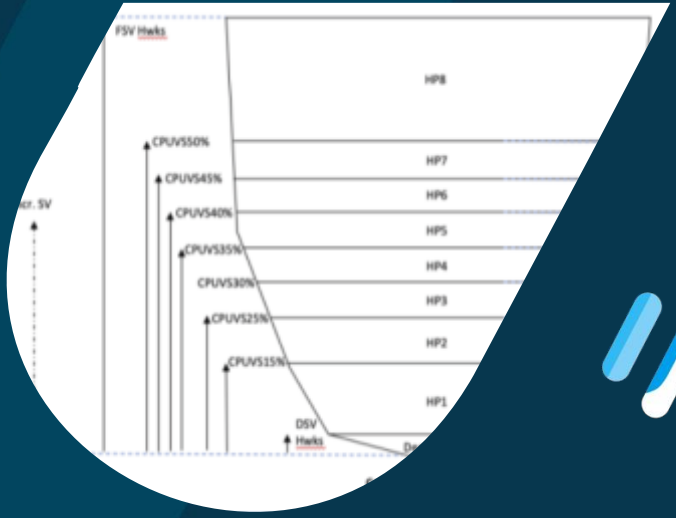

Water Solutions
Certainty in Water

Report to

QUEENSLAND COMPETITION AUTHORITY

on

RURAL IRRIGATION PRICE REVIEW 2020-24

ASSESSMENT OF HYDROLOGIC FACTORS: FURTHER ASSESSMENT - CENTRAL BRISBANE

Job Number	**WS0895.1901.001**
Doc Number	**WS190095**
Revision	**3**
Date	**28 January 2020**

THIS PAGE INTENTIONALLY LEFT BLANK

Queensland Competition Authority
Rural Irrigation Price Review 2020-24
Further Assessment - Central Brisbane

Prepared for: **Queensland Competition Authority**

GPO Box 2257
Brisbane Qld 4001 Australia

Phone: 07 3222 0555
Fax: 07 3222 0599

Prepared by: **Water Solutions Pty Ltd**

PO Box 1031
Kenmore QLD 4069 Australia

Phone: 07 3378 7955
Fax: 07 3378 7966

Email: info@watersolutions.com.au

Document Quality Control

Job No. WS0895.1901.001
Document No. WS190095

Revision	Date	Revision Details	Author	Reviewer
0	16/12/2019	Draft Report	TM	JM
1	6/01/2020	Updated Draft	TM	JM
2	14/01/2020	Updated Draft	TM	JM
3	28/01/2020	Final Report	TM	JM

THIS PAGE INTENTIONALLY LEFT BLANK

Executive Summary

Following on from Water Solutions' initial advice summarised in the report "Rural Irrigation Price Review 2020-24 – Assessment of Hydrologic Factors", this report provides additional advice to assist with pricing for the Central Brisbane Water Supply Scheme, in response to hydrologic issues raised in submissions on the draft QCA report.

An initial review of the relevant submissions identified that the key component for review was the revised estimation of the MP HUF presented in the Badu Advisory Oct 2019 Report, included in the Seqwater and MBRI submission.

Badu Advisory's approach to estimating the MP HUF was compared to the estimate in Water Solutions Sept 2019 and the standard methodology documented in Sunwater 2018j. A number of differences in approach were identified. Each difference was assessed, and in summary it was concluded that the methodology applied in Water Solutions Sept 2019 is generally more in keeping with the standard HUF methodology than that documented in Badu Advisory Oct 2019.

However one change implemented by Badu Advisory was considered to be an improvement, the direct allowance for storage evaporative losses implemented by Badu Advisory in their calculations. An update to the methodology presented in Water Solutions Sept 2019 was thus made to directly account for storage evaporation loss in a similar manner as implemented by Badu Advisory. The revised MP HUF with this change was calculated to be 1.39%.

It is thus recommended that the 2020-24 Price Review adopts a MP HUF of 1.39% for the apportionment of costs between HP and MP allocation holders.

The reviewed submissions raised a number of other relevant hydrologic issues, and comment on these issues is contained in this report. However the key conclusions presented in Water Solutions Sept 2019 remain unchanged – comparison of the two cases presented in the Central Brisbane Benefits Study is not considered to be an appropriate method to assess relative benefit, and the available evidence indicates that the scheme does provide hydrologic benefit to MP users.

Water Solutions

Table of Contents

Nomenclature

Term	Description
AA	Announced Allocation
AEP	Annual Exceedance Probability
AHD	Australian Height Datum
Att	Attachment
ARI	Average Recurrence Interval
ARR2016	Australian Rainfall and Runoff, 2016 Edition
AWSP	Annual Water Security Performance
BA	Badu Advisory
BPEQ	Board of Professional Engineers of Queensland
BRIA	Burdekin River Irrigation Area Irrigators Ltd
CBBS	Central Brisbane Benefits Study
CPUVS	Combined Percentage of Useable Volume
CUFSV	Combined Useable Full Supply Volume
CV	Current Volume
CWSA	Critical Water Sharing Arrangements
DD	Diversion Days
DERM	Department of Environment and Resource Management
DNRM	Department of Natural Resources and Mines
DNRME	Department of Natural Resources, Mines and Energy
DLWC	Department of Land and Water Conservation
DSL	Dead Storage Level
DSV	Dead Storage Volume
DSV Hwks	Dead Storage Volume Headworks
EA	Engineers Australia
EC	Existing Case
EFO	Environmental Flow Objective
FSL	Full Supply Level
FSV	Full Supply Volume
FSV Hwks	Full Supply Volume Headworks
Govt	Government
GS	Gauging Station
HP	High Priority
HPA	High Priority Allocations
HPAmax	High Priority Allocations, maximum
HP1	High Priority Zone 1
HP1util	Effective Utilisation of the HP1 Zone
HP2	High Priority Zone 2
HP2util	Effective Utilisation of the HP2 Zone

HUF	Headworks Utilisation Factor
HZA	Haughton Zone A
IQQM	Integrated Quantity Quality Model
MAD	Mean Annual Diversion
MBRI	mid Brisbane River Irrigators
MP	Medium Priority
MPA	Medium Priority Allocations
MPAmin	Medium Priority Allocations, minimum
MP0	Storage volume associated with 0% AA for MP, 100% AA for HP
MP100	Storage volume associated with 100% AA for MP, 100% AA for HP
MP1	Medium Priority Zone 1
MP100_EvapShare	For the Central Brisbane, the share of storage evaporative losses assigned to MP users.
MP1F	For the Central Brisbane, a factor to estimate transmission and operational losses associated with delivering water to MP users during the year.
MP1_HP	For the Central Brisbane, a subdivision of MP1 to more closely reflect the storage that is primarily ensuring water security for users other than MP.
MP1_MP	For the Central Brisbane, a subdivision of MP1 to more closely reflect the storage required to supply MP users in the current year.
MP1util	Effective Utilisation of the MP1 Zone
MP1util_HP	For the Central Brisbane, a subdivision of MP1util to more closely reflect the effective utilisation of volume in Zone MP1_HP for HP WAE
MP1util_MP	For the Central Brisbane, a subdivision of MP1util to more closely reflect the effective utilisation of volume in in Zone MP1_MP for MP WAE
MP2	Medium Priority Zone 2
MP2util	Effective Utilisation of the MP2 Zone
MOV	Minimum Operating Volume (usually same as DSV)
NOL	Nominal Operating Level
NV	Nominal Volume
OM	Operations Manual
PB	Parsons Brinckerhoff
P1, P2, P3	Probability of Utilisation for zones in the headworks storages
QA	Quality Assurance
QCA	Queensland Competition Authority
Qld	Queensland
RFQ	Request For Quote
ROL	Resource Operations Licence
ROP	Resource Operations Plan
RPEQ	Registered Professional Engineer of Queensland
S or s	Section
SEQ	South-East Queensland

SILO	Scientific Information for Land Owners
SL	Storage Loss
TOL	Transmission and Operational Loss
TOR	Terms of Reference
UV	Useable Volume
WAE	Water Allocation Entitlements
WASO	Water Allocation Security Objective
WOD	WithOut Dams Case
WMP	Water Management Protocol
WP	Water Plan
WRP	Water Resource Plan
WS	Water Solutions Pty Ltd
WSS	Water Supply System

1 Introduction

1.1 Background

The Queensland State Government referred the monopoly business activities of Sunwater and Seqwater to the QCA for an investigation about pricing practices via a referral notice to the QCA dated 29 October 2018. The monopoly business activities to be investigated are those associated with the bulk water supply and distribution of water for irrigation in a specified set of water supply schemes and distribution systems. The key objective of the investigation was to recommend irrigation prices for the period 1 July 2020 to 30 June 2024.

Sunwater and Seqwater subsequently provided submissions to the investigation, as have a range of stakeholders, with the submissions available on the QCA website.

In April 2019 the QCA issued a Terms of Reference (TOR) for a project to undertake an assessment of hydrological factors as a basis for cost allocation in specific water supply schemes, and in May 2019 Water Solutions was engaged to provide this assessment. The results of this assessment was reported in the Water Solutions report "Rural Irrigation Price Review 2020-24 – Assessment of Hydrologic Factors", Doc No WS190040 Rev 2 dated 3 September 2019. This report covered three main topics, quality assurance of Headworks Utilisation Factor (HUF) calculations for six specified schemes, a hydrologic review of submissions associated with pricing for the Central Brisbane River scheme Medium Priority (MP) irrigators, and a hydrologic review of submissions associated with pricing for the Giru Benefited Groundwater Area (GBGA) MP irrigators.

The QCA subsequently released their draft report on 9 September 2019. Following the release of the QCA's draft report a range of parties made submissions on the draft report.

The QCA's draft report, the Water Solutions report and the submissions from stakeholders may be found on the QCA website.

Following receipt of the submissions Water Solutions was requested to provide further input in relation to issues identified in submissions in the Central Brisbane scheme and the Giru Benefited Groundwater Area.

This report presents the results of the further hydrologic investigations carried out into issues associated with the Central Brisbane scheme, while the companion report (WS190096) presents the results of the further hydrologic investigations carried out into issues associated with the Giru Benefited Groundwater Area.

It is highlighted that this report follows on from the original Water Solutions report "Rural Irrigation Price Review 2020-24 – Assessment of Hydrologic Factors", Doc No WS190040 Rev 2 dated 3 September 2019. A good understanding of the earlier report is strongly recommended before reading this report.

1.2 Key Objective

The key objective of this report is the same as in the original report, that is:

To provide expert hydrologic advice and guidance to assist the QCA to determine the appropriate apportionment of costs between different customer groups in specified schemes/systems.

It is highlighted that this review is focused on hydrologic factors. There may be a range of other factors that have influence on the appropriate apportionment of costs between users groups in the scheme. Assessment of non-hydrologic factors is beyond the scope of this review.

1.3 Structure of this Report

The remainder of this report is structured as follows:

- Section 2 presents an overview of the submissions made on the draft QCA report which raise hydrology related issues pertinent to pricing in the Central Brisbane scheme.
- Section 3 provides a review of the revised estimation of the MP HUF presented in the Badu Advisory Oct 2019 Report included in the Seqwater and MBRI submission.
- Section 4 discusses a range of other hydrology related issues raised in the reviewed submissions.
- Section 5 summarises the conclusions of this report.
- Section 6 lists the key references used in this assessment.

2 Submissions Overview

The QCA provided key submissions received that related to the hydrologic matters relevant to the Central Brisbane pricing issue for consideration in this assessment. The list of submissions provided for review was:

- Seqwater and Mid Brisbane River Irrigators (MBRI) Submission 1/11/2019
- Mid Brisbane River Irrigators (MBRI) Submission 4/11/19.
- Schmidt K Submission (undated)

An initial review of the submissions identified that the key component for review was the revised estimation of the MP HUF presented in the Badu Advisory Oct 2019 Report included in the Seqwater and MBRI submission. Section 3 thus presents a review of the Badu Advisory estimate of the MP HUF.

A range of other hydrology related points were identified in the submissions, and comment on these issues is provided in Section 4.

3 Central Brisbane MP HUF

3.1 Introduction

The Badu Advisory Oct 2019 Report included in the 1 November 2019 Seqwater and MBRI submission presents the methodology and outcome of Badu Advisory's estimate of the MP HUF for the Central Brisbane scheme, and also provides comment on the previous estimate included in Water Solutions Sep 2019.

As part of this review Seqwater provided a copy of the spreadsheet used to calculate the HUF using the methodology outlined in the Badu Advisory report. Comment on the Badu Advisory report and revised MP HUF estimate is provided in the sections below.

It is noted that the rest of 1 November 2019 Seqwater and MBRI submission includes a series of comments related to the evaluation of the benefits of the Central Brisbane scheme to MP users, reiterating the view that no hydrologic benefit is provided. The comments provided are noted, however the key conclusions presented in Water Solutions Sept 2019 remain unchanged – comparison of the two cases presented in the Central Brisbane Benefits Study is not considered to be an appropriate method to assess relative benefit, and the available evidence indicates that the scheme does provide hydrologic benefit to MP users.

With the Central Brisbane scheme providing benefit to both HP and MP users, the task at hand is to estimate a fair and balanced apportionment of costs between the two user groups. The HUF methodology has been adopted as the appropriate method to apportion costs between user groups in a scheme state-wide, with Section 3.2 providing reference to the documented standard HUF methodology. Section 3.3 to 3.9 then discuss Badu Advisory's approach to estimating the MP HUF, comparing it to the methodology in Water Solutions Sept 2019 and the standard methodology. Section 3.10 then provides an updated estimate of the MP HUF after consideration of the recommendations of the Badu Advisory Oct 2019 report.

3.2 Standard HUF Methodology

The standard HUF Methodology adopted in this Price Review is that documented in Sunwater 2018j. This methodology underwent refinement and review in the 2012/3-17 Price Review and has been accepted by the QCA as being fit for purpose. This methodology, as documented in Sunwater 2018j and as applied in the six schemes reviewed in Water Solutions Sep 2019, was used as the benchmark for reviewing the approach applied in the Badu Advisory report.

It is noted that the standard procedure does allow some adjustments so that it may be reasonably applied in schemes with varying operational rules and characteristics. As discussed in Water Solutions Sep 2019, application to the Central Brisbane scheme does require some adjustment. The extent of adjustment that is appropriate is a matter of professional judgement, and this is discussed where relevant in the sections following.

3.3 Conversion of MP to HP Allocation

In Section 2.2.1 of Badu Advisory Oct 2019 report Badu Advisory converts a portion of MP allocation to HP allocation for the purposes of the HUF calculation. Badu Advisory used a 1.0 conversion rate (sourced from the 1.0 rate in s14 of the Water Management Protocol) to convert 153 ML of MPA to 153 ML of HPA, taking the total HPA to 279,000 ML, which is the limit specified in Table 1 of the Water Management Protocol.

However Step 1a half way down page A-7 of the documented HUF methodology (Appendix J of Sunwater's Nov 2018 submission) indicates that this step is only applicable if a medium to high conversion factor is specified in the ROP (now the WMP).

Section 14 of the Water Management Protocol specifies a HP to MP conversion factor, but does not specify a MP to HP conversion factor.

Based on the documented methodology, this step should not be performed for the Central Brisbane.

Additionally, while this report is recommending some modifications to the standard HUF methodology to cope with the peculiarities of the Central Brisbane Scheme, there does not appear to be any Central Brisbane characteristic which would warrant a departure from the adopted standard MP to HP conversion methodology.

3.4 Proportion of the CPUVS in Wivenhoe Dam and Somerset Dam

The definition of CPUVS includes the volume and storage losses in both Wivenhoe and Somerset Dams. There are a number of different sets of Wivenhoe and Somerset storage volumes that you could use that will give the same volume of CPUVS. Because the relationship of storage evaporative losses with volume is non-linear, assuming different shares of storage between the two dams will give a different result.

It is thus necessary to decide what a fair apportionment of volume between the two storages is for the purposes of the HUF calculation.

The Badu Advisory Oct 2019 and Water Solutions Sept 2019 reports have taken different approaches to this issue,

Badu Advisory took the approach of effectively dividing the CPUVS into two parts, and then evaluating CPUVS just for Wivenhoe for each required percentage (15% to 50%), and then evaluating CPUVS just for Somerset for each required percentage (15% to 50%). Badu Advisory's procedure effectively assumes that both dams are drawn down in a similar ratio, i.e. that it is likely that the two dams will both be at 15% (say) at the time the announced allocation decision is taken.

However the operating rules of the Central Brisbane WSS do not draw both dams down at the same % rate. As can be seen in Figure 3.3 and Figure 3.4 of Water Solutions Sept 2019, when it gets really dry more water (proportionally) tends to be stored in the upper dam, Somerset Dam. Water Solutions Sept 2019 based the share of water stored in the two dams on the predicted probabilities of relative storage levels from the water planning model.

Table 3.1 summarises the effect of these two different methodologies on the resultant combined volume of the two dams (which directly affects the size of the HUF methodology zones).

Table 3.1 – Central Brisbane – Effect of Different Storage Levels

CPUVS	WS Sept 2019			BA Oct 2019		
	Wivenhoe Dam (ML)	Somerset Dam (ML)	Combined Volume (ML)	Wivenhoe Dam (ML)	Somerset Dam (ML)	Combined Volume (ML)
15%	200,000	117,500	317,500	237,500	84,400	321,900
50%	755,000	192,500	947,500	705,000	244,000	949,000

It can be seen that the differences are not large – Badu Advisory's estimate of the combined volume at 15% CPUVS is about 4,400 Ml higher than the WS estimate, while at 50% CPUVS Badu Advisory's combined volume is about 1,500 ML higher.

While the differences are not large, the WS method is considered to better reflect Central Brisbane scheme characteristics than Badu Advisory's method, and is thus preferred.

3.5 Critical Period and Storage Volume Time Series

S2.2.3 of the Badu Advisory Report indicates the driest 15 year period that was used to calculate the HUF was 1/7/1899 to 30/6/1914.

This date range is also listed on the storage volume exceedance plot included on pg 9 of the Badu Advisory report.

However in the provided spreadsheet the storage volume exceedance plot appears to have been calculated based on a time series of storage volumes from 1889 to 1904, and it appears that this 1889-1904 plot has been used to determine the HUF of 0.8 quoted in the Badu Advisory report.

At first it was though this was a simple typo in the report, and that the critical period should be documented as 1889 to 1904, however closer perusal of the spreadsheet identified a cell that contained a hard coded number, 5.5E9, labelled as "minimum 15 year storage", and indicating it was for the 1899-1914 period. The daily values in the spreadsheet for 1899-2014 were summed and gave this total.

Additionally, the 1890s were a particularly wet decade in the Brisbane catchment, with 3 of the largest Brisbane floods ever recorded occurring in that period. It is not impossible, but it would appear odd that the driest 15 year period would include the very wet 1893-94 period.

Hence it appears that the 1899-1914 period is drier than the 1889-1904 period (using the criteria of the minimum sum of the daily combined storage volumes over the 15 year period), but that the calculations in the report have been performed on the 1889-1904 period instead.

To further complicate matters, the spreadsheet also contain two daily sequences of storage levels for the period 1996 to 2011, one set labelled as coming from the IQQM model, and the other labelled as actual values. The actual 1996-2011 data has a slightly higher summed volume than the modelled 1899-2014 period, but the modelled 1996-2011 data has a significantly lower summed volume. The critical period should perhaps have been defined as 1996-2011 based on the data and the lowest sum criteria.

It is also noted that the storage volumes used in the critical periods go well above the FSV of the storages. For example, the highest combined storage volume from the IQQM model is 3.3E6 ML in Jan 2011, over double the combined FSV of the two dams at 1.5E6 ML. These volumes tend to

quickly reduce as the flood recedes, but counting water in the dams above FSV as part of the estimation of the driest period for water supply purposes may bias the result[1].

Finally, it appears that the intent in the Badu Advisory report was to determine the driest period based on the lowest summed daily volume over 15 year periods. The current methodology applied by Sunwater, as documented in Sunwater 2018j, determines the appropriate 15 year periods by estimating the HUF for rolling 15 year periods through the entire time series, and selects the driest period based on the one which produces the lowest HUF. There is no guarantee that these two methods will select the same period (especially when one is counting volume over storage FSVs).

The previous WS HUF estimate determined the critical period to be the 1995-2010 period, slightly different to the 1996-2011 period analysed in the Badu Advisory spreadsheet, based on combined capped storage volumes calculated from IQQM time series of storage volumes for each dam provided by Seqwater.

A comparison of the combined storage volume sequences used in the Badu Advisory and WS HUF calculation is provided in Figure 3-1. (Note Badu Advisory data was only provided for the 1889-2014 and 1996-2011 periods). It can be seen that the sequences are basically identical, except for the capping to FSV undertaken in the WS calculations. It is also noted that the 2000's drought drops the combined storage volume to a much lower level, but the 1900's drought persists for slightly longer period (evaluated by the length of time between reaching FSV).

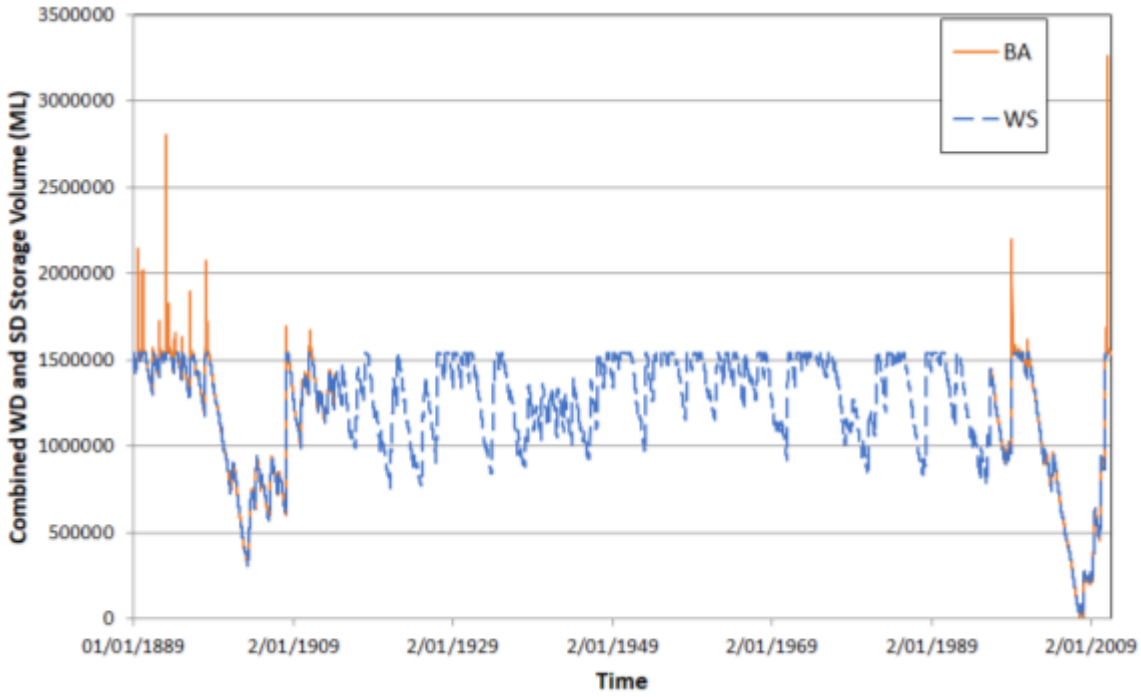

Figure 3-1 – Comparison of Storage Volume Sequences Used in HUF Calculations

[1] The capping of modelled storage volume timeseries at each storages individual FSV does not appear to be documented in Sunwater 2018j, but it is considered good practice, and Sunwater has applied this rule in the calculation of the HUFs for the schemes reviewed in Water Solutions Sept 2019.

Figure 3-2 provides a comparison of the original driest period daily volume exceedance plot included in the Badu Advisory Oct 2019 report (the orange line, for the period 1889-1904), to daily volume exceedance traces for the 1899- 1914 period and 1996-2011 periods. Note all these three lines are based on modelled data. The fourth line is the 1996-2011 actual data included in the Badu Advisory spreadsheet. (Note all four data series include volumes above the combined FSV of 1.5E6 ML)

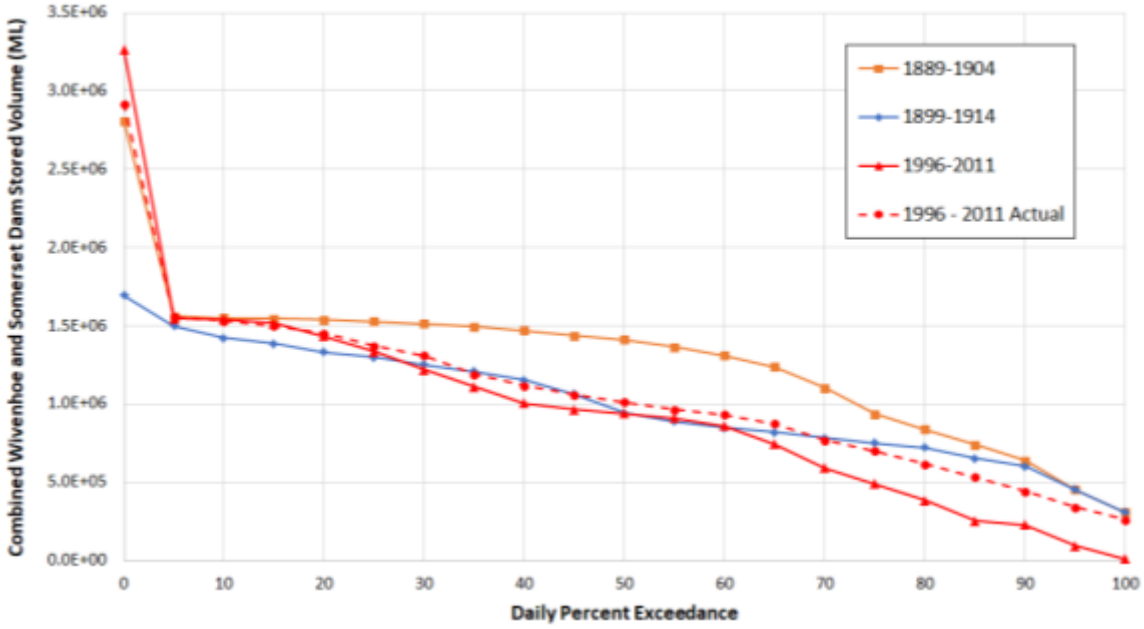

Figure 3-2 – Comparison of Exceedance Plots

It can be seen that the 1899-1914 period is substantially drier than the 1889-1904 period, and that 1899-1914 and the actual 1996-2011 periods are similar. The modelled 1996 – 2011 period is a little higher in the wet part of this period, but significantly lower in the dry part of this period.

In summary, including dam volumes above FSV in the selection of the driest 15 year period is not considered good practice and is thus not supported. Additionally, the error in the selection of the driest 15 year period would need to be addressed, however the methodology used to select this period also has issues, see Section 3.8 for further discussion.

3.6 Top Horizontal Layer

The standard HUF methodology outlined in Sunwater 2018j subdivides the scheme storage into four horizontal zones as shown on Figure 3-3. Zone HP1 is conceptually the zone for HPA water in the current year, zone MP1 the zone for MPA water in the current year, and the top horizontal zone is conceptually MPA and HPA water for future years. Steps 10 and 11 on pg A-9 of Attachment A to Sunwater 2018j require the upper zone to be divided between MPA and HPA users based on the ratio of MPAmin and HPAmax, i.e. the ratio of MPA to HPA in the Central Brisbane.

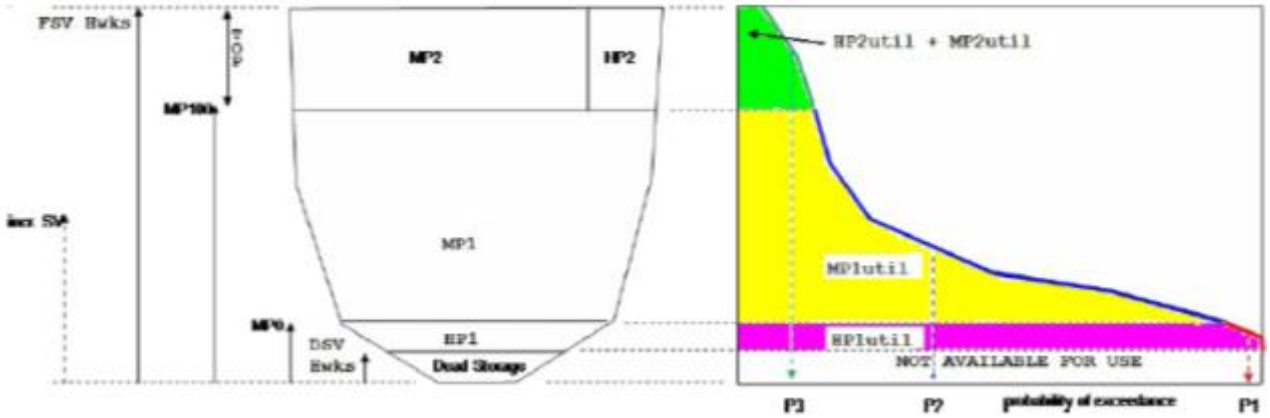

Figure 3-3 – HUF Parameters (Sunwater 2018j)

Badu Advisory's method assigns the entire upper section of the storage to HP (zone HP8 on Figure 3-4). This appears to be a significant departure from the documented standard HUF methodology in Sunwater 2018j, and is thus not supported.

3.7 Number of Subdivisions of Zone MP1

Badu Advisory has subdivided the standard HUF methodology Zone MP1[2] (ref Figure 3-3) into a number of layers based on the AA rule specified for the Central Brisbane WSS in the Operational Manual. Table 3.2 shows the core AA rule from that Operations Manual, where the MP AA is determined based on CPUVS.

Table 3.2 – Central Brisbane – Relationship of CPUVS to MP AA

Combined Percentage of Useable Volume in Storage of Wivenhoe and Somerset dams (%)	Announced allocation for medium priority water allocations (% of nominal volume)
0 to 14.9	0
15 to 24.9	15
25 to 29.9	25
30 to 34.9	40
35 to 39.9	55
40 to 44.9	70
45 to 49.9	85
50 to 100	100

Badu Advisory has attempted to allow for each row of this table individually, with Badu Advisory's conceptual approach illustrated in Figure 1 of Badu Advisory's report, shown below for convenience.

[2] Unfortunately Sunwater 2018j and BA Oct 2019 use the abbreviation MP1 to represent two different zones of the conceptual scheme storage. Apologies for any confusion this may cause.

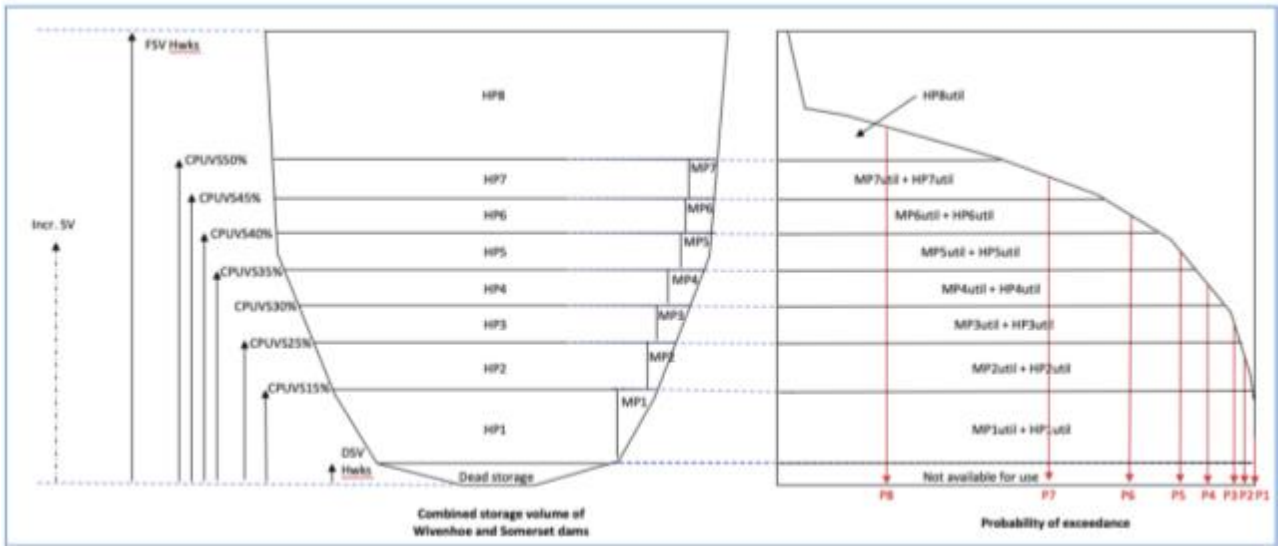

Figure 3-4 – Badu Advisory's Modified HUF Parameters for Central Brisbane

WS also based its subdivision of the MP1 zone on the AA rule in the Operations Manual, but took a simpler approach, subdividing the middle zone into the parts for HP and MP, see Figure 3-5.

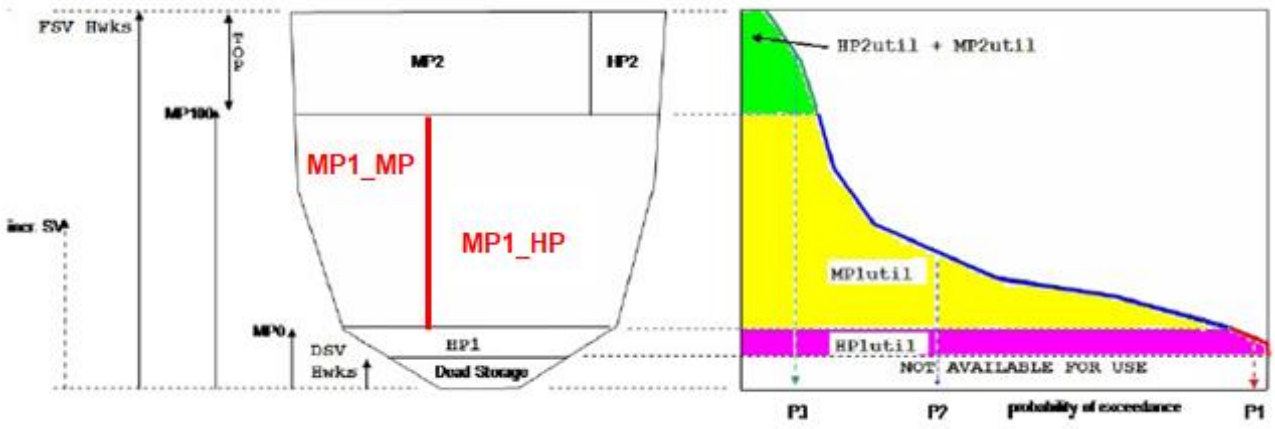

Figure 3-5 – Modified HUF Parameters for Central Brisbane

The approach taken in WS Sept 2017 appears to be more in keeping with the standard HUF procedure documented in SunWater 2018j. For example, page A-7 and page A-8 outlines the steps for calculating MP0 and MP100, which defines the top and bottom of the middle zone. Of course all schemes with AA rules do, from time to time, announce an allocation between 0% and 100%, but the standard procedure does not require calculation of separate zones for intermediate MP AA values. The Central Brisbane AA rule uses a different method of calculation, but the outcome is the same – MP AA's are announced each year at values between 0% and 100%, the same as most other schemes. As per the discussion in Section 3.3, there does not appear to be a substantial difference here which would warrant a departure from the adopted standard MP to HP conversion methodology.

It is thus recommended that the standard HUF approach of only creating a horizontal storage slice at 0% and 100% MP AA is maintained for the Central Brisbane in this price review.

3.8 Calculation of Average Zone Utilisation

It is noted that the spreadsheet provided to support the calculations in the Badu Advisory Oct 2019 report calculates average utilisation of the storage zones differently to the standard HUF methodology spreadsheets provided by SunWater.

In the Badu Advisory spreadsheet:

- The 15 year driest period is pre-selected before the utilisations and MP HUF is calculated. As discussed in Section 3.5, it appears this selection was intended to be done by summing the total storage volumes over 15 year periods and selecting the period with the lowest total volume.
- Once the period is selected the daily storage volume exceedance curve is prepared.
- The probability of the combined storage being at the volume at the bottom and top of each slice is determined from the daily storage volume exceedance curve. These two values are averaged to provide the average probability of utilisation for the slice.
- The average utilisation is then multiplied by the volume in the slice for each priority group to get the utilisation volume for the slice.
- The utilisation volumes for all slices for each priority group are then summed, and the HUF is the percentage of each priority groups' component of the total utilisation volume[3].

The HUF methodology applied in the Sunwater spreadsheets in accordance with the methodology documented in Sunwater 2018j has some significant differences to the approach used by Badu Advisory, as follows:

- The calculations of the utilisation volumes and HUF percentage is undertaken before the driest period is selected. The selection of the driest period is based on the period which gives the lowest MP HUF.
- Daily storage volume exceedance plots, and the probability of utilisation percentages, are not required to be prepared in order to determine the HUF.
- Rather, the volume in each storage zone is determined on every day of the 120 odd year modelled sequence of storage levels, and then averaged over rolling 15 year periods to give the average utilisation of each zone directly.
- The HUF is calculated from the determined zone utilisation volumes using the formulae in dot point 1 under the heading "Determine the Headworks Utilisation Factors" on pg 10 of Attachment A of Sunwater 2018j.

It is noted that the section under the heading "Assess the hydrologic performance of each component of headworks storage" on pg 10 of Attachment A of Sunwater 2018j does not well document these steps as implemented in Sunwater's spreadsheets. This is why it was recommended to update the documentation of these steps in Section 2.6.1 of WS Sept 2019.

[3] The methodology applied by BA may represent an earlier version of the HUF calculation methodology. Review of previous iterations of the HUF methodology was not part of the scope of this review, but it is understood that a previous reviewer identified that using the average of the top and bottom % from the daily storage exceedance plot can misrepresent the trace of the curve between those two points, and hence recommended the procedure applied in the Sunwater spreadsheet.

Owing to these differences, the methodology applied by Badu Advisory might identify a different driest period, and might calculate different utilisation volumes for the various storage zones, which may lead to a significant difference in the final calculated MP HUF.

In summary, use of the alternate Badu Advisory methodology to estimate average utilisation of the storage zones is not supported.

3.9 Allowance for Operational Losses

In Section 3.1 Badu Advisory states that the adoption of the MP1F factor in WS Sept 2019 is not justified and not appropriate.

Badu Advisory's opinion is acknowledged, however it is considered that subdivision of the middle zone of the standard HUF approach (zone MP1 on Figure 3-3) should be undertaken with consideration of the likely operational losses on the delivery of this water in a dry year. The justification for this allowance was outlined in WS Sept 2019, that is, that most standard MP AA rules in other schemes around Queensland do have an allowance for these losses in the formulae used to determine the AA. Also, there are evaporative losses from stored water in dams in dry periods, and there are transmission losses in releases along natural channels in dry periods, and thus accounting for these losses in the calculation is appropriate.

It is noted that Badu Advisory has made an allowance for storage evaporation in the volume assigned to MP in each horizontal slice they evaluated in their spreadsheet. This is a good idea - a more explicit way to directly allow for the share of storage evaporation losses for MP users. Adoption of Badu Advisory's idea of directly accounting for storage losses is thus recommended.

3.10 Updated Estimate of MP HUF

Sections 3.3 to 3.9 have identified a number of differences between the HUF methodology applied in Badu Advisory Oct 2019, the standard methodology documented in Sunwater 2018j, and the methodology applied in Water Solutions Sept 2019.

In summary, it is considered that the methodology applied in Water Solutions Sept 2019 is generally more in keeping with the standard HUF methodology than that documented in Badu Advisory Oct 2019. However one change implemented by Badu Advisory is considered to be an improvement, the direct allowance for storage evaporative losses discussed in Section 3.9. This section thus presents an update of the estimation of the MP HUF to directly account for this loss.

The total evaporative loss estimated at the MP100 levels determined in WS Sept 2019 is 179,300 ML. Apportioning this to HP and MP based on the volume of water they are allocated at this level (100% of their allocation), gives a 4,511 ML share of the storage evaporative loss that should be assigned to MPA.

Badu Advisory however made no allowance for transmission losses in their estimation of MP HUF. If all MP users drawn directly from the Somerset Dam and Wivenhoe Dam ponds, this assumption would be reasonable. However it is understood that some MP allocations are downstream of Wivenhoe Dam, and there would thus be some incremental transmission loss in delivering this water. With the HPA daily release in dry times being so much bigger, the incremental transmission loss for the MP release is likely to be fairly small.

The MP1F factor is now slightly redefined to only cover expected additional incremental transmission losses (including river seepage, evaporation and maintenance losses) in releasing

this water to downstream MPA allocation holders. In the absence of data, selection of an appropriate value is not straightforward. With releases to HP users likely to take up the majority of the transmission loss, a small incremental transmission allowance of 5% of MPAMin is adopted for the purposes of this review.

MP1_MP is then recalculated as follows

MP1_MP = MPAmin + MP100_EvapShare + MP1F * MPAMin

= 7194 + 4511 + 0.05 * 7194

= 12,064 ML

Other than the above, the methodology presented in Water Solutions Sept 2019 is unchanged.

The effect of this change on the MP HUF is summarised in the updated table below.

Table 3.3 – Updated Estimation of Central Brisbane MP HUF

Parameter	Central Brisbane
MPAmin (ML)	7,194
HPAmax (ML)	278,847
FSV Hwks (ML)	1,545,050
DSV Hwks (ML)	8,886
MP0 (ML)	317,500
MP100 (ML)	947,500
HP1 (ML)	308,614
MP1 (ML)	630,000
HP2 (ML)	582,521
MP2 (ML)	15,029
MP100_EvapShare (ML)	4511
MP1F	0.05
MP1_MP (ML)	12,064
MP1_HP (ML)	617,936
HP1util (ML)	282,929
MP1util (ML)	431,046
MP1util_MP (ML)	8,254
MP1util_HP (ML)	422,792
HP2util (ML)	147,208
MP2util (ML)	3,798
MP HUF (%)	1.39%
MP HUF in QCA 2013	1.6%

The resultant MP HUF is now calculated to be 1.39%, smaller than the 1.6% MP HUF adopted in the previous price review, but larger than the previous estimate of 1.12% in WS Sept 2019.

3.11 Benchmarking

A HUF of 1.39% rate is lower than the value accepted as reasonable by the QCA in the past price review, so on this basis would appear to provide an apportionment of costs that does not assign excessive costs to MP allocation holders.

However, as discussed in s3.4.3 of WS Sept 2019, it is important to review this result to see if it is fit for its intended purpose. The HUF methodology is an approximate method that may not provide an appropriate answer in all basins, given the differences in topography, climate, infrastructure, operation rules, usage and water security, and thus benchmarking the resultant HUF is prudent.

A MP HUF of 1.39% in the Central Brisbane equates to a HP:MP Cost Ratio of 1.8:1, i.e. using a MP HUF of 1.39% means that the costs assigned to HP allocations per ML are approximately 1.8 times the unit cost assigned to MP allocations[4].

Comparison of the 1.8:1 HP:MP Cost Ratio to the other schemes presented in Table 3.7 of WS Sept 2019 show that the Central Brisbane cost ratio is lower than the other schemes examined. As discussed in s3.4.3 of WS Sept 2019, Central Brisbane MP allocations have a higher level of required security than in many other schemes, and thus a relatively low HP:MP Cost ratio would appears reasonable. 1.8:1 is at the low end, but does not appear to be dramatically outside the range of reasonable values for the relative hydrologic benefit provided to HP and MP allocation holders.

Hence a MP HUF of 1.39% is recommended for use in the current Price Review.

[4] Noted that, as with ratios in WS Sept 2019, this is without the further ~56% reduction for MP allocations associated with accounting for the flood mitigation benefits provide by the dams in the last pricing review.

4 Other Issues

The submissions received on the draft QCA report raise a number of other hydrology related issues. Some brief comments on these issues are provided in the sub-sections below.

4.1 Seqwater and MBRI Submission

4.1.1 Evaluating Water Supply Benefit in a Dry Period

Page 4 of the Seqwater and MBRI submission discusses the importance for accounting for irrigation performance in a critically dry period and stating that Water Solutions challenged the validity of this approach.

On the contrary, Water Solutions supports the approach of using a dry period to assess the water supply benefits of a water supply scheme.

As highlighted in the WS Sept 2019 report, Dams and Weirs do not create water, they create security. It is not a simple task to distil the benefits that water supply schemes provide to users in a complex climatic environment to a single number, however focusing on dry periods is considered to be generally appropriate. This is why the HUF approach, focusing on the 15 year driest period in the modelled record, was used to assess the benefits of the scheme for high and medium priority allocations in the WS Sept 2019 report.

4.1.2 Benefits of Water Supply Schemes

Page 5 of the Seqwater and MBRI submission states that Water Solutions approach is inconsistent with standard hydrological approaches used in water planning.

As discussed in the WS Sept 2019 report, it is considered that water supply schemes provide a number of hydrologic benefits to allocation holders. If it was desired to quantify these benefits in some way, then the approaches suggested in the WS Sept 2019 report would be reasonable methods to do this.

The adopted HUF approach is a simplified technical method that has been adopted to assist in determining the appropriate share of the scheme's assets required for each user group. It is not designed to specifically quantify all possible hydrological benefits that the water supply scheme provides. Again, it is a simplified method that attempts to reduce the complexity of the service provided by the dams to high and medium allocations to a single number for pricing purposes.

It is noted that, while the WS Sept 2019 report does describe a number of benefits that likely accrue to MP allocation holders from the scheme, the modified HUF calculation in WS Sept 2019 does not make any special adjustments to the HUF process for any of the identified benefits. Rather, it, and the updated calculation in Section 3, attempts to stick as close as possible to the standard methodology while taking account of the key differences in the Central Brisbane Announced Allocation procedure.

Further, it is noted that the 2012-13 pricing review did make a further adjustment for one of these other benefits. As discussed in s3.3.8 of the WS Sept 2019 report, the previous price review further modified the HUF to effectively assign all costs associated with flood mitigation benefits to

urban users. As discussed in s3.3.8 of the WS Sept 2019 report, these benefits[5] actually apply to many landholders which are not necessarily well correlated with the amount of HP allocation they hold, and this is why the WS Sept 2019 report recommended this as an area for further reform.

4.2 Letter from SLR 28/10/19

A letter from SLR, the consultant who carried out the Central Brisbane Benefits Study, was included in the Seqwater and MBRI submission. Some responses on key comments raised in this letter are provided in the sections below.

4.2.1 Definition of Hydrologic Benefits

On the top of pg 2 of the 28/10/19 letter from SLR they state that they were constrained to evaluating only one type of benefit/ dis-benefit.

SLR were of course constrained by their brief, however it is suggested that the concept of "hydrologic" benefit does encompass a wider scope than that analysed by SLR.

Hydrology is the study of water. The boundaries on this definition are somewhat general, but it is considered that any matter related to water (including its volume, flow rate, level and timing) could reasonably be considered to be relevant to hydrology. The benefits discussed in the WS Sept 2019 report are thus considered to fall within the definition of a hydrologic benefit.

4.2.2 Selection of Scenarios

On the top of the 28/10/19 letter from SLR they state that the modelled scenarios were developed jointly by Seqwater and MBRI, without any input from SLR. SLR then states that they are providing no comment in this letter on the selection of the modelled scenarios.

Once again, SLR are constrained by the brief issues to them by their clients. It appears SLR had no scope to comment on the validity of the scenarios they were asked to model in relation to the objectives of that report.

It is fairly self-evident that it is not valid to compare dry period performance in any two random scenarios to evaluate benefit to MP allocations. The two scenarios must be valid to compare for the purpose they are being applied.

For the reasons presented in the WS Sept 2019 report, the Without Dams case presented in the SLR 2018 report is not considered to be suitable for its purpose of informing an evaluation of the relative benefit to HP and MP allocation holders.

4.2.3 Allocation and Environmental Performance

Row 1-3 of Table 1 of the 28/10/19 letter from SLR provides comment on the WS Sept 2019 recommendation to present results against the scheme EFOs and WASO's.

SLR's comments are noted, but the key conclusion of the WS Sept 2019 report is unchanged, i.e. to be able to compare scheme performance in one area, the cases compared must provide the same level of performance in other areas. Key areas for comparison include both environmental and allocation performance.

[5] Row 11 of Table 1 of the 28/10/19 SLR Letter raises the issue that not all benefits are necessarily positive. Future investigations of flooding related impacts should consider both positive and negative impacts.

A range of statistics could be used in this comparison, but since the Water Planning process has adopted the EFOs and WASOs specified in the Plan, it would appear to be prudent to include such statistics as part of the set of statistics used for the evaluation.

4.2.4 Use of Ponds

Row 4 of Table 1 of the 28/10/19 letter from SLR provides comment on the discussion on the use of Ponds in s3.2.4 of the WS Sept 2019 report.

It is noted that the limitations on the use of water in river ponds during extreme dry periods is not a direct consequence of the dams. Rather, it is a consequence of the increased understanding of environmental flow needs in the Brisbane River. This growth in understanding, i.e. that the environment needs water too, has led to the quantification of EFOs through the Water Planning process in both supplemented and unsupplemented sections of catchments across the state. Even in an 'alternate history' scenario where there are no dams on the Brisbane River, it is likely that restrictions would have been put in place to limit the ability of irrigators to divert water from stored volumes in instream ponds for environmental reasons.

The conclusion in s3.2.4 of the WS Sept 2019 report, that use of ponds should be treated equally in both cases, is still considered valid.

4.2.5 Diversion Days

Row 5 of Table 1 of the 28/10/19 letter from SLR provides comment on the discussion on diversion days statistic in s3.3.2 of the WS Sept 2019 report.

SLR's response is noted, however one of the major benefits of water supply schemes with large dams is the flexibility that it provides to water allocation holders on when they can take their water. That is, if the AA is bigger than 0%, the water may be taken on any day in that water year (the AA limits the annual volume of diversion, but not when it can be extracted). Without the dams, if there is no flow (above environmental requirements) then no water can be extracted. And, of course, it is when there is no local rain that irrigators are most likely to want to extract water from the river. The diversion days statistic, as presented in SLR 2018, tends to imply that the without dams case provides access on more days, when this is unlikely to be correct.

The conclusion in s3.3.2 of the WS Sept 2019 report, that the diversion days statistic should not be used, is thus still considered valid.

4.2.6 Hydrologic Benefit

Rows 6 to 8 of Table 1 of the 28/10/19 letter from SLR restates SLR's conclusion that the dams provide no additional hydrologic benefit. The additional reinforcement is noted, but the conclusions of the WS Sept 2019 report, that the dams do provide hydrologic benefit to MP allocation holders, is still considered valid.

4.2.7 Water Planning Model Assumptions

Row 9 of Table 1 of the 28/10/19 letter from SLR criticises the suggestion to consider the flexibility available to water allocation holders in when they choose to divert their water, stating it is inconsistent with the full use of entitlements approach adopted in the models behind Water Plans.

SLR's comment on the 'full use of entitlements' methodology that is generally adopted in the IQQM modelling behind Water Plans is correct. However the actual conditions on water allocations generally have significantly more freedom, and these freedoms are a significant benefit to allocation holders.

It won't be a surprise that the models behind Water Plans were generally prepared for the purpose of those Water Plans.

The full use of entitlements approach is a simplified approach that attempts to reduce the complexity of the potential impact of water allocations on each other and the environment to a simplified standard 'maximum annual diversion' case for water planning purposes.

The purpose of the WS Sept 2019 report is somewhat different. The first question answered in the WS Sept 2019 report was whether the two scenarios in the SLR report were appropriate for assessing relative benefits to MP and HP allocation holders. The flexibility of extraction is a benefit, and the cases presented did not assess that. Hence the conclusion presented in s3.2.6 of the WS Sept 2019 report, that additional cases would be required to provide an appreciation of performance in this area, is still considered valid.

4.2.8 Rain

Row 10 of Table 1 of the 28/10/19 letter from SLR again states the philosophy that assumptions adopted as reasonable in water planning must also be applied when the model is used for assessing relative benefits to MP and HP allocation holders for pricing purposes.

The two purposes are not the same. The assumptions adopted for modelling to evaluate benefit for pricing purposes need to be appropriate for that purpose.

The concerns regarding the effect of the method used to model demands in the Without Dams stated in s3.2.5 of WS Sept 2019 are still considered valid.

4.2.9 Hydrologic Benefits / Dis-benefits - Flooding

Row 11 of Table 1 of the 28/10/19 letter from SLR provides further comment that hydrologic benefit should be narrowly constrained. See Section 4.1.2 and 4.2.1 for discussion on this point.

While SLR appears to be arguing that relative flooding benefits / impacts should not be considered in evaluating relative costs, S2 of the Schmidt K submission indicates that significant impacts have occurred owing to changes in the regulatory framework associated with flooding at the dams.

More generally, issues associated with the imposition of the water regulatory system are addressed by the QCA in s6.4 of Part C of the Draft QCA Report.

4.3 MBRI Submission

The MBRI submission includes a number of statements critical of the draft QCA Report and Water Solutions Report.

The comments are acknowledged, but in general the conclusions of the Water Solutions Sept 2019 report are still considered valid.

4.3.1 Historical Conditions

A number of sections of the MBRI submission discuss the history of water in Queensland and the changes over time to the Central Brisbane scheme. A full review of historical circumstances was beyond the scope of this assessment, other than the brief points made in s3.2.1 of WS Sept2019, i.e. that if the Without Dams case was meant to be a 1920's (pre-dams) era conditions scenario, it was not well configured to achieve that.

More generally, issues associated with changes in the regulatory system over time are addressed by the QCA in s6.4 of Part C of the Draft QCA Report.

4.3.2 General Modelling Issues

A number of sections of the submission raise issues associated with reasonably modelling the Central Brisbane system, for example, page 11 and 15.

If more detailed modelling is undertaken in the future, these concerns should be considered.

4.3.3 HUF Calculation Issues

Page 23 and 24 of the MBRI submission provide some comments on the re-calculation of the HUF in the WS Sept 2019 report. One numerical issue is raised on pg 23, that the MP allocation used in the HUF calculation needs to be reduced to only cover allocation used for irrigation.

Under the Water Plan allocations are put into priority groups, high priority and medium priority in the Central Brisbane. As discussed in s2.2 of the WS Sept 2019 report, it is the priority group generally associated with irrigation which is pertinent to the HUF calculation, hence the adoption of scheme MP and HP allocation volumes here, consistent with the standard HUF methodology documented in Sunwater 2018j.

4.4 Schmidt K Submission

As discussed in Section 4.2.9, Section 2 of this submission indicates that significant impacts have occurred owing to changes in the regulatory framework associated with flooding at the dams. Issues associated with the imposition of the water regulatory system are addressed by the QCA in s6.4 of Part C of the Draft QCA Report

Section 4 of this submission contains some comment on the WS Sept 2019 report. The comments made are noted, however the conclusions of the WS Sept 2017 report are still considered to be valid.

5 Conclusions

Following on from Water Solutions' initial advice summarised in the report "Rural Irrigation Price Review 2020-24 – Assessment of Hydrologic Factors", this report provides additional advice to assist with pricing for the Central Brisbane Water Supply Scheme, in response to hydrologic issues raised in submissions on the draft QCA report.

An initial review of the relevant submissions identified that the key component for review was the revised estimation of the MP HUF presented in the Badu Advisory Oct 2019 Report, included in the Seqwater and MBRI submission.

Badu Advisory's approach to estimating the MP HUF was compared to the estimate in Water Solutions Sept 2019 and the standard methodology documented in Sunwater 2018j. A number of differences in approach were identified. Each difference was assessed, and in summary it was concluded that the methodology applied in Water Solutions Sept 2019 is generally more in keeping with the standard HUF methodology than that documented in Badu Advisory Oct 2019.

However one change implemented by Badu Advisory was considered to be an improvement, the direct allowance for storage evaporative losses implemented by Badu Advisory in their calculations. An update to the methodology presented in Water Solutions Sept 2019 was thus made to directly account for storage evaporation loss in a similar manner as implemented by Badu Advisory. The revised MP HUF with this change was calculated to be 1.39%.

It is thus recommended that the 2020-24 Price Review adopts a MP HUF of 1.39% for the apportionment of costs between HP and MP allocation holders.

The reviewed submissions raised a number of other relevant hydrologic issues, and comment on these issues is contained in this report. However the key conclusions presented in Water Solutions Sept 2019 remain unchanged – comparison of the two cases presented in the Central Brisbane Benefits Study is not considered to be an appropriate method to assess relative benefit, and the available evidence indicates that the scheme does provide hydrologic benefit to MP users.

6 References

- Badu Advisory (2019) *Headworks Utilisation Factors for the Central Brisbane Water Supply Scheme.* 31 Oct 2019.
- DNRME (2018a) *Central Brisbane River Water Supply Scheme Resource Operation Licence.*
- DNRME (2018b) *Central Brisbane River Water Supply Scheme Operations Manual.* Jan 2018
- DNRME (2018g) *Moreton Water Management Protocol* Jan 2018
- Gilbert & Sutherland (2011) *Quality Assurance of a Review of Sunwater's Headworks Utilisation Factors Methodology.* March 2011.
- Markar S. (2010) *Peer Review Of Headworks Utilisation Factors Draft Technical Paper – Preliminary Recommendations.* Letter to T. Vanderbyl, Sunwater, 6 August 2010.
- MBRI (2019) *Response Submission for Central Brisbane Water Supply Scheme.* 4 November 2019.
- Parsons Brinckerhoff (2012) *Hydrologic Assessment of Headworks Utilisation Factors (HUFs).* March 2012.
- QCA (2013) *Seqwater Irrigation Price Review: 2013-17, Volume 2, Central Brisbane Water Supply Scheme.* Final Report. April 2013
- Qld Govt (2017b) *Water Plan (Moreton) 2007.* Current as at 29 September 2017
- Schmidt K (2019) *Submission to the Queensland Competition Authority*
- Seqwater (2018) *Central Brisbane Water Supply Scheme. Scheme submission to QCA. 2020-21 to 2023-24.* 30 November 2018.
- Seqwater and MBRI (2019) *Joint Response Submission for Central Brisbane Water Supply Scheme. 1* November 2019.
- SLR (2018) *Central Brisbane Benefits Study – Technical Modelling Report.* SLR Ref 620.12496-RD1 Version 4.0 October 2018
- Sunwater (2010) *Headworks Utilisation Factors Technical Paper.* 3 September 2010.
- Sunwater (2011) *QCA review of irrigation prices, Supplementary information, Headworks Utilisation Factors, Critical Periods and Bulk Water Supply Capital Cost Allocation.* April 2011.
- Sunwater (2018i) *Irrigation Price Review Submission, Appendix I, Pricing arrangements for irrigation customers.* 6 November 2018.
- Sunwater (2018j) *Irrigation Price Review Submission, Appendix J, Headworks Utilisation Factors Technical Paper.* 6 November 2018.