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Contents

Executive Summary 1

1. Introduction 7
   1.1 Background 7
   1.2 Purpose of the Project 7
   1.3 Structure of this report 8

2. Methodology 9
   2.1 Literature Review 9
   2.2 Model 18
   2.3 Monitoring and evaluating 19

3. Literature Review 20
   3.1 Floodplain agriculture 20
   3.2 Location and extent of Floodplains 21
   3.3 Value and Significance of Floodplain Agriculture 22
   3.4 Demographic profile 25
   3.5 Drivers of Change 31

4. Implications of the Proposed Basin Plan for Floodplain Producers 35
   4.1 Proposed changes to water management 35
   4.2 Regions of floodplain-based agriculture affected by Basin Plan 36
   4.3 Interactions between floodplain producers and other key stakeholders 38
   4.4 Review of previous work to assess impact of the Basin Plan for Floodplain Producers 40

5. Understanding of floodplain production activities based on engagement with primary producers 42
   5.1 Introduction 42
   5.2 Farm details 43
   5.3 Nature of floodplain production activities 44
   5.4 History of flood events on production 46
   5.5 Values floodplain-based primary producers hold in relation to landscapes and their management 46

6. Model 47
   6.1 Introduction 47
6.2 Key model parameters 47
6.3 Assumptions 48
6.4 Economic value of agricultural production on floodplains in the Basin 51
6.5 Sensitivity analysis 52
6.6 Analysis over a 113-year timeframe 53
6.7 Extrapolation 58

7. Further work to more comprehensively assess the benefits of the proposed Basin Plan 61
7.1 Data required for monitoring and evaluation 61
7.2 Monitoring and Evaluation 63
7.3 Options for future work 64

8. Reference List 65

Table Index

Table 1 Spills analysis statistics for Maude Weir (Gauge 410040, overbank threshold 20 GL/day) 12
Table 2 GIS data 13
Table 3 GIS layers used to map the floodplain 14
Table 4 Floodplain region selection matrix 15
Table 5 Stakeholder engagement activities 18
Table 6 Floodplain areas 24
Table 7 Demographic profiles 30
Table 8 SDL changes from surface water resource units 37
Table 9 Summary of farm details for northern Basin floodplain producers 43
Table 10 Management strategies of primary producers on floodplains 45
Table 11 Key model parameters 47
Table 12 Area of floodplain land use – baseline scenario 49
Table 13 Frequency of overbank flows 51
Table 14 Model results – baseline (20 year period) 51
Table 15 Model results – incremental value BP-2750 (20 year period) 51
Table 16 Sensitivity analysis 1: Proportion of grazing land for sheep vs cattle (20 year period) 52
Table 17 Sensitivity analysis 2: Stocking rate with overbank flows (20 year period) 52
Table 18  Sensitivity analysis 3: Additional % of land inundated under BP-2750 (20 year period)  53
Table 19  Sensitivity analysis 4: Discount rate of 4% (20 year period)  53
Table 20  Model results, 1896 – 2008  54
Table 21  Area of floodplain land use (ha) – entire Basin  59
Table 22  Extrapolation to northern Basin, 20-year timeframe  59

Figure Index
Figure 1  Gauge 410040 – Murrumbidgee at Maude Weir  11
Figure 2  Gauge 422015 Culgoa at Brenda  11
Figure 3  Gauge 425003 – Darling at Bourke  11
Figure 4  Study regions  16
Figure 5  Northern, central and southern Basin communities  26
Figure 6  Water Sharing Plan rules  39
Figure 7  Barwon-Darling, 1896 – 2008  55
Figure 8  Lower Balonne, 1896 – 2008  56
Figure 9  Lower Murrumbidgee, 1896 – 2008  57
Figure 10  Land subject to inundation  60
Figure 11  Lower Darling – Land subject to inundation  71
Figure 12  Lower Darling – Land use  72
Figure 13  Lower Balonne – Land subject to inundation  73
Figure 14  Lower Balonne – Land use  74
Figure 15  Lower Murrumbidgee – Land subject to inundation  75
Figure 16  Lower Murrumbidgee – Land use  76

Appendices
A  Hydrograph
B  Floodplain maps
C  Focus Group Agenda and Phone Surveys
D  Case studies and focus group summaries
Abbreviations and acronyms used in this report

ABARE  Australian Bureau of Agricultural and Resource Economics
ABS    Australian Bureau of Statistics
AFA    Australian Floodplain Association
ACLUMP Australia Collaborative Land Use and Management Program
BDL    Baseline Diversion Limit
BP     Basin Plan
BP-2750 Basin Plan reduction in diversions of 2750 GL/year, relative to baseline diversion limits
BCA    Benefit-Cost Analysis
BRS    Bureau of Rural Sciences
CMA    Catchment Management Authority
CSIRO  Commonwealth Scientific and Industrial Research Organisation
DSEs   Dry Sheep Equivalents
EWP    Environmental Watering Plan
EWR    Environmental Water Requirements
GIS    Geographical Information Systems
GVAP   Gross Value of Agricultural Production
ISP    Independent Scientific Panel
M&E    Monitoring and Evaluation
MDB    Murray-Darling Basin
MDBA   Murray-Darling Basin Authority
NSW DPI NSW Department of Primary Industries
RIS    Regulation Impact Statement
SC     Steering Committee
SDL    Sustainable Diversion Limits
SEIFA  Socio-Economic Index For Areas
Glossary of terms used in this report

Baseline Scenario: Baseline conditions represent the Basin development, water use and water sharing arrangements as at June 2009. It is similar to current conditions and includes environmental water already recovered for The Living Murray and Water for Rivers for the Snowy Rivers.

BP-2750 Scenario: The proposed Basin Plan 2750 GL scenario represents a reduction in diversions of 2,750 GL/year across the Basin, relative to baseline diversion limits, assuming current water sharing and operational arrangements.

Environmental Flows: The flows of water in our rivers and streams that are necessary to maintain healthy aquatic ecosystems. They are designed to mimic the natural condition in our rivers.

Environmental Water Requirements: The water regime needed to maintain water-dependent ecosystems, including their processes and biological diversity, at a low level of risk.

Floodplains: Low lying, relatively flat, areas adjacent to a river or tributary that are formed chiefly of river sediment and are subject to occasional or periodic flooding.

Gross Margin: Difference between revenue and cost before accounting for certain other costs.

Hydrological Indicator Sites: Locations within rivers, floodplains and wetlands across the Basin at which the environmental water requirements have been determined by assessing the needs of the local ecology, as well as the water needed to provide the many functions that are necessary for healthy ecosystems both locally and downstream.

Land Subject To Inundation: Low lying land usually adjacent to lakes or watercourses, which is regularly covered with flood water for short periods.

LiDAR: Light Detection And Ranging, is an optical remote sensing technology that can measure the distance to, or other properties of a target by illuminating the target with light, often using pulses from a laser.

Spells Analysis: Spells Analysis is a statistical technique to estimate stream flow characteristics including timing, frequency and duration.

Sustainable Diversion Limits: Environmentally sustainable limits on the amount of water that can be taken from the Basin’s water resources.

Water Access Licences: Entitles holder to share in available water in specified water source, and to take water from specified location. Specifies:

- Size of share (generally as units)
- Water source (defined river, catchment or aquifer)
- Category (categories are a mixture of priority and purpose)
- Location (usually a zone)
- Nominated works (usually a works approval ID)

Can also include a right to share of channel capacity, or daily flow.
Executive Summary

MDBA contracted GHD to deliver project MDB2106 – *Assessment of benefits of the Basin Plan for primary producers on the floodplains in the Murray Darling Basin*. The purpose of this project is for the MDBA to gain:

- An improved understanding of the primary producers and agricultural production on floodplains in the Basin, and the effects of the Basin Plan on these primary producers;
- A preliminary assessment of the benefits of the Basin Plan for primary producers and agricultural production on the floodplains; and
- Guidance to set foundations for further longer-term work pertinent to primary producers and agricultural production on the floodplains.

The information compiled in this report will be used to inform the preparation of the Regulation Impact Statement (RIS) for the proposed Basin Plan.

The methodology for the project included a combination of: desktop review of literature, consultation with floodplain producers in three selected regions, hydrology modelling and spatial analysis of the Basin Plan on the timing and extent of floodplain inundation, financial modelling to assess benefits in the selected regions and extrapolation across the Basin, and recommendations for future monitoring and evaluation activities to assess outcomes following the implementation of the Basin Plan.

The assessment of benefits was based on a calculation of the net value of floodplain production under the ‘baseline’ scenario compared to the net value under the proposed Basin Plan reduction in diversions of 2750 GL/year (BP-2750) relative to baseline diversion limits.

*Literature Review*

The literature quantifying the value of primary production on floodplains is scarce apart from some limited case studies that may not be representative of the Basin as a whole. Almost without exception, documents on floodplain production qualify their conclusions with caveats similar to the following: “there was a lack of sufficient information to support adequate consideration of the socio-economic impacts of floodplain agriculture to inform a planning process” (Arche Consulting, 2010).

Despite this, there are numerous studies and surveys documenting the benefits of inundation on floodplains, especially in the northern Basin (approximately north of the Murrumbidgee River). For example Mottell (1995) found in the northern Basin that “a flood not only generates financial benefits in increased stocking rates, greater profits and more assured cropping patterns, but that enormous social and environmental benefits are enjoyed.”

Mottell also considered damage caused by flooding and despite some producers taking into account the increase in depreciation of machinery, on-farm labour and other running costs, most producers “adopted the view that there was a net benefit in flooding and any damage suffered was incidental and should be ignored.”

It is likely there is a contrary view in the southern Basin where increased flooding as a consequence of environmental flows, for example in the River Murray, are seen by landholders to reduce profitability through damage to improved pasture, damage to infrastructure, and interruption to access. This has been formally recognised by purchase of easements to allow flooding for environmental flows.
The quantification of the value of floodplain production across the Basin has not been reported in the literature. The literature generally provides estimates of the gross value of agricultural production (GVAP) based on two components - irrigated agriculture and dryland agriculture – and rarely is there any reference to floodplain agriculture as a component of dryland agriculture.

Based on the literature, GHD calculated the GVAP for floodplain agriculture at $395 million per year but cautions the reader on the accuracy of this estimate given the assumptions underlying the calculation.

The overall premise of the current GHD project could be summarised as follows: “these (floodplain) enterprises have suffered through water being taken away through the process of over-issuing of entitlements. If water is returned to the rivers these enterprises will have an improved outcome economically, socially and mentally” (Australian Floodplain Association, 2010).

Stakeholder consultation

Given the limited time available to complete the project GHD selected three northern Basin regions for investigation and consultation with landholders: Lower Balonne, Barwon-Darling and Lower Murrumbidgee/Lower Lachlan.

Consultation was via focus groups, phone interviews and on-property case studies with a total of 37 floodplain producers. Participants in the study were recruited using two primary approaches: i) by responding to a request for expressions of interest from the Australian Floodplain Association (AFA) following discussions between the AFA and MDBA about the proposed study; and ii) identification of key informants by GHD during conversations with regional Catchment Management Authority staff and landholders who had responded to the request for EOI from the AFA. While the AFA sent out the request to its members, these members were encouraged to speak with and to nominate others, including those who were not members. A list of respondents was compiled by MDBA and provided to GHD. GHD then reviewed the list, selecting respondents from the selected case study regions and supplementing these with the key informants.

While there were no specific criteria for selection, all landholders had at least some part of their properties located on floodplains and all were willing to provide quantitative and qualitative information on the impact of flooding regimes on property management and profitability, and to discuss the perceived impacts of the proposed Basin Plan. The timeframe for the study did not allow GHD to attempt to ensure participants would be a representative sample of all producers within the individual regions or across the Basin.

The stakeholder recruitment process (self-nomination and key informants) potentially creates a risk that information provided is biased towards more positive benefits of floodplain production. This is acknowledged by GHD and is accommodated to some extent through completing sensitivity analyses of key assumptions in the financial model. The potential bias could be removed through a further study that included consultation with a more representative sample of landholders from all Basin regions.

Outcomes from the consultation were used to develop assumptions for GHD’s financial model. Some key aspects included:

- Property sizes are variable but generally large with averages around 30,000 ha. Areas have increased over time to enable economies of scale and also enable production and financial resilience in response to variable climate and market conditions. Duration of ownership varies but most properties are considered to be ‘family farms’ with current owners second generation or more;
Floodplains comprise varying percentages of total farm area and the area of the floodplain inundated varies depending on the type of flood (size, duration, antecedent conditions) and timing of local rainfall events;

Enterprises are predominantly livestock (sheep, cattle and some goats) with small areas of cropping. Core breeding herds / flocks comprise 50-75% of stocking potential with trading stock and/or agistment comprising the balance. This allows flexibility in management in response to flooding;

Stocking rates on floodplains vary with averages around 0.8 DSE/ha (dry sheep equivalents per hectare) in the absence of flooding and to 1.2 DSE/ha after flooding. Dry periods are frequent and result in partial or complete destocking in some years;

Subdivision of properties into paddocks is used for pasture management, including restriction of grazing for periods after flooding or rainfall events which enables species to seed and increase plant density. This results in a ‘living haystack’ that provides resilience;

Landholders place additional value on flooding events, outside of the financial production benefits to their farm businesses. Better ecological health of the farm environment assists with farming family well-being which promotes better decision making; and

Landholders considered that BP-2750 will have the greatest impact on small to moderate flood events. Large floods are the result of above average local or natural rainfall events.

Hydrology

MDBA provided hydrological information such as flow (ML/day) and river height (m) at more than 100 gauging stations throughout the Basin for the years 1895 to 2009. In addition, MDBA provided modelled data on the impact of BP-2750 on hydrology over the same period.

GHD prepared flow duration curves to show the proportion of time flow is exceeded (%) for the relevant gauge stations in the three study areas. River height duration curves were also developed for gauging stations where rating tables were available from the MDBA. For each gauging station, the flow duration curves provided an indication of the flow range (and in particular the overbank flow range) that is likely to be impacted by the Basin Plan.

An example of the outputs from this analysis are shown for Maude Weir in the table below where overbank flows for floodplain inundation occurred above a threshold of 20,000 ML/day. The statistic that was of most interest in the financial model (see below) was the frequency of years with floods. In the example shown, BP-2750 increased the frequency of years with floods from one in 2.8 years to one in 1.7 years.

---

1 GHD decided to perform the spells analyses using calendar years (1896 - 2008), to minimise the risk of splitting a large rainfall event across two years (i.e. there are significantly less large rainfall events occurring over December / January compared to over June / July). Data for the years 1895 and 2009 are incomplete therefore are excluded from the analysis.
Spatial analysis

GHD used a combination of GIS mapping tools to estimate the extent of floodplain inundation in hectares. The main source of data was from the Geoscience Australia 1:250,000 topographic data series which defines land subject to inundation as “low lying land usually adjacent to lakes or watercourses, which is regularly covered with flood water for short periods”. This data does not show the maximum extent of inundation for different flooding events but was considered acceptable for use especially as landholders considered that BP-2750 was likely to have most impact for small to medium flows. Other potentially more accurate inundation GIS data are available but due to license and other restrictions were not available for this project.

GHD overlayed the inundation layer with the Australia Collaborative Land Use and Management Program (ACLUMP) Land use data (Updated March 2010) supplied by the Department of Agriculture, Fisheries and Forestry. This was used to determine the current land use on the floodplain, particularly to differentiate grazing and non-irrigated cropping land from other forms of land use on the floodplains (conservation areas and national parks, plantations, irrigated agriculture, water bodies).

The table below shows the extent of potential floodplain cropping and grazing land for the three case study regions.

<table>
<thead>
<tr>
<th>Region</th>
<th>Cropping (ha)</th>
<th>Grazing (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barwon-Darling</td>
<td>0</td>
<td>667,827</td>
</tr>
<tr>
<td>Lower Balonne</td>
<td>34,177</td>
<td>583,010</td>
</tr>
<tr>
<td>Lower Murrumbidgee</td>
<td>1,164</td>
<td>99,371</td>
</tr>
</tbody>
</table>

This methodology was also used by GHD to extrapolate the assessed benefits from the three case study regions to the whole of Basin floodplain area with non-irrigated agricultural production.

Financial model and outputs

GHD developed an Excel model to calculate net surplus income of floodplain production to enable comparison of the baseline and BP-2750 scenarios. Assumptions underpinning the model include:

- Area of inundation for cropping and grazing land use (see above table)

---

2 Statistics are based on the period 1896-2008 due to incomplete data for 1895 and 2009.
Frequency of flooding events (see above table)

Gross margin budgets for cropping and livestock (derived initially from NSW DPI gross margins and modified via consensus in focus groups)

Overhead costs removed. Overhead costs included fixed costs such as rates, rents, taxes, repairs & maintenance, depreciation of plant and equipment, and operating labour.

The result was an estimated value of floodplain agriculture of $313 million (Net Present Value modelled over 20 years\(^3\)), as shown in the table below.

<table>
<thead>
<tr>
<th></th>
<th>Barwon-Darling</th>
<th>Lower Balonne</th>
<th>Lower Murrumbidgee</th>
<th>Total (3 regions)</th>
<th>Value per hectare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total economic value</td>
<td>$143.8 million</td>
<td>$147.0 million</td>
<td>$22.1 million</td>
<td>$313.0 million</td>
<td>$226</td>
</tr>
<tr>
<td>– baseline</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The incremental value of floodplain agriculture under BP-2750 is estimated to be $32 million (Net Present Value over a 20 year period).

<table>
<thead>
<tr>
<th></th>
<th>Barwon-Darling</th>
<th>Lower Balonne</th>
<th>Lower Murrumbidgee</th>
<th>Total (3 regions)</th>
<th>Value per hectare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incremental economic</td>
<td>$12.2 million</td>
<td>$17.9 million</td>
<td>$2.1 million</td>
<td>$32.2 million</td>
<td>$23</td>
</tr>
<tr>
<td>– BP-2750</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The analysis was also undertaken for the period 1896 – 2008\(^4\), with similar outcomes. Furthermore sensitivity analysis was undertaken for the key model variables of:

- Proportion of grazing land for sheep production versus cattle production;
- Stocking rate during over-bank flows;
- Additional area of land inundated under BP-2750; and
- Discount rate.

For this project, GHD has chosen to include only the northern Basin floodplain for assessing the benefits of the Basin Plan, on the assumption that in the southern Basin any benefit could be offset by a disbenefit. Further analysis is required to confirm the accuracy of this assumption. CSIRO (2012) states that grazing of floodplains in the southern Basin has effectively been eliminated in recent years due to the change in land tenure from freehold to National Park, from State Forest or State Park to National Park or Indigenous Protected Area. MDBA (2012a) also describes the differences between the northern and southern parts of the Basin, stating that irrigators in the north tend to "rely more on opportunistic annual crops and depend on a few good seasons to generate the return required to offset years with lower water availability." In contrast, those in the south have developed farming systems “that depend on continuity of water supply, such as perennial horticulture.”

\(^3\) All calculations in the report are based on 2012 dollars, discounted over 20 years at a rate of 7% unless otherwise stated.

\(^4\) 1895 and 2009 excluded due to incomplete data.
The results of the extrapolation to the northern Basin are provided in the table below. Under the Basin Plan, the incremental economic value of floodplain agricultural production is estimated at $64.9 million (Net Present Value over 20 years).

<table>
<thead>
<tr>
<th>Area</th>
<th>Value per hectare</th>
<th>Total economic value – baseline</th>
<th>Incremental economic value – BP-2750</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grazing natural pastures</td>
<td>2,027,406</td>
<td>$435.9 million</td>
<td>$36.9 million</td>
</tr>
<tr>
<td>Grazing improved pastures</td>
<td>159,452</td>
<td>$34.3 million</td>
<td>$2.9 million</td>
</tr>
<tr>
<td>Cropping</td>
<td>117,289</td>
<td>$73.8 million</td>
<td>$25.1 million</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,304,147</strong></td>
<td><strong>$543.9 million</strong></td>
<td><strong>$64.9 million</strong></td>
</tr>
</tbody>
</table>

A more detailed assessment of the benefits of the proposed Basin Plan on floodplain agriculture would be supported by the following (noting that some of this work may have already been undertaken by the MDBA):

- Develop a detailed M&E plan based on the above guidelines to provide on-ground assessment of the impacts of the proposed Basin Plan on floodplain producers;
- Develop data sharing agreements between relevant regional, State, and Commonwealth agencies to ensure that available information is utilised, particularly where this is based on high quality data and/or detailed modelling;
- Undertake a stocktake of available flood mapping and imagery held by regional, State and Commonwealth agencies, and compile a directory of this data. This data directory would include as a minimum the location and type of floodplain mapping/imagery, and an agency contact for the data. In some cases there will be limitations on the use of this data imposed by the data provider, and these conditions should be flagged;
- Continue the acquisition of LiDAR data for the floodplains of the Murray Darling Basin. LiDAR data has multiple uses, however for the purposes of the proposed Basin Plan, the focus should be on the floodplain extent that is likely to be impacted by the proposed Basin Plan;
- Undertake a co-ordinated assessment of regional floodplains within the Murray Darling Basin where hydrodynamic modelling would provide multiple benefits, and prioritise these areas. This could be an extension of this current project whereby consultation and modelling is conducted across all Basin Plan Regions to reduce the risk of bias that is present in this study;
- Develop a more comprehensive model that relates changes in hydrological flows to economic costs and benefits; and
- Investigate further the relationship between the ecological, economic and social benefits of the proposed Basin Plan on floodplain producers.
1. Introduction

1.1 Background

The Murray-Darling Basin Authority (MDBA) contracted GHD to deliver project MDB2106 – Assessment of benefits of the Basin Plan for primary producers on the floodplains in the Murray Darling Basin.

Floodplains are low lying areas adjacent to a river or tributary that are formed chiefly of river sediment and are subject to flooding. Floodplains exist across the full extent of the Murray-Darling Basin and the primary production that occurs on the floodplain land varies from extensive livestock grazing through to intensive horticulture. Overbank flows cause inundation of floodplains and the impacts of this varies depending on vegetation type and land use and may result in benefits or disbenefits depending on circumstance such as season, duration and frequency of flooding.

The MDBA is the single agency responsible for planning integrated management of the water resources of the Murray-Darling Basin. MDBA has developed a proposed Basin Plan which aims to achieve a healthy working Basin by establishing new long-term average sustainable diversion limits (SDLs) that reflect an environmentally sustainable level of water use. Also, an Environmental Watering Plan (EWP) has been developed to “ensure that the size, timing and nature of river flows maximise benefits for the environment.” (MDBA, Delivering A Healthy Working Basin – About the draft Basin Plan, pg14).

The proposed Basin Plan indicates that an average of a further 2,750 GL/year of water needs to be recovered compared to the 2009 baseline condition. It is recognised that such recovery is likely to have flow-on impacts in some communities, including primary producers on floodplains.

This project follows several reports which have been unable to quantify the Basin-wide impacts of the Basin Plan on floodplain producers. Arche Consulting (2010) recommended the need for further study into the benefits of the Basin Plan for primary producers on the floodplains, stating that insufficient information was available about floodplain-based agricultural production to enable robust analysis of the benefits for this sector from enhanced environmental flows.

1.2 Purpose of the Project

The purpose of this project is for the MDBA to gain:

- An improved understanding of the primary producers and agricultural production on floodplains in the Basin, and the effects of the Basin Plan on these primary producers;
- A preliminary assessment of the benefits of the Basin Plan for primary producers and agricultural production on the floodplains; and
- Guidance to set foundations for further longer-term work pertinent to primary producers and agricultural production on the floodplains.

The information compiled in this report will be used to inform the preparation of the Regulation Impact Statement (RIS) for the Basin Plan.

This project is the first stage of what was envisaged as a two-stage project designed to:

- Assess the benefits of the Basin Plan for primary producers on floodplains in the Basin; and
Establish a robust methodology for monitoring and evaluating the effects of the Basin Plan for primary producers on floodplains.

The primary focus of the study is the agricultural production benefits (or disbenefits where applicable) of the Basin Plan on floodplain producers. The model developed as part of the project seeks to place an economic value on these production impacts. The project also collected qualitative information on other benefits arising from the Basin Plan (e.g., social and environmental) through the stakeholder consultation process.

1.3 Structure of this report

This report provides a preliminary assessment of the benefits of the proposed Basin Plan for primary producers on floodplains in the Basin. Drafts of the report were previously provided to a Steering Committee and their feedback has been incorporated where relevant. The structure of the report is described below.

Section 2 describes the methodology used to complete the project. It includes a detailed description of the hydrology and GIS information available and how this has been used to inform key assumptions of the extent of floodplains and impacts of the proposed Basin Plan.

Section 3 presents the results of a literature review that summarises what is already known about primary production on floodplains in the Basin, and identifies key issues and information gaps.

Section 4 describes the implications of the proposed Basin Plan for primary producers on floodplains in the Basin. This includes a review of proposed changes to water management regimes, consideration of the potential interactions between floodplain producers and other Basin stakeholders, and a review of previous studies assessing the impacts of the proposed Basin Plan on floodplain producers.

A summary of the results of GHD’s engagement with floodplain producers is provided in Section 5.

The model developed to estimate the impacts of the proposed Basin Plan on agricultural production value is described in Section 6. The modelling results are also presented.

Section 7 provides suggestions for further work that would improve the accuracy of the assessment as well as advice regarding options for monitoring and evaluation.
2. Methodology

GHD developed a 5-step approach to completing the project as follows:

- Step 1: Project inception and literature review;
- Step 2: Review current understanding of the implications of the proposed Basin Plan;
- Step 3: Engage with primary producers on floodplains in the Basin;
- Step 4: Preliminary assessment of the economic value of agricultural production; and
- Step 5: Communicating findings and further work that could be undertaken.

The project inception included a workshop held in Canberra with members of the project Steering Committee (SC) and Independent Scientific Panel (ISP). Following this, GHD developed an Issues Paper that included more detail on the proposed work program. The SC and ISP commented on the Issues Paper and GHD was further guided by these comments.

2.1 Literature Review

A literature review was undertaken to summarise what is already known about floodplain producers in the Basin, and to identify key issues and gaps in this information. The literature review detailed:

- Industry characteristics;
- The economic and broader context and the drivers of change influencing these; and
- The socioeconomic profile (including demographic information) and trends for the floodplain communities within the Basin.

2.1.1 Understanding of the implications of the proposed Basin Plan

The implications of the proposed Basin Plan can be predicted to some extent using the extensive data that have been produced by the MDBA. GHD selected a range of data relevant to floodplain production with a view to modelling potential impacts and also for discussion with floodplain producers.

In understanding the implications of the proposed Basin Plan it was first necessary to understand the ‘baseline’ – that is, the situation against which the proposed Basin Plan was to be compared. A discussion on this and other information is provided below.

Definition of the baseline

The baseline is defined as the water management arrangements in place and the flow regime in the Basin, including any water recovered under The Living Murray Initiative and Water for Rivers, up to 30 June 2009 (CSIRO, 2012). These water management arrangements are described in MDBA (2012a) and include:

- Entitlements;
- Water allocation policies;
- Water sharing rules;
- Operating rules; and
Infrastructure such as dams, locks and weirs.

This encompasses the legislative framework and water resource plans, which were previously only regulated by individual State jurisdictions. The key objective of the proposed Basin Plan is to reduce water consumptive diversions, and to return some water for environmental flows.

The change in diversion limits (yielding a total of 2,750 GL recovered per annum) for each MDB catchment is outlined in Section 4. MDBA’s hydrological model provides long-term averages of flows from July 1895 to June 2009 under pre-European settlement conditions (‘without development’), the baseline level and the proposed 2,750 GL per year reduction in diversions, relative to baseline diversion limits. The latter is referred to as BP-2750\(^5\).

Apart from isolated situations, under the proposed Basin Plan the various structures will remain in situ and it is unlikely that flow will ever return to the ‘without development’ scenario. GHD therefore did not investigate the ‘without development’ scenario in this project. Benefits are assessed as the difference between baseline outcomes and BP-2750 outcomes.

**Hydrology**

The purpose of the hydrological analysis was to determine the change in frequency and duration of specific flood events (defined by magnitude) under the BP-2750 scenario, compared to the Baseline. It is understood that in most regions, the proposed Basin Plan will have the greatest impact on small to moderate flood events.

From the hydrological data provided by the MDBA, flow duration curves were prepared for three gauging stations in three regions in the Basin (Figure 1 to Figure 3)\(^6\). The three regions were selected as case studies as limited time did not allow a more comprehensive analysis. The graphs show the proportion of time flow is exceeded (%) as well as river height duration curves where rating tables were available from the MDBA. For each gauging station, the flow duration curves provided an indication of the flow range (and in particular the overbank flow range) that is likely to be impacted by the proposed Basin Plan.

For example, flow duration curves for the Murrumbidgee River at Maude Weir (Figure 1) indicates that the overbank flow threshold of 20 GL/day is exceeded approximately 4% of the time under the Baseline scenario, and approximately 6% of the time under the BP-2750 scenario. The flow duration curve also shows that flood events greater than 30 GL/day are relatively unimpacted by the proposed Basin Plan.

---

\(^5\) As detailed in MDBA 2012, “while the Authority decision making process led to an eventual proposed Basin Plan containing a 2750 GL reduction, the BP-2800 scenario is still the most current and relevant for many valleys as the change in one northern valley (Condamine-Balonne) had little impact on the environmental flow indicators downstream of its confluence with the Barwon-Darling.” GHD’s analysis is based on the 2750 GL reduction, in order to align with the proposed Basin Plan.

\(^6\) Flow duration curves are based on data from July 1895 to June 2009.
Figure 1  Gauge 410040 – Murrumbidgee at Maude Weir

![Flow Duration Curve: July 1895 - July 2009](image1)

Figure 2  Gauge 422015 Culgoa at Brenda

![Flow Duration Curve: July 1895 - July 2009](image2)

Figure 3  Gauge 425003 – Darling at Bourke

![Flow and River Level Duration Curves: July 1895 - July 2009](image3)
A spells analysis\(^7\) was undertaken to review how proposed changes to water management regimes under the proposed Basin Plan may be implemented in the three study areas. Overbank flow thresholds were estimated from the MDBA Environmental Water Requirements where information was available for the relevant gauging stations, or from the stakeholder consultation undertaken as part of this study. While the original intent of the study was to assess a range of flow thresholds relevant to floodplain agricultural production, a simplified approach was ultimately adopted for the study which defined flood events as flows which exceed the overbank flow threshold. For simplicity, no independence criteria were applied for the analysis to differentiate between separate flood events. A number of flood event statistics were calculated for the Baseline and BP-2750 scenarios to provide an indication of the changes to the flooding regime in terms of event frequency and duration.

An example of the spells analysis statistics for the Murrumbidgee River at Maude Weir (gauge 41040) is shown in Table 1 for an overbank threshold of 20 GL/day. The analysis indicates that the total number of flood events over the period 1896 to 2008\(^8\) increases from 75 under the Baseline scenario to 140 under the BP-2750 scenario. The number of years with flood events increases from 40 under the Baseline scenario to 65 under the BP-2750 scenario, which increases the frequency of years with floods from 1 in 2.8 years under the Baseline scenario to 1 in 1.7 years under the BP-2750 scenario. Outputs of the spells analysis (hydrographs and flood statistics) are provided for the three gauging stations in Appendix A.

**Table 1** Spells analysis statistics for Maude Weir (Gauge 410040, overbank threshold 20 GL/day)

<table>
<thead>
<tr>
<th>STATISTICS</th>
<th>Baseline</th>
<th>BP 2750</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of flood events (1896 - 2008)</td>
<td>75</td>
<td>140</td>
</tr>
<tr>
<td>Number of years with flood events (1896 - 2008)</td>
<td>40</td>
<td>65</td>
</tr>
<tr>
<td>Frequency of years with floods (1 in X years)</td>
<td>1:2.8</td>
<td>1:1.7</td>
</tr>
<tr>
<td>Number of events per year (for years with flood events)</td>
<td>1.9</td>
<td>2.2</td>
</tr>
</tbody>
</table>

**GIS**

GHD proposed to use GIS information to calculate the extent of change in floodplain area inundated between the baseline and BP-2750, using the maximum extent of floodplain information and modelled flow inundation area (or historical flow inundation areas). Table 2 lists the GIS data that potentially could be used to calculate the extent of change in floodplain area inundation and the availability of the data for this Project.

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\(^7\) Spells Analysis is a statistical technique to estimate stream flow characteristics including timing, frequency and duration.

\(^8\) GHD decided to perform the spells analyses using calendar years (1896 - 2008), to minimise the risk of splitting a large rainfall event across two years (i.e. there are significantly less large rainfall events occurring over December / January compared to over June / July). Data for the years 1895 and 2009 are incomplete therefore are excluded from the analysis.
<table>
<thead>
<tr>
<th>Data</th>
<th>Source</th>
<th>Availability for this study</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘Overton floodplain layer’</td>
<td>CSIRO’s 2011-12 MDB-FIM floodplain GIS data</td>
<td>CSIRO noted that the Overton floodplain layer may not fit the purpose of this study and therefore was not made available to this project</td>
</tr>
<tr>
<td>Maximum Floodplain Extent</td>
<td>Extracted from the NASA Moderate Resolution Imaging Spectroradiometer combined with CSIRO’s SRTM Digital Elevation Model of Australia.</td>
<td>The accuracy of the inundation layer was deemed not to be sufficiently robust for use in this project</td>
</tr>
<tr>
<td>Land Subject to Inundation</td>
<td>Geoscience Australia 1:250,000 topographic data</td>
<td>The definition of land subject to inundation is “low lying land usually adjacent to lakes or watercourses, which is regularly covered with flood water for short periods”. Does not show the maximum extent of inundation. Data were used in this project for the Lower Murrumbidgee and Darling regions</td>
</tr>
<tr>
<td>Hydrological Indicator Sites</td>
<td>Murray Darling Basin Authority.</td>
<td>Hydrologic indicator sites for assets were compiled from following datasets:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- DIWA - Directory of Important Wetlands of Australia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- AUSHYDRO Watercourse Lines - Named with 5m Buffer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Wetlands GIS of the Murray-Darling Basin Series 2.0 - clipped as directed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- RAMSAR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- CAPAD</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- AUSHYDRO Lakes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- AUSHYDRO Watercourse Areas</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Indicative the Living Murray Icon Sites</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Nth B watercourse areas Sthn B 56flood</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- MCMA Wetlands</td>
</tr>
<tr>
<td></td>
<td></td>
<td>This layer was available for the Lower Murrumbidgee and Lower Balonne</td>
</tr>
<tr>
<td>Narran Lakes Scoping Study (Thoms et al. 2002)</td>
<td>CRC for Freshwater Ecology</td>
<td>Sims et al, used remotely sensed Landsat TM images of 16 different flood events to investigate floodplain inundation for the Lower Balonne</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GHD could not locate flooding maps produced from this study</td>
</tr>
<tr>
<td>Landsat imagery (various years) and remote sensing to determine the area inundated</td>
<td>Office of Environment and Heritage</td>
<td>GHD investigated the possibility of using historical flood imagery to determine the extent of inundation for different flows. Lack of time to field test the data for accuracy meant it was not used in this project.</td>
</tr>
</tbody>
</table>
Table 2 shows what is potentially available for future use to assess the extent of floodplain inundation under different scenarios. However, due to concerns over accuracy of the data for this project, GHD relied on stakeholders to provide anecdotal information on perceived changes to the extent of inundation under the BP-2750 scenario compared to the baseline. A series of hydrographs were produced to assist floodplain producers assess the changes likely to occur with the BP-2750 scenario compared to the baseline.

To determine the land use of the floodplain for the scenario models, GHD used the GIS layers listed in Table 3 to map the ‘floodplain’ (See Appendix B for maps of the ‘floodplain area’). These layers were overlayed with the Australia Collaborative Land Use and Management Program (ACLUMP - updated March 2010) supplied by the Department of Agriculture, Fisheries and Forestry to determine the current land use of the floodplain.

<table>
<thead>
<tr>
<th>Study Area</th>
<th>GIS Layer</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower Murrumbidgee/Lower Lachlan</td>
<td>Geoscience Australia 1:250,000 topographic data - Land Subject to Inundation</td>
<td>The focus group indicated that this layer did not map the maximum extend of inundation. It also was underestimating the extent of flooding at 20 GL/day at Maude Weir.</td>
</tr>
<tr>
<td>Lower Darling</td>
<td>Geoscience Australia 1:250,000 topographic data - Land Subject to Inundation</td>
<td>The only available data of the floodplain.</td>
</tr>
<tr>
<td>Lower Balonne</td>
<td>Hydrological Indicator Site layer from MDBA being a composite of multiple datasets (see Table 2).</td>
<td>It is recognised that inundation patterns in the Lower Balonne are complex and follow the courses of palaeo channels across the region. However, with no other information available, GHD adopted the Hydrological Indicator Site layer to define the floodplain.</td>
</tr>
</tbody>
</table>

2.1.2 Selection of floodplain areas for analysis

Due to time constraints, the analysis focused on a sub-set of floodplain regions with outcomes extrapolated across the Murray Darling Basin (MDB) based on transparent assumptions.

The MDB is divided into 19 Basin Plan (BP) regions, however it was considered that the majority of benefits of the BP for primary production on floodplains were likely to be captured in relatively few regions. This was supported by a CSIRO (2012) report to the MDBA which identifies three regions as having high qualitative values of incremental changes in the supply of ecosystem services under a 2,800GL scenario relative to the baseline (see Table 6.3 of the CSIRO report).

MDBA has also published assessments of environmental water requirements (EWR) for the proposed BP for a number of the regions (MDBA 2012b). GHD reviewed these EWR for selected regions to gain an understanding of the data within the regions that are available to support the floodplain project.
GHD constructed a shortlist of BP regions for possible selection and considered these against a number of criteria. The criteria for selection were:

- Incremental value from CSIRO 2012 report (discussed above) – short list includes only those regions with high or medium incremental change in floodplain grazing value;
- Hydrology data from EWR reports (discussed above);
- Extent of potential floodplain grazing – based on review of EWR reports, discussions with MDBA and GHD’s knowledge of the regions;
- Potential impact of 2,750GL Basin Plan scenario – assessment of the potential for flow management to expand floodplain grazing and cropping. This is separate from floodplain inundation as a result of uncontrolled flooding events; and
- Availability of landholders and agency staff (eg CMAs) to discuss floodplain agriculture.

Table 4 is a matrix of the above criteria for a shortlist of six BP regions. GHD subjectively assigned a ranking between 1 (low) and 5 (high) for each criterion and summed these to guide selection.

### Table 4 Floodplain region selection matrix

<table>
<thead>
<tr>
<th>Basin Plan region</th>
<th>CSIRO floodplain value</th>
<th>Hydrology data</th>
<th>Extent of floodplain grazing</th>
<th>Impact of 2800^9 scenario on floodplain grazing extent</th>
<th>Landholders for engagement</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barwon-Darling</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>19</td>
</tr>
<tr>
<td>Condamine-Balonne</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>5</td>
<td>21</td>
</tr>
<tr>
<td>Goulburn-Broken</td>
<td>3</td>
<td>5</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>Murray-Middle</td>
<td>5</td>
<td>5</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>Murrumbidgee</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>19</td>
</tr>
<tr>
<td>Warrego and Paroo</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>9</td>
</tr>
</tbody>
</table>

From the above, GHD selected to base the majority of data collection on the following regions (Figure 4):

- Barwon-Darling River upstream of Menindee Lakes;
- Lower Balonne River Floodplain; and
- Lower Murrumbidgee River Floodplain and its intersection with the lower Lachlan River.

More detailed mapping of the regions is provided in Appendix B.

GHD recognises that selection of the three regions means that data cannot simply be extrapolated across the Basin. Assessed benefits from the three regions are likely to be higher than in other regions, meaning that simple extrapolation is likely to bias results and predict overall benefits as higher than would occur. This is discussed further in section 6.7.

9 Based on CSIRO 2012.
Figure 4 Study Area

Legend

--- Rivers

Study Areas

MDB

Lower Balonne - Hydrological Indicator Sites, MDB
© Murray Darling Basin Commission

Darling and Lower Murrumbidgee - "Land Subject to Inundation", Rivers States
© Commonwealth of Australia, Geoscience Australia

Study areas

MDBA
Benefits of Basin Plan for Primary Producers

Job Number: 21-21461
Revision: A
Date: 30 May 2012

1:171,113,372 (at A3)
2.1.3 Engagement with primary producers in floodplains in the Basin

The purpose of the stakeholder consultation was to develop a more detailed understanding of primary producers on floodplains in the Basin and the potential benefits of the proposed Basin Plan for agricultural production including:

- Farm physical details;
- Understanding of the nature of floodplain production activities;
- Historical benefits of flood events for management of agricultural production; and
- The values floodplain-based producers hold in relation to landscapes and their management.

GHD employed an engagement strategy with the purpose of informing our analysis and increasing the robustness of the study. The engagement was not based on consulting a representative sample of affected landholders, nor was it a community engagement exercise.

As such, GHD undertook consultation with key informants in the selected regions to obtain information on floodplain production and the likely benefits (and possible drawbacks) of BP-2750 over the baseline. A multi-step engagement process was conducted including face-to-face case studies, focus groups, as well as phone surveys. Table 5 shows the planned and actual consultation activities completed. Actual numbers attending focus groups were less than planned because flooding along the Darling caused the closure of local roads resulting in producers being unable to congregate for a meeting. Additional phone interviews were undertaken to compensate.

Participants in the study were recruited using two primary approaches: i) by responding to a request for expressions of interest from the Australian Floodplain Association (AFA) following discussions between the AFA and MDBA about the proposed study; and ii) identification of key informants by GHD during conversations with regional Catchment Management Authority staff and landholders who had responded to the request for EOI from the AFA. While the AFA sent out the request to its members, these members were encouraged to speak with and to nominate others, including those who were not members. A list of respondents was compiled by MDBA and provided to GHD. GHD then reviewed the list, selecting respondents from the selected case study regions and supplementing these with the key informants.

While there were no specific criteria for selection, all landholders had at least some part of their properties located on floodplains and all were willing to provide quantitative and qualitative information on the impact of flooding regimes on property management and profitability and discuss the perceived impacts of the proposed Basin Plan. The timeframe for the study did not allow GHD to attempt to ensure participants would be a representative sample of all producers within the individual regions or across the Basin.

The stakeholder recruitment process (self-nomination and key informants) potentially creates a risk that information provided is biased towards more positive benefits of floodplain production. This is acknowledged by GHD and is accommodated to some extent through completing sensitivity analyses of key assumptions in the financial model. The potential bias could be removed through a further study that included consultation with a more representative sample of landholders from all Basin regions.

**Case studies**

GHD undertook two case studies in each of the three regions (total of six case studies) to obtain more in-depth detail of floodplain grazing and cropping and the expected benefits from the proposed Basin Plan.
Lower Murrumbidgee and Lower Balonne case studies were conducted at the floodplain producers’ properties.

**Focus groups**
GHD proposed to undertake one focus group in each of the three chosen floodplain regions (total of three focus groups. The aim of the focus group was to workshop the benefits/costs and other related impacts of the various flow regimes in each of the regions and gain an understanding of potential impacts on farm management. Members of each group were supplied with an outline of the data sought to quantify impacts. The focus group meetings were also used to review the gross margin and fixed cost variables for adoption in the model. The agenda of the focus group meeting is provided in Appendix C.

**Phone surveys**
GHD conducted 16 phone surveys across the three regions to capture information from landholders not able to attend the focus group meetings.

Case studies, focus groups and phone surveys were guided by a semi-structured interview protocol developed by GHD to capture the relevant information required. Drafts of these were provided to the SC and ISP and comments incorporated in final protocols (see Appendix C).

<table>
<thead>
<tr>
<th>Region</th>
<th>Stakeholder engagement activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower Murrumbidgee / Lachlan</td>
<td></td>
</tr>
<tr>
<td>Focus group attendees</td>
<td>10</td>
</tr>
<tr>
<td>Case studies</td>
<td>2</td>
</tr>
<tr>
<td>Phone interviews</td>
<td>4</td>
</tr>
<tr>
<td><strong>Darling</strong></td>
<td></td>
</tr>
<tr>
<td>Focus group attendees</td>
<td>10</td>
</tr>
<tr>
<td>Case studies</td>
<td>2</td>
</tr>
<tr>
<td>Phone interviews</td>
<td>4</td>
</tr>
<tr>
<td><strong>Lower Balonne</strong></td>
<td></td>
</tr>
<tr>
<td>Focus group attendees</td>
<td>10</td>
</tr>
<tr>
<td>Case studies</td>
<td>2</td>
</tr>
<tr>
<td>Phone interviews</td>
<td>4</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>48</td>
</tr>
</tbody>
</table>

**2.2 Model**
Using the information from the hydrological analysis and stakeholder consultation, GHD developed an Excel-based model for each of the three study regions. The purpose of the model scenarios was to make
a preliminary assessment of the benefits of the proposed Basin Plan for primary producers on the floodplain.

This project constructed a modified benefit-cost analysis (BCA) of the marginal benefits in floodplain agricultural production as a result of the proposed Basin Plan compared to the baseline. The modified BCA was constructed using the 2009 baseline data and BP–2750 scenario. The project considered the benefits over a 20-year time period. All calculations in this report are Net Present Values based on 2012 dollars, discounted over 20 years unless otherwise stated.

Further details regarding the model are provided in Section 6.

2.3 Monitoring and evaluating

Drawing on the tasks undertaken in this project, GHD proposes further works that could be undertaken to more comprehensively assess the benefits of the proposed Basin Plan for primary producers on floodplains in the Basin. Further details are provided in Section 7.
3. Literature Review

This section is designed to cover the following sections of the project Terms of Reference:

- Undertake a literature review to summarise what is already known about primary producers on floodplains in the Basin, and identify key issues and gaps in current understanding about floodplain agriculture, including:
  - industry characteristics (e.g. value of production, number of enterprises, location, extent and significance);
  - understanding the broader and economic context and the drivers of change influencing these; and
  - the socioeconomic profile and trends for the communities, including demographic information such as:
    - population characteristics (size, age profiles);
    - employment;
    - education;
    - income;
    - indices of advantage and disadvantage as measures of vulnerability, adaptive capacity and resilience; and
    - an indication of the relative importance of agricultural production on the floodplains for these communities.

3.1 Floodplain agriculture

A floodplain is relatively flat land adjacent to a river that experiences occasional or periodic flooding (Arche 2010 and CIE 2011). Floodplains support ecological communities that have developed to suit this pattern of inundation. In many situations, the pattern of flooding and deposition of topsoil has created highly fertile floodplain country that is suitable for farming and grazing enterprises (Arche 2010). These floodplain wetlands are essential to the maintenance of the hydrological, physical and ecological health of the riverine environment (CIE 2011).

Floodplain systems are characterised by a high degree of variability in both the frequency and period of inundation (Baldwin and Mitchell, 2000). Elements of a floodplain system have the potential to remain inundated even during the most severe droughts. On the other hand, higher floodplain benches may only be inundated for very short periods. Flooding and drying patterns of many lowland floodplain systems have changed due to river regulation (Baldwin and Mitchell, 2000).

Floodplains provide relatively moist and thus productive habitats for groundcover plants in arid and semi-arid regions (Morton, 1990). Floodplains throughout Australia provide floodplain and river communities with food and habitat resources for native fauna that otherwise range across large areas of surrounding landscape (Kingsford, 2000).

As in many other countries, Australian floodplains also support a large pastoral industry (Reid et al, 2011). Widespread flooding occurs periodically due to the gently sloping terrain, low banks and
meandering nature of the drainage profile. In regions where rainfall is extremely variable these periodic floods, which can occur without local rainfall, are considered by most landholders to be highly desirable (Mottell 1995).

Vegetation distribution and productivity on dryland river floodplains are heavily influenced by flooding and flood history (Bagstad et al., 2006). Climate change has the potential to reduce the frequency of flooding, with possible flow-on effects on the composition and productivity of plant communities and the health of pastoral economies (CSIRO, 2008; Thomas and Brandt, 1994; Pierce, 1996; Gregory et al., 1997; Morrison, 1999). Mitigation of these impacts requires a good understanding of the relationship between flooding and both productivity (Baldwin and Mitchell, 2000; Ogden et al., 2007) and community composition.

Reid et al (2011) suggest that determining the relationships between flooding and vegetation productivity and distribution on floodplains is not straightforward because of the complex nature of plant responses to wetting and complications from other environmental factors affecting vegetation. Productivity may be elevated through moisture from flooding (Bagstad et al., 2005), however this is not guaranteed and floodwater also has the potential to reduce production in waterlogged areas (Sims and Thoms, 2002).

Soils on floodplains are generally heavy grey/brown cracking clay soils which require substantial volumes to wet them (Mottell 1995). Farmers take advantage of the wet soil profile to grow winter crops and graze animals in the following year on growth promoted by residual soil moisture. Floodplain soils require deep saturation that can only come from flooding events.

Floodplain cropping in the Nimmie-Caira region of the Lower Murrumbidgee is a unique system that differs from the flood-dependent floodplain cropping in other regions. Here, a system of check banks allows the ponding of diverted floodwater on a field for up to four weeks in order for deep water penetration. The ponding kills weed seeds which enables producers to grow crops without the use of herbicides and thus obtain organic status for their produce (MCMA 2009, GRDC 2011). Eastburn (2007) describes that cultivation after ponding seals the moisture in the soil and reduces evaporation over the hottest months. The residual water eventually drains back into the floodway and continues downstream creating significant environmental benefit (DLWC 1999). (Note that GHD considers that this is more typical of an extractive enterprise rather than a floodplain enterprise and as such the area of land assessed as floodplain in the Lower Murrumbidgee/Lower Lachlan does not include the Nimmie-Caira area for this project).

Farmers in the Lower Murrumbidgee have used the nutrients and naturally occurring chemicals released from floodplain soils in order to support their organic and conventional cropping enterprises. Through using the lands’ natural tendency to flood, the cropping regime requires no inputs of fertilisers and chemicals and also greatly reduces the problem of weeds.

3.2 Location and extent of Floodplains

Floodplains are dispersed across the Murray Darling Basin with the majority located below 250 metres (AHD) and where there is less than 500 millimetres of annual rainfall (Kingsford et al, 2004). Table 6 provides a summary of the Basin sub-catchment land areas, including the floodplain area for many catchments. The floodplain areas are from Kingsford et al (2004) and exclude wetlands, lakes and reservoirs but do include some land with non-agricultural use. The Murray Darling Basin covers approximately 106 million ha of which 77% of land is used for agricultural production and 3% of that is used for irrigated agriculture. The North West catchments of Warrego, Condamine-Balonne and Paroo
have the highest proportion of total catchment area defined as floodplains (11.1%, 10.5% and 26.6% respectively). Floodplain areas of other catchments range between 1% and 6% of total area.

Data for floodplain areas below the River Murray are not available. CSIRO (2012) states that grazing of floodplains in the southern Basin has effectively been eliminated in recent years due to the change in land tenure from freehold to National Park (e.g. Yanga and the Taroo group), from State Forest or State Park to National Park or Indigenous Protected Area (e.g. Lower Ovens, Lower Goulburn, Lindsay–Wallpolla, Barmah, Wera, Millyela, Baroonga). Grazing is now much more of an issue for floodplain management in the northern Basin, especially in the Gwydir Wetlands, southern Macquarie Marshes, parts of the Warrego and Darling systems, and parts of the Lachlan (those in the semi-arid zone; the higher rainfall areas are cropping country).

3.3 Value and Significance of Floodplain Agriculture

A series of community profiles were developed by Marsden Jacob Associates (MJA 2010) based on the CSIRO’s Sustainable Yield regions. These profiles along with ABS, ABARE & BRS (2009) data examine a range of different aspects of the socio-economic implications of reducing diversions, relative to baseline diversion limits. These studies were prepared for each region and separate catchments by total agricultural land and total irrigated land.

Non-irrigated gross value of agricultural production (GVAP) for the MDB was approximately $9.4 billion in 2006 (Table 6). The final column in Table 6 shows GHD’s calculation of an estimate of the GVAP for floodplain agriculture at $395.5 million per year (floodplain percentage of dryland area multiplied by total GVAP for dryland agriculture). This is a crude estimate as it assumes similar production values from dryland and floodplain agriculture but it gives some guidance on the value of floodplain agriculture which is otherwise not available. GHD compares this estimate further in section 6.6.

Floodplain agriculture is not only important in sustaining the farming enterprises that directly rely upon flooding events for vegetation growth; it is also essential in supporting and sustaining the economies of many rural communities. Eastburn (2003) outlines that the Lower Murrumbidgee floodplain has played a central role in the economy and society of the Hay-Balranald district since European settlement:

“The inundation of the floodplain provided a rich environment to support a large Aboriginal population for tens of thousands of years and was the key element on which large pastoral properties were built and maintained over the past 150 years. Today, the inundation of the rich alluvial soils of the floodplain supports the largest organic grain-growing area in Australia. The red gum forests have also played a key part of the traditional Aboriginal and European economy of the area. Over the past two decades the sustainable harvesting and milling of the red gum and the utilisation of the dead waste from past harvesting operations has contributed greatly to the economy of the Balranald district.”

Many of these communities are also reliant on tourism which is a major income earner for outback towns along river systems when rivers are in a healthy state. Poor river health reduces the contribution to rural communities made by tourists (Australian Floodplain Association 2010).

Historically, the main commercial agricultural activity on floodplains was the grazing of sheep and cattle. Eastburn (2003) reports that the declining value of wool from 1958 and a highly profitable barley crop grown in the Lower Murrumbidgee resulted in many farmers expanding their operations to include both livestock grazing and cropping. Floodplain farmers and graziers have traditionally been very responsive to global markets being able to benefit from good years through opportunistic farming and the ability to
move between the sheep (food and fibre) and cattle (food) production markets (Australian Floodplain Association 2010).
### Table 6  Floodplain areas

<table>
<thead>
<tr>
<th>Sub-catchment</th>
<th>Region (Ha)</th>
<th>Agriculture (Ha)</th>
<th>Irrigated Agriculture (Ha)</th>
<th>Dryland Agriculture (DA) (Ha)</th>
<th>Floodplain Area (Ha)</th>
<th>Floodplain as % of MDB</th>
<th>Floodplain as a % of Region</th>
<th>Floodplain as a % of DA</th>
<th>Dryland Ag GVAP ($m)</th>
<th>Floodplain contribution to DA GVAP ($m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warrego</td>
<td>7,630,492</td>
<td>7,477,882</td>
<td>300</td>
<td>7,477,582</td>
<td>843,262</td>
<td>0.79%</td>
<td>11.1%</td>
<td>11.3%</td>
<td>99</td>
<td>11.16</td>
</tr>
<tr>
<td>Condamine-Balonne</td>
<td>13,629,225</td>
<td>12,402,595</td>
<td>1,116,234</td>
<td>11,286,361</td>
<td>1,435,964</td>
<td>1.35%</td>
<td>10.5%</td>
<td>12.7%</td>
<td>1,145</td>
<td>145.68</td>
</tr>
<tr>
<td>Paroo</td>
<td>3,553,636</td>
<td>3,375,954</td>
<td>N/A</td>
<td>3,375,954</td>
<td>945,616</td>
<td>0.89%</td>
<td>26.6%</td>
<td>28.0%</td>
<td>15</td>
<td>4.20</td>
</tr>
<tr>
<td>Moonie / Border</td>
<td>5,829,254</td>
<td>4,795,813</td>
<td>86,028</td>
<td>4,709,786</td>
<td>108,652</td>
<td>0.10%</td>
<td>1.9%</td>
<td>2.3%</td>
<td>594</td>
<td>13.70</td>
</tr>
<tr>
<td>Gwydir</td>
<td>2,498,874</td>
<td>2,074,065</td>
<td>51,852</td>
<td>2,022,214</td>
<td>58,792</td>
<td>0.06%</td>
<td>2.4%</td>
<td>2.9%</td>
<td>335</td>
<td>9.74</td>
</tr>
<tr>
<td>Nambour</td>
<td>3,888,091</td>
<td>2,871,426</td>
<td>89,014</td>
<td>2,782,411</td>
<td>45,775</td>
<td>0.04%</td>
<td>1.1%</td>
<td>1.6%</td>
<td>567</td>
<td>9.33</td>
</tr>
<tr>
<td>Macquarie-Castlereagh</td>
<td>7,363,412</td>
<td>6,111,632</td>
<td>42,781</td>
<td>6,068,851</td>
<td>436,292</td>
<td>0.41%</td>
<td>5.9%</td>
<td>7.2%</td>
<td>722</td>
<td>51.90</td>
</tr>
<tr>
<td>Barwon-Darling</td>
<td>14,250,128</td>
<td>13,252,619</td>
<td>397,579</td>
<td>12,855,040</td>
<td>450,405</td>
<td>0.42%</td>
<td>3.2%</td>
<td>3.5%</td>
<td>305</td>
<td>10.69</td>
</tr>
<tr>
<td>Lachlan</td>
<td>8,565,456</td>
<td>7,194,983</td>
<td>64,755</td>
<td>7,130,228</td>
<td>445,794</td>
<td>0.42%</td>
<td>5.2%</td>
<td>6.3%</td>
<td>992</td>
<td>62.02</td>
</tr>
<tr>
<td>Murrumbidgee</td>
<td>8,724,183</td>
<td>7,066,588</td>
<td>353,329</td>
<td>6,713,259</td>
<td>262,933</td>
<td>0.25%</td>
<td>3.0%</td>
<td>3.9%</td>
<td>1,239</td>
<td>48.53</td>
</tr>
<tr>
<td>Murray</td>
<td>20,775,824</td>
<td>15,374,110</td>
<td>491,972</td>
<td>14,882,138</td>
<td>350,220</td>
<td>0.33%</td>
<td>1.7%</td>
<td>2.4%</td>
<td>1,213</td>
<td>28.55</td>
</tr>
<tr>
<td>Wimmera</td>
<td>3,051,137</td>
<td>2,410,398</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>807</td>
<td>N/A</td>
</tr>
<tr>
<td>Loddon-Avoca</td>
<td>2,480,653</td>
<td>2,058,942</td>
<td>137,949</td>
<td>1,920,993</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>594</td>
<td>N/A</td>
</tr>
<tr>
<td>Campaspe</td>
<td>393,681</td>
<td>303,134</td>
<td>22,432</td>
<td>280,702</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>110</td>
<td>N/A</td>
</tr>
<tr>
<td>Goulburn-Broken</td>
<td>2,220,130</td>
<td>1,354,279</td>
<td>203,142</td>
<td>1,151,137</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>415</td>
<td>N/A</td>
</tr>
<tr>
<td>Ovens</td>
<td>777,240</td>
<td>303,124</td>
<td>12,125</td>
<td>290,999</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>123</td>
<td>N/A</td>
</tr>
<tr>
<td>Eastern Mt Lofty Ranges</td>
<td>468,721</td>
<td>393,726</td>
<td>23,624</td>
<td>370,102</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>132</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>106,200,137</td>
<td>88,821,270</td>
<td>3,093,114</td>
<td>83,317,758</td>
<td>5,383,725</td>
<td>5.07%</td>
<td>5.1%</td>
<td>6.5%</td>
<td>9,407</td>
<td>395.50</td>
</tr>
</tbody>
</table>


N/A – data not available.

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3.4 Demographic profile

3.4.1 Murray-Darling Basin

Table 7 summarises some key demographic information for the MDB. The MDB is home to over two million Australians and accounts for 68,000 of Australia’s 103,000 farmers. Irrigated agriculture is a major activity in the Basin and supports approximately 3.4 million people including 2.1 million people who live within the Basin and 1.3 million people living in the immediate vicinity of the Basin (Nous Group 2010).

The MDB contains 20% of Australia’s agricultural land holdings, 39% of Australian farms and 65% of Australia’s irrigated land. In 2004-05, the agriculture sector accounted for around 83% of consumptive water use and accounts for around 84% of total land area. However, irrigated agriculture accounts for a relatively small proportion (around two per cent) of the total area used for agriculture in the Basin (Nous Group 2010).

Irrigated agricultural development has occurred differently in the northern and southern parts of the Basin. The MDBA (2011a) outlines that cotton is the dominant crop in the north of the Basin, and rice in the south centred around the Murrumbidgee and Murray Valleys. The dairy industry is centred in the Goulburn–Murray and horticulture is scattered throughout the Basin, however is more prevalent in the southern parts of the Basin.

The largest employment sector in the Basin is wholesale and retail trade (14% of employed persons) followed by public administration and education and training services. The ABS reports that approximately one-third of businesses within the Basin are in the agriculture, forestry and fishing sector. Also, the agriculture, forestry and fishing sector employed around 18% of the Basin workforce in 2006 equating to approximately 90,000 people.

The literature does not separately identify the demographics of floodplain producers. However, following are some broad aspects of Basin communities (northern, central and southern; see Figure 5) with inferences related to floodplain agriculture.
Figure 5 Basin Plan Regions

Legend

MDBA BASIN PLAN REGIONS  MDB

MDBA Basin Plan Regions, MDB
© Murray Darling Basin Commission

States
© Commonwealth of Australia, Geoscience Australia

3.4.2 Northern Basin (Paroo, Warrego, Condamine-Balonne, Moonie, Border Rivers)

Agriculture in the Queensland catchments was predominantly based on the extensive grazing industries prior to irrigation development. The higher rainfall areas of the eastern part of the region supported higher stocking rates, whilst the country west of St George is part of the broader pastoral zone of the Australian interior. In between, the Darling Downs have always supported a thriving broadacre cropping industry. Cotton has become the dominant agricultural industry since the broader development of irrigation resulting from the construction of dams (MJA et al 2010).

The beef industry is the second most significant agricultural industry in the region. Grazing is the dominant land use of the river flood plain and pastoral country in the south and west of the region.

The region is highly reliant on agriculture with approximately one third of all jobs (12,105) directly associated with agriculture, forestry and fisheries (refer to Table 7). Opportunities for diversification into irrigation crops that have lower water use are limited, as other regions already have a competitive advantage in those crops. A reduction in diversion limits is likely to lead to irrigated agriculture being replaced by dryland cropping and pastoral production.

3.4.3 Central Basin (Gwydir, Namoi, Macquarie-Castlereagh, Barwon-Darling)

The Gwydir valley is the largest cotton-growing region in Australia, with over 100 growers producing an average of around 460,000 bales per year (between 2000 and 2008). Dryland cropping and livestock is very profitable in this region depending on the season and commodity prices. Largely due to the heavy clay soils, livestock and cropping enterprises are generally undertaken on separate parts of a farm rather than in rotation.

The Barwon–Darling flows into the Lower Darling region between Wilcannia and Menindee. The region’s agricultural land use is dominated by dryland grazing. The dominant irrigated crop in the region is cotton, accounting for 93% of water used for irrigation.

Traditionally Bourke’s agricultural fortunes were centred on the wool industry. The advent of off-river storages has seen the development of a cotton industry at Bourke. The major land use in terms of area remains dryland pasture for sheep and cattle. The predominant irrigated farming system at Bourke is cotton. Cotton is a major source of regional economic activity where it is grown and generated close to 60% of the total value of agricultural production in 2001.

Increased environmental flows is likely to benefit floodplain graziers, as the benefits of a flood are said to last 2-3 years after the flooding event and increase production capacity by 100-150%. This would have flow on effects to communities in terms of purchases for goods and services. Flooding has a big impact on the gross profit of these graziers (EBC et al 2011).

In the Macquarie Valley, both the number of cotton growers and the amount sown and harvested varies each year in accordance with comparative prices and water availability. EBC et al (2011) estimated the gross value of agriculture production (irrigated and non-irrigated) in the Macquarie totalled $492 million (MJA et al 2010). The graziers in the lower reaches of the river rely on inundation of the floodplain to sustain grazing.

Provision of enhanced flows down the Macquarie to benefit the river and the Macquarie Marshes could lead to greater flooding of land used for grazing, as the large majority of the marshes are in private hands and are used conjunctively for grazing. There are up to fifty graziers in the wider region that might
benefit from greater frequency of flooding (MJA et al 2010). While it is not easy to place a dollar value on increased grazing, the results of an Australian Floodplain Association commissioned study suggest that:

- Flooding generates additional annual gross income of approximately $12.50 per ha of floodplain country;
- The Macquarie Marshes are approximately 150,000 ha; and
- That generates a potential annual benefit of $1.875 million per year.

3.4.4 Southern Basin (Lachlan, Murrumbidgee, Murray)

The Lachlan catchment covers an area of 84,700 km², running from Crookwell and Gunning in the east to Oxley and Ivanhoe in the west. The Lachlan River rises near Yass and flows for approximately 1,450 km to the Great Cumbung Swamp, northwest of Hay. The Lachlan River terminates in wetlands and effluent (diverging creeks) in the lower part of the catchment and is only intermittently connected to the Murrumbidgee River when both rivers are in flood. This has occurred only twice in the last 100 years.

The Griffith and Hay catchments are highly reliant on agriculture. The lack of diversity in the economy of this western portion of the region indicates that these communities are highly dependent on irrigated agriculture both directly and indirectly as a major source of economic activity and employment.

The Murray region extends from the Upper Murray to the confluence of the Murrumbidgee and Murray Rivers near Euston. The region focuses on a more intensively irrigated area extending from Berrigan in the east to Moulamein in the west.

Prior to irrigation development, the central NSW Murray area was used for extensive grazing in the Barham and Deniliquin catchments and dryland cropping and grazing in the Finley catchment. The development of irrigation involved closer settlement, development of villages and towns and the establishment of public utilities (EBC et al 2011).

The dryland farms created from the General Security water sales to Government are most likely to be absorbed into the remaining farm businesses. The dry land would be used for opportunity farming including livestock grazing in higher rainfall years and small areas of irrigated summer cropping (rice) in those years of higher water availability. A viable dryland farm in the western area (Deniliquin – Wakool) would be in the order of 10 times larger than the standard irrigation farm. The higher rainfall within the Finley social catchment provides greater scope for dryland farm business viability to complement rather than replace irrigation, particularly in the south eastern areas of Murray Irrigation and West Corurgan Irrigation (EBC et al 2011).

3.4.5 Socio-economic indicators

Table 7 includes the Socio-Economic Index for Areas (SEIFA) level for the Basin sub-catchments. SEIFA is an index for comparing relative disadvantage across different areas. SEIFA is a composite of the following four indices:

- Index of Relative Socio-economic Disadvantage: is derived from Census variables related to disadvantage, such as low income, low educational attainment, unemployment, and dwellings without motor vehicles.
- Index of Relative Socio-economic Advantage and Disadvantage: a continuum of advantage (high values) to disadvantage (low values) which is derived from Census variables related to both advantage and disadvantage, like household with low income and people with a tertiary education.
- Index of Economic Resources: focuses on Census variables like the income, housing expenditure and assets of households.
- Index of Education and Occupation: includes Census variables relating to the educational and occupational characteristics of communities, like the proportion of people with a higher qualification or those employed in a skilled occupation.

This suite of indexes ranks geographic areas across Australia in terms of their socio-economic characteristics. Scores below the Australian average of 1000 are deemed to be relatively more disadvantaged than scores above 1000 which are deemed less disadvantaged compared with other areas. Two thirds of all observed SEIFA levels fall between 900 and 1100.

All sub-catchments in the Basin have SEIFA levels less than 1000 meaning they were relatively disadvantaged compared with other areas across Australia with the exception of the Murrumbidgee with a score of 1048. The Murrumbidgee SEIFA level is higher because of the inclusion of Canberra within the sub-catchment. The lowest SEIFA levels (Barwon-Darling and Warrego) are generally associated with remote communities.
### Table 7  Demographic profiles

<table>
<thead>
<tr>
<th>Sub-catchment</th>
<th>Area (Ha)</th>
<th>Population</th>
<th>% Ag Land</th>
<th>Agriculture Employment</th>
<th>Agriculture, Forestry, Fishing Employment</th>
<th>Median Income ($) p/w</th>
<th>SEIFA Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warrego</td>
<td>7,630,492</td>
<td>6,269</td>
<td>98</td>
<td>675</td>
<td>22</td>
<td>760</td>
<td>921</td>
</tr>
<tr>
<td>Condamine-Balonne</td>
<td>13,629,225</td>
<td>188,947</td>
<td>91</td>
<td>6,246</td>
<td>7</td>
<td>876</td>
<td>954</td>
</tr>
<tr>
<td>Paroo</td>
<td>3,553,636</td>
<td>409</td>
<td>98</td>
<td>103</td>
<td>52</td>
<td>477</td>
<td>958</td>
</tr>
<tr>
<td>Border Rivers</td>
<td>4,364,577</td>
<td>49,673</td>
<td>78</td>
<td>4,578</td>
<td>22</td>
<td>671</td>
<td></td>
</tr>
<tr>
<td>Moonie</td>
<td>1,464,677</td>
<td>1,899</td>
<td>95</td>
<td>503</td>
<td>50</td>
<td>833</td>
<td>965</td>
</tr>
<tr>
<td>Gwydir</td>
<td>2,498,874</td>
<td>25,354</td>
<td>83</td>
<td>2,827</td>
<td>26</td>
<td>780</td>
<td></td>
</tr>
<tr>
<td>Namoi</td>
<td>3,988,091</td>
<td>88,626</td>
<td>72</td>
<td>5,463</td>
<td>14</td>
<td>779</td>
<td></td>
</tr>
<tr>
<td>Macquarie-Castlereagh</td>
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<td>180,302</td>
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<td>5,953</td>
<td>8</td>
<td>845</td>
<td>954</td>
</tr>
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<td>93</td>
<td>1,212</td>
<td>17</td>
<td>765</td>
<td>901</td>
</tr>
<tr>
<td>Lachlan</td>
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<td>90,557</td>
<td>15</td>
<td>6,204</td>
<td>17</td>
<td>704</td>
<td></td>
</tr>
<tr>
<td>Murrumbidgee</td>
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<td>548,160</td>
<td>81</td>
<td>13,000</td>
<td>5</td>
<td>968</td>
<td>1048</td>
</tr>
<tr>
<td>Murray</td>
<td>20,775,824</td>
<td>309,845</td>
<td>74</td>
<td>19,292</td>
<td>15</td>
<td>792</td>
<td>939</td>
</tr>
<tr>
<td>Wimmera</td>
<td>3,051,137</td>
<td>47,617</td>
<td>79</td>
<td>3,978</td>
<td>19</td>
<td>729</td>
<td>930</td>
</tr>
<tr>
<td>Loddon-Avoca</td>
<td>2,480,653</td>
<td>146,758</td>
<td>83</td>
<td>5,771</td>
<td>9</td>
<td>718</td>
<td>937</td>
</tr>
<tr>
<td>Campaspe</td>
<td>393,881</td>
<td>47,051</td>
<td>77</td>
<td>1,420</td>
<td>7</td>
<td>909</td>
<td>978</td>
</tr>
<tr>
<td>Goulburn-Broken</td>
<td>2,220,130</td>
<td>147,086</td>
<td>61</td>
<td>7,872</td>
<td>12</td>
<td>836</td>
<td>947</td>
</tr>
<tr>
<td>Ovens</td>
<td>777,240</td>
<td>46,101</td>
<td>39</td>
<td>2,091</td>
<td>10</td>
<td>798</td>
<td>955</td>
</tr>
<tr>
<td>Eastern Mt Lofty Ranges</td>
<td>468,721</td>
<td>61,532</td>
<td>84</td>
<td>2,363</td>
<td>9</td>
<td>774</td>
<td>938</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>106,200,137</strong></td>
<td><strong>2,005,521</strong></td>
<td><strong>77</strong></td>
<td><strong>89,551</strong></td>
<td><strong>18</strong></td>
<td><strong>780</strong></td>
<td><strong>952</strong></td>
</tr>
</tbody>
</table>

3.5 Drivers of Change

3.5.1 Infrastructure construction

The construction of dams, primarily driven by irrigated agriculture, has had impacts on the hydrological patterns on a number of floodplains across the Murray-Darling Basin. “A cumulative synergy between dam building (including building of weirs and off-river storages) and diversion increasingly alienates floodplain wetlands by reducing the frequency and volume of flows to them” (Kingsford 2000). Wilson et al (2009) found that the construction of Copeton Dam in the Gwydir Catchment in 1976 resulted in a “significant reduction in flood frequency, duration and extent.” Since the development of Copeton Dam the floodplain vegetation has changed and “additional grazing pressure also impacts the response of native wetland vegetation following inundation.” Eastburn (2003) also commented that in the Murrumbidgee Valley “natural flooding occurs less frequently than under pre-regulation conditions because small and medium floods are captured in Burrinjuck (constructed in 1928) and Blowering (constructed in 1968) storages.” Cullen et al (2003) also point out that while infrastructure has impacted on small and medium flooding events, it should not impact upon larger flooding events which are expected to still occur on average every ten years in the Lower Balonne.

Mottell (1995) argues that irrigation developments, which may deliver productivity gains in a small area, inevitably cause massive permanent reductions in productivity in larger areas. They believe that both grazing and irrigation enterprises can exist on the floodplain if proper planning is implemented to provide for all to share in the water resource.

Large irrigation storages have also affected the seasonality of flow peaks as water is stored and released downstream in order to meet the demands of irrigation. Within the southern Basin these flow peaks usually occur in late-summer but also are common within the Macquarie, Gwydir and Namoi Rivers in central and northern NSW (Crossman et al 2011).

Regulations of rivers and creation of large storages have reduced the frequency and duration of flooding events. Flow regulation has resulted in a “Size or complete elimination of the many small to medium sized floods that would have naturally occurred” (Crossman et al 2011). From an ecological perspective, it is these small to medium floods that are required to sustain the flood dependent vegetation in significant parts of the floodplain (Eastburn 2003).

3.5.2 Reductions in extent of flooding

The reduction in these small to medium floods also impacts on the viability and sustainability of many regional communities:

“In the northern areas of the Murray-Darling Basin floodplain properties significantly outnumber irrigation properties. These farmers and graziers who have traditionally relied upon overland flows to prime their land have been directly and adversely affected by the gradual and continuous loss of water across their land through the diminution in size and frequency of flood events – this has halved income, seen small rural communities diminish or disappear – these communities will benefit from healthier rivers” (Australian Floodplain Association 2010).

Mottell (1995) also found that in undertaking consultation with landholders on the Lower Balonne Floodplain “the smaller, or minor flood on a more or less regular basis was considered to be the most important. It is the minor flood which produces social and economic benefits and simple sustainability of
enterprise and the existing ecosystems on the floodplain. Without the smaller flood events the productivity and bio-diversity of the flood plain and its wetlands would decline.” In a survey of landholders, Mottell found that 78.6% of landholders thought their land values would decrease if the number and frequency of small to medium floods reduce.

Where there is extensive pastoral activity on floodplains, the reduced frequency of flooding on these pastoral properties has resulted in a reduction in agricultural productivity. Pastoralists also reported a reduction in productivity due to grass growth from reduced wetting (Cullen et al 2003). Floodplain graziers estimate that “floodplain pastures become about 20 times more productive after a flood” (Wroe 2011) and would welcome environmental flows that flood their property if legal rights to establish voluntary ‘flood easements’ could be overcome.

Thoms et al (2002) also noted that the reduction in the frequency and extent of overbank flows on pastures has resulted in the decline of employment opportunities among aboriginal communities. Eastburn (2003) estimates that a reduction in floodwater levels of a matter of 30cm can mean that ‘hundreds or even thousands of hectares of land are not watered’ which in turn impacts on the ecology of the associated region. In relation to the duration of flooding there was no uniform response to the ideal number of days to which a farmer wanted their property inundated for and was dependent on the type of enterprise in which they were engaged (Mottell 1995).

3.5.3 Change in enterprise mix

The change in enterprise mix from traditional grazing to irrigated agriculture represented a significant shift in land use and water resource requirements. This change in enterprise mix resulted in the construction of levee banks and additional water storages in order to meet the expansion of irrigated agricultural land across the Basin particularly around cotton crops. In the Lower Balonne, where the major irrigated crop is cotton, the area planted to cotton ‘has increased from approximately 4,300 ha in 1998 to some 38,000 ha in 1999. Associated with this expansion in the cotton crop has been an expansion in water storage on the floodplain from 54,750 ML to more than 592,500 ML over the same period’ (Thoms et al 2002). Floodplains in Northern NSW and Queensland have been affected by the extraction of water for irrigation (Arche 2010). The Australian Floodplain Association in their submission to the Australian Government House of Representatives Inquiry into the impacts of the Murray-Darling Basin Plan on Regional Australia (2010) outlined their concerns on floodplain harvesting:

“The ability to intercept and divert floodplain flows on an individual’s property has a detrimental impact on the natural and healthy flow of water across a floodplain and impinges on the rights of fellow floodplain landholders to the water that would flow across their property if no ‘harvesting’ occurred.”

Thoms et al (2002) believes that “this may have a significant impact on the hydrology of the floodplain by effectively reducing the hydrological connectivity between river channels and floodplains.”

Eastburn (2007) describes the ‘symbiotic relationship’ that exists between people, seasonal flooding and the three major ecosystems in the Lower Murrumbidgee. He outlines that landholders are conscious of the ecosystem mix that exists in the area and their practice of movement of stock between floodplain and surrounding saltbush ecosystems:

“Stock was moved to graze on the saltbush plains in winter and back to the floodplain vegetation in summer, after flooding had receded, so that both ecosystems could be rested.”

Assessment of Benefits of the Basin Plan for Primary Producers on Floodplains in the Murray-Darling Basin

Final Report
3.5.4 Benefits and damages associated with flooding

There is limited literature on the benefits and damages associated with overbank flows. Mottell (1995) in undertaking their work with the landholders in the Lower Balonne has sought to outline the benefits and damages associated with conducting agricultural enterprises on floodplain country.

Landholders reliant on floodplain agriculture prefer effective rainfall over average rainfall. Mottell (1995) describes effective rainfall as “that rainfall which adds to sub-soil moisture or that rainfall which exceeds total evaporation over a 10 day growing period.”

While landholders agreed that damage is caused by flooding, this was clearly outweighed by the benefits. Landholders categorised the damages and benefits caused by flooding as:

<table>
<thead>
<tr>
<th>Damages caused by flooding</th>
<th>Benefits of flooding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potential for stock losses due mainly to inadequate management</td>
<td>Forced destocking of floodplain</td>
</tr>
<tr>
<td>Minor damage to fencing and roadways</td>
<td>Increased wool production</td>
</tr>
<tr>
<td>Ruins existing forage which may not regrow for some months</td>
<td>Increased stocking rates</td>
</tr>
<tr>
<td>Environmental damage, growth of woody weeds and loss of some species</td>
<td>Increased joining opportunities</td>
</tr>
<tr>
<td></td>
<td>Increased wool cut per sheep</td>
</tr>
<tr>
<td></td>
<td>Opportunities to shear lambs</td>
</tr>
<tr>
<td></td>
<td>Opportunities to carry over lambs</td>
</tr>
<tr>
<td></td>
<td>‘Guaranteed’ cropping opportunities in Year 1, with further opportunities in Years 2 and 3</td>
</tr>
<tr>
<td></td>
<td>Greater benefit from small rainfall events because of residual sub-soil moisture</td>
</tr>
<tr>
<td></td>
<td>Resting of ridge lines from domestic stock with conservation benefits</td>
</tr>
<tr>
<td></td>
<td>Rejuvenation of flood plain generally</td>
</tr>
<tr>
<td></td>
<td>Rejuvenation of flood plain species, particularly forage species</td>
</tr>
<tr>
<td></td>
<td>Social benefits with increased disposable income due to increased productivity</td>
</tr>
</tbody>
</table>

Landholders attributed most of the damage caused by flooding to be related to the “effects of velocity and flow.” Mottell’s analysis found that when landholders estimated the dollar cost of damage caused by flooding, some took into “account depreciation of machinery, costs of on-farm labour and other running costs” while some landholders “adopted the view that there was a net benefit in flooding and any damage suffered was incidental and should be ignored.” When landholders were surveyed about the benefits of flooding, 98% indicated that there were benefits while 2% indicated that floods do not give any benefits.

Across floodplain communities, the economic benefits associated with floodplain agriculture are widely recognised and the benefits gained from these flooding events may be apparent for some years after the
event. Mottell (1995) when examining the benefits of flooding with landholders in the northern Basin noted that “a flood not only generates financial benefits in increased stocking rates, greater profits and more assured cropping patterns, but that enormous social and environmental benefits are enjoyed. Security of family life, economic and environmental sustainability are all interdependent on each other.”

Smith et al (2006) in a study in the Lower Balonne also examined the community values associated with this floodplain. These values encompass economic, social, environmental, cultural heritage and aesthetic values. In particular, many residents appreciated the beauty of the floodplain, specifically mentioning an affinity for the large trees in the riparian zone, native wildflowers that bloom profusely in certain environmental conditions, and the numerous species of birds that visit or inhabit the floodplain and associated wetlands.

The two main agricultural benefits resulting from floods were increased stocking rates and increased production. Following a flood, there is the potential to increase the stocking numbers in order to produce profits. Mottell (1995) found that generally cattle numbers increased more than sheep as:

- Cattle more readily adapt to the wet conditions than sheep
- Cattle are more readily available on an agistment arrangement
- Cattle do not interfere with breeding programs in a predominantly sheep grazing enterprise.

It was generally found that the dollar value of grazing was realised in the first year after the flood event and then declined in the following two years as quality and quantity of feed declined.

Following floods, there are significant opportunities to increase cropping on flood prone land. Mottell found that there were generally increases in cropping areas by 70% across all the different types of flood levels. With cropping, the dollar value of increased cropping was realised in years 1 and 2 following a flood event. In some instances the greater dollar value was only realised in year 2 as some areas may remain inundated for long periods of time.

3.5.5 Future directions

With limited literature about the true impact of floodplain grazing across the Murray-Darling Basin, Mottell (1995) concluded that there is a clear need for an economic study to be completed at some time in the future so the real costs of floods, and the real benefits of floods, can be properly assessed.

The Australian Floodplain Association (2010) also believes that the socio-economic studies completed to inform the proposed Basin Plan are not representative of the contribution and role of non-extractive enterprises:

“Further socio-economic studies into the impacts of the proposed targets must include a full account of the socio-economic contribution made by floodplain producers to regional communities and a better appreciation of the fact that these enterprises have suffered through water being taken away through the process of over-issuing of entitlements. If water is returned to the rivers these enterprises will have an improved outcome economically, socially and mentally.”

The study by Arche Consulting (2010) Socio-Economics of Floodplain Agriculture in the Murray-Darling Basin concluded that there was “lack of sufficient information to support adequate consideration of the socio-economic impacts of floodplain agriculture to inform a planning process.”
4. Implications of the Proposed Basin Plan for Floodplain Producers

This section is designed to cover the following sections of the project Terms of Reference:

- Review current understanding of the implications of the Basin Plan for primary producers on floodplains in the Basin, including:
  - Reviewing proposed changes to water management regimes (e.g. changes to sustainable diversion limits or water resource plans) that would be implemented under the Basin Plan, in regions where floodplain-based agricultural production is important;
  - Considering interactions between primary producers on the floodplains and other key stakeholders (eg other water resource users), and the potential redistribution of water resources between floodplain producers and other key stakeholders; and
  - Reviewing previous work that is relevant to assessing the impacts of the Basin Plan for primary producers on the floodplains (eg the Arche Consulting (2010) report);

4.1 Proposed changes to water management

The following section summarises the key management changes outlined in the proposed Basin Plan (MDBA 2011a, MDBA 2011b, MDBA 2011c) that are likely to impact on floodplain producers.

The proposed Basin Plan has been developed on the understanding that the Murray–Darling Basin must be returned to a healthy, working condition if it is to have a sustainable and productive economic future. The aim is to achieve a healthy economy, a healthy social fabric and a healthy environment for the Basin. It is based on an understanding that the solution is not just about more water being sent down the river, but how the water is managed.

The return of water to the environment will be achieved by purchase of water entitlements by the Commonwealth from willing sellers and investment in water saving infrastructure, including off-farm and on-farm modernisation programs under the Water for the Future initiative and Works and Measures program. The proposed Basin Plan highlights the opportunities for Basin communities to identify ways to reduce the amount of water diverted for consumptive use. This may be through: improved water efficiencies delivered by infrastructure; constructing works which get the water to environmental assets more efficiently; and/or improving the rules we currently have for operating the rivers, or the way water is traded.

It is proposed that the reduction in consumptive use will be via a reduction in the long-term average sustainable diversion limit (SDL) for each catchment to replace the current Cap on diversions. SDLs will be calculated for different Water Resource Plan Areas across the Basin with the overall proposal of a reduction of 2,750 GL per year in overall consumptive use to achieve an Ecologically Sustainable Level of Take (ESLT). This total is achieved through a transition to a SDL for each surface water resource unit in the Basin by 2019 through revision of water resource plans by jurisdictions. The SDL process is detailed in Schedule 2 of the proposed Basin Plan.

The implication for floodplain producers is that more water will be required to flow through rivers and channels to key ecological assets, and that this increased flow could potentially inundate floodplains and...
result in increased opportunities for productive agriculture. Depending on the timing and duration of flooding there may also be some negative consequences of flooding. Increases in flow regimes will occur through changes in average extractions over time as well as through specific releases of environmental water held by the Commonwealth as part of the implementation of environmental watering plans for specific ecological assets. As discussed in Section 3 inundation on floodplains is extremely variable and is a consequence of both natural (local and remote rainfall) and regulated events and the areas subject to flooding are affected by levees, channels and other floodplain infrastructure. Only those floodplain producers within regulated systems will be affected by the proposed Basin Plan.

The regulated water systems in the Basin will be controlled by water resource plans to be managed by state agencies which set out the water available for consumptive use. These plans and associated environmental water plans will identify the environmental watering requirements of priority environmental assets and priority ecosystem functions. The plans are required to express environmental watering requirements in the following terms:

a) a flow threshold or total flow volume;

b) the required duration for that flow threshold, or the duration over which the volume should be delivered (as the case requires);

c) the required timing of the flow event;

d) the required frequency of the flow event;

e) the maximum period between flow events;

f) the extent and thresholds for any groundwater dependency;

g) the required inundation depth at the site.

In addition to the success of environmental outcomes, the above factors are also critical in determining whether an inundation event is beneficial to increasing production, resilience and profitability on floodplains.

### 4.2 Regions of floodplain-based agriculture affected by Basin Plan

Schedule 2 of the proposed Basin Plan lists surface water SDL resource units and the proposed long-term average SDL for each resource unit. The Schedule provides a BDL (baseline diversion limit) for each resource unit and proposes an additional SDL where BDL is considered insufficient to meet the required environmental targets. Table 8 shows those surface water resource units where a local reduction in allocations is required to achieve the proposed SDL. In addition to local reductions, a shared reduction amount across SDL resource units is also required.
Table 8  SDL changes from surface water resource units

<table>
<thead>
<tr>
<th>Water resource unit</th>
<th>SDL local reduction (GL/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warrego-Paroo-Nebine</td>
<td>9</td>
</tr>
<tr>
<td>Condamine-Balonne (Qld)</td>
<td>100</td>
</tr>
<tr>
<td>Queensland Border Rivers</td>
<td>8</td>
</tr>
<tr>
<td>Barwon-Darling Watercourse</td>
<td>6</td>
</tr>
<tr>
<td>NSW Border Rivers</td>
<td>7</td>
</tr>
<tr>
<td>Gwydir</td>
<td>42</td>
</tr>
<tr>
<td>Namoi</td>
<td>10</td>
</tr>
<tr>
<td>Macquarie-Castlereagh</td>
<td>65</td>
</tr>
<tr>
<td>Lachlan</td>
<td>48</td>
</tr>
<tr>
<td>Murrumbidgee</td>
<td>320</td>
</tr>
<tr>
<td>NSW Murray and Lower Darling</td>
<td>262</td>
</tr>
<tr>
<td>Victorian Murray</td>
<td>253</td>
</tr>
<tr>
<td>Northern Victoria</td>
<td>374</td>
</tr>
<tr>
<td>Wimmera – Mallee</td>
<td>23</td>
</tr>
<tr>
<td>South Australian Murray</td>
<td>101</td>
</tr>
</tbody>
</table>

Source: MDBA 2011a

Table 8 shows that major local reductions to achieve SDLs are required in the southern Basin regions. However, information suggests that floodplain production is of most importance in the north. CSIRO (2012) states that “grazing of floodplains in the southern Basin has effectively been eliminated in recent years due to changes in land tenure from freehold to National Park…Grazing is now much more of an issue for floodplain management in the northern Basin” (p. 158).

This is supported by previous work undertaken by GHD along the River Murray and other southern areas where parts of floodplain properties are inundated when environmental flows are made. In general, such inundation has negative impacts due to loss of improved pasture species, interruption to management and damage to infrastructure (access, fencing). The financial impacts of this have been recognised when establishing easements for flooding.

However, the southern region floodplain properties generally have different agricultural enterprises compared to the north. Southern regions receive higher natural rainfall and as a consequence have more intensive production systems which require increased inputs for optimum productivity. By contrast, northern region floodplain properties have lower and more variable effective rainfall with consequent increased production risks. Management is therefore more conservative in response to the increased risks.

In addition the natural variability in river flows is generally far greater in the north of the Basin than in the main stem of the Murray. For example the ratio of average annual maximum to minimum flows in the Darling is 1400:1 vs 70:1 for the Murray. The importance of variability was described by Mottell (1995)
as “averages disguise a most significant fact about rainfall and river flows, that is, the huge year to year and season to season variability. It is this variation which is significant in planning water resource development and not the average.”

Although Table 8 describes SDLs on a yearly basis, MDBA recognises that the reductions are based on long-term averages. It is proposed that water resource plans developed by the responsible state authorities will achieve long term average reductions, but there could be significant yearly variations caused by many uncontrolled factors. One of the factors will be local rainfall events and the aim to achieve improved efficiency of water use by ‘piggy backing’ environmental flows with these natural events.

4.3 Interactions between floodplain producers and other key stakeholders

The distribution of water between users is determined via a water sharing plan for a catchment. The steps that guide this distribution are shown in Figure 6 which is extracted from the Guide to the Water Sharing Plan for the Murrumbidgee Regulated River Water Source (NOW 2004).

Floodplain producers potentially receive benefits at several steps in the water sharing process because varying proportions of their land can be inundated when river and channel flows occur for different purposes. For example, floodplain land can be inundated when water is provided for the environment (Step 2) and for basic landholder rights (Step 3). Several case studies (see Appendix D) indicated that varying proportions of their total floodplains were inundated when minimal flows occurred, for example for the supply of domestic and stock rights.

In some cases, floodplain producers also have licences for general access which can be used for irrigation. However, in most cases licences are for General Security water which requires pumping from the river when allocations are available. Allocations are variable and down to zero in some years, e.g. during extreme drought.
Floodplain producers with Water Access Licences also have the ability to trade water if they consider cash returns from this approach outweigh the net benefits and risks of irrigating crops and pastures. From focus group discussions, producers stated that variability in allocations may result in inadequate
maintenance of irrigation infrastructure with consequent costly repairs required. Trading in water provides a stream of income that has been most beneficial during the recent drought.

4.4 Review of previous work to assess impact of the Basin Plan for Floodplain Producers

The proposed Basin Plan is likely to increase the frequency of inundation on floodplains because of the incidental nature of environmental water being delivered to a target site overflowing banks on floodplain properties in transit.

CSIRO (2012) discussed floodplain flooding and the difficulty of assessing the impact between the baseline and modelled SDL scenarios (CSIRO used 2800 GL/year as the scenario) because of the complexity of fodder generation and grazing dynamics. CSIRO concluded that modelled changes in flooding are only one part of the story and that a more comprehensive analysis linking grasslands response with feed availability and grazier profitability was required.

CSIRO (2012) estimated the incremental changes in the value of floodplain grazing under the 2800 SDL scenario relative to the baseline but in the absence of robust monetary values presented qualitative estimates only. Of the 21 Basin Plan regions, three regions (Barwon-Darling, Condamine-Balonne and Murray-Middle) were assessed as achieving ‘High’ values, with five regions assessed as ‘Medium’, nine regions assessed as ‘Low’ and four assessed as receiving no floodplain grazing benefits.

CIE (2011) also considered the economic benefits for non-irrigated agriculture through increased productivity of wetlands. It was recognised that the characteristics of flow regimes such as the magnitude, frequency, duration, seasonal timing, period between floods, rate of rise and fall, variability, and regularity of flow events influence the nature of ecological responses to flow. However, the SDL scenarios and associated additional flows for the environment in the proposed Basin Plan are defined in terms of long-term average flows without clarity on their real time delivery to achieve the intended environmental benefits.

CIE (2011) concluded that while floodplain grazing is considered to be an important activity, the extent of the grazing on floodplains is largely unknown. Further, there is limited information available regarding the SDL scenarios and their potential impacts on the productivity of the agricultural activity located on the floodplains. The increase in water is likely to result in improvements in the growth of grasses on the floodplains with the potential to improve the productivity of private land on the floodplains used for grazing by bringing in a greater load of nutrients and organic matter being deposited on the floodplain. Pasture growth would also benefit from increased soil moisture.

Arche Consulting (2010) sought to estimate the socioeconomic benefits of floodplain grazing and cropping in the Basin. Given the limited data on a broad regional scale, the study conducted three case studies of farms located on the Paroo River, on a tributary of the Warrego River and on the Darling River in Wilcannia. The study provided estimates of the area of land in wetlands that are subject to floodplain agricultural activity in the Basin, based on assumptions regarding the change in flooding patterns and the change in productivity in response to the change in flooding patterns. The study concludes amongst other things that, for the three case study farms, “flooding adds approximately $6.8 million in gross profit over 15 years”.

While acknowledging the complexity of assessing the impacts that changed flooding regimes will have on floodplains, none of the above three studies provides a financial estimate of the Basin-wide impact of the proposed Basin Plan. The Arche report presents differences in values between ‘minimal flooding’ and
‘with flooding’ but these are not related to SDL scenarios. The report provides recommendations on future study areas required to more accurately assess the benefits.

It should be noted that responses to changes in flooding regimes on floodplains are further complicated by management decisions taken by owners. In circumstances where ecological changes could be similar (for example increased pasture production and quality), the effective utilisation of pasture will vary depending on grazing management decisions. In addition, any increase in production is not necessarily reflected in profit because marketing decisions (when to buy and sell and the category of livestock to buy and sell) will influence financial performance.

In addition, the above studies refer exclusively to benefits of floodplain production without reference to possible ‘disbenefits’ that may occur. Mottell (1995) discussed damage caused by flooding with landholders including the following possible impacts:

- Potential for stock losses due mainly to inadequate management;
- Minor damage to fences and roadways;
- Ruins existing forage which may not grow for some months
- Environmental damage, growth of woody weeds and loss of some species.

In general, landholders considered that “there is no real damage from floods, and the benefits are enormous.” A mean result of 94% of landholders across the Lower Balonne floodplain stated that floods are a natural benefit compared to 6% stating they were a natural disaster.

The current project provides an opportunity to address the limitations in the above three reports.
5. Understanding of floodplain production activities based on engagement with primary producers

This section is designed to cover the following sections of the project Terms of Reference:

- Engage with primary producers on floodplains in the Basin to develop a more detailed understanding of floodplain production activities and the potential benefits of the Basin Plan for agricultural production, including:
  - farm details, including location, type of enterprise, duration of ownership, area of enterprise, proportion of floodplain used, livestock information (breeds, stocking rates under different conditions), cropping information (crop types, annual/perennials, rotations), relative contribution of the production system to total farm profit, and relevant financial and operational information;
  - understanding of the nature of floodplain production activities, including strategies designed to manage the risk of cycles of flooding and drying, the role of the floodplains in this management, and attitudes relating to these management strategies—of particular interest would be an understanding about the aims and objectives of management strategies and how these address the ecosystem health of riparian zones (e.g. whole farm plans that aim to manage the health and resilience of riparian zones);
  - historical benefits of flood events for management of agricultural production, including details of flood events (timing, duration, volume, extent, average return intervals) and impacts of these on management strategies and productivity, including lag times/duration of benefits;
  - the values floodplain-based primary producers hold in relation to landscapes and their management.

5.1 Introduction

GHD developed a range of producer engagement activities as discussed in section 2.1.3 to gain a more detailed understanding of floodplain production activities and the potential benefits of the proposed Basin Plan for agricultural production. This information supplements findings from the literature review in Section 3 and provides more contemporary information on trends that are occurring in floodplain management. The information has been used to guide input assumptions to the economic model in Section 6 to calculate the impacts of the proposed Basin Plan on floodplain producers.

The information is presented as a summary under key headings. In addition, summaries of focus group meetings and case studies are included in Appendix D to provide more detailed information as well as an explanation of floodplain management options that producers consider.

The information provides a snapshot only of the production activities and does not fully explore the almost limitless range of activities and business decisions that individual producers make. It is unrealistic to expect that all possible combinations can be documented and outcomes modelled to assess the benefits. However, further consultation would assist to improve the accuracy of the assumptions in the model.
### 5.2 Farm details

A summary of farm details is provided in Table 9. This information is mainly sourced from stakeholders consulted for this project.

Table 9  Summary of farm details for northern Basin floodplain producers

<table>
<thead>
<tr>
<th>Farm attribute</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Details relate to the northern Basin (ie north of the Lower Murrumbidgee)</td>
</tr>
<tr>
<td>Type of enterprises</td>
<td>Enterprises are mainly livestock (sheep, cattle and some goats) with small areas of cropping, some of which may be irrigated using General Security water entitlement. The Nimmie-Caira area in the Lower Murrumbidgee is a unique cropping area (discussed in section 3.2) which differs from other areas. Parts of the Lower Balonne are also cultivated regularly, including the Narran floodplain.</td>
</tr>
<tr>
<td>Duration of ownership</td>
<td>Although this varies, most properties are considered to be ‘family farms’ with current owners second generation or more.</td>
</tr>
<tr>
<td>Area of enterprises</td>
<td>Variable but generally large with averages around 30,000 ha. Areas have increased over time to enable economies of scale and also enable production and financial resilience in response to variable climate and market conditions.</td>
</tr>
<tr>
<td>Proportion of floodplain used</td>
<td>In general, most of the floodplains are used when conditions allow (eg after flooding has receded). Some properties have protected ecological areas (eg with CMAs) and grazing is restricted to ensure target outcomes.</td>
</tr>
<tr>
<td>Livestock information</td>
<td>Cattle breeds include the range of <em>Bos taurus</em> and <em>Bos indicus</em> types. Sheep enterprises are predominantly Merino but emphasis on meat breeds (eg Dorper) has increased in recent years. Cattle and non-Merino sheep breeds are easier to manage in inundated areas. Core breeding herds and flocks comprise between 50% and 75% of average property stocking potential. Trading stock and/or agistment of mainly cattle comprise the balance of the stocking potential – this ensures flexibility in management in response to variability in climate. Stocking rates vary with averages ranging from 0.8 DSE/ha in the absence of flooding, to 1.2 DSE/ha after flooding. However, dry periods are frequent and result in partial or complete destocking in some years.</td>
</tr>
<tr>
<td>Crop types</td>
<td>Most crops are annual crops of wheat, barley, safflower, chickpeas or sorghum with choice depending on time of year when conditions for planting are most favourable. Climate variability means that cropping on floodplains in the absence of irrigation is infrequent and opportunistic. The cost of cropping plant and machinery means that preference is for operations to be completed by contractors or sharefarmers although basic plant is retained by most with a history of cropping.</td>
</tr>
</tbody>
</table>
Pastures

Pastures are generally natural pastures and include a diversity of annual and perennial species. Natural saltbush (Chenopodiaceae spp) is an important component in the lower half of the northern Basin. Winter annuals (eg trefoils) germinate in response to seasonal rainfall or autumn/winter flooding.

Subdivision of properties enables pasture management, including restricting grazing for periods (eg two years) to enable species to seed and increase in density. This results in a ‘living haystack’ that provides resilience.

Contribution to total farm profits

Floodplains comprise varying percentages of total farm area and in addition the area of the floodplain inundated varies depending on the type of flood (size, duration, antecedent conditions) and timing of local rainfall events.

Despite this, floodplains are an important component of businesses and farmers rely on them as part of their total enterprise mix.

5.3 Nature of floodplain production activities

Table 9 provided some information on the nature of floodplain activities. Table 10 provides more information on management strategies.
Table 10  Management strategies of primary producers on floodplains

<table>
<thead>
<tr>
<th>Activity</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Managing the risk of cycles of flooding and</td>
<td>Floodplain producers understand the unpredictability of the cycles of flooding and drying and therefore generally adopt conservative approaches to production (eg conservative stocking rates).</td>
</tr>
<tr>
<td>drying</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Also, as highlighted in Table 9, core livestock breeding herds and flocks are maintained and these are complemented by trading or agisted stock with flexible purchase and sale decisions depending on seasons.</td>
</tr>
<tr>
<td></td>
<td>Producers also generally receive advanced warning (three or more weeks) of flooding and can make appropriate management decisions to optimise production/profit. This includes moving stock to higher ground or destocking areas that will be difficult to manage and/or minimise potential losses.</td>
</tr>
<tr>
<td>The role of floodplains in management</td>
<td>Floodplains are integral to management of floodplain properties. Their relatively better quality soil fertility and moisture holding capacity means that pasture production is superior to surrounding lands. Producers take advantage of this to 'finish' stock prior to sale or for grazing of other priority stock such as weaners or pregnant animals.</td>
</tr>
<tr>
<td></td>
<td>Producers recognise that flood water also contains weed seeds which can become established and threaten pasture production. Most ‘weeds’ (with the exception of some species eg burrs) however are considered to be another fodder source which can be managed by grazing practices or which are naturally controlled through the wetting and drying processes. It is generally not cost effective to manage weeds using herbicide sprays.</td>
</tr>
<tr>
<td></td>
<td>Some weeds (eg groundsel and lippia) are increasing in density and spread and there is uncertainty of the effectiveness of grazing management for their control. Most weeds become established where there is lack of competition (eg bare ground) and therefore retention of pasture cover through the avoidance of overgrazing is a key management task.</td>
</tr>
<tr>
<td>Managing the ecosystem health and resilience</td>
<td>Maintaining or enhancing ecosystem resilience is paramount to the continued viability of floodplain properties. Producers consider that there is a greater recognition of this over the last 20 years.</td>
</tr>
<tr>
<td>of riparian zones</td>
<td>The management activities adopted to promote resilience are outlined above, with the major activities being:</td>
</tr>
<tr>
<td></td>
<td>• Conservative and flexible (ie core breeding plus trading/agistment) stocking rates</td>
</tr>
<tr>
<td></td>
<td>• Conserving paddocks from grazing for up to two years to promote pasture density and provide a ‘living haystack’</td>
</tr>
<tr>
<td></td>
<td>• Increase property sizes to take advantage of economies of scale. Overhead costs are absorbed across a larger production base so there is less emphasis on the need for short term profits</td>
</tr>
</tbody>
</table>
5.4 **History of flood events on production**

The timing, duration, volume, extent and average return intervals of flood events have important consequences for management strategies and productivity. However, producers believe it is not possible to be overly prescriptive. In other words, every flood is different and despite lessons being learnt from previous events there is always some new dimension that needs to be addressed. This is not surprising given the complexity of biological interactions that occur in agricultural production.

Despite the above caution, producers generally have ‘rules of thumb’ that they adopt for particular circumstances although history has taught them the need to be flexible.

In the south, producers consider that it is preferable if flows are timed to coincide with natural rainfall events in autumn and winter to augment growing conditions. Conversely, if flooding occurs in summer and the floodplain dries up in hot weather, the ground becomes scalded and there is no pasture production. This scalded land then requires autumn rainfall before pastures again germinate and grow.

Another example from history is the impact of the return interval. A dry period of several years prior to a flood event means that the creeks and tributaries are relatively devoid of vegetation and water flows quickly through the system without spreading across the floodplain. Conversely, antecedent floods or local rain events promote vegetation (e.g., lignum) along the channel system with the result that water is slow moving and is more likely to spread to the floodplain in the upper reaches.

The timing of flood events is important for cropping as it will impact on the choice of crops sown. Producers need to be flexible with crop choice as planting a variety outside of its optimal planting window results in yield reductions and therefore reduced profitability. As suitable conditions for planting move from winter through to spring, crop choice will generally follow a sequence. For example, the sequence may proceed in the following order: wheat, barley, safflower and sorghum.

5.5 **Values floodplain-based primary producers hold in relation to landscapes and their management**

5.5.1 **Non production values placed on flood events**

Consultation suggests landholders place additional value on flooding events, outside of the economic production benefits to their farm businesses.

Landholders value the ecosystems of the river system. They appreciate seeing the land rejuvenate after a flood event through the return of flora and fauna, particularly birdlife. Having water in the river system is uplifting, and helps to remind landholders and the community of the resilience of their landscape.

Landholders view regular flooding of their land as being the proper natural regime, and therefore feel concerned that flood events have reduced over time.

More intrinsic examples of the social value of the river system are observed in increased recreational opportunities, particularly camping, fishing and bird-watching, which attract more visitors to the region during wet years.

Landholders cited the importance of the river flows to local towns, particularly those with high indigenous populations. Some landholders also cited anecdotal evidence that crime rates usually decrease when river flows provide recreational opportunities to town residents.
6. Model

This section is designed to cover the following sections of the project Terms of Reference:

- Make a preliminary assessment of the economic value of agricultural production on floodplains in the Basin, including:
  - the total economic value of agricultural production on floodplains in the Basin in the absence of the proposed Basin Plan; and
  - the incremental economic value to agricultural production on floodplains in the Basin as a result of the proposed Basin Plan;

and to the extent possible, assess those values on an individual catchment or floodplain basis.

6.1 Introduction

As noted in Section 2.1.2 GHD’s analysis focused on three regions within the Basin. These regions are:

- Barwon-Darling River upstream of Menindee Lakes;
- Lower Balonne River floodplain; and
- Lower Murrumbidgee River floodplain and its intersection with the Lachlan River.

Using the information from the hydrological analysis, GIS modelling, literature review and stakeholder consultation, GHD developed an Excel-based model for each of the three study regions to estimate:

- The net value of agricultural production from floodplains under the baseline scenario; and
- The incremental change in net agricultural production value under BP – 2750, relative to the baseline scenario.

Details regarding the model are provided in Table 11 below.

6.2 Key model parameters

The model for each region includes the following parameters:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Assumption</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model period</td>
<td>20 years</td>
<td>As agreed with MDBA. Over long time periods, the process of discounting also makes distant costs or benefits relatively insignificant compared to the present, therefore a 20 year timeframe is considered appropriate.</td>
</tr>
<tr>
<td>Discount rate</td>
<td>7%</td>
<td>As agreed with MDBA.</td>
</tr>
<tr>
<td>Dollars</td>
<td>2012 dollars</td>
<td>Corresponds with data collected from floodplain landholders.</td>
</tr>
<tr>
<td>Parameter</td>
<td>Assumption</td>
<td>Comment</td>
</tr>
<tr>
<td>--------------------------</td>
<td>----------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Cropping gross margin</td>
<td>$195 / ha</td>
<td>NSW Department of Primary Industries (2012), adjusted based on floodplain landholder consultation. Contract rates for all operations used which include depreciation and interest on capital for cropping machinery</td>
</tr>
<tr>
<td>Cropping overhead costs</td>
<td>$7.20 / ha</td>
<td>GHD estimate based on previous experience and floodplain landholder consultation. Includes: depreciation and interest on non-cropping plant and equipment; and general business overheads such as rates, insurance, etc.</td>
</tr>
<tr>
<td>Sheep gross margin</td>
<td>$30.72 / DSE</td>
<td>NSW Department of Primary Industries (2011a), adjusted based on floodplain landholder consultation</td>
</tr>
<tr>
<td>Sheep overhead costs</td>
<td>$6.70 / ha</td>
<td>GHD estimate based on previous experience and floodplain landholder consultation. Includes: depreciation on vehicles and fencing; and general business overheads such as rates, salary</td>
</tr>
<tr>
<td>Cattle gross margin</td>
<td>$18.15 / DSE</td>
<td>NSW Department of Primary Industries (2011b), adjusted based on floodplain landholder consultation</td>
</tr>
<tr>
<td>Cattle overhead costs</td>
<td>$6.40 / ha</td>
<td>GHD estimate based on previous experience and floodplain landholder consultation. Includes: depreciation on vehicles and fencing; and general business overheads such as rates, salary</td>
</tr>
<tr>
<td>Stocking rate without overbank flows</td>
<td>0.8 DSE / ha*</td>
<td>GHD estimate based on consultation with floodplain landholders during focus groups, phone interviews and case studies.</td>
</tr>
<tr>
<td>Stocking rate with overbank flows</td>
<td>1.2 DSE / ha</td>
<td>GHD estimate based on consultation with floodplain landholders during focus groups, phone interviews and case studies.</td>
</tr>
</tbody>
</table>

* DSE/ha: Dry Sheep Equivalent per hectare

6.3 Assumptions

A number of assumptions were required in order to keep the model manageable within the project timeframes, and to help overcome data limitations. These assumptions are explained below.
6.3.1 Impacts on overhead costs

It was originally intended that the model would consider potential changes in overhead costs arising from the proposed Basin Plan, such as:

- Farm infrastructure, e.g. fencing;
- Interruptions to access; and
- Clean-up costs.

Consultation with landholders, however, indicated that a marginal increase in overheads arising from the proposed Basin Plan would be offset by a marginal increase in yield. It was also agreed by landholders that any significant ‘disbenefits’ arising from overbank flows were generally not applicable for the volume of water associated with the BP-2750 scenario; that is, any substantial damage to farm infrastructure or major disruptions to farm access routes are associated with much larger volumes of water passing through the system. In light of this, the model assumes that overhead costs do not change as a result of the proposed Basin Plan.

6.3.2 Area of inundation

As detailed in Section 2.1.1, no data were available on the maximum extent of the floodplain or flooding inundation patterns. GHD relied on the GIS layers listed in Table 3 and anecdotal information from stakeholders which indicated that the ‘floodplain’ areas were representative of ‘low’ overbank flows. The floodplain area was overlaid with the ACLUMP land use data to estimate the extent of cropping and grazing land that is likely to be influenced by the proposed Basin Plan. Table 12 shows the land areas of the floodplain that were assumed for the baseline:

<table>
<thead>
<tr>
<th>Region</th>
<th>Cropping (ha)</th>
<th>Grazing (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barwon-Darling</td>
<td>0</td>
<td>667,827</td>
</tr>
<tr>
<td>Lower Balonne</td>
<td>34,177</td>
<td>583,010</td>
</tr>
<tr>
<td>Lower Murrumbidgee*</td>
<td>1,164</td>
<td>99,371</td>
</tr>
</tbody>
</table>

* Excludes Nimmie-Caira, as discussed in Section 3.1.

The model also assumes that under BP-2750, there is no additional land area inundated (relative to the baseline). This reflects the relatively small volume of additional flows associated with the proposed Basin Plan. It is recognised, however, that any additional extent of inundation would be heavily influenced by other factors, such as whether the flow was ‘piggy-backed’ on a rainfall event.

6.3.3 Impact of the proposed Basin Plan on grazing

Both the literature (e.g. Mottell, 1995) and landholder consultation indicated that the grazing benefits of over-bank flows can be realised for 2-3 years following a flood event. In light of this, the model assumes that the maximum grazing benefit is realised in the same year as an over-bank flow and that a benefit remains (albeit declining) in the following year. The model accounts for this by applying an adjustment.
factor’ to grazing profit (1.0 in Year 1 of an over-bank flow, 0.75 in Year 2). The model has relied on only a partial carryover of benefits (i.e. benefits for grazing occur in the year following flooding but to a lesser extent), so as to employ a conservative approach.

To reflect the fact that sometimes an over-bank flow may result in pasture loss, the model assumes that 50% of total pasture area is destroyed every fourth flood year.

Given the effect of a marginal increase in overheads offsetting a marginal increase in yield (as discussed in Section 6.3.1 above), the model assumes that the impact of the proposed Basin Plan on grazing is only reflected in increased stocking rate (rather than increased wool or carcase yield).

The GIS land use data cannot distinguish between grazing land used for sheep versus cattle production. The model assumes a 75/25 split between sheep and cattle grazing area respectively. The impact of this assumption is explored in the sensitivity analysis, as detailed in Section 6.5 below.

6.3.4 Impact of the proposed Basin Plan on cropping

Although some of the literature indicates that cropping opportunities can extend into the year (or two) following flooding (e.g. Mottell, 1995), consultation with landholders indicated that this was less likely with the volume of water under BP-2750. The model therefore employs a conservative approach and assumes that cropping is purely opportunistic and only occurs in the same year as an over-bank flow.

To reflect the fact that sometimes an over-bank flow may result in a crop loss, the model assumes that a crop is destroyed every fourth flood year.

The model also assumes contract rates for cropping activities (e.g. sowing, harvest). This aligns with landholder feedback during consultation, which indicated a preference for operations to be completed under contract or sharefarm arrangements. It also removed the need to account separately for machinery depreciation and interest on capital as these costs are implied in contract rates.

6.3.5 Frequency of inundation

As discussed in Section 4.2, there is substantial variability in both rainfall and river flows from year to year and season to season. This variability is not reflected in the model, due to the complexity of doing so within a 20-year model timeframe.\(^{12}\)

As described in Section 2.1.1, a spells analysis was undertaken to investigate the hydrological impacts of the proposed changes to water management regimes under the proposed Basin Plan. Based on analysis for representative gauge stations, the model assumes flow frequencies for each region as shown in Table 13.\(^{13}\)

As stated in Section 5.4 the extent of inundation of floodplains is impacted by the flooding return interval as this impacts on the density of vegetation and movement of water. The current model does not include this in the calculation and the influence of return interval is likely to average out over time. Further investigation is warranted to check if this assumption is valid.

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\(^{12}\) The results from running the model over a 113 year timeframe are presented in Section 6.6

\(^{13}\) As discussed in Section 2.1.1, the 20 year analysis draws on the spells analysis over a 113 year period – in particular regarding the frequency of years with floods.
### Table 13  Frequency of overbank flows

<table>
<thead>
<tr>
<th>Region</th>
<th>Frequency of overbank flow (ML) – 1 in X years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
</tr>
<tr>
<td>Barwon-Darling</td>
<td>1:2.6</td>
</tr>
<tr>
<td>Lower Balonne</td>
<td>1:3.9</td>
</tr>
<tr>
<td>Lower Murrumbidgee</td>
<td>1:2.8</td>
</tr>
</tbody>
</table>

### 6.4  Economic value of agricultural production on floodplains in the Basin

#### 6.4.1  Total economic value in the absence of the proposed Basin Plan

The net economic value (surplus after variable and overhead costs including operator allowance removed) of agricultural production on floodplains in the Barwon-Darling, Lower Balonne and Lower Murrumbidgee is estimated to be $313 million (Table 14) over the 20-year model period. This equates to $226 per hectare over the 20 year period.

### Table 14  Model results – baseline (20 year period)

<table>
<thead>
<tr>
<th></th>
<th>Barwon-Darling</th>
<th>Lower Balonne</th>
<th>Lower Murrumbidgee</th>
<th>Total (3 regions)</th>
<th>Value per hectare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total economic value – baseline</td>
<td>$143.8 million</td>
<td>$147.0 million</td>
<td>$22.1 million</td>
<td>$313.0 million</td>
<td>$226</td>
</tr>
</tbody>
</table>

#### 6.4.2  Incremental economic value as a result of the proposed Basin Plan

The benefits of floodplain agriculture under BP-2750 arise due to the incidental nature of water en route to environmental sites. The incremental net economic value of floodplain agriculture under the proposed Basin plan is estimated to be $32.2 million over the 20-year model period (Table 15). This equates to $23 per hectare over the 20 year period.

### Table 15  Model results – incremental value BP-2750 (20 year period)

<table>
<thead>
<tr>
<th></th>
<th>Barwon-Darling</th>
<th>Lower Balonne</th>
<th>Lower Murrumbidgee</th>
<th>Total (3 regions)</th>
<th>Value per hectare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incremental economic value – BP-2750</td>
<td>$12.2 million</td>
<td>$17.9 million</td>
<td>$2.1 million</td>
<td>$32.2 million</td>
<td>$23</td>
</tr>
</tbody>
</table>
6.5 Sensitivity analysis

Sensitivity analysis has been undertaken for key model variables, to test the extent to which the model results would vary from changes in selected model parameters. The results of the sensitivity analysis are provided below.

Table 16 investigates the impact of the proportion of land used for sheep relative to cattle grazing. A decrease in the area for sheep to 50% of total grazing area results in a 13% decline in total economic value and an 11% decline in incremental economic value.

<table>
<thead>
<tr>
<th>Proportion of grazing land for sheep vs cattle (20 year period)</th>
<th>Sheep – 50%, Cattle – 50%</th>
<th>Sheep – 25%, Cattle – 75%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total economic value – baseline (3 regions)</td>
<td>$272.3 million</td>
<td>$231.1 million</td>
</tr>
<tr>
<td>Incremental economic value – BP-2750 (3 regions)</td>
<td>$28.8 million</td>
<td>$26.0 million</td>
</tr>
</tbody>
</table>

A decline in the stocking rate associated with overbank flows, to 1 DSE/ha, results in a 14% decline in total economic value and a 68% decline in incremental economic value (Table 17). In contrast, an increase in stocking rate to 1.4 DSE/ha leads to a 17% increase in total economic value and a 100% increase in incremental economic value.

<table>
<thead>
<tr>
<th>Stocking rate with overbank flows (20 year period)</th>
<th>1.0</th>
<th>1.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total economic value – baseline (3 regions)</td>
<td>$269.1 million</td>
<td>$364.7 million</td>
</tr>
<tr>
<td>Incremental economic value – BP-2750 (3 regions)</td>
<td>$10.3 million</td>
<td>$46.1 million</td>
</tr>
</tbody>
</table>

The estimates presented in Table 14 and Table 15 may under-estimate the value of floodplain agriculture (both with and without the proposed Basin Plan) as they assume low overbank flows only. It is understood that medium and high overbank flows will result in increased benefits for floodplain producers, however the variability in the timing of such events adds to the complexity of representing these in a 20-year model period. There is also no reliable information on the extent of inundation under ‘medium’ and ‘high’ flows.

Table 18 estimates the incremental economic value associated with an additional 2.5 – 10% of land being inundated, for example due to a medium overbank flow. An additional 2.5% of land area inundated is associated with a 27% increase in incremental economic value, to $40.8 million.
Table 18  Sensitivity analysis 3: Additional % of land inundated under BP-2750 (20 year period)

<table>
<thead>
<tr>
<th>Incremental economic value – BP-2750 (3 regions)</th>
<th>2.5%</th>
<th>5%</th>
<th>7.5%</th>
<th>10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>$40.8 million</td>
<td>$49.4 million</td>
<td>$58.0 million</td>
<td>$66.7 million</td>
<td></td>
</tr>
</tbody>
</table>

The model results presented thus far are based on a discount rate of 7%. The impact of varying the discount rate used in the model is shown in Table 19. At a discount rate of 4% the net economic value of floodplain agricultural production is $399 million, which equates to $288 per hectare. The incremental economic value associated with the proposed Basin Plan is estimated to be $40.7 million or $29 per hectare.

Table 19  Sensitivity analysis 4: Discount rate of 4% (20 year period)

<table>
<thead>
<tr>
<th>Barwon-Darling</th>
<th>Lower Balonne</th>
<th>Lower Murrumbidgee</th>
<th>Total (3 regions)</th>
<th>Value per hectare</th>
</tr>
</thead>
<tbody>
<tr>
<td>$183.7 million</td>
<td>$187.3 million</td>
<td>$28.3 million</td>
<td>$399.3 million</td>
<td>$288</td>
</tr>
<tr>
<td>Incremental economic value – BP-2750</td>
<td>$15.4 million</td>
<td>$22.6 million</td>
<td>$2.6 million</td>
<td>$40.7 million</td>
</tr>
</tbody>
</table>

6.6  Analysis over a 113-year timeframe

The results of running the model using MDBA’s 113-year\textsuperscript{14} data set are presented in Table 20. The model was run for the period 1896-2008 (based on the spells analysis of frequency of overbank flows under the baseline and BP-2750 for this period) and a net present value was calculated.

The net economic value of floodplain agriculture under the baseline is estimated to be $375 million (over 113 years), which equates to $271 per hectare. The incremental economic value under BP-2750 is $31.2 million (over 113 years) or $23 per hectare. Not surprisingly these results are relatively similar to those presented in Table 14 and Table 15, due to the impact of discounting future values. That is, when calculating a net present value over a long time horizon (in this case, 113 years), the process of discounting makes distant costs or benefits relatively insignificant compared to those in earlier years.

\textsuperscript{14}Data from 1895 and 2009 are incomplete therefore are excluded from the analysis.
The 113-year analysis is based on the following assumptions (in addition to those outlined in Sections 6.2 and 6.3):

- It makes no difference how many over-bank flows occur in any given year; and
- Where there are consecutive years of over-bank flows, the grazing ‘flow-on benefit’ (described in Section 6.3.3) occurs in the year following the last over-bank flow.

The difference between the nominal (i.e. not discounted) net value of agricultural production under BP-2750 relative to the baseline is depicted below over the 113-year timeframe for the Barwon-Darling (Figure 7), Lower Balonne (Figure 8) and Lower Murrumbidgee (Figure 9).

The peaks within each graph are of a similar magnitude because the model assumes that when there is an overbank flow in say, the Barwon-Darling, the same area of land is inundated on each occasion. This assumption was necessary because the GHD project team did not have access to higher level modelling that would enable changes in inundation area to be considered in more detail. The information required to do this could be gathered during the monitoring and evaluation phase (see Chapter 7) and then inputted to the model as part of a subsequent stage of the project.

Similarly, ‘flat line’ periods (e.g. which occurs between 1896 and 1931 in Figure 7) occur because the spells analysis for the gauge sites show no difference in the occurrence of overbank flows during this period; that is, under both the baseline and BP-2750 scenarios the pattern of ‘dry’ and ‘flood’ years is exactly the same.

Negative values occur where the value of floodplain agricultural production under BP-2750 is less than the value of floodplain agricultural production under the baseline. There are two reasons for this:

- The timing of ‘dry’, ‘flood’ and ‘post-flood’ years differs between the two scenarios, and therefore the value of production differs; and
- The timing of pasture and crop losses (described in Section 6.3.3 and 6.3.4) differs between the two scenarios.

For example in the Barwon-Darling, 1937 was a ‘flood’ year under both the baseline and BP-2750 scenarios, however a crop and pasture loss occurred in the model under BP-2750. Therefore the difference in the nominal value of production under BP-2750 relative to the baseline was - $8.8 million. Similarly in the Lower Murrumbidgee, 1920 was a ‘dry’ year under the baseline but a ‘flood’ year under BP-2750. Therefore the difference in the nominal value of production under BP-2750 relative to the baseline was - $219,000.
Figure 7  Barwon-Darling, 1896 – 2008
Figure 8  Lower Balonne, 1896 – 2008
Figure 9  Lower Murrumbidgee, 1896 – 2008
6.7 Extrapolation

As identified in Section 2.1.2, extrapolating the results of the project to the entire Basin is not a straightforward exercise. This reflects several factors including:

- The extent of consultation that was possible during the current project, and the possibility that the information collected is not representative of stakeholders throughout the Basin;
- The differences in hydrology throughout the Basin;
- Individual landholder business management response to changing floodplain conditions;
- Uncertainty regarding the proposed Basin Plan and, in particular, the range of “variables for reducing water use and applying water across the Basin” (MDBA 2012). These include:
  - The range of environmental water holding and how it is used conjunctively;
  - The mix of water recovery by market purchase versus infrastructure programs;
  - Where water will be recovered (along a river system);
  - The characteristics of the recovered water including allocation and accounting provisions;
  - How river systems are operated in future to optimise environmental and consumptive use outcomes and how environmental water is allocated for use; and
- The analysis does not consider ‘flow-on impacts’, such as effects on input prices or employment.\(^{15}\)

For illustrative purposes only, this project uses the floodplain area data presented in Table 21 and Figure 10 to extrapolate the model results to the entire Basin floodplain. Caution should be exercised when considering these results, however, due to the limitations described.

Table 21 shows that the majority of floodplain land (90%) occurs in the northern Basin and this is at least partially due to the land use change that has occurred in the southern Basin (as discussed in Section 3.2).

The extent of floodplain land (Figure 10) is based on ‘Land Subject to Inundation’ for the Northern and Southern Basin from the Geoscience Australia 1:250,000 topographic data except for the Lower Balonne where the ‘Hydrological Indicator Site’ is used (see Table 2 and Table 3 for further description). These layers were overlain with the ACLUMP land use data to calculate the areas used for grazing and cropping (Table 21).

The floodplain area for agricultural production is about 2.6 million hectares. This compares to GHD’s computation from the literature of a floodplain area of 5.4 million hectares (Table 6). The discrepancy is likely to be one of definition where Table 21 considers grazing and cropping land only on the floodplains. Table 6 includes total floodplain areas and not just those suited to agriculture.

\(^{15}\) It was agreed that flow-on impacts were beyond the scope of the present study; however it is recognised that these could be considered as part of any ‘phase 2’ study.
Table 21  Area of floodplain land use (ha) – entire Basin

<table>
<thead>
<tr>
<th>Land use</th>
<th>Northern Basin</th>
<th>Southern Basin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grazing natural pastures</td>
<td>2,027,406</td>
<td>61,449</td>
</tr>
<tr>
<td>Grazing improved pastures</td>
<td>159,452</td>
<td>175,304</td>
</tr>
<tr>
<td>Cropping</td>
<td>117,289</td>
<td>16,205</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,304,147</strong></td>
<td><strong>252,958</strong></td>
</tr>
</tbody>
</table>

Table 21 also shows that the majority of floodplain land (70%) in the southern Basin is grazing on improved pastures. GHD’s experience is that flooding of improved pastures can result in a range of damage - from a temporary decline in production to loss of plant density that requires replanting of pasture. Also, flooding in the southern Basin appears to result in damage to infrastructure and impeded access that reduces enterprise profitability. This was discussed in section 4.2.

For this project, GHD has chosen to include only the northern Basin floodplain for assessing the benefits of the proposed Basin Plan, on the assumption that in the southern Basin any benefit could be offset by a disbenefit. This is supported by previous studies undertaken by GHD in the southern Basin however further analysis is required to confirm the accuracy of this assumption. CSIRO (2012) states that grazing of floodplains in the southern Basin has effectively been eliminated in recent years due to the change in land tenure from freehold to National Park, from State Forest or State Park to National Park or Indigenous Protected Area. MDBA (2012a) also describes the differences between the northern and southern parts of the Basin, stating that irrigators in the north tend to “rely more on opportunistic annual crops and depend on a few good seasons to generate the return required to offset years with lower water availability.” In contrast, those in the south have developed farming systems “that depend on continuity of water supply, such as perennial horticulture.”

The results of the extrapolation to the northern Basin are provided in Table 22. Under the proposed Basin Plan, the incremental economic value of floodplain agricultural production is estimated at $64.9 million (over 20 years).

Table 22  Extrapolation to northern Basin, 20-year timeframe

<table>
<thead>
<tr>
<th>Land use</th>
<th>Area</th>
<th>Value per hectare*</th>
<th>Total economic value – baseline</th>
<th>Incremental economic value – BP-2750</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grazing natural pastures</td>
<td>2,027,406</td>
<td>$234</td>
<td>$435.9 million</td>
<td>$36.9 million</td>
</tr>
<tr>
<td>Grazing improved pastures</td>
<td>159,452</td>
<td>$234</td>
<td>$34.3 million</td>
<td>$2.9 million</td>
</tr>
<tr>
<td>Cropping</td>
<td>117,289</td>
<td>$844</td>
<td>$73.8 million</td>
<td>$25.1 million</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,304,147</strong></td>
<td></td>
<td><strong>$543.9 million</strong></td>
<td><strong>$64.9 million</strong></td>
</tr>
</tbody>
</table>

* Based on average value of grazing and average value of cropping, across the three study regions.
Figure 10 Land Subject to Inundation

Legend
- Southern Basin - Land Subject to Inundation
- Northern Basin - Land Subject to Inundation

Hydrological Indicator Sites, MDB
© Murray Darling Basin Commission
"Land Subject to Inundation", States
© Commonwealth of Australia, Geoscience Australia

MDBA
Benefits of Basin Plan for Primary Producers
Land Subject to Inundation

Job Number
Revision
Date

21-21461
A
30 May 2012

Data source: Data Custodian: Data Set Name/Title - Version/Date. Created by:

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7. Further work to more comprehensively assess the benefits of the proposed Basin Plan

This section is designed to cover the following sections of the project Terms of Reference:

- Propose further work that could be undertaken to more comprehensively assess the benefits of the Basin Plan for primary producers on floodplains in the Basin and a robust methodology for monitoring and evaluating the impacts of the Basin Plan for primary producers and agricultural production on floodplains in the Basin, including:
  - identifying information and data that would be required for monitoring and evaluating the effects of the Basin Plan on these primary producers;
  - proposing methods through which the information could be collected; and
  - proposing further work that would need to be undertaken to use the information to make a full assessment of the effects of the Basin Plan on these primary producers and agricultural production.

### 7.1 Data required for monitoring and evaluation

The above assessment is necessarily based on the limited information available on floodplain production generally and the additional uncertainty of the extent of impacts of the proposed Basin Plan. Any improvement in the availability of information would support the verification of the assumptions used in the above assessment of benefits and would help enable their accuracy to be improved. This will then ensure that the calculation of the overall benefits of the proposed Basin Plan is more robust and hence more likely to be accepted by the range of stakeholders involved.

Following is a list of information and data, in priority order, that would support a more comprehensive assessment of the benefits of the proposed Basin Plan:

- Extent of floodplain inundation under differing flow regimes;
- Categorisation of land use on floodplains; and
- Development of production functions to more readily simulate production and economic outcomes to assist decisions by land managers, ie decision support tools.

#### 7.1.1 Extent of floodplain inundation

This project has highlighted a number of issues with data availability relating floodplain inundation and streamflow in some parts of the Murray Darling Basin:

- In some cases, inundation data has been developed by a range of regional, State and Commonwealth agencies, however jurisdictional licensing issues means much of the data cannot be accessed;
- In other cases, spatial and streamflow data sets are available, however analysis has not been undertaken to derive relationships between flow and floodplain inundation;
- In yet other cases, the appropriate spatial and streamflow data has not been collected to enable inundation relationships to be developed.
While good quality data has been developed over many years relating River Murray flows to floodplain inundation, inundation information for the northern Basin is relatively sparse. For these catchments, it was not possible to implement GHD’s proposed method which sought to develop a relationship between flood magnitude, floodplain inundation and land use.

Where inundation data has been developed, the short project timeframe meant that it was difficult to source some of this data. Inundation data is held by a range of regional, State and Commonwealth agencies, and agencies are relatively protective of this data. Reluctance to share data between agencies and third parties is in many cases due to quality control, and concerns regarding potential misuse of this data. Data sharing arrangements will be a key issue for any future studies exploring floodplain benefits of the proposed Basin Plan.

To implement a more detailed assessment of the benefits of the proposed Basin Plan on floodplain agriculture, it is necessary to develop relationships between streamflow (either observed or modelled) and the spatial extent of floodplain inundation and land use. Broadly, there are three levels for which relationships can be developed, each with an increasing level of cost and complexity:

1. **Analysis of historical flood extent and observed or modelled streamflow.**
   Using aerial or satellite imagery, it is possible in most cases to identify a range of flood events that can be linked to a corresponding streamflow. Streamflow can be based on gauged data (where available) or modelled data, such as the MDBA’s Basin Plan modelling. Digitisation of the aerial and satellite imagery allows the historical flood extent to be mapped and overlaid on existing land use layers. While this method provides useful information for historical flood events, it does not lend itself to interpolation across a range of flows.

2. **Analysis of historical flood extent and observed or modelled streamflow, together with LiDAR-derived digital elevation model.**
   The availability of a high resolution digital elevation model, based on LiDAR, enables a more detailed assessment of the relationship between streamflow and floodplain inundation. The combination of historical flood extents and a detailed digital elevation model allows flood backwater curves to be analysed, and improves the confidence with which flood events can be interpolated across a range of flows. This approach is useful where the cost of developing a floodplain hydrodynamic model cannot be justified, or is impractical.

3. **Development of detailed floodplain hydrodynamic model (based on LiDAR-derived digital elevation model)**
   In many catchments, a floodplain hydrodynamic model provides the most reliable relationship between streamflow and floodplain inundation. The development of hydrodynamic models is however data intensive and costly, and consideration should be given to the marginal benefits of adopting this approach. Due to their high development cost and large data requirements, hydrodynamic models are typically suited to smaller floodplains, and are unlikely to be a realistic option for larger floodplains such as the Lower Balonne.

The development of hydrodynamic models requires a number of data sources including (SKM 2010):

- LiDAR datasets for terrain mapping;
- Vegetation mapping for floodplain hydraulic roughness estimation;
- Soil infiltration mapping to determine the response of soil to wetting;
- Location of diversions (weirs, regulators, embankments) controlling flows;
Historical inundation outlines for past watering events; and
Hydrological inflow series for diversions from the river or overbank flooding.

7.1.2 Development of production functions
It is possible to develop an econometric model that incorporates multiple variables that impact on the benefit of the proposed Basin Plan on floodplain agriculture. The variables would include: hydrological information from hydrodynamic models; GIS information on the extent of inundation and land use for different agri-ecological zones; crop and pasture response curves following inundation; livestock production response curves for different livestock species and classes of livestock; financial information on farm inputs and outputs.

Such a model would be complex but would enable benefits to be calculated more quickly as new information comes to light. In its initial stages the model would rely on assumptions that would need to be tested in the field before any results could be publicised.

7.2 Monitoring and Evaluation
The above provided information on the future direction of the collection of more comprehensive information that will assist in better defining the benefits of the proposed Basin Plan for floodplain producers. In the shorter term GHD proposes that a monitoring and evaluation (M&E) strategy is developed that will collect data on the impacts of the proposed Basin Plan from its commencement. The broad approach to M&E for floodplain production could consider the following elements:

Select case study areas within each of the 19 Basin Plan regions;
Study areas are likely to be in specific sub-catchments within the regions and be subject to a current Water Sharing Plan;
Establish monitor farms (perhaps 5 in each sub-catchment) within the study areas where on-ground data on inundation and production responses can be measured; and
Establish whole farm production and financial models prior to the introduction of the proposed Basin Plan to provide the baseline, and monitor activity over time to enable evaluation of the proposed Basin Plan.

The M&E component can be assessed against current models (including the model developed for this project) and assumptions in the models can be updated to provide a more accurate assessment of impacts across the whole of the Basin.

The outcomes from M&E will provide increased confidence in the relationships between flooding regimes measured at gauging stations, the area of land inundated as predicted by spatial data and production responses from different timing and duration of flood events. A more accurate assessment of disbenefits from flooding (crop and pasture losses, infrastructure damage, implications of reduced access) will also be provided. For further details regarding the M&E framework refer to the separate report prepared by GHD titled ‘Assessment of Benefits of the Basin Plan for Primary Producers on Floodplains in the Murray-Darling Basin - Monitoring and Evaluation: Recommendations to Murray-Darling Basin Authority’.
7.3 Options for future work

To enable more detailed assessment of the benefits of the proposed Basin Plan on floodplain agriculture, the following advice is provided (noting that some of this work may have already been undertaken by the MDBA):

- Develop a detailed M&E plan based on the above guidelines to provide on-ground assessment of the impacts of the proposed Basin Plan on floodplain producers;
- Develop data sharing agreements between relevant regional, State, and Commonwealth agencies to ensure that available information is utilised, particularly where this is based on high quality data and/or detailed modelling;
- Undertake a stocktake of available flood mapping and imagery held by regional, State and Commonwealth agencies, and compile a directory of this data. This data directory would include as a minimum the location and type of floodplain mapping/imagery, and an agency contact for the data. In some cases there will be limitations on the use of this data imposed by the data provider, and these conditions should be flagged;
- Continue the acquisition of LiDAR data for the floodplains of the Murray Darling Basin. LiDAR data has multiple uses, however for the purposes of the proposed Basin Plan, the focus should be on the floodplain extent that is likely to be impacted by the proposed Basin Plan;
- Undertake a co-ordinated assessment of regional floodplains within the Murray Darling Basin where hydrodynamic modelling would provide multiple benefits, and prioritise these areas. This could be an extension of this current project whereby consultation and modelling is conducted across all Basin Plan Regions to reduce the risk of bias that is present in this study;
- Develop a more comprehensive model that relates changes in hydrological flows to economic costs and benefits; and
- Investigate further the relationship between the ecological, economic and social benefits of the proposed Basin Plan on floodplain producers.
8. Reference List


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Appendix A.

Hydrographs
STATISTICS

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<thead>
<tr>
<th>Description</th>
<th>Baseline</th>
<th>BP 2750</th>
</tr>
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<tbody>
<tr>
<td>Total number of flood events (1896 - 2008)</td>
<td>75</td>
<td>140</td>
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<tr>
<td>Number of years with flood events (1896 - 2008)</td>
<td>40</td>
<td>65</td>
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<tr>
<td>Frequency of years with floods (1 in X years)</td>
<td>2.8</td>
<td>1.7</td>
</tr>
<tr>
<td>Number of events per year (for years with flood events)</td>
<td>1.9</td>
<td>2.2</td>
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<tr>
<td>Median duration (days)</td>
<td>17</td>
<td>11</td>
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<tr>
<td>Maximum duration (days)</td>
<td>246</td>
<td>248</td>
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</tbody>
</table>
Murray Darling Basin Authority
Spells Analysis

422015 – Culgoa@Brenda: Baseline vs. BP 2750

Overbank Threshold – 11,840 ML/day

<table>
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<tr>
<th>STATISTICS</th>
<th>Baseline</th>
<th>BP 2750</th>
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<tr>
<td>Total number of flood events (1896 - 2008)</td>
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<td>Number of years with flood events (1896 - 2008)</td>
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<tr>
<td>Frequency of years with floods (1 in X years)</td>
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<td>2.7</td>
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<td>Number of events per year (for years with flood events)</td>
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<td>1.6</td>
</tr>
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<td>Median duration (days)</td>
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<td>9</td>
</tr>
<tr>
<td>Maximum duration (days)</td>
<td>39</td>
<td>41</td>
</tr>
</tbody>
</table>
425003 – Darling@Bourke: Baseline vs. BP 2750

Flow (ML/day)

- BP 2750
- Baseline

Overbank Threshold ~ 27275 ML/day

<table>
<thead>
<tr>
<th>STATISTICS</th>
<th>Baseline</th>
<th>BP 2750</th>
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</thead>
<tbody>
<tr>
<td>Total number of flood events (1896 - 2008)</td>
<td>63</td>
<td>60</td>
</tr>
<tr>
<td>Number of years with flood events (1896 - 2008)</td>
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<td>47</td>
</tr>
<tr>
<td>Frequency of years with floods (1 in X years)</td>
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<tr>
<td>Number of events per year (for years with flood events)</td>
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</tr>
<tr>
<td>Median duration (days)</td>
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<td>21.5</td>
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<tr>
<td>Maximum duration (days)</td>
<td>119</td>
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Appendix B

Floodplain maps
Figure 12 Darling - Land use
Figure 13 Lower Balonne - Land subject to inundation
Figure 14 Lower Balonne - Land use

Legend
- Towns
- Gauge Stations
- Landuse
- Weir
- Roads
- Rivers

1 Conservation and natural environments
2 Production from relatively natural environments
3 Production from dryland agriculture and plantations
4 Production from irrigated agriculture and plantations
5 Intensive uses
6 Water

MDBA - © Murray Darling Basin Commission
State, Towns, Road, Rivers
© Commonwealth of Australia, Geoscience Australia
Weir, Gauge Station - © Bureau of Meteorology
Land Use
© Australia Collaborative Land Use and Management Program (ACLUMP - updated March 2010) supplied by the Department of Agriculture, Fisheries and Forestry

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Figure 15 Lower Murrumbidgee - Land subject to inundation
Appendix C

Focus Group Agenda and Phone Surveys
MDB2106 – benefits of Basin Plan for primary producers on floodplains

Focus Group Agenda
Date: 9 May 2012, 1pm
Region: Lowbidgee/Lachlan
Venue: Balranald Bushfire Hall

1. Introduction
   - Introductions
   - Explanation of project, (Short timeframe - draft report due. Stage 2)
   - Purpose of the meeting,
   - Other engagement activities (phone interviews and case studies)
   - Confidentiality,
   - How information will be used,

2. Review of materials
   - Review and discussion of historical and baseline flow charts
   - Review and discussion of footprint mapping
   - Are there any suggested amendments to the projected inundation footprint?

3. Typical agricultural production on floodplain in region
   - Discussion of typical livestock production
     - Types of systems
     - Productivity (DSE/Ha)
     - Local gross margins compared to DPI figures
   - Discussion of typical crop production
     - Types of systems
     - Productivity (tonnes/Ha)
     - Local gross margins ($/ha, $/tonne) compared to DPI figures
     - Irrigated areas
   - Other agricultural production

4. General impacts of Basin Plan
   - How has the extent of inundation changed over the years?
   - What is the ideal frequency of inundation and is there a frequency at which flooding becomes a dis-benefit (ie. annual)?
   - What is the ideal timing of inundation (seasonality), and is there a timing where flooding becomes a dis-benefit?
   - What is the ideal duration of inundation, and is there a duration beyond which flooding becomes a dis-benefit?
   - What are the likely impacts of the Basin Plan due to:
     - changes in frequency of inundation?
     - changes in timing of inundation (i.e seasonality)?
     - changes in duration of inundation (i.e. Days under water)?

5. Livestock impacts and response
• What is the likely pasture response?
  o Quantity of pasture produced (i.e. kgDM/ha)
  o Quality of pasture produced (e.g. species mix)
  o Potential weed issues
• How will increased pasture quantity/quality be utilised?
  o Increase stocking rate? (%)
  o Increase animal performance – e.g. higher lambing/calving percentage; for sheep, wool cut; death rate;
  o Any cost increases – e.g. variable costs such as drenching, fly control, other diseases;
  o The interaction between season and pasture expressed through the variables noted above;
• What is most likely livestock business plan/strategy after inundation
  o Natural build-up of numbers
  o Purchase stock (breeding or trading)
  o Agistment
  o How would this be financed?

6. Cropping impacts and response
• How will floodplain inundation influence cropping programs
  o The impact of change in area inundated
  o The impact on crop yield
  o Impacts on gross margins
• What is the most likely cropping business plan/strategy after inundation
  o Owns machinery and plants/harvests all crop
  o Use sharefarmers
  o Contract sow, harvest etc.
  o How would this be financed?

7. Other impacts
• Infrastructure impacts including access, fences, water supply
• Interruption to normal enterprise operations

8. Next Steps

9. End of meeting
The Project terms of reference include:

i. **engage with primary producers on floodplains in the Basin** to develop a more detailed understanding of production activities and the potential benefits of the Basin Plan for agricultural production, including:

   – *farm details*, including location, type of enterprise, duration of ownership, area of enterprise, proportion of floodplain used, livestock information (breeds, stocking rates under different conditions), cropping information (crop types, annual/perennials, rotations), relative contribution of the production system to total farm profit, and relevant financial and operational information;

   – *understanding of the nature of floodplain production activities*, including strategies designed to manage the risk of cycles of flooding and drying, the role of the floodplains in this management, and attitudes relating to these management strategies—of particular interest would be an understanding about the aims and objectives of management strategies and how these address the ecosystem health of riparian zones (e.g. whole farm plans that aim to manage the health and resilience of riparian zones);

   – *historical benefits of flood events for management of agricultural production*, including details of flood events (timing, duration, volume, extent, average return intervals) and impacts of these on management strategies and productivity, including lag times/duration of benefits;

   – *the values floodplain-based primary producers hold* in relation to landscapes and their management;

ii. drawing on steps (i) through (iii) above, **make a preliminary assessment of the economic value of agricultural production on floodplains in the Basin**, including the total economic value of agricultural production on floodplains in the Basin in the absence of the proposed Basin Plan.
MDB2106 – benefits of Basin Plan for primary producers on floodplains

(GHD job 2121461)

Phone Survey template – 15 May 2012

Introduction

- Who is GHD,
- Who are you,
- Explanation of project,
- How we got your name,
- Confidentiality,
- How information used,
- OK now or call later?

Stress that information is required on the perceived impact of the Basin Plan compared to current (baseline) situation.

Landholder details

<table>
<thead>
<tr>
<th>Landholder name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
</tr>
</tbody>
</table>

**Basin Case Study area**
- Southern
- Central
- Northern

<table>
<thead>
<tr>
<th>Duration of ownership</th>
</tr>
</thead>
</table>

Farm details

**Size**

<table>
<thead>
<tr>
<th>Total area of farm (ha or acres)</th>
<th>Ha</th>
<th>Acres</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area of floodplain (ha or acres)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relative contribution of the production system (and the floodplain) to total farm profit (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 ha = 2.47 acres / 1 acre = 0.4 ha
Agricultural enterprises

Livestock carrying capacity

<table>
<thead>
<tr>
<th></th>
<th>DSE/ha in a dry area</th>
<th>DSE/ha in floodplain area</th>
<th>% increase in DSE/ha when floodplain inundation occurs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Alternatively, if this is not known, list stock numbers below

<table>
<thead>
<tr>
<th>Sheep</th>
<th>Head</th>
<th>Cattle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Breeders (ewes)        | Breeders                  |
|                       | (cows / heifers)          |
| Dry sheep (dry ewes / wethers) | Dry females |
| Lambs                 | Steers / Bulls            |
| Rams                  | Calves                    |
|                       | (less than 9 months)      |
| Total                 | Total                     |

Cropping

<table>
<thead>
<tr>
<th>Crop type</th>
<th>Area</th>
<th>Own or share-farm?</th>
<th>Any irrigation?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Floodplain (perceived alterations of Basin Plan)

General discussion on extent of inundation over years and how this has reduced over time.

Are there any flow rates or gauge heights in the system that you reference?

What are these and do you have benchmarks which guide your management?

Do these benchmarks relate to area of land that is inundated, and when does full inundation of the floodplain occur?

How does the floodplain respond to different events?
  - Short vs long duration?
  - Time of year?

Note: If required briefly explain the potential changes that will occur under the Basin Plan. For ease of visualising, use examples such as 10,20,30% additional water to baseline.
**Impact of Basin Plan**

| The change in the area experiencing inundation |  |
| The change in frequency of inundation |  |
| The change in timing (i.e. season) |  |
| The change in duration (days under water) |  |

**Pasture response on floodplain**

- Quantity of pasture produced (i.e. kgDM/ha) –
- Quality of pasture produced (e.g. species)
- Discuss any weed or other issues from flooding
- Any impact on soil nutrient or chemical balance of changed flooding regimes?

**How do you utilise increase quantity/quality of pasture**

| Increase stocking rate? (%):  |
| Increase animal performance – e.g. higher lambing/calving percentage; for sheep, wool cut; death rate;  |
| Any cost increases – e.g. variable costs such as drenching, fly control, other diseases;  |
| The interaction between season and pasture – Benefit period?  |
| How is the floodplain utilised? – e.g. Crash grazing, sheep/cattle mix  |
Livestock

Gross margin for livestock ($/ha, $/dse, $/breeding cow/ewe)

Do they have their own?

*We will have indicative information from DPI – If not suggest DPI values and get feedback.*

Business plan for Livestock after floodplain inundation

<table>
<thead>
<tr>
<th>Natural build-up of numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase stock (breeding or trading)</td>
</tr>
<tr>
<td>Agistment</td>
</tr>
<tr>
<td>How financed?</td>
</tr>
</tbody>
</table>

Cropping

| For cropping, the influence of floodplain inundation on cropping programs and responses for the base case; |
| The impact of change in area inundated |
| The impact on crop yield from base case to The Basin Plan flow regime; |
| The gross margin ($/ha) from the cropping enterprise for each of the crops that will behave differently with the implementation of The Basin Plan; |

Gross margin for crops ($/ha)

Do they have their own?

*We will have indicative information from DPI – If not suggest DPI values and get feedback.*
**Business plan for cropping** (note any changes in approach from ‘baseline’ to Basin Plan 2750)

| **Owns machinery and plants/harvests all crop** |  |
| **Sharefarms – if so share details** |  |
| **Contract sow, harvest etc.** |  |
| **How financed?** |  |

**Other impacts**

| **Infrastructure impacts including access, fences, water supply** |  |
| **Interruption to normal enterprise operations** |  |
| **Management strategies to address ecosystem health (including strategies designed to manage the risk of cycles of flooding and drying)** |  |

**Other benefits**

Are there ecological benefits apart from productivity/profitability benefits of increased water on floodplains?

Do these benefits have any impact on social issues – eg improved wellbeing that results in better management decisions?

Link answers and explore “values” floodplain-based producers hold in relation to landscapes and there management.

**Any other comments**

Appendix D
Case studies and focus group summaries
Case study one

Region: Lower Balonne

Total farm area: 14,917 ha

Duration of ownership: since 1996 but within the family since 1953

Irrigation: None

Floodplain extent:

Approximately 12,000 ha (81%), inundated in last three floods (2010, 2011, 2012)

Since upstream developments began (in the early 1980s) the small/middle sized floods have become much less regular due to upstream extraction. Larger floods still continue to occur sporadically when the season permits (such as the past 3 years).

Regular small/medium floods are important for the property as they support regular pasture production and also allow stock and domestic water storages to be refilled. Once refilled, stock and domestic water will last for approximately 12 months. When stock and domestic water supplies become depleted the property is supported by bore water which reduces the land’s grazing potential.

Enterprises:

Livestock: Self replacing merino flock. When additional feed is available cattle and goats are purchased or introduced through agistment.

Stocking rate: Since 2001 = 0.61 DSE/ha average

1953 – 2001 = 1.07 DSE/ha average

Crop: none

Use of floodplain – baseline (ie under current development conditions)

Since 2001 the property’s carrying capacity has reduced considerably, with the property being completely destocked during certain drought years. A reduction in both rainfall and river flows resulted in reduced pasture production and stock and domestic water to support livestock.

The floodplain incorporates the majority of the property (81%) and therefore flood activity has a dramatic impact on overall productivity. When the floodplain is active, per hectare production is estimated to be double the long-term property average.

Analysis of a specific site on the property demonstrates how variability in rainfall and flood activity can greatly impact on feed availability, groundcover and pasture species.

<table>
<thead>
<tr>
<th>Year</th>
<th>2003</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainfall</td>
<td>200mm</td>
<td>661mm</td>
<td>700mm</td>
</tr>
<tr>
<td>Flood activity</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Feed availability</td>
<td>100-250 kg/ha</td>
<td>4,000 kg/ha</td>
<td>5,000 kg/ha</td>
</tr>
<tr>
<td>Groundcover</td>
<td>40%</td>
<td>96%</td>
<td>98%</td>
</tr>
<tr>
<td>Predominant species</td>
<td>Buck Bush</td>
<td>Curly Mitchell Grass</td>
<td>Curly Mitchell Grass</td>
</tr>
<tr>
<td>---------------------</td>
<td>-----------</td>
<td>----------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td></td>
<td>Rolly Polly</td>
<td>Queensland Blue Grass</td>
<td>Queensland Blue Grass</td>
</tr>
</tbody>
</table>

The variability in rainfall and the uncertainty about flood events requires careful management. Rotational grazing is used to allow feed to be monitored and rationed according to availability. Following a large flood event feed can be rationed to last for 2-3 years.

A generally conservative stocking rate is maintained however the operators take advantage of additional feed and market opportunities as they become available. Typically additional stock will either be purchased or agisted following a flood event. This year 5,000 goats were purchased and 800 cattle were agisted for 6 months ($5/head/week). In addition sheep numbers have gradually increased through breeding.

The property has a long term average gross margin of $42/ha.

**Perceived impact of Basin Plan - profitability**

The owners consider that BP2750 will improve profitability by increasing the frequency of floods (from every 3.9 years to 2.7) and increasing the extent of inundation. Duration of flooding is considered to be an important in encouraging flood waters to spread and inundate more land. Therefore the impact of a change in duration (from 7 – 9 days average) is considered beneficial.

The owners believe that more frequent small/medium floods would be particularly beneficial in maintaining pasture production and allowing stock and domestic storages to be refilled. However the owners remain sceptical that BP2750 will return these floods which have been lost since upstream developments and private storages were established.

Similarly the owners believe maintaining stock and domestic flows in the main rivers (Culgoa and Birrie) would be of particular benefit.

In the 2010/11 financial year (with significant flooding) the property achieved gross margins of $54/ha - a 29% increase from the long term average ($42/ha). Regardless of the weather outlook the owners are expecting strong gross returns in the coming 2-3 years on the back of a very strong bank of feed and as purchased stock are turned off.

Input costs are significantly increased as a result of flood events. A large flood will endanger livestock and therefore require additional work to move stock to high ground (estimated 20 additional work days per event). A flood year will also require additional labour throughout the year. In a non-flood year the owners will budget for 10 days stock work, whereas in a large flood year up to 120 days of stock work can be required with additional crutching, drenching, fly-treatment, lambing etc.

Flood years see improved animal performance, particularly with regards to weight gain. More wool is cut per head, however this is often offset by reduced quality (increased vegetable matter, colour stain and tender wool).

The owners observe the following agronomic benefits following flooding:
- Sediment deposits improve soil quality and fertility,
- Added biomass from pasture growth adds organic matter to the soil profile, as vegetation breaks down.

These benefits are felt for up to 3 years with pasture responding better to additional rainfall.

Access issues during large flood events can hamper the owner’s ability to move livestock and resources into and out of the property. Often the owner has missed opportunities to buy or sell livestock as a result.
Overall BP2750 would allow the owner to gradually increase sheep numbers while continuing to take advantage of short-term opportunities in the market.

**Perceived impact of Basin Plan - other**

More frequent flood events would enable the owners to rest areas of the property for longer and reduce the risk of overgrazing. This would lead to an improved on farm environment.

Having the Culgoa and Birrie Rivers running more often would be uplifting for the owners, who appreciate the additional bird life.
Case study two

Region: Lower Balonne

Total farm area: 11,000 ha

Duration of ownership: 36 years

Irrigation: None

Floodplain extent:

The most recent flood inundated 10,800 ha (98% of the property). The majority of this area had not been inundated since 1991.

Enterprises:

Livestock: Self replacing Merino flock (4000 head)
Store cattle (800 head)

Stocking rate: Long term average = 0.25 DSE/ha
Current stocking rate = approximately 1.1 DSE/Ha

Crop: none

Use of floodplain – baseline (i.e. under current development conditions)

Like most properties in the area, the property was completely destocked for extended periods during the drought. Reduced flows due to upstream developments have also contributed to a reduction in carrying capacity.

Conservative stocking rates and careful pasture budgeting have been adopted to try make the property capable of surviving dry years, however the owners concede that destocking will usually be required when drought occurs.

Conversely the owners take advantage of flood years by purchasing stock or agisting onto their property. The recent flood allowed the owners to purchase 300 additional cattle.

The property has two bores providing stock and domestic water to approximately 75% of the property. In addition, the property relies on a number of turkey nest water storages which are filled when water is available to pump from the river (approximately 5% of the time). Once full, the dams can provide stock water for 12 months. However when dry approximately 25% of the property is without water and therefore cannot be grazed.

The property has averaged gross margins of approximately $42/ha over the longer term.

Perceived impact of Basin Plan - profitability

The basin plan is expected to improve productivity by producing more frequent floods and improving stock and domestic water availability.

Large floods can provide the property with enough feed to last up to 3 years, if budgeted correctly. The quality of pasture also improves with more Coolah, Mitchell grass, Sugar Grass and Flinders Grass.
Weed species can become more prevalent following a flood, however are easily controlled with grazing pressure.

Following a flood animal performance is improved significantly. Sheep will cut approximately 30% more wool, and cattle can achieve weight gains of up to 1kg per day making the property more suitable for fattening.

Variable costs increase with additional animal health and stock movement activities. For example sheep are generally given an additional drench and additional crutching is also required. In the recent large floods the owners spent approximately $40,000 on contract labour mostly to manage stock movement. In an average year the owners would usually spend $10,000 on contract labour.

**Perceived impact of Basin Plan - other**

The owners believe having some amount of flow in the river is beneficial to the community by providing recreation opportunities and improved environmental outcomes. The owners believe that river health can be maintained and improved with increased environmental flows from St George. This is important for river bank stability and bird habitat.

The owners also cited the following social and environmental costs associated with flooding.

- Properties can become cut-off for long periods of time during floods which reduces social contact.
- Heavy fast-moving flood water can cause considerable stream bank erosion and gouging.
Case study three

Region: Lower Darling River

Total farm area: 26,300 hectares

Duration of ownership: Since 1885

Irrigation: N/A

Floodplain extent:

a) Full inundation – 13,150 ha (50%) – occurs only when a natural flood event

Inundation of the floodplains starts to occur on the property when the river reaches 11 meters at Tilpa. The amount of inundation then depends on the level of the river. As the property is located on the low side of the river, the property is inundated at a lower level than properties located on the high side.

Enterprises:

Livestock: Sheep (Dorpers), 3,000 breeding ewes
Livestock: Cattle, 2,000 breeding cows

Stocking rate: 0.5 DSE/ha

Use of floodplain – baseline

The Lower Darling region experiences a highly variable rainfall. The flooding events that occur on the Darling are generally due to high rainfall events in Queensland. It is therefore very difficult to regulate the timing and duration of flood events in the Lower Darling catchment.

The property has a 17 km frontage to the Darling River. The owners believe that about half of the area is floodplain. The production on the floodplain contributes 40-50% of the total farm profit (depends on the season).

The owners believe that the introduction of increases in river height before extraction pumping is allowed and the increased environmental flows have improved the health of the Darling River. They hope that this will continue under the Basin Plan.

Perceived impact of Basin Plan - profitability

The owners don't believe that the Basin Plan 2750 will have an impact on their profitability. However they believe that the environmental and social benefits to their local benefits are much more important to the sustainability of the area. The owners will use the flows to help maintain current stocking rate and to ensure that the environmental benefits on their farm continue for the next generation.

Perceived impact of Basin Plan - other

The owners consider that the Basin Plan is not likely to increase the number of overbank flows unless it is combined with the timing of a natural flood event. However, they expect environmental improvements from the Basin Plan, namely - increasing the groundwater supplies, improving the biodiversity in the local landscapes and maintaining local wetlands. During the 1990's when the drought was at its peak these three environmental areas suffered.
The owners also believe that if the Darling river is kept flowing as a result of the Basin Plan there is less likelihood of salinity problems or algae blooms that have occurred in the past.

The other positive impact for property owners along the river under the Basin Plan is that the river will remain as their property boundary and therefore prevent stock straying to neighbouring properties when the river is dry.

The owners also point out that there are some negative impacts that come with flood events. The extent of these impacts depends on the level of inundation. The negative impacts include the cost of replacing fencing and loss of access to services due to impassable roads. The owners have been isolated for seven out of the last 13 months. Their only access has been by air. Whilst the lack of access has been difficult, the owners try to think of the positive impacts to come from the inundation.
Case study four

Region: Darling

Total farm area: 40,000ha

Duration of ownership: since 1980 but within the family prior to then

Irrigation: Have a general security licence for 800 Ha, but have not used for a number of years and do not intend to use in future. (No off river storage)

Flooding extent:
Approx 28,000 Ha of the property is floodplain. Use the Tilpa gauge plus local property records and experience to judge extent of flood.
  b) 12.00m at Tilpa will wet a decent part of the floodplain, maybe 25%.
  c) 12.25m at Tilpa will wet approximately 35% of floodplain.
  d) 13.00m at Tilpa will wet approximately 60% of floodplain.
  e) 12.25m at Tilpa will wet approximately 80% of floodplain.

Enterprises:
Certified organic.

Sheep comprise a Merino self-replacing flock and a Dorper self-replacing flock (30,000 total)

200 Cattle

Stocking rate: Approx 0.4 DSE/Ha average across property (0.3 DSE/Ha in dry country, 0.5 DSE/Ha on floodplain)

Crop: 1,200 Ha in a “typical” year. (800 Ha Oats and 400 Ha Canola)

Use of floodplain – baseline (ie current under 2012 development conditions)
The unregulated nature of the river and the location of the property means there is not a typical or average year when a certain proportion of the floodplain gets wet; it is a highly variable system.

The pasture mix is typical of western areas with saltbush and perennial native grasses across the property. Highly variable seasons mean that it is important to maintain these pastures across the property. The basic approach for property management is to always stock and crop conservatively.

Soil temperature is seen as much more important for pasture establishment (species and growth rate) than rigid definition of what might or might not be expected to grow in a particular month. This means that management has to be very flexible; expecting a flood response to be similar to an earlier flood event will lead to lots of problems. They have measured standing dry matter from a flood on the back of local rain at 5t/Ha.

When the floodplain has been subject to significant local rainfall and/or flooding, stock are moved in from the drier areas (“red country”) onto the floodplain (“black country”). The red country is rested for as long as possible to assist with pasture and other native plant regeneration and seeding. When floodplain groundcover starts to drop off, some stock are then moved back to the red country, or to market, depending on timing.

Floods provide a significant increase in stocking rate, wool cut and lambing and calving percentages. The owners tend to rely on natural build-up of stock numbers, but will occasionally buy in or agist stock on the property. However, the preference is to not agist or buy in stock because it compromises pasture re-establishment and opportunities for feed across the property.
In ideal circumstances it would be possible to crop a total of 5,000 Ha of the floodplain. However, a more conservative management means that a typical year, including the current one, would have 1,200 Ha of cropped and the maximum ever cropped has been 3,000 Ha. The owners occasionally share-farm on other properties and from time will provide contract sowing and harvesting. But again this is not common as it can compromise existing property operations.

The variability of the property is well captured by a recent decision to no longer use an irrigation licence that has previously been used on an 800 Ha lakebed. After many years of drought with no irrigation possible, the last two years has seen the area under water most of the time. A decision was made to return to dryland cropping which is less capital intensive and can provide a more consistent

**Perceived impact of Basin Plan - profitability**

The think it is unlikely that BP 2750 will make any difference in terms of the area of floodplain inundated on their property, or the time it remains wet.

A critical issue is timing the release of any environmental water under the Basin Plan to coincide with local rain events or other antecedent conditions. However this is impossible when they are located towards the end of an unregulated river. In shorter, more regulated rivers it is possible to deliver environmental water on top of local rain to deliver economic, social and environmental outcomes, but this can simply not be done in this part of the Murray Darling Basin.

**Perceived impact of Basin Plan - other**

The BP 2750 will not have any additional impact on infrastructure, property operations or general property management strategies.

A more healthy river will deliver a range of less tangible benefits to the area, so they are supportive of it. Local initiatives for recovering environmental water are already seen as delivering positive environmental and social benefits for the region. They see BP 2750 operating as follows:

- Delivering more low flows (just water in the river) will provide social and some environmental benefit
- Delivering more moderate flows will provide social and some economic and environmental benefit
- High flows will happen regardless and deliver significant economic and environmental benefit
**Case study five**

**Region:** Lower Lachlan

**Total farm area:** 44,500ha

**Duration of ownership:** since 1982 but within the family prior to then

**Irrigation:** 900ML General Security licence, 280ha flood irrigation area

**Floodplain extent:**

a) Full inundation – 1,800 ha (4% of total land area) – occurs only when a natural flood event occurs

b) Environmental flow (“translucent”) – 600 ha (1.3%) – occurs every 4 to 5 years but has not occurred since year 2000

c) Regular (S&D) – 200 ha (0.5%) – occurs every year

The extent of inundation depends on allocations under the WSP for the Lachlan Regulated River Source. In general, the property receives regular inundation over a small area because of allocations made for domestic and stock rights. Increased inundation occurs when ‘translucent’ releases are made from Wyangala Dam designed to improve lower system flows and winter/spring flow variability.

The rules for environmental diversions are complex and dependent on a number of inter-acting flow events to trigger regulated releases (NOW 2004, A guide to the Water Sharing Plan for the Lachlan Regulated River Water Source). For this reason, information on flows and river heights at gauging stations do not provide suitable information on the extent of floodplain inundation.

**Enterprises:**

Livestock: Merino self-replacing flock, 7,000 breeding ewes

Stocking rate: 0.4 DSE/ha (average)

Crop: winter pasture on irrigated land

**Use of floodplain – baseline** (ie under current development conditions)

This region has extremely variable natural rainfall and farm management is directed at ensuring resilience of the pasture base via a conservative stocking rate. In response to good growing conditions (ether local rainfall or inundation from flood events), selected paddocks are preserved from grazing for extended periods (eg two years). This enables pasture species to seed and increase pasture density and growth. The paddock is then considered to be a “living haystack”.

The pastures which include a range of forbs (saltbush and bluebush) and perennial native grasses retain their nutritive value for many months so that quantity and quality is not diminished when preserved in the paddocks.

The timing of river and creek flows also impacts on the effectiveness of any additional water on the floodplains. It is preferable if flows are timed to coincide with natural rainfall events in autumn and winter to augment growing conditions. Seasonality is also important as their experience is if water on floodplains dries up in hot weather it leaves ground scalded and with no production. This land then requires an autumn break before pastures again germinate and grow.
Irrigation country is used for winter pastures (sub clover and ryegrass) when allocations are available. The production is used to finish stock prior to sale. Irrigated pastures have been found to be less risky than crops (eg wheat) and capital investment in cropping machinery is less onerous.

Experience has taught the owners that maximising livestock numbers to take advantage of short-term flushes in pasture growth is unwise. This approach has resulted in overgrazing with consequent pasture deterioration and slow recovery. The recent purchase of more land means that the relatively large area of land enables economies of scale such that overhead costs are distributed over a larger income earning base and there is less pressure on the owners to maximise stocking rates.

The general management approach is to maintain a core breeding flock with flexibility in stocking rate provided by the decisions around retention or sale of wethers at varying ages.

**Perceived impact of Basin Plan - profitability**

The owners do not consider that BP2750 will have a large impact on profitability. The increase in the volume of water expected under the BP is considered to be a small percentage of the water currently being delivered to floodplains.

If there is to be any benefit a release will need to coincide with natural rainfall events and the seasonality of the release will also be important.

An overall benefit might be to provide further resilience to the system which will assist both the profitability of the farm and reduce risks of land degradation.

**Perceived impact of Basin Plan - other**

The owners value the ecological condition of the land very highly. They take a great interest in wildlife on the property and in particular the bird breeding events that occur when conditions allow. The health of the land is an essential part of living in this region.

The owners also believe that the better ecological health of the farm environment assists with farmer well-being and enables better decisions to be made. This in turn has a positive impact on overall profitability.
**Case study six**

**Region:** Lower Murrumbidgee River – Excluding the Nimmie Caira

**Total farm area:** 35,000 hectares

**Duration of ownership:** Since 1985

**Irrigation:** Irrigated pasture (100ha), organic cropping (3,000ha under a private water sharing agreement involving 10-12 people), conventional cropping (1,000ha).

**Floodplain extent:**

a) Full inundation – 20,000 ha (57%)

Overbank flows occur at 22,000GL at Maude. On average, the property experiences a ‘reasonable’ inundation every 3-4 years which then carries the property for at least the next two years.

**Enterprises:**

- Livestock: Sheep, 3,000 breeding ewes (ideally stocks 4,000)
- Livestock: Cattle, 450 breeding cows (ideally 500-600 head, previously had up to 2,500)
- Irrigated pasture: 100ha
- Certified organic cropping: 3,000ha (subject to water availability and Nimmie-Caira share rules)
- Conventional cropping: 1,000ha

Stocking rate: 0.8 (dry area) - 1.2 (floodplain area) DSE/ha

**Use of floodplain – baseline**

The property has 70 km frontage to the Murrumbidgee River. The owner believes that more than half of the area is floodplain. Production on the floodplain is estimated to contribute 70-80% of the total farm profit which is attributed in part to the 50% increase in stocking rates which occurs with overland flows (0.8-1.2 DSE/ha).

The level of flooding which occurs has varied across the life of the property. From 1987-97 experienced a flood every year, however from 1997-2007 did not experience any flooding at all. On average the property experiences a flood every 3-4 years however the property has been subject to 3 floods in the last 18 months. The manager believes that if the system was unregulated flooding would occur every three years.

Irrigation for cropping purposes is largely subject to water allocation. If sufficient water is available it is pumped from riparian areas. For conventional cropping the cost $26/ML to run the pump.

**Perceived impact of Basin Plan - profitability**

It is expected that the Basin Plan (2750 GL) will affect the change in frequency of flood inundation and increase the duration of existing flood events. This is not anticipated to impact significantly on cropping enterprises as the overland flows primarily impact on the grazing country, with blocks assigned to cropping subject to regulated flows through the use of banks and ponds.
Positive impacts include (increased profitability):
- Effects of stocking densities: flooding increases property stocking densities (predominantly used for stocking cattle versus sheep). However it should be noted that there are significant lag times involved to take advantage of these overbank flows. Typically these are three months however under high flood conditions lag times can be up to six months.
- Potential for some conventional cropping on floodplain land (if land sufficiently dries out to allow for crop planting and establishment).

Negative impacts include (decreased profitability):
- Floods carry weed seeds including species previously not occurring on the property. May not cause major consequences as Fireweed and Bathurst Burr are only competitors under dry conditions.
- Animal health: may be increased input costs associated with treating liver fluke in cattle.
- Infrastructure: increased flooding may cause degrading of steel and wire posts earlier than normal, and increase the frequency of replacement.
- Operational costs: affects routine management operations. Stock may need to be inspected by helicopter or boat. Stock may become stranded and potentially could reduce stock condition due to an inability to access other grazing land.

Perceived impact of Basin Plan - other
The manager anticipates environmental benefits as a result of increased flooding, an assessment made through observed ecological benefits achieved through the Environmental Water Allowance Agreement. Under this agreement there has been a positive effect on land values. Germination of Red Gum seedlings has also been observed following the recent flood conditions. Red gums had previously died during drought conditions during which profits were derived from using timber as firewood.
Focus Group: Lower Balonne

Introduction and discussion of SDL on flooding (ie gauge heights, frequency of flooding)

The group believes that inundation of the floodplain requires flows of over 30,000GL/day at St George for duration of at least 10 days.

The area is also very reliant on “stock and domestic flows”, which allow property owners to refill farm water storages. The group believes that a flow of 5,000 GL/day at St George for duration of at least 10 days will provide flow to all rivers in the system therefore enabling landholders to refill water storages. Once refilled, water storages will generally hold water for approximately 12 months. When water storages run dry, landholders are wholly reliant on bore water. In this scenario some properties have sufficient bores and water points to remain in full production, while other properties will only be able to graze a proportion of their property.

Properties on the Narran River south of Wilby Wilby are less likely to have bores and are therefore more reliant on stock and domestic flows.

Typical agricultural production on floodplain in region

The area typically supports sheep, cattle and occasional goat production. Cropping occurs on certain areas near the Birrie River downstream from Brenda.

Stocking rates on the floodplain fluctuate significantly depending on the following factors:

- Flood events
- Rainfall
- Stock water availability
- Overall capacity/quality of the soil and vegetation.

In drought years stock numbers decline significantly with many properties destocking completely. Feed availability in drought years can be as low as 100kg/ha.

Flood events usually always coincide with years of above average rainfall, to produce a substantial increase in pasture growth (up to 5 tonnes/ha). Land-holders take advantage of additional feed by either purchasing stock or agisting to take advantage of years of high rainfall and/or flood events. Stock numbers can also be increased through breeding, however this requires more time and therefore may not allow landholders to fully take advantage of the initial boost in pasture growth which follows a flood event.

Long-term average stocking rates range between 0.3 – 0.6 DSE/ha. However landholders have experienced a district decline in carrying capacity as upstream developments have occurred.

Gross margins vary with production levels, however have generally averages around $45/ha per annum over the long term. In flood years gross margins can generally be expected to be $10-$15/ha higher.

The majority of the region is not suitable for cropping, however there are some properties who produce wheat crops when conditions are suitable (i.e. following a flood event).
Livestock and cropping impacts of SDL and response

Livestock enterprises benefit from flooding primarily through the ability to sustain higher stocking rates. Productivity can also be seen in individual animal performance, with cattle achieving weight gains of up to 800g/day and sheep cutting up to 30-40% more wool. However, wool quality can suffer through increased vegetable matter, colour stain and tenderness.

Flood events usually result in considerably higher costs in livestock enterprises. Sheep usually require an additional drench and fly strike treatment. Sheep also usually have to be crutched and high pasture can require increased monitoring during lambing.

During large flood events landholders can require more labour to help muster stock to higher ground. Large floods events can also cut access in and out of properties and interrupt normal farm operations.

Overall gross margins in flood years can increase to around $56/ha. However, returns could vary significantly from property to property and from flood to flood, depending on stock prices and availability, timing, existing pasture condition etc.

Flooding provides opportunity for certain landholder to crop their land, which is not possible in dry years.

Other impacts

Flooding generally produces an increase in weed species. However, most landholders find that weeds can be easily managed through grazing.

Dense regrowth of native vegetation is also common following a flood. If left un-grazed, this regrowth can limit pasture production in the long term.

Social Values of the floodplains

The group places a high social value on the river system, both individually and as a community. Having water in the river system is uplifting, and helps to remind the community of the resilience of their landscape.

More intrinsic examples of the social value of the river system are observed in increased recreational opportunities, particularly fishing and bird-watching.

The group cited the importance of the river system in local towns with high indigenous populations. Anecdotally, the group observed that local police experience a decrease in crime rates when water is flowing in the river, attributed to the added recreational opportunities.
Focus interviews: Lower Darling River

Introduction and discussion of SDL on flooding (ie gauge heights, frequency of flooding)

The diverse nature of the group and their geographic spread meant there was no single flow rate or gauge height they used. In general terms, gauge height was used as a guide to probable flood levels rather than a rate of flow per day. Recent BOM web upgrades giving live flow and heights were utilised in the most recent flood. Some landholders used the gauge at Bourke, even though it was a long way upstream, because it was a good guide to local events. Most were able to indicate what would happen on their property with heights on 25cm intervals (eg 12.5m at Tilpa means 10% of property will flood, 12.75m at Tilpa means 25% of property will flood.)

The river is primarily used for stock and domestic purposes and in many cases also forms the “boundary fence.” The limited irrigation in this area ceased through the drought and some landholders indicated they did not see it would commence again because of the capital costs of doing so.

The lack of data made it difficult for landholders to estimate the impacts of the Basin Plan. In general terms landholders believed that an increase in low to moderate floods would have mostly in-stream beneficial impacts with limited floodplain benefits from an environmental and economic perspective.

Typical agricultural production on floodplain in region

The area typically supports sheep (merino, dorpers and damaras), cattle and occasional goat production. Some floodplain cropping occurs following moderate to high floods. The areas of a property that were cropped varied significantly and most landholders indicated there were larger areas of potential cropping area than were currently or likely to be cropped.

Stocking tends to be conservative with a mix of set stocking and one of the approaches to cell grazing/ holistic resource management. The general approach is that floodplain areas are stocked following a flood so that other parts of the property can be rested entirely or subject to a greatly reduced stocking rate. When groundcover in floodplain country starts to decline, stock are then moved back to non-floodplain areas.

In a similar fashion to other areas, stocking rates as a whole are dependant on the following factors:

- Flood events
- Local Rainfall
- Stock water availability
- Overall land capability.

Agistment of stock either on property or off property is generally not carried out for a range of reasons. Natural build up of numbers is the generally adopted strategy to increase numbers because high stock prices coinciding with floods and distance to market generally make purchase of stock an unattractive option.

Long-term average stocking rates range between 0.3 – 0.5 DSE/ha, with floodplain country tending to be able to be stocked at rates 50-80% of non-floodplain country. In flood events, stocking rates can be as high as 1DSE/Ha in optimal conditions.

Feed availability in drought years can be as low as 100kg/ha and this can rise to as much as 5t/ha on
the floodplain, again under optimal conditions.

Landholders reported less flood events owing to upstream development and possibly climate change. Most felt that there had been a move to more summer floods, rather than winter floods and most reported that summer floods were more beneficial than those in early to mid winter.

Gross margins generally aligned with DPI values of $35 to $50, over the long term.

**Livestock and cropping impacts of SDL and response**

In a similar manner to other regions, livestock enterprises benefit from flooding primarily through the ability to sustain higher stocking rates for longer. Productivity gains are seen in an increased in woolcut of 20-30%, lambing percentages that can as much as double, and increases of up to 30% in weight gain.

Flood events were not reported as adding significantly to operating costs from fly control, additional crutching, etc.

In flood years gross margins can generally be expected to be $10-$15/ha higher. Returns could vary significantly depending on antecedent conditions including existing stock numbers, local rainfall, stock prices, extent of flooding, etc.

Flooding provides opportunistic cropping for a range of landholders. It is important to note that landholders did not see that the Basin Plan would provide any significant increased in areas flooded, time of inundation, flood height, etc with the result that there were no significant impacts predicted for individual properties. Landholders stated that they were at the bottom of an unregulated system and timing a flood to piggy back on a local rain event was simply not possible.

**Other impacts**

Landholders were very supportive of the Basin Plan, but did not see any significant economic benefits from the 2750 proposal.

Weeds were not reported to be a major problem with flood events, with most weeds confined to relatively small areas.

Flood events see an increase in native pasture species mix with better nutritional value (especially protein levels) and with the right management this pasture mix can contribute to property productivity and biodiversity in the long term. This was particularly the case with flood events that came on the back of local rainfall and also at the right time of year.

**Social Values of the floodplains**

The group were very supportive of the Basin Plan. They say that an increase in low to moderate floods was primarily about environmental and social benefit rather than economic gain for them as floodplain landholders.

The group cited the importance of the river to the social fabric of “river towns” along the entire Darling. It was seen to add to tourism, fishing and other recreational opportunities.
Focus Group: Lower Murrumbidgee

Introduction and discussion of SDL on flooding (ie gauge heights, frequency of flooding)

With more regular floods under the Basin Plan, landholders believe they would have the ability to undertake more rotational grazing resulting in steady income. The timing and duration of flooding is critical. On lignum country, a lot of feed can be grown if the water comes on and off quickly. If flooding occurs in the spring, it will kill the feed that is currently there and will prevent many species (e.g. clover) from germinating.

When flooding occurs, landholders undertake sub-soil farming, whereby the soil profile is filled one year for cropping (or pasture) the following year.

The lay time of the water varies depending on a number of factors. Some properties will begin grazing immediately as some species are water tolerant as opposed to other areas where water takes months to recede. In areas where lay time is brief, follow up rain is critical for pasture growth (this occurred with positive results during summer 2010/11).

Typical agricultural production on floodplain in region

Production on the floodplain in the Lower Murrumbidgee is typically cropping, sheep production (Merino, Crossbreds, Dorpers) and cattle. Livestock are a combination of self-replacement herds and flocks supplemented by trading stock, which allows for management of stock numbers.

There has been a recent trend (past 5 years) of increased numbers of Dorpers which are replacing Merinos and cattle through their suitability to the floodplain environment (walk through water, don’t have problems with flystrike, less labour intensive and have higher pregnancy percentages through greater response to floodplain conditions).

Stocking rates generally vary between 0.4 – 0.25 DES/ha in dry country to 2.5 DSE/ha in flooded country.

Cropping activities vary between share farming, landholders owning their own equipment and contract harvesting. Typical yields for cereal crops were nominated as 2 – 2.5 tonnes/ha for dryland and 2.5 – 3 tonnes/ha for irrigated land.

The group shares the view that when the land becomes degraded, agricultural production also becomes degraded. One landholder commented “if you can look after the ecological system, the economics takes care of itself.”

During the drought period in 2008, one landholder commented they were “down to 8% of stock of the property”. During this drought period, the floodplains were “basically non-productive and stocking rates reduced dramatically as the ground is too heavy and soil quality declines.

Livestock and cropping impacts of SDL and response

The primary benefits of flooding are increased stocking rates for livestock and increase subsoil moisture for cropping and pastures. These benefits come in the form of channel water for cropping and overbank flows for grazing.

Pasture benefits included not just quantity, but quality. Fresher more readily digestible species became available; and there is an increase mix of species which provided more nutritional value than a monoculture. There are typically more weed species from seed carried in flood water, with native groundsel bush particularly toxic to livestock. Species such as mustard weed can be an issue, although sheep will graze it when it’s short. Mustard weed inundates fences and causes sheeting
which results in fences being knocked over when further floodwater hits.

Livestock growth rates and pregnancy percentages improve following flood events and death rates are typically lower if managed appropriately. Surplus feed also allows for landholders to adjust if the market isn’t appropriate for trading stock themselves. This is also dependent on the availability of finance which allows flexibility.

Changes in wool cut vary mainly due to genetics rather than seasonality; however there are minor improvements when grazing conditions improve.

Cropping activities tend to be reliant on flooding, with one landholder commenting “if you don’t have a flood you don’t have a crop.” Landholders suggested 6,600ML/day at Hay gives good crop preparation. Anything over 1,000ML/day is useful.

Timber and firewood production is also important to the region, e.g. the red gum market generates employment in Balranald and, in the past, has helped moderate the impact of falling wool prices. Whilst increased regularity of flooding is desirable for red gum growth, it is unfavourable for timber harvesting due to access issues.

**Other impacts**

Flooding can damage infrastructure such as roads, channels, levies and fences. Repair costs can be substantial, particularly if earthworks are required. The immediate labour implications for any clean-up and maintenance is outweighed by the reduced labour unit cost of a higher stocking rate.

Access can also be a problem during flooding, e.g. stock need to be moved to higher ground or off the property, and livestock sales can be impeded due to trucks being unable to access the property.

The group felt that in most cases, however, they receive reasonable warning about potential flooding and can adapt their decision-making accordingly. This helps reduce any negative impacts associated with flooding. Considerations include, but are not limited to:

- The timing of the flood;
- The timing of the last flood;
- The timing of the last rain event; and
- The relative prices of commodities.

Increased bird life after flooding has a positive impact on the control of grasshoppers and caterpillars, e.g. an ibis feeding its young eats about 0.5kg / day of insects. Other bird species, however, can have a negative effect, e.g. an increased population of wood ducks has led to the birds eating lettuce crops and fouling pastures.