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Department of Trade, Business and Innovation

Adelaide River Off-stream Water Storage - Part A: Preliminary Assessment

August 2020

pwc

Strictly private and confidential

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Executive summary

Project context

The Department of Trade, Business and Innovation (DTBI), in partnership with Power and Water Corporation (PWC), has identified that there is a strategic need to address the supply and demand issues associated with water in the greater Darwin region. This Preliminary Assessment has been developed to:

- Confirm the strategic need and priority for water supply augmentation (the Project) in the region
- Investigate and assess non-infrastructure and infrastructure options
- Provide a robust rationale and justification for progression of a preferred water supply strategy to a Detailed Business Case (DBC).

The purpose of the Preliminary Assessment is outlined in Figure 1.

Figure 1: Purpose of the Preliminary Assessment

Water supply in the greater Darwin region is not sufficient to meet future demand

There are two key organisations in the Northern Territory with responsibility for the management and delivery of water in the greater Darwin region. These are:

- PWC, which is the sole licensed water provider in the region. PWC owns and manages the Darwin River Dam, the reticulation network and provides water to users across the reticulated water network.
- The Department of Environment and Natural Resources (DENR) which administers the *Northern Territory Water Act 1992* and provides water management and monitoring services on behalf of the Northern Territory Government.

Water in the greater Darwin region is sourced from surface water and groundwater resources. In the greater Darwin region urban area, water is supplied through the reticulated network owned and managed by PWC. PWC draws water for its network from the Darwin River Dam and through an allocation from the Howard groundwater resource. The majority of the water for the Darwin rural region is sourced directly by users from groundwater resources through bores. Water demand in the greater Darwin region primarily consists of urban, industrial, commercial, government and non-revenue water consumption for PWC's network and rural stock, domestic, agriculture and horticulture consumption for the groundwater resource. The location of the major surface and groundwater resources are shown in Figure 2.

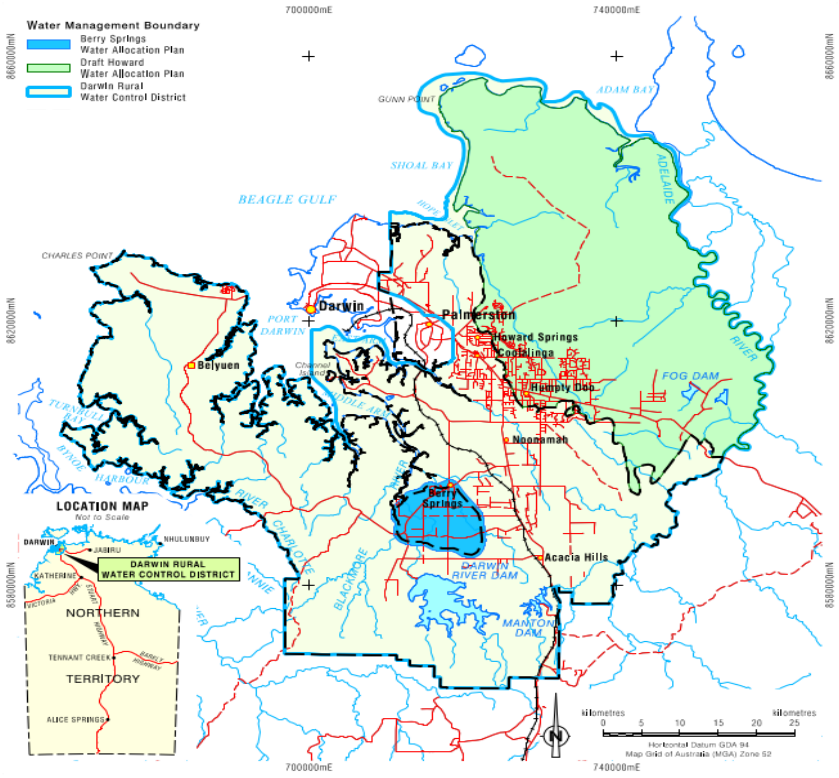

Figure 2: Darwin Rural Water Control District and Water Allocation Planning areas[1]

Rural water supply

The Darwin rural area has a number of discrete groundwater resources, which are located within the Darwin Rural Water Control District (DRWCD). Over the past 30 years' reliance on groundwater within the DRWCD has increased significantly from approximately 1,000 bores in the 1980s to over 8,000 bores in 2019.

[1] Department of Environment and Natural Resources, 2020.

The major groundwater resources in the greater Darwin region are already over allocated and over used. The Howard Groundwater System (HGS) is the largest, and most used, groundwater resource in the greater Darwin region. The West and Central Zones of the HGS supply 80 per cent of current extraction. These zones are 300 per cent to 380 per cent, and 100 per cent to 150 per cent over extracted respectively[2]. The Department of Environment and Natural Resources (DENR) has estimated that extraction from the HGS would be required to be reduced by 24,000 ML p.a. to return the groundwater network to a sustainable level of extraction. The extraction from the Berry Springs groundwater resource estimated to be approximately equal to its sustainable yield of 8,900 ML p.a. The remainder of the DRWCD may have additional resources available however it is understood that the highly productive areas are already fully utilised.

Given this, the available supply of groundwater is assumed to be at its maximum and no further allocations would be granted other than those required under current legislative provision. In the absence of the identification of new groundwater resources, any growth in domestic, stock, agriculture or horticulture demand in the rural region will need to be supported by water from an alternate resource or additional demand management measures to reduce the existing demand.

Reticulated water network

The reticulated water network, managed by PWC, is supplied by the Darwin River Dam and PWC's allocation from the HGS. Constructed in 1972 Darwin River Dam has an earth embankment 518 metres long with an unregulated 265 metre wide spillway. The Dam was upgraded in 2010 and has a storage capacity of 305 GL and an assessed yield of 33,780 ML p.a., supplying approximately 85 per cent of Darwin's reticulated water with the remainder sourced from PWC's groundwater allocation. The assessed yield of the sources on which the reticulated network relies was 42,200 ML p.a. in 2019 which assumes full extraction from PWC's groundwater allocation of 8,420 ML p.a.. PWC has not extracted their full license from their HGS in recent seasons. This has resulted in an increase in the required production from Darwin River Dam and potential extraction above its assessed yield[3]. Overall, the reticulated water supply system has operated at its approximate yield over the last 10 years.

Based on the current understanding of climate change, population growth and long-term economic growth Figure 3 displays the base case supply and demand for the existing reticulated network. It is currently projected that climate change will result in increased evaporation and a reduction to dam inflows, resulting in a reduction in yield over time.

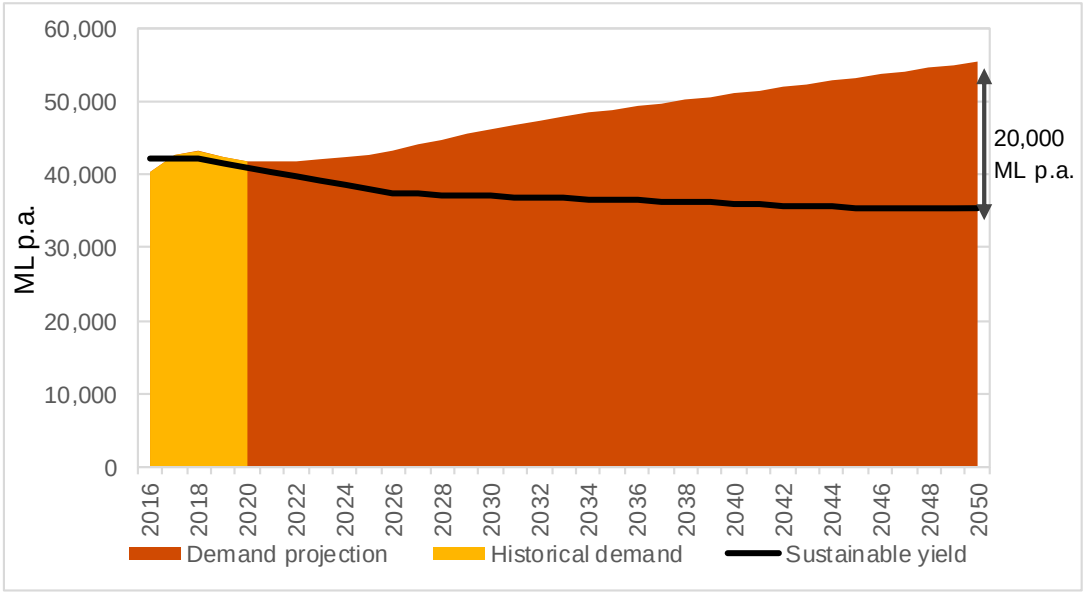

Figure 3: Supply and demand greater Darwin region water supply balance[4]

[2] SMEC through information provided by DENR, 2020.
[3] Assessed yield is the total volume of water estimated to be able to be extracted while meeting PWC's Level of Service objectives.
[4] SMEC and Power and Water Corporation (2020).

This base case assumes that no major industrial, agricultural/horticultural or commercial development involving a step change in water demand occurs and that growth in residential, industrial/commercial, and government use continues at the long run trend, with continued efficiency in water consumption as per PWC's *Living Water Smart* program. The base case confirms the minimum levels of water required to support current activities and the impact if no augmentation to the water supply is undertaken under PWC's current Levels of Service (LOS).

Figure 3 also demonstrates that under the base case assumptions, water demand will exceed the assessed yield of the reticulated water network from 2021 with a shortfall of 20,000 ML p.a. by 2050. This forecast shortfall between yield and demand creates a significant short to medium term water security risk. PWC LOS will be breached under this scenario and the risk of water restrictions needing to be imposed on the greater Darwin region to ensure long term continuity of water supply increases. The forecast assessed yield also assumes that PWC takes its full groundwater allocation.

PWC, through its 2013 *Darwin Region Water Supply Strategy,* identified a range of initiatives and projects to increase water security and enable growth. These include the implementation of Manton Dam's Return to Service to meet immediate water requirements and the delivery of Adelaide River Off-stream Water Supply (AROWS) in the longer term. Project planning activities for both of these projects have been approved by the PWC board and funding for the next four years is identified in PWC's *Statement of Corporate Intent.* However, while part of PWC's future planning, and endorsed by the PWC board, they do not form part of the base case for this report as they are not committed or funded projects and are still subject to consideration and approval by the NT Government.

More water is needed to enable and drive economic growth

The greater Darwin region has a number of strategic advantages to drive economic development. Firstly, the strategic location of gas reserves across the Northern Territory provides the opportunity to support downstream processing and manufacturing in the oil and gas sector through the development of Middle Arm. Secondly, the opportunity to capitalise on the Darwin rural region being the most productive area for horticultural development in the Northern Territory. These opportunities cannot be realised without access to an additional water source. The identified economic value of this opportunity, developed in the Economic Assessment, is over $900 million in net present value terms over the life of the investment if the total industrial, agricultural and horticultural growth is realised.

Each of these sectors has substantial water requirements. Given the identified lack of available water supply, the economic future of the greater Darwin region related to these activities depends on water being made available to support new economic activities.

The industrial opportunity and water demand

Darwin is located on a world-class harbour, proximate to rapidly growing markets throughout Asia and there are a range of opportunities to expand the oil and gas sector that will further catalyse industrial activity. Key demand in growth sectors is expected at the Middle Arm Gas and Strategic Minerals Precinct (Middle Arm Precinct). The Middle Arm Precinct is a 2,300 to 2,500 ha industrial precinct, located on the Middle Arm peninsula in Darwin Harbour. The precinct can accommodate industries such as:

- Industrial - Oil and Gas, Chemical and Minerals
- Utilities - Power generation
- Logistics - Rail
- Commercial.

The identification of water requirements for Middle Arm was undertaken in close collaboration with the Department of Infrastructure, Planning and Logistics (DIPL), DTBI, and industry participants to develop an estimated profile of expected water demand over time. These estimates have then been moderated to account for:

- The risk of the projects being delayed, with most projects in the revised demand profile expected to start in 2024 or later to more closely align to the expected timeframes for both gas and water availability and project approval processes
- The chance of success of the project, with the chance of success ranging between 25 per cent and 75 per cent for each project in the mid-case.

Whilst this analysis has been undertaken on a project-by-project basis, this information is commercial-in-confidence and therefore cannot be represented by company in this Preliminary Assessment. Figure 4 illustrates the aggregated forecast demand under High, Mid and Low Cases of development at the Precinct. This forecast water demand profile is currently being tested via market engagement with the industrial sector and is expected to evolve over time.

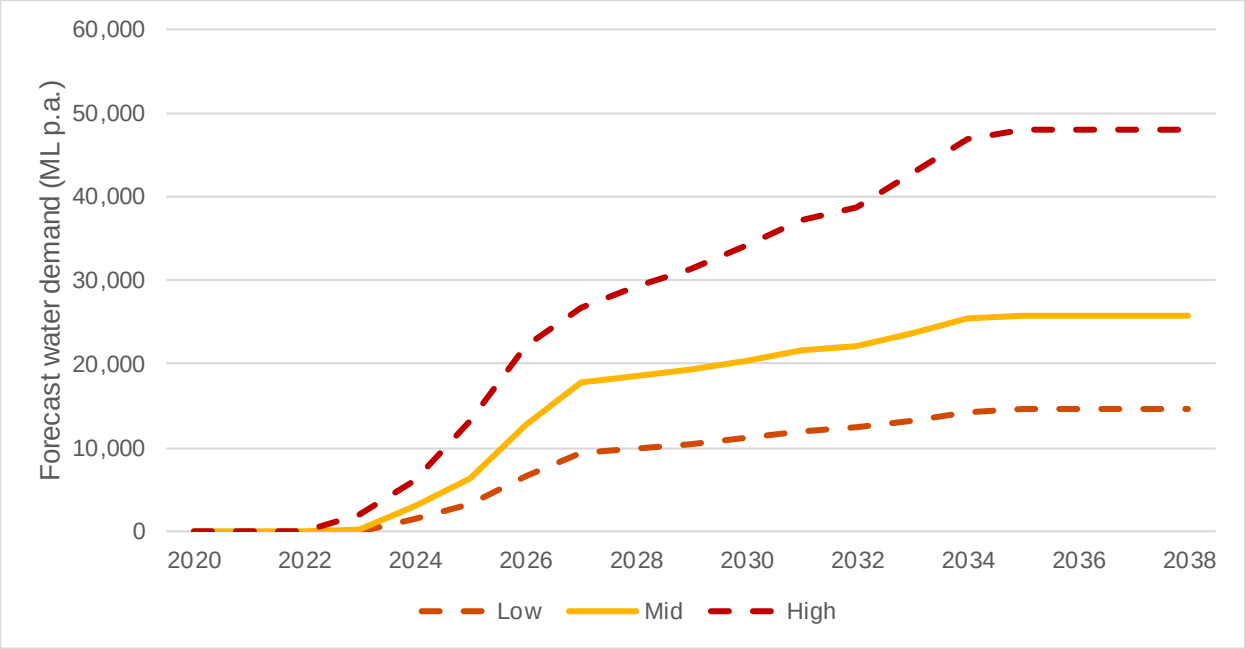

Figure 4: Forecast water demand growth at Middle Arm associated with major industry

The agricultural and horticultural opportunity and water demand

The greater Darwin region has a diverse agricultural and horticultural sector, with agricultural land occupying approximately 550 square km[5] with potential for expansion. The NT is already a substantial producer and supplier of high-quality mangoes, melons and Asian vegetables to domestic and international markets. The horticulture industry in the Northern Territory has grown significantly, and now produces around 52 per cent of Australia's total mango crop [6], with the greater Darwin region producing 67 per cent of the NT's total crop[7].

Many factors determine the success of agricultural and horticultural developments, including climate, soils, pests and diseases, as well as the key agronomic, management, financial, and market and supply chain factors. Access to a reliable water supply is a key challenge constraining growth in horticulture in the greater Darwin region. Based on the results of market engagement with the agricultural and horticultural industries, it is believed that there is demand for a 2,000 ha horticultural precinct if land and water are packaged together as single marketable commodity. The most prospective regions identified for an horticultural precinct appear to be both Lambells Lagoon and Middle Point.

Lambells Lagoon is well suited to horticulture, with existing production in the area including bananas, pineapples, mangoes, passionfruit, rockmelons, honeydew melons, watermelons, pumpkins, papaya, durian, bitter melon, dragon fruit and other tropical species[8]. Approximately 1,994 ha of Crown owned land has been identified as possible for further development and suitable for agriculture and horticulture. The prospective land at Middle Point covers approximately 2,840 ha of land

[5] Australian Government Department of Agriculture, Water and the Environment: ABARES. *About my region – Greater Darwin Northern Territory*. Accessed at https://www.agriculture.gov.au/abares/research-topics/aboutmyregion/nt-darwin#regional-overview

[6] The Territory (2019). *Agribusiness*. Accessed at https://theterritory.com.au/invest/key-sectors/agribusiness

[7] ABC (2020). *Northern Territory confirmed as mango king, producing 52 per cent of national crop.* Accessed at https://www.abc.net.au/news/rural/2020-05-14/northern-territory-claims-title-of-biggest-mango-producer/12246604

[8] Queensland Country Life (2018). *On the market: NT delivers Sweet Life Farms.* Accessed at https://www.queenslandcountrylife.com.au/story/5596165/nt-delivers-the-sweet-life-video/

potentially suitable for horticulture. This land is currently owned by the NT Land Corporation and is planned for future development. Mangoes, bananas and dragon fruit are already produced at Middle Point.

Given the current horticultural activity in the Lambells Lagoon area and the findings from CSIRO's Northern Australia Water Resource Assessment (NAWRA), the expected overall crop mix is assumed to be split between three main crop types: mangos, citrus (lemons and oranges) and Asian vegetables (okra is used as a proxy for Asian vegetables). The ultimate expected crop mix is outlined in Table 1.

Table 1: Ultimate crop mix

Crop type	Ultimate land developed (ha)
Mango	1,000
Citrus oranges	250
Citrus lemons	250
Okra	500

Forecast water demand at Lambells Lagoon and Middle Point

Table 2 displays the total water demand based on the identified crop mix and the water requirement from each crop at maturity and full production. These values were selected following a comprehensive assurance process, consisting of both desktop research and market consultation.

Table 2: Annual agricultural and horticultural water demand (ML p.a.)

	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Total	1,785	3,570	5,355	7,140	8,925	10,710	12,495	14,280	16,065	17,850

Total forecast additional demand

It is evident that there is a strategic need for investment in additional water supply for the greater Darwin region. The total forecast additional water demand required to facilitate growth in the urban, industrial and agricultural /horticultural sectors, and ensure long-term water security, is outlined in Figure 5.

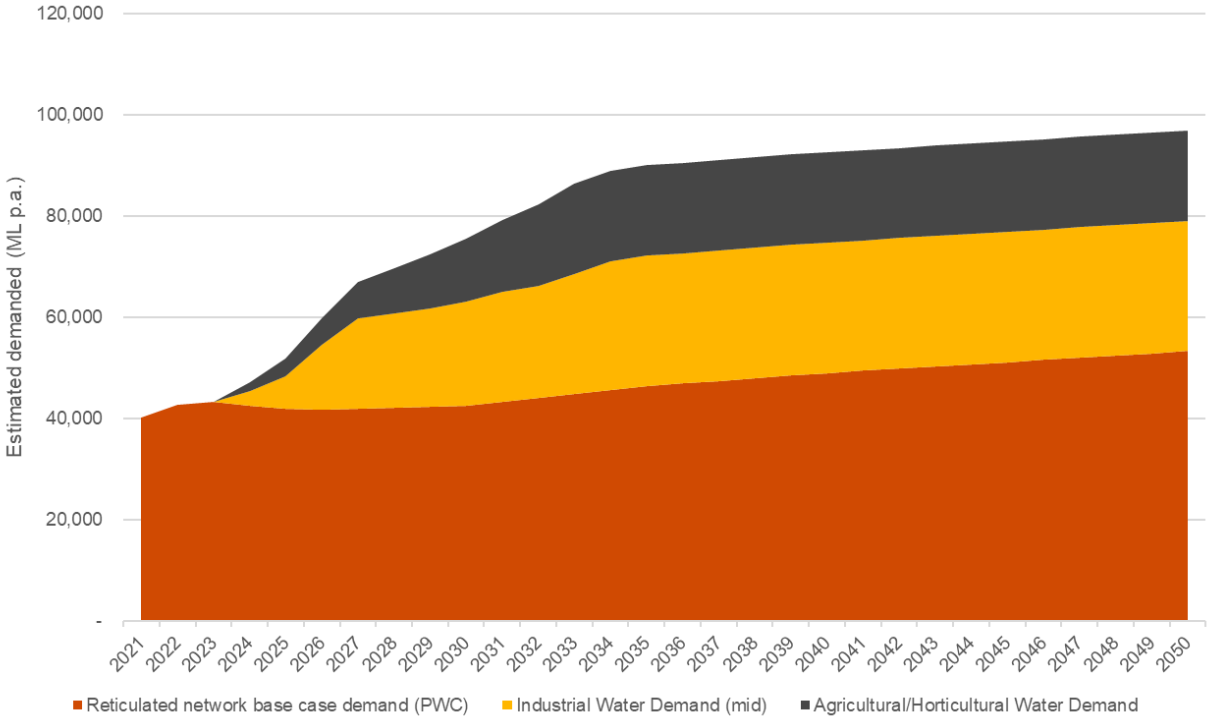

Figure 5: Total forecast additional water demand

Based on the project drivers, and the demand and supply balance, a range of problems and opportunities were identified. These were developed and confirmed through an Investment Logic Mapping process undertaken with key representatives from the NT Government, industry and the Project's advisors. The problems and opportunities are listed in Figure 6.

1. Darwin water supply over the medium term (5+ years) is not sufficient to provide the Level of Service that PWC offer or support increased population growth in the urban areas
2. Regional reliance on one primary water source increases the exposure of the water supply to environmental and seasonal factors and climate change which poses water security risks due to a lack of redundancy
3. Groundwater in the Darwin rural region is oversubscribed creating water reliability, security and environmental risks and inhibiting further strategic land development
4. The strategic positioning and development of additional cost effective and efficient water supply can enable increased high-value agricultural and horticultural production in the greater Darwin region
5. Potential industrial growth, specifically the Middle Arm precinct, is constrained by current water availability in the Darwin region
6. Inefficient water consumption by urban, industrial and agricultural water users results in higher water consumption impacting water availability to potential new users
7. Potential efficiencies gained in water consumption may be offset by the impacts of climate change on increased water usage leading to a lack of resilience in the Darwin region water supply

Figure 6: Problems and opportunities

Whilst the over-allocation of the groundwater resource was identified as a key problem, there are many specific policy responses which should be taken, prior to infrastructure solutions being considered, as previous investigations undertaken by the NT Government have indicated that the cost of the distribution and reticulation infrastructure to service rural suburbs is significant. Given this, it was agreed by the key stakeholders in the NT Government that reducing the over-extraction from the groundwater resource would be excluded from the scope of this Project. This project is subsequently focussed on ensuring sufficient water availability for the forecast growth in urban, industrial and agricultural/horticultural sectors to enable the continued economic growth of the greater Darwin region.

Options assessment

A key part of the Preliminary Assessment is a multi-stage options assessment process designed to undertake progressively more quantitative based assessment as the number of options and their scope becomes more defined. The options assessment utilised a filtering process, multi-criteria assessment (MCA) and Rapid Cost Benefit Analysis (CBA) to determine the preferred options for more detailed consideration. The options assessment process and the outcomes of each stage is shown in Table 3.

Table 3: Preliminary Assessment options assessment process

Options assessment stage	Process	Outcomes
ILM options longlist identification	• Identify the full range of options which could respond to the problems and opportunities developed in the ILM	• 18 options identified
High level options longlist filtering	• Review the options longlist to develop a shortlist for assessment in an MCA • Those options which do not meet the service need considered on their potential to form part of a package of lower cost initiatives • Options which are not feasible or cannot meet the service need removed	• 18 options from the ILM longlist assessed • 10 options progressed to the MCA, in addition to the base case
Multi Criteria Assessment	• Undertake an MCA of the shortlisted options from the ILM to determine a set of options for progression to a Rapid CBA • Assess each option against a set of criteria developed to link to the service need of the Project	• 10 options assessed in addition to the base case • 5 options progressed to the Rapid CBA
Rapid CBA	• Assess the options progressed from the MCA in a CBA framework to determine benefit cost ratios and net present values of the options to determine a preferred option • Considers whether the additional economic benefits realised from the larger options outweigh the cost of realising the increased supply	• 5 options assessed

MCA outcomes

An MCA was completed using a qualitative assessment of the options against an agreed set of criteria to determine the preferred options for consideration in the Rapid CBA. The six criteria used to assess the options in the MCA were; deliverability, economic impact, strategic alignment to the Northern Australia Agenda, cost, environmental and social impact, and adaptability. A summary of the options assessed in the MCA is included in Table 4[9].

[9] Under all of these options it is assumed that PWC retains its current allocations to both Darwin River Dam and the groundwater resource.

Table 4: MCA options summaries

Option	Indicative yield (ML p.a.)	Direct Capital Indicative cost ($million)[10]	Delivery time frame	Stageable
Base case	N/A	N/A	N/A	N/A
Option 1 – Do minimum	6,000 – 8,000	$10 – $20 million	5 - 10 years[11]	✓
Option 2 – Recycled water	5,000	$30 million	2 years	✓
Option 3 – Do minimum & disaggregated supply	11,000 – 13,000	$40 - 60 million	2-10 years	✓
Option 4 – Manton RTS & AROWS 1a (PWC's existing strategy)	17,500	$580 million	3 – 5 years	✓
Option 5 – Manton RTS & AROWS 1c	38,500	$675 million	3 – 5 years	✓
Option 6 – Desalination	60,000	$1,400 million	2 - 5 years	✓
Option 7 – AROWS 3	60,000	$610 million	5 years	X
Option 8 - In-stream dams	150,000 – 800,000	$180 - $850 million	> 10 years	X
Option 9 – Manton RTS & AROWS 3	67,500	$720 million	3 – 5 years	✓

The outcome from the MCA was a ranked list of the 11 options, displayed in Table 5.

Table 5: Options ranking

Rank	Option in ranked order	Score (out of 5)
1	Option 9 – Manton RTS & AROWS 3	4.10
2	Option 5 – Manton RTS & AROWS 1c	3.90
3	Option 7 – AROWS 3	3.80
4	Option 3 – Do minimum & disaggregated supply	3.40
5	Option 8 - In-stream dams (Marrakai, Mount Bennett and Upper Adelaide River Dams)	3.12
6	Option 4 – Manton RTS & AROWS 1a	3.09
7	Option 6 – Desalination	3.07
8	Option 2 – Recycled water	2.51
9	Option 1 – Do minimum	2.32
10	Base case	1.20

The process has confirmed that those options which can provide sufficient water for both economic development and water security over the short, medium and long term are the strongest performing. The options which include Manton RTS and AROWS perform most strongly as they respond to short-term water security risks with differing medium and long term

[10] Note – AROWS and In-stream dam options do not include the network distribution infrastructure e.g. piping in the costs estimate. This cost is expected to be significant for the in-stream dams.
[11] Whilst some savings are able to be realised earlier, it is expected to take between 5 and 10 years for the full demand reduction to be realised.

performance relative to the AROWS scale. Based on the outcomes of the MCA, the top five performing options from the MCA were progressed to the rapid CBA.

1 Option 9 – Manton RTS & AROWS 3

2 Option 5 – Manton RTS & AROWS 1c

3 Option 7 – AROWS 3

4 Option 3 – Do minimum & disaggregated supply

5 Option 8 - In-stream dams.

Economic assessment

A rapid economic analysis examined the potential costs and benefits of the five shortlisted options. The key benefits for each option included:

- Reduction in the incidence of water restrictions for households connected to the reticulated network
- Increased industrial output at the Middle Arm Precinct which was unlocked by the additional water
- Increased horticultural production enabled by the additional water.

The rapid economic analysis is displayed in Table 6.

Table 6: Rapid economic analysis results ($m, discounted at 7 and 4 per cent real)

	Do minimum & disaggregated supply	Manton RTS & AROWS 1c	AROWS 3	UARD	Manton RTS & AROWS 3
Option	**3**	**5**	**7**	**8**	**9**
Costs					
Capital costs	$431	$659	$872	$769	$957
Operating costs	$134	$148	$250	$61	$253
Total Costs	**$566**	**$807**	**$1,122**	**$830**	**$1,212**
Benefits					
Urban user benefits	$57	$59	$61	$48	$59
Industrial user benefits	$284	$444	$440	$224	$539
Agricultural / Horticultural user benefits	$0	$0	$256	$157	$284
Total Benefits	**$341**	**$503**	**$758**	**$429**	**$882**
NPV @ 7% discount rate	**$ -224**	**$ -303**	**$ -364**	**$ -401**	**$ -330**
BCR @ 7% discount rate	**0.60**	**0.62**	**0.68**	**0.52**	**0.73**
BCR @ 4% discount rate	**0.84**	**0.86**	**1.03**	**0.97**	**1.05**

These results indicates that:

- There is a need for Manton Dam RTS to be implemented in the short term to overcome the impending urban supply shortfall.

  - This has been recognised by PWC and is a key component of their water supply strategy.
- There is an opportunity to develop AROWS 3 to provide 60 GL p.a. of additional water to provide further urban water security as well as to realise growth in industrial demand and provide opportunities for the agricultural and horticultural sector.
- In the longer term, there may be opportunities to further explore the Upper Adelaide River Dam to provide continued growth for agriculture and horticulture in the areas in close proximity to the dam.
  - The capital cost of the Upper Adelaide River Dam is relatively low if there is the ability to remove significant pipeline and water treatment infrastructure. By implementing AROWS 3 and Manton RTS in the shorter term, there will be limited need for additional treated water to be delivered to the greater Darwin region. The Upper Adelaide River Dam could, therefore, be constructed as a stand-alone asset providing a relatively low-cost source of additional supply for the agriculture and horticulture industry. Given that the Upper Adelaide River Dam is reliant on a subset of the AROWS catchment, hydrological risks will need to be carefully managed in the planning phases of both of these potential projects.
- There is also an opportunity to explore small scale disaggregated water supply options including desalination and recycled water to supplement the water supply as required. This is likely to be for dedicated industrial demand where there are short term constraints limiting industrial growth where there is a high willingness and capacity to pay for the water
- Non-infrastructure, demand management options have the potential to provide a reduction in water use over the short to medium term, and hence an increase in available supply, of 6,000 – 8,000 ML p.a. While substantial, these volumes are not adequate to offset forecast growth from industrial use. Demand management and water efficiency options are likely to be lowest cost options to increase water availability in the region. These options should be investigated and pursued by the NT Government to promote more efficient and responsible use of water and be implemented alongside any infrastructure solution to maximise the benefits of any investment.

Conclusions and recommendations

The Northern Territory has recognised that there is a strategic need to address the supply and demand issues associated with water in the greater Darwin region. Without a new water supply, the greater Darwin region is likely to be subject to water restrictions in the medium term, and new investment and growth in the agricultural, horticultural and industrial sectors will likely be constrained. A comprehensive range of options was identified and investigated in response to the key problems and opportunities. Whilst a number of these options appeared to have a number of strengths, they also have some limitation which meant they could not respond to the service need and therefore they will not be investigated in further detail. These include:

- Option 8 – UARD has been discounted due to its inability to meet the short and medium term water requirements, and significant development risks. However, as discussed above, its long term development could provide continued growth for the agricultural and horticultural industries.
- Option 7 – AROWS 3 has been discounted as it cannot meet the short term water requirement.
- Option 5 – Manton RTS and AROWS 1c has been discounted as it does not provide sufficient water to fully activate the industrial precinct and provides no water for agricultural or horticultural growth.

It is recommended that DTBI:

- Obtain endorsement to progress the Project to the DBC phase
  - The recommended options to progress to the DBC are:
    - Option 9 – Manton RTS and AROWS 3
    - Option 3 – Do minimum and disaggregated supply (including the delivery of a desalination plant at Middle Arm as part of the disaggregated supply component)
- Explore in greater detail the following components of the project in the DBC:
  - Environmental impacts

  - Legal and regulatory considerations
  - Delivery model
  - Financial analysis, including detailed costs and potential funding options.
- Commence works to progress Manton Dam's return to service and AROWS to minimise timeframes post completion of the DBC, including:
  - Developing an Environmental Impact Statement (EIS)
  - Undertaking community and landowner consultation to ascertain community support for the Project
  - Investigations surrounding potential native title implications
  - Developing water allocations and licencing frameworks for the additional water supplied under the Project
  - Engaging with Infrastructure Australia to confirm ongoing support for the Project from Federal Government, including developing a Stage 2 (Options Analysis) submission.

In addition to progressing the DBC and associated activities for the preferred options, it is also recommended that the NT Government pursue further regulatory and reform initiatives. These initiatives could include:

- Implementing further demand management measures, building on the success of *Living Water Smart,* to ensure maximum value is obtained from any subsequent infrastructure investment.
- Implementing a water tariff that is based on full cost pricing principles across the PWC network to assist with the high per capita water use across residential, commercial and industrial, and government sectors.
  - This recommendation is in line with competition reform which has been undertaken across Australia since the 1990s. Full cost pricing is a central tenet of the competition policy reform agenda and has been reconfirmed as a component of the *National Water Initiative Pricing Principles* by the Australian Government's 2015 *Review of Competition Policy.*

Further investigation is required to manage the overuse of groundwater resources across the greater Darwin region. This Preliminary Assessment has noted the ongoing issues related to this overuse, however, this issue has been determined by the NT Government as beyond the remit of the AROWS project. To materially reduce this overuse, a significant and potentially Territory wide reform program is required. This is a complex task which can be undertaken alongside other water supply and demand initiatives. These will likely include initiatives such as legislative reform to limit extraction from groundwater resources, introduce more stringent licensing requirements, and mandate metering at every bore, and further studies to increase the confidence of estimates of sustainable extraction and use of ground water resources

The DBC will provide analyse the two shortlisted options and provide clear direction for the Northern Territory Government to ensure that the future population and economic growth for the greater Darwin region is enabled.