, changes have been made to ensure the assessment criteria are:

- within the scope of the WM Act (that is the cost of works is now a consideration of the landholder, not the assessing officer)
- able to be assessed in a quantitative rather than qualitative way, wherever possible
- as consistent as possible with other rural valley FMPs that have commenced such as for the Gwydir Valley, Upper Namoi Valley and Barwon–Darling Valley Floodplains
- relevant for each proposed management zone rather than be applied across the whole floodplain.

The thresholds for the proposed local hydraulic impacts assessment criteria are similar to those in the Narrabri to Wee Waa FMP 2005. They are also consistent with the assessment criteria in the Upper Namoi Valley FMP 2019 (Table 20).

Table 20. Comparison of hydraulic assessment criteria with the previous FMP and the adjacent Upper Namoi Valley FMP 2019

Local hydraulic assessment criteria	Lower Namoi Valley FMP 2020	Narrabri to Wee Waa FMP 2005	Upper Namoi Valley FMP 2019
Redistribution	5%	2%–5%	5%
Flood levels—General	20 cm	10cm–20 cm	20 cm
Flood levels—High-value infrastructure	No impact	No impact	No impact
Velocity—General	50%	50%	50%
Velocity—Soil erodibility	Y	Y	Y

Y= considered

In the Narrabri to Wee Waa FMP 2005, cumulative hydraulic impacts were indirectly considered in previous studies. In all the other areas, there was not an equivalent policy. The cumulative

hydraulic impacts assessment criteria are a change because it is a new rule. It was referenced originally from the Gwydir Valley FMP 2016. It is expected that existing flood work developments have altered the flow distribution between major branches of the Lower Namoi Valley Floodplain. Further redistribution may have consequences from socio-economic, hydraulic, ecological and cultural perspectives. Therefore, the cumulative impact of current and future works is required to be assessed to ensure that the current flood flow distribution is maintained. Management Zone AD (including identified flood flow corridors) and Management Zone D also require that the potential cumulative effect of the proposed flood work and other flood works be considered; however, the approach is a qualitative assessment.

Existing flood works and structures

The Lower Namoi Valley FMP 2020 includes rules which enable the Minister to accept applications for a limited range of existing *unapproved flood works* (specifically access roads, infrastructure protection works, stock refuges or supply channels) that do not comply with the rules for Management Zone AD (including identified flood flow corridors) or Management Zone D. For an approval to be granted these existing works must satisfy the assessment criteria for the relevant management zone.

For *approved flood works* that do not comply with the rules of Management Zone AD (including identified flood flow corridors) and Management Zone D, the plan allows for the amendment of these works so long as the modification will reduce their impact on flow patterns. Under previous floodplain management arrangements, the modification of such works that would result in an increased impact would unlikely have been approved, so this is not likely to represent any change from the previous arrangements.

Step 10: Assess socio-economic impacts

Step 10 presents the socio-economic impact assessment of the Lower Namoi Valley FMP 2020. It sets out the two-phase methodology applied and briefly describes the base case (floodplain without reform) and the FMP construct. This is followed by a comparison of rules for the base case and the FMP, a description of the impacted area, and an estimation of the negative socio-economic impacts of the plan.

Purpose

The objective of this assessment is to calculate the negative effects from the implementation of the Lower Namoi Valley FMP 2020. These costs are expressed in 2011 dollars as well as a proportion of total agricultural revenue for the Lower Namoi Valley Floodplain, the gross value of agricultural production (GVAP). The use of 2011 dollars is applied across all of the analysis and is consistent with data from the ABS Agricultural Census (2011).

There are significant benefits from the implementation of the Lower Namoi Valley FMP 2020. Some of the benefit categories include minimising impacts of flooding due to constructed flood works; reduced erosion and reduced sediment deposition; and the protection of ecological and cultural assets. Benefit value types include use, existence and bequest values. The benefits of the proposed FMP are expected to outweigh the negative impacts and calculation of the benefits is beyond the scope of a socio-economic impact assessment. Because the benefits of the FMP will not be enumerated, this is not a cost-benefit analysis.

Methodology

Phase 1 is a preliminary assessment undertaken before public exhibition of the plan and the results are presented below. The assessment compared the proposed rules against a base case with the intent of identifying the effects that a change in management practises may have on communities throughout the floodplain. The impacts are considered for their extent, likelihood, intensity and timing in an initial assessment, and if shown to be significant are assessed in more detail.

Phase 2 is a more detailed analysis that is undertaken if the preliminary assessment indicates the impact is significant or if major concerns are raised during public exhibition of the proposed FMP.

During phase 2, the detailed analysis of any significant impact is undertaken by:

- clearly stating the key assumptions underlying the proposed analysis
- considering the key quality assurance principles in defining the analysis
- identifying an appropriate method of analysis and the tools and techniques to be utilised
- identifying appropriate sources of data to collect.

The assessment approach is based on the Socio-economic Assessment Guidelines for River, Groundwater and Water Management Committees prepared by the Independent Advisory Committee for Socio Economic Assessment (IACSEA 1998). This approach has been and is being applied to the development and remake of water sharing plans in NSW. Further details are available in the *Rural Floodplain Management Plans: Technical Manual for plans developed under the Water Management Act 2000*.

Phase 1: preliminary assessment

The base case

The base case is the socio-economic condition of the floodplain had the Lower Namoi Valley FMP 2020 not been prepared. In the base case, the following assumptions are made over the next ten years (the period of the Lower Namoi Valley FMP 2020):

1. flood work approvals will continue under the relevant provisions of the WM Act
2. a greater area of floodplain will be covered by new FMPs in due course
3. Floodplain Guidelines¹⁰ may be revised or upgraded to an FMP as better data and modelling become available
4. more emphasis will be put on environmental issues associated with flood work approvals as the community increases their general awareness of such issues
5. flood works will continue to be approved in areas outside of the floodway networks identified in FMPs and guidelines
6. the approval rate of flood works within the floodway networks identified in FMPs and guidelines will decline as cumulative impacts approach acceptable limits.

Under the base case, applications for flood work approvals or amendments were assessed under the relevant provisions of the WM Act. The Lower Namoi Valley Floodplain was also previously managed through a combination of three first-generation, non-statutory guidelines and one second-generation statutory FMP (see step 3 for further detail). A brief summary of the rules under the base case compared to the rules in the Lower Namoi Valley FMP 2020 are presented in Table 21.

Lower Namoi Valley FMP 2020

The Lower Namoi Valley FMP 2020 is a third-generation plan and builds upon previous plans by incorporating the latest modelling techniques, as well as extending the coverage of the FMP to the entire floodplain. In preparing the Lower Namoi Valley FMP 2020, new hydraulic models were developed, and existing models updated. The outputs from these models together with inputs from several other sources were used to develop detailed floodway network maps and management zone maps in the floodplain (see step 4 for further detail).

The updated floodway network is largely similar to those floodways identified by first- and second-generation FMPs/Guidelines. The Lower Namoi Valley FMP 2020 identifies a floodway network that is located in areas where any application for flood works under previous management arrangements would be unlikely to be approved.

The Lower Namoi Valley FMP 2020 identifies six management zones (see step 7 for further detail):

- *Management Zone AD—major discharge areas, defined floodways
- *Management Zone AID—major discharge areas, ill-defined floodways¹¹
- Management Zone B—flood storage and secondary flood discharge
- Management Zone C—flood fringe and flood protected areas.
- Management Zone CU—the urban area zone

¹⁰ These guidelines are indicative and while being informative, do not carry any legal status. They form a starting point that discourages absurd applications but allows some room for the landholder and the department to negotiate a compromise position in the face of uncertain modelling.

¹¹ Management Zone A ill-defined is a management zone where the floodway is not clearly defined. Applications for flood works in these areas will be assessed on case-by-case basis and the flood flow corridor clearly identified. Subsequent to this the flood work will either fall under Management Zone AD or Management Zone B rules. Land covered in Management Zone A ill-defined were previously managed and identified by their hydraulic criteria and would therefore have been subject to similar rules to Management Zone AD.

- Management Zone D—special protection zone.

*The assessment is conservative and considers the whole of Management Zone AID under the same rules as Zone AD (the combination of Management Zone AID and Management Zone AD is referred to as Management Zone A throughout the assessment)

Each management zone has specific rules for granting or amending flood work approvals (see step 8 for further detail). The combination of the management zones and their rules may cause a reduction in land use options for the landholder, change the risk of inundation, and/or change access to floodwater afforded to flood dependant vegetation communities.

Table 21. Summary of rule changes between the Base Case and the Lower Namoi Valley FMP 2020

Base case	Lower Namoi Valley FMP 2020
<p>Floodways</p> <p>In managed areas (Narrabri to Wee Waa FMP 2005), flood works are not prohibited. However, it is unlikely that they will be approved due to the need to maintain natural flooding patterns to these areas for hydraulic and/or environmental requirements. All applications will be considered under existing FMP assessment criteria.</p> <p>All applications are deemed to be non-complying, require advertising and any objections are to be considered before possible approval.</p> <p>Major Flood work applications are unlikely to be approved in floodways.</p> <p>In other areas, in an identified floodway in a Guideline area or a suspected unidentified floodway in a non-guideline area, the applicant is required to provide a floodplain engineers report identifying any flood work impact on flood flow behaviour and ensuring that the floodway is maintained to effectively convey flood flows.</p> <p>All applications require advertising and any objections are to be considered before possible approval.</p> <p>Major Flood work applications are unlikely to be approved in floodways.</p>	<p>MZ AD (including identified flood flow corridors in MZ AID) provides for flood work approvals by application that is one of the following:</p> <ul style="list-style-type: none"> • Aboriginal cultural value enhancement works • access road up to 15 cm • primary access road up to 50 cm • ecological enhancement work • heritage site enhancement work • infrastructure protection work • stock refuge • supply channel • existing works—licensed and unlicensed. <p>Applications do not require advertising.</p> <p>MZ D provides for a prohibition of flood work approvals except for:</p> <ul style="list-style-type: none"> • Aboriginal cultural value enhancement work • ecological enhancement work • heritage site enhancement work • existing works—licensed and unlicensed. <p>Applications do not require advertising.</p>

Base case	Lower Namoi Valley FMP 2020
<p>Outside floodways</p> <p>In managed areas (Narrabri to Wee Waa FMP 2005), the applicant is required to provide supporting evidence (typically a floodplain engineers report) identifying that the flood work complies with the existing FMP assessment criteria.</p> <p>All applications are deemed to be complying applications and do not require advertising unless they trigger the assessment criteria. Non-complying applications do require advertising and objections are to be considered before possible approval.</p> <p>In other areas, the applicant is required to provide a floodplain engineers report identifying any flood work impacts on flood flow behaviour.</p> <p>All applications are deemed to be non-complying and require advertising and objections are to be considered before possible approval.</p>	<p>MZ B provides that flood work approvals or modifications by application does not require advertising if it is one of the following:</p> <ul style="list-style-type: none"> • less than 40 cm in height • stock refuge • infrastructure protection works. <p>All other flood works require advertising.</p> <p>Statewide exemptions apply in this zone. See the department's website for the list of exemptions.</p> <p>MZ C provides for flood work approvals by application if they meet the assessment criteria.</p> <p>Applications do not require advertising.</p> <p>Statewide exemptions apply in this zone. See the department's website for the list of exemptions.</p> <p>MZ CU is urban area where flood management is generally provided by local government.</p>

Impact of rule changes in Narrabri to Wee Waa FMP 2005 area

The Narrabri to Wee Waa FMP 2005, prepared under Part 8 of the *Water Act 1912*, was the only second-generation FMP enacted within the Lower Namoi Valley Floodplain.

Management Zone A (defined and ill-defined floodways)

Management Zone A is defined by hydraulic as well as ecological and cultural criteria. The hydraulic criteria are used to determine areas of significant flood discharge (floodways) using the depth-velocity products generated by flood modelling. The ecological and cultural components of Management Zone A are referred to as ecological and cultural amendments.

Management Zone A—defined by hydraulic criteria

Generally, land within floodway networks defined by the hydraulic requirements within the existing Narrabri to Wee Waa FMP 2005 area fall into Management Zone A in the Lower Namoi Valley FMP 2020. Most of the provisions in the Narrabri to Wee Waa FMP 2005 for floodways were largely similar to the provisions of the Lower Namoi Valley FMP 2020 Management Zone A. Despite this, there are three areas where landholders may be negatively affected:

- access roads—the allowable height for general access roads has been reduced from 30 cm to 15 cm. However, the height for *primary access roads* has been increased to 50 cm.
- stock refuges—there was no equivalent rule in the Narrabri to Wee Waa FMP 2005
- infrastructure protection works (IPW)—there was no equivalent rule in the Narrabri to Wee Waa FMP 2005.

Factors that may minimise the impact of these changes, include:

- small areas involved in IPW works and close proximity of alternative sites outside Management Zone AD
- conditions required by a controlled activity approval (required within 40 m of a water body) under the WM Act.

Overall, it is unlikely that works more substantial than those permissible in Management Zone A would have been approved under the base case. Therefore, it is expected that flood work

approvals in this area are not likely to be substantially negatively affected by the Lower Namoi Valley FMP 2020.

Management Zone A—defined by ecological and cultural criteria

Land included as ecological or cultural amendments will be subject to significant change under the proposed Lower Namoi Valley FMP 2020. Under the base case it is likely that flood work proposals in these areas would have been assessed in general accordance with the rules in the adjacent zone, sometimes Management Zone B and other times Management Zone A. However, these areas are now subject to Management Zone A rules. These are expected to impose costs on landholders due to lost option value on this land compared with the base case.

Flood work approvals in these areas are assessed to be significantly negatively affected by the Lower Namoi FMP 2020. However, this assessment is likely to be conservative as all works were assumed to have previously been considered against Management Zone B rules when in reality some were as Management Zone A.

Management Zone B

Management Zone B is floodplain land outside Management Zone D and Management Zone A that is defined as flood storage and/or secondary flood discharge under the modelled large design flood scenario. Management Zone B is important for preserving floodplain connectivity and providing significant pondage of flood water.

In Management Zone B, landholders must advertise applications to undertake flood works, with only limited exclusions to this rule (see Table 21 for Rule changes). Compared to the base case, the area of land with requirements that land users advertise applications for flood works has increased. However, a number of flood works have been excluded from the requirement to advertise and this reduces the need to advertise certain drainage-related flood works on land captured under the Narrabri to Wee Waa FMP 2005.

Overall, these changes will likely result in minor costs to landholders and government from costs associated with advertising and addressing objections. The area and number of applications within Management Zone B that will be impacted by this rule is unknown as it is not feasible to forecast exact numbers, the complexity of applications, or the time required to advertise, assess objections, negotiate modifications and consider approval or rejection. Considering the maturity of the irrigation water resources in the area, and that future expansion of the irrigation industry will depend on water use efficiency gains, the number of applications is expected to decrease but the complexity of applications is expected to increase. This cost has not been estimated in this assessment.

Impact of rule changes in guideline and other floodplain areas

There are three areas within the Lower Namoi Valley FMP 2020 area that previously only had first-generation floodplain guidelines for floodplain development. They are Gardens to Drildool, Merah North to Burren Junction and Boolcarrol to Bulyeroi. Flood work approvals in these areas and the remainder of the Lower Namoi Valley Floodplain would have been determined under the WM Act in the base case.

Management Zone A (defined and ill-defined floodways)

Management Zone A—defined by hydraulic criteria

Management Zone A includes land that under the base case would have likely been managed under a floodplain guideline as floodway area, a creek or a flood runner. In such areas it is highly unlikely that any works, other than those permitted in Management Zone A, would have been approved under the base case. Therefore, it is expected that flood work approvals in this area will not be substantially negatively affected by the Lower Namoi Valley FMP 2020.

Management Zone A—defined by ecological and cultural criteria

Land included in Management Zone A as ecological or cultural amendments will be subject to significant change under the Lower Namoi Valley FMP. Under the base case, it is likely that flood work proposals in these areas would have been assessed in general accordance with the rules in the adjacent zone, usually Management Zone B. The proposed change will therefore incur costs to landholders in the form of lost option value.

Management Zone B

Management Zone B is floodplain land outside Management Zone A and Management Zone D that modelling shows will be inundated by the modelled large design flood. Flood works below certain size limits do not require advertising (see Table 21). This will provide additional benefits to landholders and government as all applications required advertising in the base case. Flood works in excess of the size limits in Management Zone B require advertising, which is the same requirement as the base case. Flood work applications in Management Zone B, which were non-complying and unlikely to be approved in the base case, are unlikely to be approved under the Lower Namoi Valley FMP 2020.

It is expected that flood work approvals in this category may be marginally positively affected by the Lower Namoi Valley FMP 2020.

Management Zone C

Areas above the modelled floods or, with approved flood protection works (that are not limited height) have been mapped as Management Zone C. Flood work applications in Management Zone C are required to meet assessment criteria but do not require advertising. It is expected that flood work approvals in this area will not be substantially negatively affected in the previous Narrabri to Wee Waa FMP area (detailed below) and will be positively affected in the former guideline and other areas by the Lower Namoi Valley FMP 2020.

Management Zone D

Management Zone D is a special protection zone. This zone includes areas of ecological or cultural significance, or both. The purpose of this zone in the Lower Namoi Valley FMP 2020 is to ensure that flood connectivity to significant assets are maintained and protected. All the assets included in this special protection zone are associated with water bodies. Ecological or cultural enhancement works, and existing flood works (unlicensed and licensed) are permissible in this zone.

Under the base case, it is highly unlikely that any application for flood works in these areas would have been approved. This is because of the need to maintain natural flooding patterns to these areas for hydraulic, cultural or environmental reasons. Any proposed work in a water body would also require a controlled activity approval under the WM Act. It is unlikely that such a controlled activity approval would be given in the base case.

It is expected that flood work approvals in this zone are not likely to substantially negatively affected by the Lower Namoi Valley FMP 2020.

Management Zone CU

This zone includes areas managed by local government. The hydraulic, ecological or cultural criteria are not applicable in these areas. It is expected that there will not be any substantially negative impacts in this area.

Summary of negative impacts

The following negative impacts were identified after consideration of the effect of change from the base case to the Lower Namoi Valley FMP 2020 (Table 22):

- reduction in flood work options on all land zoned as ecological or cultural amendments to Management Zone A
- increased costs associated with the requirement to advertise flood work applications in Management Zone B in the managed area (Narrabri to Wee Waa FMP 2005).

Table 22. Impacts of the Lower Namoi Valley FMP 2020

	A reduction in flood work options	Increased costs (advertising)
Total area (ha)	3,541	Unknown
Possible land use	Cropping	Cropping and grazing
Impact	Lost access to complying works other than: Aboriginal value enhancement works, access roads, ecological enhancement works, heritage site enhancement works, infrastructure protection works, stock refuge, supply channels and existing works.	Lost access to non-advertising of former complying applications other than minor works.
Stakeholder impacted	Landholder	Landholder
Quantifiable (\$)	Yes	No
Data sources	GIS—area; ABS—Wheat \$ GVAP	Unknown area and number of applications: not estimated
Scale: extent & intensity*	Plan: Negative, low	Plan: Positive, Low
Scale: extent & intensity*	Regional: Negative, low	Regional: Positive, low
Scale: extent & intensity*	Local: Negative, low	Local: Positive, low
Scale: extent & intensity*	Owner: Negative, medium	Owner: Negative, medium
Likelihood & duration*	Plan: Low, permanent	Plan: Low, permanent
Likelihood & duration*	Regional: Low, permanent	Regional: Low, permanent
Likelihood & duration*	Local: Low, permanent	Local: Low, permanent
Likelihood & duration*	Owner: Medium, permanent	Owner: Low, permanent

*Impact: assess each factor with the other three factors held constant. Magnitude: low, medium, high.

Impacted areas

Ecological and cultural amendments are part of Management Zone A because they are adjacent, in close proximity to or connect with the hydraulic floodway network and therefore connect ecological and/or cultural assets to flood waters. The total area of land defined as ecological or cultural amendments to Management Zone A is estimated to be 7,781 ha (or 1.5% of the total floodplain area) (Table 23).¹²

Of the impacted area, land suitable for regular cultivation is most likely to receive applications for flood works due to the value of protecting crops, which cannot be moved. In contrast, land for grazing is not assumed to receive applications for flood works as livestock can be protected by moving them to higher ground. Moving livestock is assumed to be a lower cost alternative to building flood works (for example stock refuges).

Of the land defined as ecological or cultural amendments to Management Zone AD, 3,541 ha (just less than half of the total) would otherwise have been suitable for regular cultivation (Figure 25). This assessment was based on Land Capability data.¹³ It is acknowledged that, depending

¹² The final estimates of ecological or cultural amendments to Management Zone A may vary marginally from those used in this report as the zone mapping continues to be refined.

¹³ Land capability mapping was developed for broad scale application and may not be applicable to small scale portions of the landscape. Land Capability classification was developed by the Soil Conservation Service that identifies the suitability of land for cultivation or grazing.

on the property size, affected areas may have a large impact on option value for individual landowners.

Table 23. Land capability of areas that are Management Zone AD (ecological and cultural)

Land capability	Area (ha)	Proportion of total area (%)
Other—unsuitable for agriculture and pastoral production	8	0.1
Suitable for grazing with no cultivation	2,687	34.5
Suitable for grazing with occasional cultivation	1,545	19.9
Suitable for regular cultivation	3,541	45.5
Total floodplain area	7,781	100

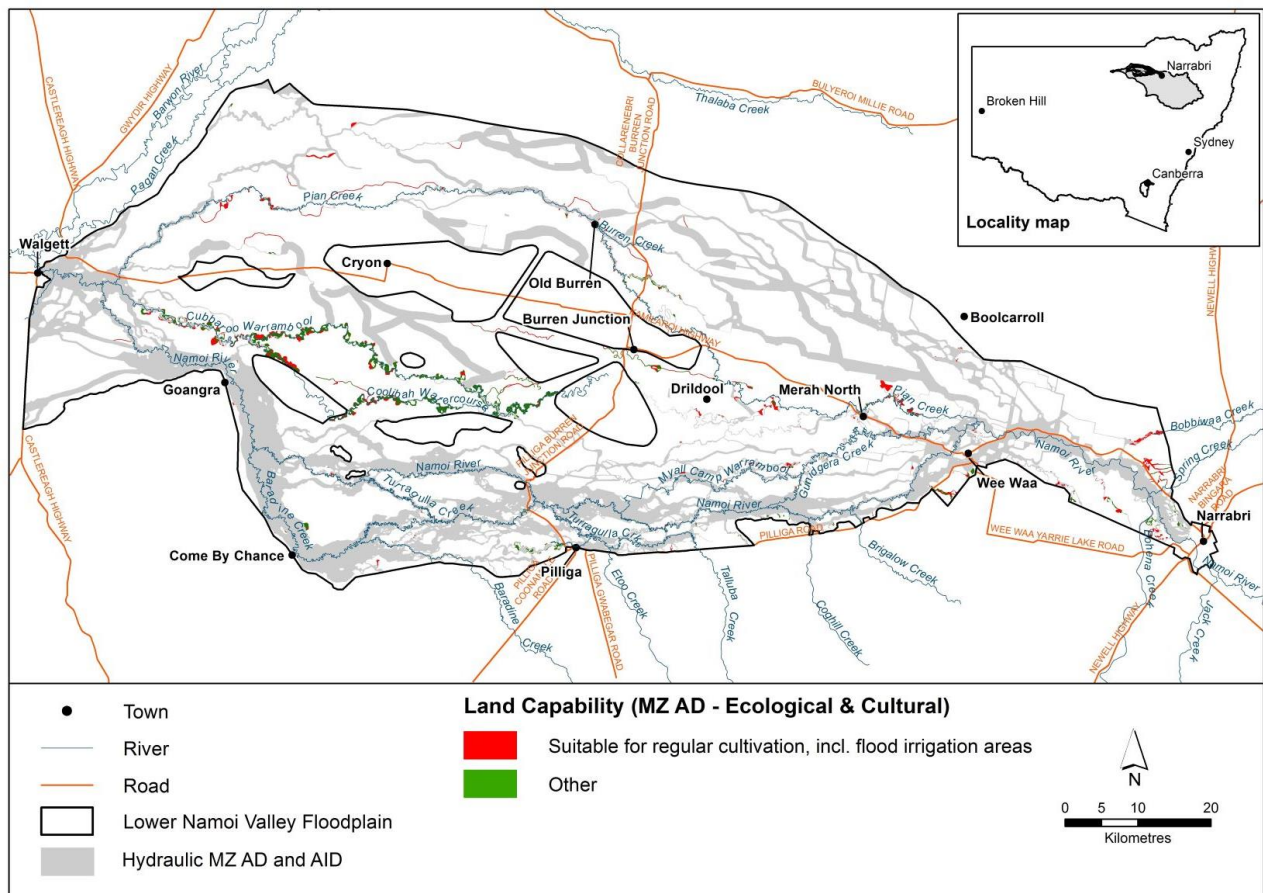


Figure 25. Land capability of areas zoned Management Zone AD (ecological and cultural criteria)

Impact on land use in ecological or cultural amendments to Management Zone A

Regulations for flood work approvals in Management Zone A apply to the construction of flood works and do not prevent cultivation or grazing of the land.¹⁴ For the central scenario it is assumed that if the FMP was not in place, all of the area defined as ecological and cultural amendments to Management Zone A, and with land capability suitable for regular cultivation would be cropped.¹⁵ This provides an upper estimate of the annual gross value of production

¹⁴ The development of these areas for cultivation may, otherwise, be limited by other legislation including the *Biodiversity Conservation Act 2016* and Controlled Activities under the *Water Management Act 2000*. Notwithstanding the *Biodiversity Conservation Act 2016*, it is expected that it would not be practical for a large proportion of this land to be developed for reliable cultivation.

¹⁵ In the absence of information on the proportion of the area that could practically be developed for reliable cultivation.

that might be lost (or foregone revenue) with the introduction of the Lower Namoi Valley FMP 2020.¹⁶

Estimated values of economic impacts

The economic impact of the Lower Namoi Valley FMP 2020 on land holders with land zoned as ecological or cultural amendments to Management Zone A is estimated as loss revenue. The assumptions used in the central scenario are intentionally conservative. While they may not be completely reflective of reality, they remain feasible and serve the purpose of clearly and fairly identifying negative socio-economic impacts.

Areas zoned as ecological or cultural amendments to Management Zone A are likely to be exposed to frequent flooding due to their proximity to watercourses. As flood works that protect crops cannot be constructed in Management Zone A, it is assumed that the outcome of these events is detrimental to crop production and causes total crop failure once every four years.¹⁷ To place this assumption into context, a small design flood that does not inundate the entire affected area occurs once every eight years.

This is a conservative assumption of the impact of flooding. This because it assumes flooding occurs more often than the small design flood, it inundates an area larger than the small flood and, because it does not consider the positive impacts of flooding. For landholders flooding can potentially improve soil fertility, improve sub-soil moisture and improve water storage levels.

To simplify the analysis and because it is unrelated to the change in management practices, it is assumed that other risks to crop production do not exist. In reality, crop yields and output are sensitive to a host of other risks such as pests and disease, extreme rainfall and temperature as well as changes in inputs.

Cropping in the Lower Namoi Valley Floodplain occurs in a wide variety of crop rotation sequences, with as many as ten varieties of summer and ten varieties of winter crops grown. The most widely recognised crop type and cropping sequence is continuous wheat production and therefore, the potential use of the area suitable for regular cultivation is assumed to be continuous wheat production. Since 2011, the crop mix may have changed. The sensitivity of the analysis to crop mix and other changes is tested later.

The potential revenue of land affected by the FMP with complete flood protection in the Lower Namoi Valley Floodplain is \$2.13 million per year (3,541 ha of land multiplied by the gross value of wheat per hectare of \$602)¹⁸. Without flood protection works, this land is estimated to produce \$1.60 million per year. This implies a potential cost of roughly \$550,000 per year on average in foregone revenue or \$150/ha. This equates to 0.46% of the total value of agricultural revenue in the entire Lower Namoi Valley FMP 2020 area (GVAP of \$116.7 million). While small in aggregate, the localised impact of the changes could be felt more intensely by individual land holders.

Sensitivity analysis

This analysis is sensitive to the assumed frequency of crop failure, the cropping area within the area of ecological or cultural amendments to Management Zone A and the impact on individual

¹⁶ The gross value of production is the value of an agricultural product measured when it leaves the agricultural sector. It is the farm gate value plus marketing costs.

¹⁷ Some of these flood events are beneficial to the crop or pasture and some are detrimental, depending on the timing (relative to crop and pasture growth cycle), depth, duration and speed of the floodwater.

¹⁸ The estimated gross value of 'wheat for grain' produced in the Lower Namoi Valley Floodplain was \$508 per hectare. These estimates were prepared as part of the socio-economic profile of the Upper and Lower Namoi floodplain area and are based on the most recent census data for 2011.

property owners. The sensitivity analysis was undertaken by varying one of the assumptions in the central scenario. The results from the analysis are summarised below:

- if crop failure from flooding increased to once every two years, the estimated impact would rise to \$1.06 million or 0.91% of the Lower Namoi Valley FMP 2020 GVAP
- if crop failure from flooding decreased to once every eight years, the estimated impact would be reduced to \$0.27 million or 0.23% of Lower Namoi Valley FMP 2020 GVAP
- if only the land suitable for regular cultivation that is flooded by the small design flood (1000 ha) was cropped, the estimated impact would be reduced to \$0.15 million, or 0.13% of Lower Namoi Valley FMP 2020 GVAP
- if the land used for grazing, based on ABARES land use data, is removed from the analysis and the cropping area affected is reduced to 1,341 ha, then the estimated impact would be reduced to \$0.20 million or 0.17% of the Lower Namoi Valley FMP 2020 GVAP
- if instead of wheat, a crop mix representative of the average crop mix in the floodplain is used, the estimated impact would rise to \$0.61 million or 0.52% of the Lower Namoi Valley FMP 2020 GVAP¹⁹. This average crop mix contains wheat (42.7%), other cereals (7.9%), cotton (9.7%), legumes (17.3%) and oilseeds (0.8%).

Further detail is provided below.

The loss due to the inability to construct flood works to protect crops from flooding is estimated to result from flood-related crop failure one in every four years. If the rate of crop failure due to flooding was to increase to one crop failure in two years, the estimated impact would rise to \$1.06 million or 0.91% of the Lower Namoi Valley FMP 2020 GVAP. Conversely, if the rate of additional crop failure due to flooding was to decrease to one crop failure in eight years, the estimated impact would be reduced to \$0.27 million or 0.23% of Lower Namoi Valley FMP 2020 GVAP.

A flood that occurs one in every eight years is consistent with modelling of a small design flood. Modelling data suggests that in the event of a small flood the area affected would be around 1,000 ha, opposed to the assumed 3,541 ha used in the central scenario. If the central scenario had assumed an area of land of 1,000 ha, the effects of the FMP are estimated to have been closer to \$0.15 million, or 0.13% of Lower Namoi Valley FMP 2020 GVAP.

The impact of the Lower Namoi Valley FMP 2020 will also depend on what the affected land could have been used for. Much of the 3,248 ha, earlier assumed in the analysis as holding potential for continuous wheat production, is currently used for grazing because it floods too often to be cropped reliably. In such cases, the farmers' assessment has been that the higher cost of cropping and the risk of loss are greater than the more reliable pasture grazing option of lower cost and smaller gain. If the area assumed to be used for cropping is reduced to 1,341 ha, based on ABARES land use data (Figure 26)²⁰ the estimated impact would be reduced to \$0.20 or 0.17% of Lower Namoi Valley FMP 2020 GVAP.

¹⁹ Using ABS data, a GVAP for the average crop mix across the Lower Namoi is calculated to be \$686 per hectare, \$84 per hectare larger than the all wheat assumption. The crop mix includes wheat (42.7%), other cereals (7.9%), cotton (9.7%), legumes (17.3%) and oilseeds (0.8%).

²⁰ ABARES land use data is for 2010–11 and was published in 2016.

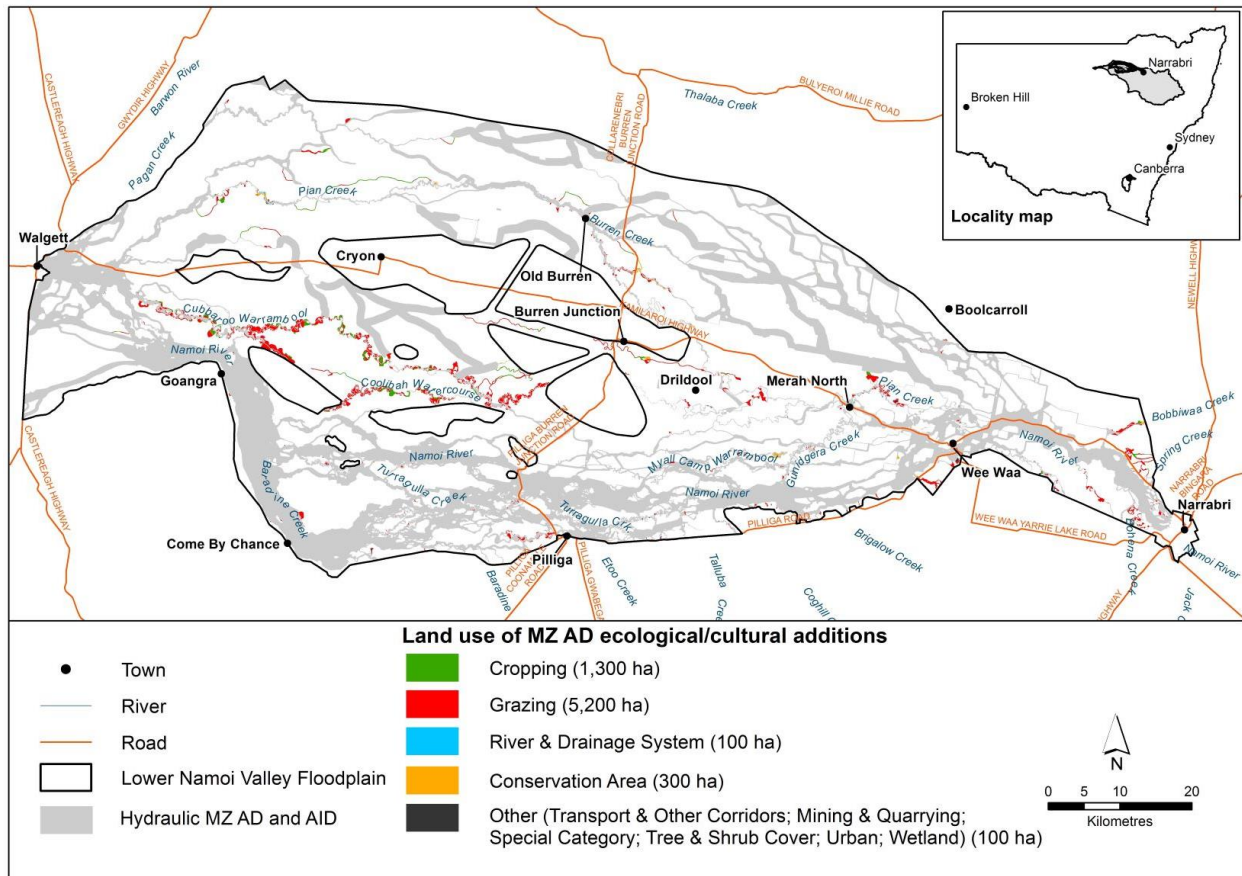


Figure 26. Land use of the areas added to Management Zone AD as part of ecological and/or cultural amendments.

If crops other than wheat were planted, the impact of the Lower Namoi Valley FMP 2020 would also change. Assuming a crop mix that is representative of the average crop mix across the Lower Namoi, the impact would rise to \$0.61 million, or 0.52% of Lower Namoi Valley FMP 2020 GVAP. This mix contains 43% wheat, 8% other cereals; 10% cotton; 17% legumes (including chickpeas); and 1% oilseeds (Table 24).²¹

Table 24. Land use in the Lower Namoi Valley FMP 2020

Broadacre crop	Share of land use in the Lower Namoi Valley FMP 2020 (%)
Wheat	42.7%
Other cereals	7.9%
Cotton	9.7%
Legumes	17.3%
Oilseeds	0.8%

Source: ABS Census (2011)

The increase in estimated costs in dollar terms is due to the higher price of crops such as cotton compared to wheat. However, farmers are likely to choose which crop to plant not solely based on potential revenue. Instead, the decision of what to plant likely reflects broader consideration

²¹ Using ABS data, a GVAP for the average crop mix across the Lower Namoi Valley Floodplain is calculated to be \$686 per hectare, \$84 per hectare larger than the all wheat assumption.

of the suitability of their land, the available alternatives (including livestock production) and a consideration of profits (which includes the associated costs).

Changes in cropping mix are likely to occur across the whole floodplain and not just in Management Zone A ecological and cultural amendments. This is because farmers respond to the same price signals from year to year. As a result, any change in crop mix is unlikely to significantly affect the size of the impact from the FMP, as it will be captured both in a change in crop mix to the impact area (the numerator) and in a change in crop mix to the overall Lower Namoi Valley Floodplain (the denominator).

Many landholders will not be impacted by the Lower Namoi Valley FMP 2020. However, there may be some individual farm level impacts that could be more significant, depending on the proportion of their land that is affected. A counter balancing item is that the area of ecological or cultural amendment to Management Zone A would probably have a discounted land value due to a higher likelihood of being flooded.

Summary

In considering change from the base case to the Lower Namoi Valley FMP 2020, the following key negative impacts were identified:

- lost opportunities to get approval in the area of ecological or cultural amendment to Management Zone A for works other than limited: access roads, below ground supply channels, stock refuge, infrastructure protection works, ecological enhancement works, Aboriginal cultural value enhancement works and heritage site enhancement works
- lost opportunities for approval in the Narrabri to Wee Waa FMP 2005 in the area of Management Zone B without advertising for other than limited drainage works.

The estimated negative impact of the Lower Namoi Valley FMP 2020 is a reduction of 0.46% of the gross value of agricultural production for the Lower Namoi Valley Floodplain. Sensitivity analysis suggests that this impact could vary between 0.13 to 0.91% of Lower Namoi Valley Floodplain GVAP. Given the size of this estimated impact, no further investigation was undertaken.

The cost of advertising applications in Management Zone B of the existing FMPs has not been estimated due to the unknown size, number and complexity of possible applications that may have occurred in the base case compared to the Lower Namoi Valley FMP 2020.

Community consultations have occurred as part of targeted consultation and public exhibition of the Lower Namoi Valley FMP 2020. Stakeholders have had the opportunity to provide feedback on potential socio-economic impacts of the management zones and rules in the Lower Namoi Valley FMP 2020. Potential socio-economic impacts and/or options identified by the community have been included in the socio-economic impact analysis where appropriate.

Many landholders will not be impacted by these estimated costs. However, there may be some individual farm level impacts that are more significant depending on where the land is situated in the landscape.

Phase 2: detailed analysis

The methodology used in this analysis requires that a detailed analysis (phase 2) be conducted, if the preliminary analysis, phase 1, indicates that there may be significant socio-economic impact. Considering that the estimated impact of the Lower Namoi Valley FMP 2020 rules (estimated to be a reduction of 0.46% of the total GVAP for the Lower Namoi Valley Floodplain) is of low significance for the regional economy, no further investigation is currently proposed. In addition, there was no other major issue raised during the public exhibition period that warrants further detailed assessment.

Role of socio-economics in FMP development

This impact assessment concludes that there is a limited negative socio-economic impact from the Lower Namoi Valley FMP 2020 and therefore no further investigation was undertaken.

Socio-economic advice has influenced the development of the Lower Namoi Valley FMP 2020 zones, rules and assessment criteria. Key consideration was given to achieve a balance at each stage between flood behaviour and the environment, social and economic outcomes.

Some examples include:

- categorising the types of flood works enabled consideration of important information on the socio-economic benefits of flood works, along with the level of risk that a flood work type would significantly impact on flood behaviour
- ensuring socio-economic impacts were included in the criteria for 'reasonable consistency' with previous floodplain management arrangements
- incorporating, wherever possible, areas with approved existing flood work developments into MZ C
- weighing up the socio-economic impacts of development controls against the potential for different types of flood works to impact on flooding behaviour. The restrictions on the types of flood works that could be applied for were made to minimise the risk that flood works would impact flooding behaviour whilst being sympathetic to landholder needs. These decisions were checked against the works likely to be approved under existing floodplain management planning arrangements and discussions held during targeted consultation with the community and interagency staff
- the requirement to advertise proposed flood works provides local landholders with an opportunity to comment on any impact that a proposed flood work could have in causing or exacerbate flooding depth, duration or flow rate problems on their land
- the non-advertising of proposed minor flood works enables landholders to construct approved flood works of a more minor nature without advertising their proposed flood works, which will save both money and time.

Consultation and review of the plan

The NSW Department of Planning, Industry and Environment was responsible for the review and consultation processes throughout the development of the Lower Namoi Valley FMP 2020. The department's Environment, Energy and Science group contributed technical expertise and local experience to the review and consultation processes. All stakeholders and interested parties had an opportunity to review and provide comment on the Lower Namoi Valley FMP 2020 at key stages throughout the plan's development.

Consultation process

Consultation activities involved:

- **technical assessment:** consultation of regional and scientific experts to collect relevant data/knowledge, provide technical input and review the FMP planning approach and criteria for delineating management zones, rules and assessment criteria
- **targeted consultation:** engagement of targeted community groups for feedback on the proposed boundary, management zones, rules and assessment criteria
- **public exhibition:** formal public exhibition of the Draft Lower Namoi Valley FMP and collection, review and incorporation of feedback from formal submissions
- **post-public exhibition consultation:** targeted consultation to collect feedback from affected landholders in response to updates to the management zones following public exhibition and incorporation of feedback to finalise the FMP for ministerial approval and commencement.

Consultation with Aboriginal stakeholders was undertaken using the approach outlined in Appendix 12 to be in line with:

- Aboriginal people, the environment and conservation (APEC) principles (DEC 2006)
- An Aboriginal Community Engagement Framework for DECC (2007)
- Working to protect Aboriginal cultural heritage (OEH 2011).

Technical assessment

Technical Advisory Group (TAG)

The TAG was responsible for providing expert knowledge and technical advice to the project team to help facilitate the development of the FMP. The TAG was composed of NSW Government agencies and other key agencies involved in water management in NSW, including the department's Environment, Energy and Science group, the department's Water group, NSW Department of Primary Industries (agriculture and fisheries interests) and Local Land Services.

The TAG was engaged throughout the FMP development process through a combination of teleconferences and face-to-face meetings. The TAG officially met four times from February 2013 to August 2014 to:

- split the Upper Namoi Valley Floodplain from the Lower Namoi Valley Floodplain at Narrabri
- identify design floods and hydraulic modelling parameters
- identify assets that are dependent on flooding
- establish conservation targets for assets for inclusion in Marxan
- identify existing floodplain management planning arrangements for consideration when delineating management zones
- identify socio-economic considerations.

Information provided by the TAG was incorporated into the development of the Lower Namoi Valley FMP 2020.

Aboriginal Technical Working Group (ATWG)

The ATWG was created as a consultative group to advise the development of FMPs on:

- the type, scope and integration of flood-dependent Aboriginal values
- the identification and prioritisation of cultural assets that require protection
- key contacts/knowledge holders in the Aboriginal community to consult with
- cultural knowledge on the history of flooding.

The ATWG was comprised of state and regional cultural heritage experts. Workshops were held with the ATWG to:

- define and identify Aboriginal cultural values that are dependent on flooding
- identify watering requirements of Aboriginal cultural values and other floodplain assets that have Aboriginal cultural value
- identify and document significance of Aboriginal cultural values and other floodplain assets that have Aboriginal cultural value
- develop a community consultation process for identification of Aboriginal cultural values in data gap areas.

Information provided by the ATWG was incorporated into the development of the FMP and is outlined in steps 4, 6 and 7.

Aboriginal community

The local Aboriginal communities were engaged by a departmental Aboriginal Natural Resources Officer through informal meetings. The aim of these informal discussions with Aboriginal stakeholders was to identify issues of concern in the valley and to introduce the objectives of the FMP in the context of the issues raised. During these activities, the Aboriginal Natural Resources Officer collected spatial information on cultural assets that are dependent on flooding. These were later analysed as part of Step 5 to be factored into the management construct. These cultural assets were discussed with the Aboriginal community during targeted consultation to obtain further feedback.

Targeted consultation

Targeted consultation was an opportunity to ‘road test’ the Draft Lower Namoi Valley FMP boundary, management zones, rules and assessment criteria (management construct). Targeted consultation was undertaken with stakeholders at Narrabri, Wee Waa, Pilliga, Tamworth and Walgett during October 2015 through to March 2016. During this period, individual meetings with landholder representatives that were unavailable to attend organised sessions also occurred.

The objectives of targeted consultation were to:

- provide background for key stakeholders as to why the FMPs were being developed, how they were developed, what management zones, rules and assessment criteria were proposed in the Lower Namoi Valley Floodplain and how stakeholders could provide feedback
- ‘road test’ the Draft Lower Namoi Valley FMP boundary, management zones, rules and assessment criteria.

Participation was at the invitation of the department’s Environment, Energy and Science group and drawn from a representative cross-section of industry groups. Targeted consultation involved the following key stakeholder groups within the Lower Namoi Valley Floodplain:

- landholder representatives including graziers, dryland and irrigation landholders and organisations
- environmental representatives
- local and state government representatives
- mining representatives
- industry representatives
- consultant and agronomist representatives
- Aboriginal community representatives.

Of the items of enquiry received, about 25% related specifically to the Draft Lower Namoi Valley FMP management construct. About 30% related to the process for developing and implementing the Draft Lower Namoi Valley FMP.

An issue raised was that the extent of Management Zone A was too great. To address this issue, the depth-velocity product threshold was changed from 0.1 m²/s to 0.2 m²/s. As a result, the hydraulic extent of Management Zone A was reduced by approximately 25% or 60,000 ha (Figure 27).

Another issue relating to the management zones raised was that landholders require more flexibility around the location of Management Zone A for floodways where the hydraulic basis for the location of the zone is more uncertain. To address this issue, a new management zone was created called Management Zone A–ill-defined (Management Zone AID). Management Zone AID was applied in areas where the depth-velocity product was less than 0.05 m²/s. The remaining floodways were classed as Management Zone AD.

Other small changes were made to the management zone layout that were not a result of stakeholder feedback but rather were done as part of internal desktop and field validation processes.

A key stakeholder group also raised the issue that the depth-velocity product is not a suitable standard for use in defining the hydraulic extent of Management Zone AD or Management Zone AID. The department convened an expert review process to investigate the options for defining the hydraulic extent of Management Zone A. No change was recommended as a result of this expert review process because the depth-velocity product as the primary basis for defining the hydraulic extent of Management Zone AD meets or is likely to meet the key parameters identified by the team of experts including:

- floodplain best management practice
- relevant legislative requirements
- consistency
- rigour
- objectivity
- accessibility
- flood passage
- conveyance
- cumulative impacts
- connectivity
- clarity
- boundaries
- current development.

There were no issues required to be addressed relating to the boundary, rules or assessment criteria.

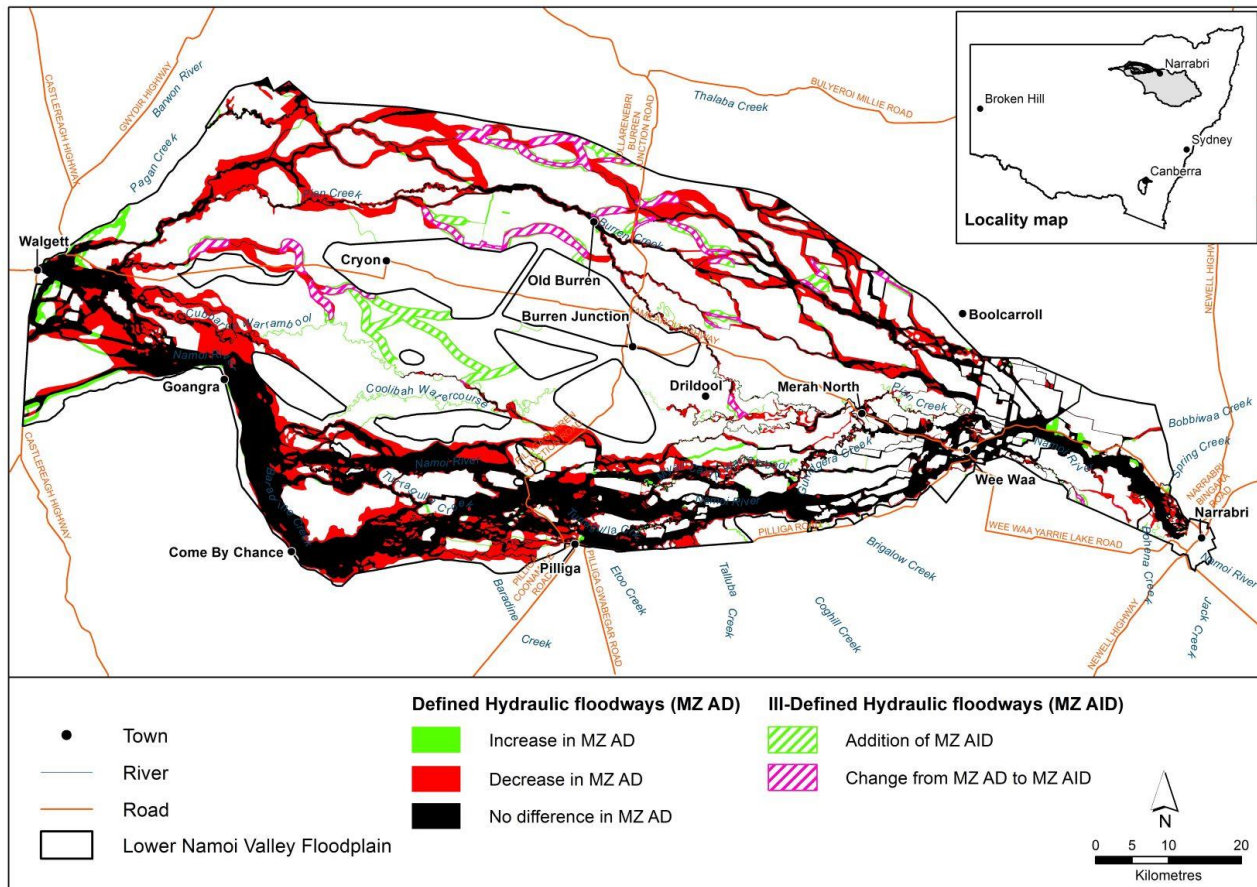


Figure 27. Differences between floodways presented at targeted consultation and floodways presented at public exhibition.

Public exhibition

The Draft Lower Namoi Valley FMP was on public exhibition over 60 days from Monday 13 February 2017 to Thursday 13 April 2017. Over this period, 15 stakeholder consultation events were held, with 59 participants and 51 submissions received, from which 415 items of inquiry were collated.

The objectives of this consultation were to provide background to stakeholders on:

- why the FMP was being developed
- how the FMP has been developed to date
- what rules and assessment criteria were proposed in the various areas
- how to make a formal submission.

The public exhibition of the plan was advertised in the *North West Magazine*, *Narrabri Courier* and the *Walgett Spectator* during the week commencing Monday 13 February 2017, and on the NSW Have Your Say website.

The department posted 450 letters to flood work approval holders, landholders who submitted floodplain harvesting registrations of interest (ROIs) and landholders whose properties intersected Management Zones AD, AID and D of the Draft Lower Namoi Valley FMP, notifying them of the exhibition period and inviting submissions.

Display packages containing information about the draft plan were available for inspection throughout the exhibition period from central locations in Narrabri, Wee Waa (2), Pilliga and Walgett, including Local Aboriginal Land Councils in the plan area.

A suite of products was developed to support stakeholders in understanding the Draft Upper Namoi Valley FMP, and this information was available to stakeholders in hard copy from each display location, by post or email upon request, and for download from the department's website (Table 25).

Table 25. Public exhibition display products for the Draft Lower Namoi Valley FMP

Document name	Description
Report cards for each management zone of the Draft Lower Namoi Valley FMP	A summary of the draft rules and key factors developed for each management zone of the Draft Lower Namoi Valley FMP
Map of the Draft Upper Namoi Valley FMP	A colour map illustrating the floodplain boundary and management zones contained within the Draft Lower Namoi Valley FMP
Rural floodplain management plans: technical manual	A general description of the method employed for development of floodplain management plans across rural New South Wales
Rural floodplain management plans: Background document to the Draft Floodplain Management Plan for the Lower Namoi Valley Floodplain 2017	A description of how the method presented in the technical manual has been applied across the Draft Lower Namoi Valley Floodplain and should be read in conjunction with the technical manual
Draft Floodplain Management Plan for the Lower Namoi Valley Floodplain 2017	The legal document that includes all of the rules and requirements in a statutory format
Floodplain management under the <i>Water Management Act 2000</i> : A guide to the changes	A guide to the transition of floodplain management planning from the <i>Water Act 1912</i> to the <i>Water Management Act 2000</i> in NSW
An overview of floodplain management plans under the <i>Water Management Act 2000</i>	A general, plain English explanation of the key provisions of floodplain management plans. The overview is a summary that should be read in conjunction with the Draft Lower Namoi Valley FMP
Submission form for public exhibition	A template that stakeholders can use to provide comments on the Draft Lower Namoi Valley FMP during public exhibition

The department hosted information appointments for stakeholders at Narrabri, Wee Waa, Pilliga and Walgett during the exhibition period to view the draft management zones at individual property scale at locations within the Lower Namoi Valley FMP area.

Submissions were accepted in writing, submitted by email or by post.

In addition to the targeted consultation and public exhibition processes, the preparation of the Lower Namoi Valley FMP was supported by the implementation of two additional consultation processes:

- ground-truthing (field validation)
- post-public exhibition consultation.

The ground-truthing process involved the department undertaking a series of property visits with three landholders to discuss issues and gain a practical understanding of flood behaviour on the ground in August 2018.

On 24 October 2018, the Interagency Regional Panel responsible for the preparation of the plan approved numerous property-scale changes to the boundary and management zones for the draft Lower Namoi Valley FMP in response to feedback received during public exhibition.

On 12 November 2018, the department wrote to 216 landholders whose properties were affected by the proposed property-scale changes, seeking their feedback. Landholders had a period of 28 days within which to respond. In response to landholder requests, this feedback period was extended until February 2019.

The department received 17 responses to post-public exhibition consultation, with 116 items of inquiry collated from within the responses. Minor changes were made to the management zones in response to 18 of these items of inquiry, where the changes were supported by the method for the delineation of the extent of the management zones.

The feedback received during public exhibition and post-public exhibition consultation was considered by the Interagency Regional Panel prior to finalising the Lower Namoi Valley FMP 2020 for commencement.

The department has written to all stakeholders who provided a submission during public exhibition (51), as well as those who responded during post-public exhibition consultation (17). These notification letters described the updates that had been made to the plan in response to the feedback received and provided a copy of the final draft of the management zones map for their information.

Review

Interagency Regional Panel

The Interagency Regional Panel (IRP) was established to review the boundary, management zones, rules and assessment criteria contained in the Lower Namoi Valley FMP 2020. The IRP consisted of one representative from the NSW Department of Planning, Industry and Environment's Environment, Energy and Science group to cover environmental interests, one representative from the department's Water group covering water management interests, and one representative from the NSW Department of Primary Industries covering agricultural and fisheries interests.

Representatives from Local Land Services, WaterNSW, the Natural Resources Access Regulator and the department's economics branch also attended meetings (as observers) to provide advice on relevant matters within their area of expertise.

The key responsibilities of the IRP were to:

- ensure that proposed management rules achieve the objectives of the WM Act
- provide information and analysis
- bring a balanced approach to the development of the plan: economic, social, environmental, and cultural considerations.

The IRP provided whole-of-government oversight and review of the Lower Namoi Valley FMP 2020 and met at key stages throughout the development of the plan:

- prior to targeted consultation
- prior to public exhibition
- prior to finalisation and commencement.

Prior to targeted consultation

The IRP reviewed the Draft Lower Namoi Valley FMP in May 2015 and supported its release for targeted consultation.

Prior to public exhibition

The IRP reviewed the Draft Lower Namoi Valley FMP and feedback from targeted consultation in June 2016.

The IRP supported the release for public exhibition of the updated management zones based on feedback from targeted consultation and further desktop and field validation activities. The IRP also supported the release for public exhibition of the boundary, rules and assessment criteria.

The IRP also made recommendations relating to:

- clarity of the wording of the rules
- the definition of major infrastructure
- advertising approach of public exhibition period
- socio-economic impact assessment.

The IRP also provided key considerations for the implementation of the Lower Namoi Valley FMP. These considerations were incorporated into departmental guidelines and will be used by WaterNSW and the Natural Resources Access Regulator as part of the implementation of the plan.

Prior to finalisation and commencement

The IRP reconvened after public exhibition to:

- consider stakeholder feedback
- recommendation changes to the draft management zones, rules and assessment criteria based on feedback from public exhibition
- review and endorse the final management zones, rules and assessment criteria prior to commencement of the FMP.

A total of 51 submissions were received in response to the public exhibition of the Draft Lower Namoi Valley FMP. From the 51 submissions received, 415 items of inquiry (IOI) were identified and collated.

The feedback received during public exhibition was considered by the IRP prior to finalising the FMP. Changes supported by the IRP are reflected in the final products in this report and the Lower Namoi Valley FMP 2020 (as published on the NSW Legislation website).

On 24 October 2018, the IRP approved changes to the rules and numerous property-scale changes to the management zones for the Draft Lower Namoi Valley FMP in response to the review processes for feedback received to public exhibition.

On 4 April 2019, the IRP approved several minor changes to the management zones for the Draft Lower Namoi Valley FMP in response to feedback received to post-public exhibition consultation.

On 22 May 2020, the IRP approved the inclusion of a transitional provision for dealing with outstanding flood work applications for flood works that are located or proposed to be located in Management Zones AD, AID and D, that were lodged with WaterNSW prior to 31 December 2019.

Plan finalisation and commencement

After endorsement by the IRP in May 2020, the Lower Namoi Valley FMP was submitted to the Minister for Water, Property and Housing for in-principle approval and then to the Minister for the Environment to seek concurrence. The Lower Namoi Valley FMP was then returned to the Minister for Water, Property and Housing for final approval. The Lower Namoi Valley FMP commenced on 11 September 2020. The FMP is available to view on the NSW legislation website.

References

ABS (2011a) Australian Bureau of Statistics, Agricultural Census 2011, Value of Agricultural Commodities Produced, Australia, 2010-11, 7503.0

www.abs.gov.au/AUSSTATS/abs@.nsf/allprimarymainfeatures/9901FE06C26DFDEECA257B7B00125B8F?opendocument

ABS (2011b) Australian Bureau of Statistics, Census of Population and Housing: Basic Community Profile DataPack, 2011, 2069.0.30.001 www.abs.gov.au/websitedbs/censushome.nsf/home/datapacks?opendocument&navpos=250

ABS (2011c) Australian Bureau of Statistics, Census of Population and Housing: Socio-Economic Indexes for Areas (SEIFA), Australia, 2033.0.55.001

www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/2033.0.55.0012011?OpenDocument

ABS (2014) Australian Statistical Geography Standard (ASGS),

[http://www.abs.gov.au/websitedbs/D3310114.nsf/home/Australian+Statistical+Geography+Standard+\(ASGS\)](http://www.abs.gov.au/websitedbs/D3310114.nsf/home/Australian+Statistical+Geography+Standard+(ASGS)).

ABS (2016) Australian Bureau of Statistics, Regional Population Growth, Australia, 3218.0.

www.abs.gov.au/ausstats/abs@.nsf/mf/3218.0

Auscover Remote Sensing Data Facility (2016) *Water Count and Prevalence – Landsat, JRSRP algorithm, NSW coverage*. Retrieved from <http://www.auscover.org.au/purl/landsat-water-count-and-prevalence>.

Australian Government – Department of Environment (2015) Directory of Important Wetlands in Australia. www.environment.gov.au/water/wetlands/australian-wetlands-database/directory-important-wetlands

Ball, IR and Possingham, HP (2000), *MARXAN (V1.8.2): Marine Reserve Design Using Spatially Explicit Annealing, a Manual*, University of Queensland, St Lucia QLD.

Ball, IR, Possingham, HP and Watts, M (2009), 'Marxan and relatives: Software for spatial conservation prioritisation', in A Moilanen, KA Wilson and HP Possingham (eds), *Spatial conservation prioritisation: Quantitative methods and computational tools*, Oxford University Press, Oxford, UK.

Brock, MA and Casanova MT (1997) Plant life at the edge of wetlands: ecological responses to wetting and drying patterns. In *Frontiers in Ecology: Building the Links*. (Eds NK Klomp and I Lunt) pp. 181-192. Elsevier Science: Oxford, U.K.

Burton, J, Junor, R and Whitehouse, G (1994) *Floodplain Management On The Liverpool Plains*. Report prepared for the NSW Floodplain (non-tidal) Management Advisory Committee, published by Department of Water Resources.

Capon, S (2016) Riparian herbs. In: *Vegetation of Australian Riverine Landscapes*. Biology, Ecology and Management. CSIRO Publishing

Capon, SJ and Brock MA (2006) Flooding, soil seed bank dynamics and vegetation resilience of a hydrologically variable desert floodplain. *Freshwater Biology* (2006) 51, 206-223.

Casanova, MT and Brock, MA (2000) How do depth, duration and frequency of flooding influence the establishment of wetland plant communities? *Plant Ecology* 147, 237-250.

Cunningham, G.M., Mulham, W.E., Milthorpe, P.L., and Leigh, J.H. (1981). *Plants of Western New South Wales*. Published in association with the Soil Conservation Service of NSW by the NSW Government Printing Office, Australia.

Danaher T. and Collett L. (2006) Development, optimisation, and multi-temporal application of a simple Landsat based water index. In: 13th Australasian Remote Sensing and Photogrammetry Conference, Canberra, Australia.

Department of Natural Resources (2005) *Narrabri – Wee Waa Floodplain Management Plan: September 2005*, Prepared by the NSW Department of Natural Resources, Tamworth.

Eco Logical Australia (2008) *Vegetation Mapping for the Namoi and Border Rivers-Gwydir CMA's. Compilation of API Datasets and Preparation of a Hierarchical Vegetation Classification*. Project Numbers 125-002 & 129-002. Report prepared for Namoi and Border-Rivers-Gwydir CMAs (VIS ID: 3842).

Eco Logical Australia (2008a) *Namoi Wetland Assessment and Prioritisation Project. Project No. 125-005. Report prepared for Namoi Catchment Management Authority, PO Box 1927, Armidale, NSW 2350.*

Eco Logical Australia (2009) *A vegetation map for the Namoi Catchment Management Authority*. (Project No. 125-004). Report prepared for Namoi CMA June 2009 (VIS ID: 3851).

Eco Logical Australia (2013) *Refinement of vegetation mapping in the Namoi Catchment: Extant and pre-European*. Prepared for Namoi CMA. May 2013 (VIS ID: 4028). Foster, N (1999) A

Preliminary Assessment of the Commence-to-flow levels of Wetlands of the Lower Namoi Valley. Department of Land and Water Conservation, Barwon Region

Green and Dunkerley (1992) *Wetlands of the Namoi Valley: Progress Report*. Department of Water Resources Technical Services Division. A progress report to the Murray–Darling Basin Commission for the Barwon–Darling Wetland Survey, funded under the Natural Resources Management Strategy.

Hadley, F. (2012) *Wee Waa area floods: following the 2nd-11th February 2012 Flood*. Unpublished report.

IACSEA 1998 'Socio-economic assessment guidelines for river, groundwater and water management committees' Independent Advisory Committee on Socio-economic Analysis.

Fisher, A, Flood, N, and Danaher, T (2016) Comparing Landsat Water Index Methods for Automated Water Classification in Eastern Australia. *Remote Sensing of Environment* (2016) 175, 167-182.

Lambert, G, and Short, A (2004) *Namoi River Styles Report: River Style, Indicative Geomorphic Condition and Geomorphic Priorities for River Conservation and Rehabilitation in the Namoi Catchment, North-West NSW*. Report to the Namoi Catchment Management Authority and Department of Infrastructure, Planning and Natural Resources (National Action Plan for Salinity and Water Quality). 162 pp.

Namoi Catchment Management Authority (CMA) (2011) *Namoi Catchment Action Plan 2010-2020: working together to look after the Namoi Catchment*. Namoi CMA, Gunnedah, NSW.

Namoi Catchment Management Authority (CMA) (2008) Wetland plants of the Namoi Catchment. Developed and written by staff from Namoi Catchment Management Authority.

NSW Department of Primary Industries (2015) *NSW Fish Community Status 2015 – Final report*.

NSW Department of Primary Industries, Office of Water (NOW) (2015) *Rural floodplain management plans: Technical manual for plans developed under the Water Management Act 2000*, DPI, Office of Water, Sydney.

NSW Government (2005) *Floodplain Development Manual: the management of flood liable land April 2005*. Published by Department of Infrastructure, Planning and Natural Resources, 23-33 Bridge Street, Sydney 2000.

NSW Water Resources Commission (1976) *Restoration of Namoi River Floodplain Waterways: Final Proposal*.

NSW Water Resources Commission (1978) *Guidelines for Merah North to Burren Junction floodplain development*.

NSW Water Resources Commission (1980) *Guidelines for Boolcarrol to Bulyeroi floodplain development*.

NSW Water Resources Commission (1984) *Proposed modifications to Narrabri-Wee Waa floodway restoration scheme*.

NSW Water Resources Commission (no date) *Guidelines for Gardens to Drilidool floodplain development*.

Office of Environment and Heritage (OEH) (2010) *State of the Catchments report – Namoi region*, Department of Environment, Climate Change and Water NSW, 59-61 Goulburn Street, PO Box A290, Sydney South 1232.

OEH (2015) BRG-Namoi Regional Native Vegetation Mapping. Technical Notes, NSW Office of Environment and Heritage, Sydney, Australia (VIS ID: 4204).

Possingham, HP, Ball, I and Andelman, SJ (2000), 'Mathematical Methods for Identifying Representative Reserve Networks', in S Ferson and MA Burgman (eds), *Quantitative Methods for Conservation Biology*, Springer-Verlag, New York.

Ridges, M. (2010) *Aboriginal Sites Decision Support Tool (ASDST). Statewide product outline and technical summary*. Department of Environment, Climate Change and Water NSW, Sydney.

Roberts, J and Marston F (2011) *Water regime for wetland and floodplain plants: a source book for the Murray–Darling Basin*. National Water Commission, Canberra

Rogers, K and Ralph, T.J (2011) *Floodplain Wetland Biota in the Murray–Darling Basin. Water and Habitat Requirements*, CSIRO Publishing, Collingwood VIC 348 pp.

Thomas, CR and Golaszewski (2012) *Refinement of procedures for determining floodway extent*. 52nd Annual Floodplain Management Association Conference: Riding the flood of change – turning risk into opportunity. Batemans Bay, 21st-24th February 2012.

URS Australia Pty Ltd (2011) *Narrabri Flood Study Review*.

Glossary

Aboriginal cultural values are sites, objects, landscapes, resources and beliefs that are important to Aboriginal people as part of their continuing culture.

annual exceedance probability (AEP) is the chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage (%) or a likelihood of 1 flood in x years. For example, a flood with an AEP of 5% means there is a 5% chance that a flood of same size or larger will occur in any one year.

borrow is an area of land where material is excavated, or removed, to construct a flood work at another location, which results in a depression or hole in the ground.

cultural asset is an object, place or value that is important for people to maintain their connections, beliefs, customs, behaviours and social interaction.

depth-velocity product is a hydraulic model output that can be used to indicate areas of a floodplain where a significant discharge of water occurs during floods; that is, areas where flow velocity and/or water depth are relatively high.

design flood is a flood of known magnitude or annual exceedance probability (AEP), that can be modelled. A design flood is selected to design floodway networks which are used to define management zones for the planning and assessment of the management of flood works on floodplains. The selection is based on an understanding of flood behaviour and associated flood risk. Multiple design floods may be selected to account for the social, economic and ecological consequences associated with floods of different magnitudes.

discharge (or flow) is the rate of flow measured in volume per unit of time (for example, megalitres per day = ML/day).

ecological assets are wetlands or other floodplain ecosystems, including watercourses that depend on flooding to maintain their ecological character and areas where groundwater reserves are recharged by floodwaters, which are spatially explicit and set in the floodplain landscape.

ecological values are surrogates for biodiversity that are used to prioritise the ecological assets and included fauna and fauna habitat, vegetation communities and areas of conservation significance.

ecosystem is a biological system involving interactions between living organisms and their immediate physical, chemical and biological environment.

exceedances per year (EY) is the expected number of times in a year that the event will occur or be exceeded.

existing development conditions refers to the level of development at the commencement of this plan.

fish passage refers to connectivity that facilitates the movement of native fish species between upstream and downstream habitats (longitudinal connectivity) and adjacent riparian and floodplain areas (lateral connectivity). Areas that are important for fish passage include rivers, creeks and flood flow paths.

flood connectivity refers to the unimpeded passage of floodwater through the floodplain, and is important for in-stream aquatic processes and biota and the conservation of natural riverine systems.

flood flow corridor is a hydraulic corridor that conveys flood flow through a management zone.

flood flow direction means the direction in which a flood flows for the relevant area as depicted on the Peak Flood Flow Distribution (1971) Map.

flood study is a comprehensive technical investigation of flood behaviour and defines the nature of flood risk.

flood-dependent assets refers to assets that have been identified in the plan as having important ecological or cultural features that rely on inundation by floodwaters to sustain essential processes.

flooding regime refers to the frequency, duration, nature and extent of flooding.

Floodplain Risk Management Plan identifies and determines options in consideration of social, ecological and economic factors relating to flood risk and the management of flood-prone land.

Floodplain Risk Management Study provides preferred options relating to flood risk and provides the information necessary for adequate forward planning of flood-prone land.

floodways are areas where a significant discharge of floodwater occurs during small and large design floods.

flood study is a comprehensive technical investigation of flood behaviour and defines the nature of flood risk.

flood wave means a rise in flows associated with flooding, culminating in a peak and followed by a recession to lower flows.

groundwater recharge areas are areas where water from a flood event leaks through the soil profile into the underlying aquifers.

heritage site is a cultural heritage object or place listed on a federal, state or local government heritage register.

high-value infrastructure includes but is not limited to houses/dwellings, infrastructure protection works, town levees, stockyards, sheds and pump sites. It does not include farm levee banks, irrigation development and fences.

Hydraulic Management Zone AD refers to areas of the Lower Namoi Valley Floodplain with floodways that have a depth-velocity product of greater than 0.2m²/s; it does not refer to areas of the Floodplain that were determined to be the Lower Namoi Management Zone AD based on ecological, cultural or existing planning arrangements criteria as part of the application of the method for delineating the extent of the management zones.

infrastructure protection works are flood works that are for the protection of houses, stock yards and other major infrastructure, such as machinery sheds.

large design flood refers to the design flood of February 1971 (4% AEP or 1 in 25 ARI at the Namoi River at Mollee gauge—419039)).

management zones are areas in the floodplain that have specific rules to define the purpose, nature and construction of flood works that can occur in those areas.

MIKE is a suite of water modelling software developed by DHI Group. Further information about the software packages used to develop the hydraulic models for the Lower Namoi Valley Floodplain is available in Appendix 5.

natural surface level is the average undisturbed surface level in the immediate vicinity of a flood work.

recharge means the addition of water, usually by infiltration, to an aquifer.

peak discharge calculation location is a section of the floodplain where flow is calculated for the purpose of assessing the change in flow behaviour due to proposed flood works.

permissible flood work is a type of flood work that can be applied for in a particular management zone. Applications for permissible flood works are still required to go through assessment in order to receive an approval.

pre-development conditions refers to natural flooding regimes.

primary access road is a road providing access from a public road to a permanently occupied fixed dwelling via a direct route.

small design flood refers to the design flood of December 2004 (13% AEP or 1 in 8 ARI at the Namoi River at Mollee gauge—419039)).

spoil refers to waste material (such as dirt or soil) that is produced during the construction or modification of a flood work.

SPOT is a commercial high-resolution optical imaging Earth observation satellite system operating from space.

stock refuge refers to a flood work that is for the purpose of protecting stock in times of flooding.

wetland refers to areas of land that are wet by surface water or groundwater, or both, for long enough periods that the plants and animals in them have adapted to, and depend on, moist conditions for at least part of their lifecycle. They include areas that are inundated cyclically, intermittently or permanently with fresh, brackish or saline water, which is generally still or slow moving except in distributary channels. Examples of wetlands include lakes, lagoons, rivers, floodplains, swamps, billabongs and marshes.

windrow refers to a row or line of material.