Inland Diversion Scheme Strategic Assessment

Draft Border Rivers Regional Water Strategy

This document provides and overview of the hydrologic and economic analysis undertaken to support the assessment of inland diversion schemes within the Border Rivers Regional Water Strategy.

The inland diversion scheme was listed as Option 8 in the long list of options in the draft Border Rivers Regional Water Strategy[1] released in late 2020. In assessing the long list of options, the Department of Planning and Environment analysed two inland diversion schemes. They are:

- **Large inland diversion:** This option involved construction of a 897 GL dam on the Timbarra River (Clarence valley) directly on the other side of the Great Dividing Range from the headwaters of the Mole River. The captured water was diverted across the range in a 41 km tunnel/pipeline through a combination of pumping and gravity. It was assumed this water was used to create high security licences at Boggabilla to maximise economic benefit. Under this option a diversion of 88.8 GL creates 49 GL of additional high security licences.
- **Small inland diversion:** This option involved constructing of a 49 GL dam on the upper Mann River (Clarence valley) directly on the other side of the Great Dividing Range from Glen Innes. The captured water was diverted across the range in a 12 km tunnel/pipeline and discharge via gravity into Beardy Waters approximately 13 km north of Glen Innes. The water would then flow down into Pindari Dam. It is assumed this water is used to increase the reliability of general security entitlements. Under this option diversion of 12.3 GL creates an additional 4.4 GL of general security water.

These options have been analysed using hydrologic modelling and the rapid economic analysis approach developed for the assessment of regional water strategy options. Aspirational assumptions were used in the analysis to understand whether the options could merit further investigation in the best possible scenario. The assumptions are detailed in this paper. Even with these aspirational assumptions, the analysis found that the significant costs of the options outweighed the benefits. As a result, the inland diversions were not progress to a shortlisted action for the Border Rivers Regional Water Strategy due to the very low benefit to cost ratio. However, during public consultation on the shortlisted action in the Border Rivers Regional Water Strategy, some parts of the community have asked for the department to undertake further analysis on inland diversion scheme options to consider flood mitigation, energy generation and connectivity benefits before the strategy is finalised. The department has agreed to this request.

The results of this assessment are presented in this document.

[1] Available for download at: https://water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies/what-we-heard/border-rivers-regional-water-strategy

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Option assessment overview

The long list of options in draft regional water strategies were analysed through an options assessment process outlined in the *Options Assessment Process: Overview*[2]. Options that influence the supply, demand, or allocation for water were initially put through a rapid economic assessment.

The rapid assessment was used as a guide to assess whether there was merit in the option moving forward to a detailed assessment.

Assumptions

Economic Analysis Assumptions

All options assessed from an economic viewpoint have been first subjected to hydrologic modelling, the results to understand how the option may change water availability for different water users.

In undertaking the rapid economic assessment, we analysed the value of water to key extractive users in the Border Rivers. The rapid economic analysis applies the water value to the change in water availability to identify quantitative benefits of the option.

Key extractive water users assessed within this process are:

- Towns
- Annual crop producers (ie cotton producers)
- Permanent crop producers (ie pecan or macadamia producers)

The economic valuation of water to these key user groups is outlined in Table 1 and has been drawn from the Regional Water Value Function (Marsden Jacobs Associates, 2021) and is applied as a $/ML supplied (or not supplied).

Table 1. Key Water Users

Key water user	Water licence	Economic benefit of water use	Marginal economic benefit (of water) ($/ML)
Towns (Ashford, Boggabilla, Mungindi)	Local Water Utility	Reduction in economic cost of water supply shortfalls	Varies depending on duration (see *Options Assessment Process)*[3]
Annual crop producers (eg. Cotton)	• General Security • Supplementary • Floodplain Harvesting Rainfall Harvesting	Marginal increased yield of crop due to irrigation, compared to dryland production.	350 (assumed cotton)

[2] Available for download at: https://water.dpie.nsw.gov.au/plans-and-programs/regional-water-strategies/identifying-and-assessing

[3] Accessible from: https://water.dpie.nsw.gov.au/__data/assets/pdf_file/0006/506463/options-assessment-process.pdf

Key water user	Water licence	Economic benefit of water use	Marginal economic benefit (of water) ($/ML)
Permanent crop producers (eg. Pecans)	High Security	Marginal increased yield of crop due to irrigation, compared to dryland production – and – Reduction in cost associated with growing replacement crops to maturation due to crop-perishing in dry periods	1,300 (2,800 in shortfall) (assumed pecans)

Environmental Water Valuation

Due to the high level of uncertainty regarding environmental valuations in a cost-benefit analysis context, no attempt has been made include an economic ecological assessment within this assessment. Separate quantitative and qualitative ecological assessments have been undertaken for options within the regional water strategy.

Flood Mitigation Benefits

No benefits for potential flood mitigation due to the inclusion of dams on the eastern side of the Great Dividing Range have been included in this analysis. The hydrologic modelling undertaken to support the assessment operates on a daily time-step whilst flooding events are typically shorter duration. Consideration of flooding impacts is undertaken on a sub-daily time-step and require event based hydrologic and hydraulic modelling to be completed. In response to community feedback during consultation, a high level assessment of the flood mitigation benefits will be considered before the Border Rivers regional water strategy is finalised.

Examining the annual inflows generated by the existing model suggests that the inland diversion would only minimally impact on regular flooding and could make extreme flooding events worse.

Hydrologic analysis assumptions

The following section outlines the assumptions adopted for the hydrologic analysis of the inland diversion options. These are simplifications required for strategic level analysis, and no optimisation of these options has taken place at this stage. The assumptions made in the analysis include:

- Large inland diversion: an 897 GL storage in the Clarence valley transferring at an annual demand of 89 GL per year, violating the coastal diversion limit, has been assumed (49 GL high security created after losses)
- Small inland diversion a 49 GL storage in the Clarence valley transferring at an annual demand of 13 GL per year has been assumed (4.4 GL general security created after losses)
- Zero dead storage has been assumed
- No environmental flow releases have been assumed from the two Clarence storages

- Existing Clarence River water users are not supplied from the new Clarence storages
- No growth-in-use action is required due to diversion from external water source
- Transferred water into the Border Rivers is assumed to be owned by the NSW Government
- Additional high security demand has been created at Boggabilla. As demand is serviced through a Clarence transfer, no adjustment to the reserve account in the Border Rivers was required

The regional water strategies represent the first round of investigation and infrastructure projects that are recommended in them will require considerable analysis before they receive final approvals. Consequentially assumptions have been made to provide the most likelihood that the option would produce net positive benefits, for instance not incorporating the cost of removing the water from the Clarence valley. The bias was towards assumptions that would make the option viable and subject to further investigation.

Two constraints were considered when creating additional high security volumes. These were:

1. end-of-year allocation reliability for other licensed products must not decrease below the base case
2. end-of-system flows must not decrease below the base case.

Infrastructure costings for the diversion schemes

The capital and operating costs of the inland diversion schemes are presented in Table 2. The capital and operational expenditure for infrastructure options are derived from cost models built to allow a consistent comparative assessment across regions. They are not site-specific cost estimates and are not intended to be used beyond the scope of the RWS. The cost models rely on the relationship between the physical characteristics of infrastructure — such as dam size or pipeline length — and the expected cost to construct, with each category of infrastructure — dams, pipelines, desalination plants, etc. — having its own unique valuation method. These relationships are arrived at through analysis of similar projects and professional assessment.

Capital and operational expenditure costs of options were discounted to present day values with the following assumptions:

- the option is constructed and fully operational from the start of Year 1 (that is, at Year 0), indicating no discounting is applied to the construction costs.
- Operational costs occur annually for the full period of the cost-benefit analysis from Year 1.
- A residual value for infrastructure was considered through the addition of an end-of-life value of the initial capital expenditure discounted at a linear rate at the end of the analysis period.

The following should also be noted for the costs of the inland diversion scheme:

- Environmental and cultural heritage offset and land acquisitions are considered through escalations of the base cost of infrastructure. These are likely lower bound estimates and in reality are highly driven by local conditions

Table 2. Border Rivers agricultural water supply economic benefit

Item	Large diversion	Small diversion
CAPEX	$6,422 million	$1,552 million
OPEX	$73 million	$18 million
Pipeline	41km DN3000 SCL	12km DN3000 SCL
Pump Station	7 MW	N/A (gravity fed)
Eastern Dam	897 GL	49 GL

Results

The following section details hydrologic and economic outcomes for both Inland Diversion schemes analysed within the Border Rivers Regional Water Strategy.

Hydrologic Outcomes

Alterations in NSW and Queensland licensed diversions

For the large inland diversion, a transfer of 88.8 GL per year allows for creation of 49 GL of high security entitlements at Boggabilla. Further increases are constrained by the reductions in end-of-system flow below the base case.

For the small inland diversion the transfer of 12.3 GL per year into Pindari Dam equates to a 4.7 GL per year increase in diversions. Over half of the transfer appears to be consumed in delivery losses or remains as an unused allocation.

Table 3. NSW and Queensland long-term average annual diversions by licence category — large and small inland diversion

Annual Average Diversions	Base case	Large diversion	Small diversion
Average Clarence transfer volume (GL/year) before losses		88.8	12.3
NSW diversions (GL/year)			
Ashford town water supply	0.10	0.10	0.11
Boggabilla town water supply	0.20	0.19	0.20
Mungindi town water supply	0.28	0.29	0.28
General security diversions	93.74	94.20	98.12

Annual Average Diversions	Base case	Large diversion	Small diversion
Supplementary diversions	70.49	71.79	70.72
Floodplain harvesting (excluding rainfall harvesting)	34.26	34.35	34.35
Rainfall harvesting	10.89	10.86	10.92
New high security		48.92	
Total	**209.96**	**260.71**	**214.69**

Alterations in NSW allocation reliability

Start- and end-of-year average allocations for newly created high security allocations and any remaining and existing products are presented in Table 4. For the small inland diversion, the transfer of water into Pindari Dam increases end of water year allocations for both general security A and B. This indicates that under existing user behaviour, some of the transferred water is used.

For the large diversion, start and end of water year allocations of general security A and B licences are largely unchanged. This is to be expected since transferred water is not being allocated to existing users.

Table 4. NSW start (1st July - 1/7) and end of water year (30th June - 30/6) allocation reliability by licence category

NSW effective allocation (%)	Base case	large diversion	Small diversion
New and existing high security 1/7	100.0	100.0	99.2
New and existing high security 30/6	100.0	100.0	99.2
General security A 1/7	30.2	29.8	30.2
General security A 30/6	93.6	93.2	95.9
General security B 1/7	44.9	45.6	46.6
General security B 30/6	76.8	77.7	80.2

Alterations in river flows

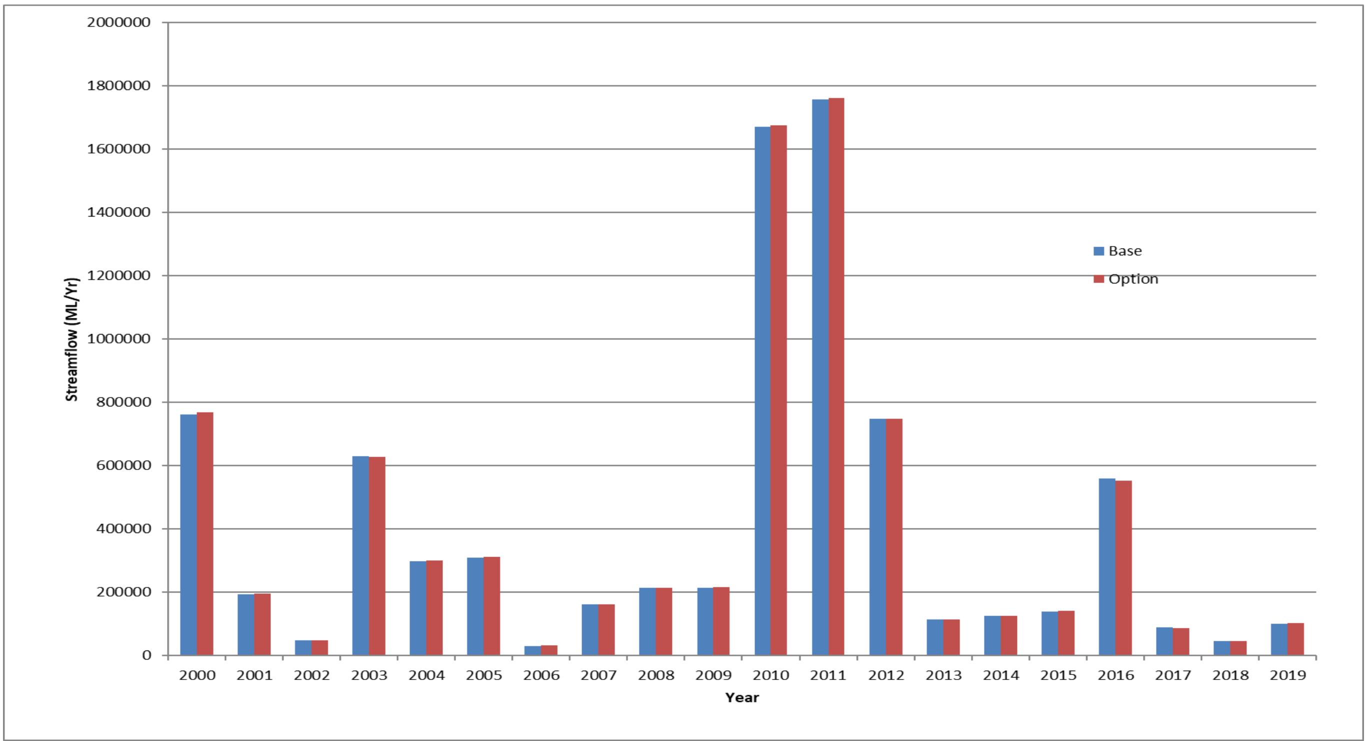
End-of-system changes to the flow regime as the result of large and small inland diversion scheme are shown in

Table 5. The results show a small increase of 2.2GL in the end-of-system flow as the result of the small inland diversion scheme and a reduction of 0.9 GL as a result of the large diversion scheme. The slight reduction in end of system flows in the large diversion scheme are a result of the volume of new high security created. A smaller volume would result in end of system flows being equal to or exceeding the base case.

Table 5. Mean annual flow changes — large and small inland diversion scheme

Mean annual streamflow (GL/year)	Base case	Large diversion	Small diversion
End of system	590.9	590.0	593.1

Figure 1: Influence of the inland diversion scheme on end of system annual streamflows (ML/Yr)



It is worth noting that in the two wettest years, 2010 and 2011 the inland diversion scheme results in an increase of 6,600 MLs and 3,900 MLs (representing 0.12% and 0.1% of annual inflows respectively).

Economic Outcomes

Both the large and small inland diversion schemes produce large negative net present values and very low benefit-cost ratios.

Table 6 – Rapid CBA Outcomes

Option	Description	NPV ($, Mil)	BCR (-)
Large diversion	Inland Diversion (89 GL/year to Mole River, New 49GL HS) – without Mole River Dam	-6,520	0.13
Small diversion	Inland Diversion (13 GL/year to Pindari Dam)	-1,797	0.01

The cost of the infrastructure required for the large inland diversion may be above $6 billion. The option assumes that all the new water would be used for a high value crop such as nuts, and there is a high level of uncertainty about whether such high value industries would actually develop because of other factors. Even with these high-level assumptions, and before the impacts of the option on the environment and coastal communities are considered, the option results in a very low benefit to cost ratio. Consequentially, this option may not be viable because it ultimately may breach extraction limits on the coast in the future. More refined assumptions would further reduce the benefit to cost ratio.

While the estimate of the smaller diversion option cost is a less than the amount of the large diversion, at approximately $1.8 billion, it still results in significant economic losses. A diversion of 13 GL/yr results in an increase in the annual general security water use of only 4.4 GL/yr, with the remainder going to delivery losses. This assessment does not factor in impacts on the Clarence River Basin.

A breakeven analysis of each inland diversion scheme has also been completed, the results of which can be seen in Table 7. The breakeven analysis increases the value of each megalitre of water until the benefit-cost ratio of each scheme is equal to 1.0. For the large inland diversion, the target user for the breakeven analysis were the assumed additional producers of permanent crops due to the creation of the 49GL of High Security licenses. The breakeven analysis for the small inland diversion targeted the value of water to annual crop producers. Both results of the breakeven analysis indicate that for either scheme to reach a neutral benefit-cost ratio the required value of water is multiples of that assumed in the initial analysis.

Table 7 – Rapid CBA Breakeven Analysis

Option	Description	Target User	Required Value of Water ($/ML)
Large diversion	Inland Diversion (89 GL/year to Mole River, New 49GL HS) – without Mole River Dam	Permanent agriculture	$10,150
Small diversion	Inland Diversion (13 GL/year to Pindari Dam)	Annual agriculture	$31,550

Limitations of assessments

Given the high-level strategic analysis undertaken of the Inland Diversion Scheme for the RWS a number of key limitations should be considered when reviewing results. Notable limitations for each scheme are given below.

Large Inland Diversion

- The modelling and assessment make no allowance for impacts in the Clarence River basin or requirements for environmental releases that would apply to the new dam on the Timbarra River, which could reduce the yield. On the other hand, if the water was used in the upper Mole

River for high value crops there would likely be increased utilisation of the water and increased benefit, but overall the option would still have a low BCR.

- Any further infrastructure required for the creation of a new significant permanent agricultural precinct has not been considered within this analysis.
- No benefits for potential flood mitigation due to the inclusion of dams on the eastern side of the Great Dividing Range have been included in this analysis.
- No analysis of the impacts on water users, Aboriginal cultural heritage or the environment has been assessed.
- The analysis assumes an uninterrupted diversion of 89 GL/year, in reality this value will fluctuate based on climatic conditions and water availability

Small Inland Diversion

- The modelling and assessment make no allowance for impacts in the Clarence River basin or requirements for environmental releases that would apply to the new dam on the Mann River, which could reduce the yield. If the water was used in the Beardy River near Glen Innes for high value crops there would likely be increased utilisation of the water and increased benefit, but overall the option would still have a low benefit to cost ratio.
- No benefits for potential flood mitigation due to the inclusion of dams on the eastern side of the Great Dividing Range have been included in this analysis.
- No analysis of the impacts on water users, Aboriginal cultural heritage or the environment has been assessed.
- The analysis assumes an uninterrupted diversion of 13 GL/year, this value will fluctuate based on climatic conditions and water availability

Further considerations

During public consultation on the draft Border Rivers Regional Water Strategy it was noted that the analysis of the Inland Diversion Scheme may show more positive outcomes if further consideration were given to the below items:

- Hydro-power generation potential of the inland diversion schemes may increase the economic outcomes. For the project to reach a favourable economic valuation the value of the power generation would need to be large enough to offset the large capital expenditure. It should also be noted that additional infrastructure required for a hydro-power scheme would add additional capital and operational expenses to the project that would offset some of the potential economic benefit.
- Flood mitigation benefits may increase the economic benefits of proposed dams on the Clarence River. The hydrologic modelling undertaken to support the assessment operates on a daily time-step whilst flooding events are typically shorter duration. Consideration of flooding impacts is undertaken on a sub-daily time-step and require event based hydrologic and hydraulic modelling to be completed. This is not cost-effective analysis at a strategic level assessment and would be considered if options were to be progress to more detailed

business cases. However, the department will undertake a high level analysis to indicate whether there may be some flood mitigation benefits that would be worthwhile further investigation.

- Connectivity benefits for the downstream river system due to new diverted water from the east may improve environmental, cultural, and downstream economic outcomes. The inland diversion scheme, particularly the large-scale scheme, assessed within this analysis includes used all new incoming water for the creation of a new agricultural precinct. To improve downstream connectivity, water from the inland diversion scheme would not be able to be used for consumptive purposes in the Border Rivers catchment. Instead the water would need to stay within the system to flow downstream. High level analysis on connectivity potential will be analysed, but this is likely to decrease the direct economic benefit to the Border Rivers region.