THE BASIN PLAN IMPLEMENTATION

# Namoi Water Resource Plan – Peel Baseline Diversions Limit Scenario Report – Peel Regulated River System

## Appendix C to Schedule F

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**More information**

Michael Sugiyanto, Department of Planning, Industry and Environment—Water, Parramatta

www.industry.nsw.gov.au/water

# Glossary

| Term | Definition |
|---|---|
| BDL | Baseline Diversion Limit under the Basin Plan |
| Cap | The Murray Darling Basin Ministerial Council Cap on Diversions |
| DPI Water | NSW Department of Primary Industries, Water Division (now Department of Planning, Industry and Environment—Water) |
| EFRG | Environmental Flows Reference Group |
| EWA | Environmental Water Allowance |
| HEW | Held Environmental Water |
| IQQM | Integrated Quantity and Quality Model |
| LTAAEL | Long term Average Annual Extraction Limit |
| MDB | Murray Darling Basin |
| MDBA | Murray Darling Basin Authority |
| MDBC | Murray Darling Basin Commission |
| MDBSY Project | Murray Darling Basin Sustainable Yields Project |
| OFS | On farm storage |
| PBP | Pre-Basin Plan |
| SDL | Sustainable Diversion Limit |
| WA 2007 | Commonwealth Water Act (2007) |
| WMA 2000 | NSW Water Management Act (2000) |
| WRP | Water Resource Plan |
| WSP | Water Sharing Plan |

# Contents



# Tables

# 1 Introduction

Statutory water sharing arrangements in NSW are generally developed with consideration of the analysis of results from computer models of a river system. These models estimate a range of water balance components such as streamflow and diversions based on climatically derived water availability, levels of water resource development, and water sharing policies. Different combinations of development and policies are tested in the models, and presented to stakeholders to gain an understanding of how policies may affect water users and the environment in a wide range of circumstances. A model scenario may also be selected as the basis for a statutory arrangement.

This process was followed by NSW to develop statutory WSPs under the WMA 2000 legislation using models developed with the IQQM software. WSP provisions were developed through modelling in IQQM. These provide an agreed set of sharing rules to achieve productivity and environmental outcomes, based on modelled annual diversions averaged over a long period of historically varying climate. A similar process will be used to develop the WRPs under the 2012 Basin Plan established under the Commonwealth Water Act 2007 (WA 2007).

A significant element of the WRP is that the long term average annual diversions have been set, known as the SDL. This SDL estimate depends on the estimate of the Baseline Diversion Limit (BDL). An estimate of the BDL was made at the time the Basin Plan was formulated. This estimate has been revised by Department of Planning, Industry and Environment based on improved modelling.

This report describes the development of the BDL scenario for the Peel River. This description incudes development information for the initial BDL scenario run in 2010 coupled with the current revisions for the improved BDL scenario run and a discussion of the output difference.

A separate report will be prepared to describe a more contemporary scenario that will be the baseline for WRP scenarios, and will be used to represent the SDL scenario.

## 1.1 The Pre-Basin Plan Scenario

The Basin Plan has a range of requirements, including a key requirement that for a WRP to be accredited, annual diversions averaged over the 114 year historical reference climate period cannot be greater than the SDL. The SDL is defined as the BDL minus a fixed recovery value. The BDL scenario is a reference point that will be used to measure all changes made by the Basin Plan including by WRPs, the achievement of SDLs and any impacts that may occur.

The BDL is included in the Basin Plan as a definition in Column 2, paragraph (a)(i) of Schedule 3 for NSW regulated rivers the "*…. the water that would have been taken… …under State water management law as of 01/07/2010…*". A note to this component provides an estimate based on reported MDBA modelling as of 2010. The BDL is based on a particular model scenario, based on the WSP rules for that water source. This scenario is the level of irrigation development and management arrangements at 1999/2000. The Basin Plan allows for this estimate to be revised whenever it can be demonstrated that a better estimate is available.

## 1.2 BDL Scenario

NSW interprets the BDL definition as being the Long Term Average Annual Extraction Limit (LTAAEL) provided for in the WSP in place as at 1 July 2010 for Namoi (and Peel). The LTAAEL is based on water use development levels at a specific point in time, e.g., 1999/2000, (crop areas, on-farm storage capacity, pump capacity, headwater storage, etc.), associated crop planting decision making, storage operation, and other management practices, and the rules set out in the WSP. The model scenario that has all these settings is the Plan Limit model, and is equivalent to the BDL.

A note was included in the WSP of the LTAAEL estimate at the time the WSP was formulated. This estimate has been revised as a consequence of continual improvement of the underlying model calibration, as well as improved representation of processes. The Plan Limit model was passed onto MDBA in 2010 to allow them to undertake Basin Plan modelling.

Further improvements have since been made, as well as a close audit to make certain the Plan Limit model conforms closely to WSP rules. These are more fully described in Chapter 2.

## 1.3 Purpose of report

This report is intended primarily for SAPs and the MDBA as a record of changes to the BDL estimate. The purpose of the report is to describe how the BDL Scenario was formed, and fully document what this scenario includes. The technical content of this report is kept to only that necessary to meet the intent.

# 2 Model Development

The Peel IQQM has been used as the principal tool to inform water planning and diversion compliance since the late-1990s, and has been subjected to continual improvement. The Peel IQQM was used to inform WSP development around 2009, and has been reviewed as fit for purpose MDBMC Cap Auditing, and for use in formulating the Basin Plan. The model described herein is an improvement on its usage for these purposes, and can be considered suitable for the WRP process.

## 2.1 Development for Water Sharing Plan

The Peel IQQM was initially developed in the late-1990s using an early version of the IQQM software. This was used to assess the valley against Cap condition.

The capability of the Peel IQQM to estimate annual and long term diversions was established by the independent review processes under Cap governance arrangements. Cap model audits by MDBC were required to assess the following aspects:

- accuracy of the model to predict annual total diversions and end of system flows
- method to establish levels of development, and their incorporation into the models
- method to adjust water use for climatic variation
- capability of the model to simulate long-term diversions
- robustness of the model to simulate outside the calibration period.

The calibration and set up of the audited model is described in the Peel Valley IQQM Cap Implementation Summary Report (Ribbons et al., April 2006). The model was independently audited by Bewsher Consulting in September 2007 for MDBC. Accordingly, the Commission approved the Peel IQQM for auditing of the MDBMC Cap.. The Independent Auditor also concluded the model to be sufficiently robust and unbiased, and it could be used to simulate long-term diversions.

The latest NSW BDL model stemmed from continuous model improvements. The key updates are listed below with details reported in Arranz (2008):

- extension of the period of data used for calibration beyond June 2003
- improving the flow simulation at Carrol gap during dry periods
- improving the irrigated area and diversions post 2004
- improving Chaffey Dam releases to TWS in Tamworth
- improving Dungowan Dam inflows
- improving calibration of the supplementary diversions.

A further review of the model was undertaken as part of the MDB Sustainable Yields Project, and to establish its fitness-for-purpose for use for MDBA modelling for the Basin Plan (Podger et al., 2010).

## 2.2 MDBA BDL Model

NSW provided 2010 version of Peel IQQM of the WSP to MDBA to commence the basin planning process. This version is consistent with the one used to estimate the gazetted WSP for Peel Regulated Water Source.

## 2.3 Revisions for NSW BDL estimates

The revisions made to the model supplied to the MDBA were principally related to the irrigation demands. A preliminary upgrade involved updating the planted crop areas using the same method employed for the Peel WSP IQQM. An alternate method more fit for purpose was then developed that allow for the crop area planted to vary with water allocations. The alternate method produced similar results as the updated original method. The steps to develop the updated BDL scenario model are described below.

### 2.3.1 Updating Water Sharing Plan representation

The MDBA BDL model did not represent 3 ML/d minimum release from Chaffey as set in the Peel WSP. At present, there is a minimum release of 10 ML/d configured downstream of Chaffey which was due to leakage when Chaffey volume is greater than 40,000 ML. The model update adds a minimum release of 3 ML/d when Chaffey is less than 40,000 ML. This is done to better represent the Peel WSP.

### 2.3.2 Updating planted areas using current method

Lucerne is the dominant crop planted by water users in the Peel Valley. Historically, the area of Lucerne planted and is higher during the years when it is climatically dry. This relationship was established in an analysis of historical records for planted crop areas for the period 1993 to 2002, which were inversely correlated with rainfall totals at Tamworth for the previous 15 months. The higher the rainfall, the less irrigated crop areas were planted. The relationship established was then used to estimate how much crop area would have been planted each year for the full climate period back to 1985 based on rainfall at Tamworth. This annual time series of area planted was the basis for the irrigation demands in IQQM.

Additional data not used in the original analysis was obtained, and used to improve the confidence in the estimate of how crop area varies according to climate. This had the effect of increasing the estimate of crop areas during dry to median rainfall conditions. The updated estimate of the planted areas resulted in irrigation diversions increasing from 6,198 GL/yr to 6,961 GL/yr, and total diversions increasing from 15,266 GL/yr to 16,031 GL/yr (5%).

### 2.3.3 Responsive method for estimating planted areas

The use of externally defined relationship imposes a static response to drivers of system behaviour. No matter how much water is available, the Peel IQQM plants the same areas for any scenario. This limitation demonstrates the need for a responsive model to allow planted areas to change based on conditions affecting water supply in Peel valley. As such, the area planted for irrigation by the Peel IQQM was configured using a non-linear risk function.

This risk function responds to the level of water availability and calibrated against recorded diversion for the period of data spanning from 1982 to 2016. The risk function aims to plant the specified maximum area during average years. Wetter years would result in lower crop prices and subsequently result in less planted area. Drier than average years would result in higher cost of water and subsequently less area would also be planted.

### 2.3.4 Maximum area

Historical data indicated the maximum area planted for irrigation in the Peel to be just over 3,700 ha. Conjunctively with calibrating the risk function discussed in Section 2.3.3, the maximum planted area was revised to 1,746 ha using the results of Landsat data for the planting season 2003, 2005, 2006, and 2010 to 2012.

### 2.3.5 Other crop model parameter changes

The re-calibration of crop areas from the risk function, constrained by a revised maximum crop area, required the re-estimation of other minor parameters as follows:

1. Whereas the planting decision date was redundant in the original model as the areas were fixed from year to year, a planting decision data was required to decide what area to plant based on resource variable. A 1$^{st}$ October date was selected based on regional consistency, and was consistent also with calibration results.
2. A consistent rainfall interception loss of 2 mm was adopted for all crops.
3. A consistent soil depletion depth of 300 mm was adopted for all crops.

### 2.3.6 Calibration results

The method underpinning diversions estimates in the MDBA BDL model, updated for additional crop area data 2003-2006, and calibrated to 2000-2015 annual diversions satisfactorily reproduces both the total diversions and the inter-annual variability, as indicated by the results reported in Table 2-1 for volume ratio and coefficient of determination respectively (a value of 1.0 for both performance indicators indicates a perfect match). The alternate method was calibrated independently and produces a slightly superior result for both performance indicators. The alternate method will be adopted as it is produces better results, and is more fit-for purpose for WRP development purposes.

**Table 2-1. Calibration performance of alternate diversion estimation methods**

| Performance indicator | Fixed areas based on regression with Tamworth 15 month prior rainfall | Non-linear risk function with planted area based on allocation level |
|---|---|---|
| **Volume ratio** | 0.97 | 0.99 |
| **Coefficient of Determination** | 0.86 | 0.89 |

**Table 2-2. Difference between original MDBA BDL and updated BDL models**

| No. | MDBA BDL Model | Updated BDL Model |
|---|---|---|
| **Planted crop area** | Based on regression of observed crop areas vs rainfall index for the period from 1993 to 2002 | Based on non- linear risk function |
| **Maximum planted area** | 3,700 ha<br>[Based on 1993 to 2002 data] | 1,746 ha<br>[Based on LandSat data analysis 2003 – 2012] |
| **Planting date** | n/a | 1 October |
| **Rainfall interception loss** | Ranging from 2 to 4 mm | 2 mm for all irrigated areas |
| **Soil depletion** | Ranging from 200 – 600 mm | 300 mm |

# 3 Results

The average annual usage for different components of the models is shown in Table 3-1. The results show that changing the method resulted in a 6% increase in water use. However, this is only an increase of 1% using the same method with updated crop area data (Section 2). The reliability of allocations results of this alternate method were also compared with the MDBA BDL model, and these were very close.

**Table 3-1. Comparison of results from original MDBA BDL and updated BDL scenarios**

| Category | Scenario | |
|---|---|---|
| | MDBA BDL | Updated BDL |
| **Entitlements** | long term average usage (ML/y) [1895-2009] | |
| General Security | 3,232 | 3,835 |
| Uncontrolled | 2,966 | 3,242 |
| TWS | 8,816 | 8,814 |
| Utilities, Domestic & Stock | 252 | 252 |
| **Total** | 15,266 | 16,143 |
| Carrol Gap Flow | 244,057 | 243,472 |
| Min Chaffey Dam Volume (ML) | 15,300 | 13,600 |

# 4 PBP model parameters

Table 4-1 contains all relevant configuration information for the PBP Scenario.

**Table 4-1. BDL Infrastructure and Development Parameters**

| Items | Description |
|---|---|
| **General** | |
| System File Name | NamoA122.SQQ |
| IQQM Version developed in | 7.91.12 |
| Available Simulation Period | 01/09/1892 - 30/06/2016 |
| Water Year | July to June |
| **Valley Development Levels** | |
| Maximum Crop area | 2003 to 2013 |
| Crop Mix | 2000 |
| Licence Volume | 2005 |
| **Catchment Information** | |
| *Headwater storages modelled* | |
| Chaffey | |
| Inactive storage (ML) | 2,400 |
| Full supply volume (ML) | 62,000 |
| Average annual inflow (ML) | 52,200 |
| Dungowan | |
| Inactive storage (ML) | 400 |
| Full supply volume (ML) | 6,300 |
| Average annual inflow (ML) | 11,200 |
| **Entitlements** | |
| *General Security Entitlements (ML)* | |
| d/s Chaffey Dam | |
| Consumptive | 30,878 |
| *High Security (shares)* | |
| d/s Chaffey Dam | 601 |
| Town Water Supply (shares) | |
| d/s Chaffey | 16,400 |
| Stock and domestic (shares) | 381 |
| **Irrigation development** | |
| Maximum planted area (ha) | 1,746 |
| Installed pump capacity (ML/d) | 440 |
| **Accounting System Lower Peel** | |
| Type | Annual |
| Debiting type | Water use |
| Maximum balance | 100% |
| Maximum use of entitlement | 100% |
| **Storage Operation** | |
| Dungowan Dam | Water is released from Dungowan dam to meet Tamworth demand, based on maximum daily limit of 22 ML/d. |

| Items | Description |
|---|---|
| Chaffey Dam | Demand from Tamworth is restricted during dry years as per advice given by Tamworth Regional Council. Reduction of demand when applies according to 2008 TRC Drought management Plan triggers.<br>**Dam Level** — **Usage Target**<br>50% — 95%<br>40% — 90%<br>35% — 85%<br>30% — 75%<br>25% — 65% |
| **In-stream requirements** | |
| *Average annual usages and maximum replenishment flow requirements (ML/y)* | |
| Stimulus Flow | 1,600 ML set aside for stimulus flow in the Peel River at Piallamore when Chaffey >= 51 GL and various flow indicators are satisfied |
| *Minimum flow requirements at various locations (ML/d)* | |
| Chaffey Dam release | 3 |
| Dungowan Creek R d/s Dungowan | 10 |
| Carrol Gap | 10 (Oct to Feb) |
| **Environmental Water** | |
| *Planned Environmental Water* | |
| Surplus flow sharing | 50% as per Water Act 1912 |
| Surplus flow threshold | As per WSP c62:<br>If AWD < 35% and Carroll Gap Flow > 40 ML/d<br>If AWD >= 35% and Carroll Gap Flow > 50 ML/d |

# 5 References

Bewsher Consulting Pty Ltd (2007), Peel Valley IQQM, Independent Audit of Component of Namoi Cap Model. September 2007, pp 40

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