Queensland Farmers' Federation Ltd

NuWater Project Feasibility Study

Volume 1 – Preliminary Business Case

March 2018

Executive summary

The Queensland Farmers' Federation (QFF), on behalf of an unofficial consortium, was successful in applying for funding under the National Water Infrastructure Development Fund (NWIDF) to undertake a feasibility study to test the viability of using recycled water from the South-East Queensland Western Corridor Recycled Water Scheme (WCRWS) and prepare a Preliminary Business Case. This is referred to as the "NuWater Project". The consortium includes QFF industry members Cotton Australia, Central Downs Irrigators Limited (CDIL), Growcom and the Queensland Chicken Meat Council (QCMC), Agforce, Lockyer Valley Growers, Lockyer Valley Regional Council (LVRC), Toowoomba and Surat Basin Enterprise (TSBE), Queensland Urban Utilities (QUU) and Seqwater. This study is supported by funding from the Australian Government National Water Infrastructure Development Fund, an initiative of the Northern Australia and Agricultural Competitiveness White Papers.

GHD was engaged to undertake the NuWater Project – Feasibility Study in June 2017.

The NuWater Project will deliver a synergistic solution arising from the nexus of two problems i.e.:

- Costs of managing environmental impacts associated with treating South-East Queensland's wastewater and disposing the effluent to sea are expected to continue to increase driven by growing SEQ population and increasingly more stringent environmental standards that are in response to the communities' expectations for maintaining the environmental health of Moreton Bay; and
- Growth in agricultural and industrial production and associated regional economic benefits (particularly as measured in regional jobs) in the Lockyer Valley and the Darling Downs is being significantly constrained by the lack of opportunities and access to traditional water source supplies and need to develop alternate supplies for the region.

The completed project will:

- Provide up to 84,680 megalitres per year of irrigation water to agriculture and industry west of Brisbane on both sides of the Great Dividing Range (including, but not limited to the Lockyer Valley, Darling Downs, and abutting regions)
- Reduce by up to 84,680 megalitres annually, the amount of treated wastewater being released into the Brisbane River and Moreton Bay
- Provide an extremely valuable source of new water into the Murray-Darling Basin, and offset some of the social and economic cost of the Murray-Darling Basin reforms on key areas of the Darling Downs
- Provide significant opportunities for new agricultural industries
- Provide a solution to some of the challenges of wastewater disposal as a result of continued urban development across South-East Queensland, including reduced water treatment costs
- Provide a potential source of water that could be used by the CSG industry to assist with supplementing its "make good" water supply obligations if necessary
- Increase on-farm production by up to $500 million over the life of the project (in Present Value terms), or approximately $64 million per annum, with consequential flow-on impacts for regional communities.

- Avoid the economic costs associated with the continued discharge of nitrogen and phosphorus from STPs into SEQ waterways and Moreton Bay. The economic benefit of avoiding these costs has been estimated at over $150 million (in Present Value terms).

Negotiations for the potential funding arrangements to advance the project have yet to be undertaken. The business case is based on key assumptions including an Australian Government capital contribution of up to 50%. Notwithstanding this, the development of this Preliminary Business Case has involved initial discussions with relevant parties regarding the nature of potential funding contributions outlined in Table E1, noting that this does not represent a commitment by any potential party to fund the project.

Table E1 Nature of potential project funding contributions

Funding Source	Nature of Contribution
Australian Government	Lump sum (up to 50% of the capital cost)
Irrigators	Contribution towards local distribution and reticulation network on the Darling Downs and Lockyer Valley
Private investors	Other investment entities

In terms of Project Governance there are three identified project proponent options available for advancing the NuWater Project i.e.:

1. A Special Purpose Vehicle (SPV) involving multiple parties
2. Seqwater (noting Seqwater has not developed an organisational position in this regard)
3. Other relevant party.

Whatever the potential proponent arrangement in advancing the project, it is likely to be heavily reliant on public funding (in recognition of broader community benefits) – from both a capital and ongoing operational perspective.

Options Analysis Process – Long List of Options

The approach for generating a long list of options involved conducting an Options Identification Workshop with key stakeholders and the project team. This process identified a broad range of potential options to deliver recycled water from Brisbane to the Lockyer Valley and Darling Downs. All identified options substantively addressed the project's Problem Statement (described in Section 2.4) and delivered against the following initial objectives:

- A water infrastructure option (distribution and potential distribution) that supports the expansion of irrigated agricultural production across the Lockyer Valley and Darling Downs by beneficially utilising treated wastewater and reducing the nutrient load on Moreton Bay
- A water infrastructure option that aligns with the Moreton and Condamine and Balonne Water Plans and does not adversely impact other water users (water allocation security objectives) or environment factors
- An infrastructure option that in turn could be supported by a sustainable irrigation water tariff regime
- A water product that is fit for purpose in terms of water quality and reliability and provides adequate certainty for crop planting and management decisions.

In identifying the long list of options, the following considerations are noted:

- Numerous combinations of option elements are possible. An assessment process was undertaken to comparatively review these based on high level assessment of CAPEX, OPEX or capacity to deliver a meaningful quantity of water. A description of the proposed assessment process is included in Section 2.4

- An overall recovery rate of 82% of treated wastewater volumes has been used for all Advanced Water Treatment Plants (AWTPs) to produce Purified Recycled Water (PRW), with the remainder being losses (mainly Reverse Osmosis Concentrate (ROC) discharge)
- All options include the bulk water transfer from the WCRWS (Lowood Booster PS) to Lockyer Valley (Gatton) and from Lockyer Valley (Gatton) to the Darling Downs (broadly the area between Toowoomba, Dalby and Cecil Plains)
- The option elements included the bulk transportation of water only and did not specifically include the works required to distribute water to individual farms or local water networks (channels, storages, etc.)
- The outcomes of the demand analysis was used to refine the extent of water distribution and storage infrastructure and determine the extent to which existing infrastructure can be leveraged
- Power supply requirements and energy costs were a fundamental consideration for all options.

The four options selected from the options short listing process to undergo more detailed analysis are summarised below:

- **Option A** – PRW water product. Infrastructure includes Western Corridor Recycled Water Scheme (WCRWS) pipeline, construction of Heathwood pump station (PS), upgrade of Gibson Island advanced water treatment plant (AWTP), new pipelines delivering source water from Redcliffe sewage treatment plant (STP) to Sandgate STP and from Sandgate STP to Luggage Point STP, new delivery pipeline and pump stations from Lowood to top of Toowoomba Range plus distribution networks to Lockyer Valley and Darling Downs agricultural areas.
- **Option B** – Class A+ water product. Infrastructure includes WCRWS pipeline, construction of Heathwood PS, upgrade of Gibson Island AWTP, new delivery pipeline and pump stations from Lowood to top of Toowoomba Range plus distribution networks to Lockyer Valley and Darling Downs agricultural areas.
- **Option C** – Class B/C water product. Infrastructure includes WCRWS pipeline, construction of Heathwood PS, new delivery pipeline and pump stations from Lowood to top of Toowoomba Range plus distribution networks to Lockyer Valley and Darling Downs agricultural areas.
- **Option D** – Mix of PRW and Class B/C water product. Infrastructure includes WCRWS pipeline (current operating capacity), new delivery pipeline from Bundamba AWTP to Lowood Booster PS, new delivery pipelines and pump stations from Lowood to top of Toowoomba Range plus distribution networks to Lockyer Valley and Darling Downs agricultural areas.

Options Analysis Process – Short Listed Options MCA Review

The second stage involved more detailed investigations and analysis of options to confirm the preferred option and Reference Project consistent with the project phasing identified in the Building Queensland Business Case Development Framework - Preliminary Business Case.

A Multi-Criteria Assessment (MCA) tool was developed to firstly filter and ultimately rank preferred options by using both qualitative and quantitative information to achieve the best balance between:

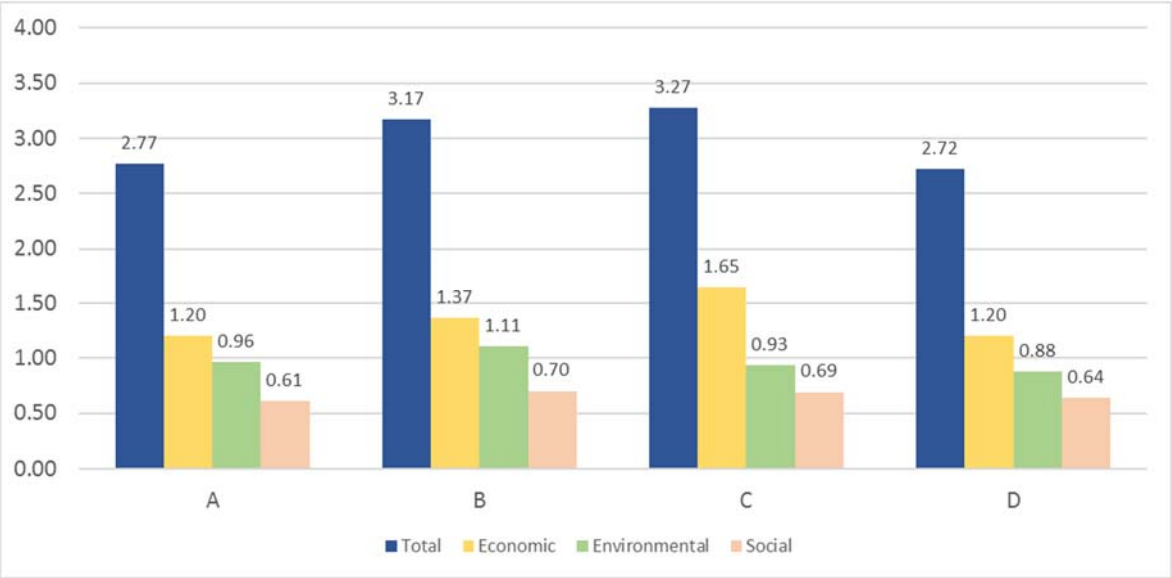
- Economic/viability Goals
- Environmental Goals

- Social Goals.

The evaluation of the projects was undertaken using a five-level ranking/scoring system, with score of 1 indicating that the project/scenario contributes poorly to the criterion outcome while a score of 5 would indicate a significant contribution beyond that required to just meet the criterion outcome.

The scoring (1 – lowest to 5 – highest) against economic (50% weighting), environmental (30% weighting) and social (20% weighting) criteria and overall outcomes of the MCA are displayed in Figure E-1 below.

Figure E1 MCA Scoring Results



These findings show that:

- On the basis of economic criteria, Option C is preferred followed by Option B. This is largely due to the lower CAPEX and OPEX related to the reduced treatment requirement for these water products. Option A is impacted by additional capital infrastructure required to add source water and operational costs of producing PRW. Option D comprises some duplicate delivery pipeline sections (between Bundamba and Grantham) and incurs OPEX associated with delivering a significant quality of PRW.
- On the basis of environmental criteria, Option B is preferred. Option A is impacted by the additional waterway crossings for source water pipelines and associated high ecological significance areas. This is countered to a degree by the fact that this option utilises the highest quantity of source water, thereby creating the greatest benefit to Moreton Bay. Option C scoring is impacted by a low score in terms of potential to exacerbate salinity impacts. Option D scoring is impacted by additional pipelines along with higher resource consumption.
- On the basis of social criteria, all options scored very similar, with some minor reductions assigned to those options with a greater infrastructure footprint.

Based on the weightings assigned to the MCA criteria, Option C scores as the preferred option followed by Option B. This underlines the relatively importance of the economic criteria in determining the most viable Reference Project.

Economic analysis

The purpose of an economic analysis is to estimate the net economic impact of a project by comparing all economic benefits that are measurable, material and attributable to the project with the identified economic costs.

The key economic benefits identified and assessed for the shortlisted options were:

- The additional economic value from the use of recycled wastewater for irrigated agricultural production, both in the Lockyer Valley and on the Darling Downs
- The avoidance of costs associated with the maintenance of WCRWS infrastructure in 'care and maintenance' and 'hot standby' modes
- The avoidance of the cost associated with increased nutrient loads in Moreton Bay as a result of the continued discharge of wastewater effluent from STPs in SEQ.

The additional value of agricultural production in the Lockyer Valley and on the Darling Downs was quantified based on the results of the crop modelling undertaken as part of the demand assessment. This demand assessment indicated significant demand for additional water from broadacre crop producers on the Darling Downs, both to increase yields on existing crops and to expand the area of crop production. Demand was also identified, although far more limited, for the expansion of vegetable crop production in the Lockyer Valley.

Anticipated industry marginal nutrient abatement costs were applied as a 'proxy' value for the economic benefit of avoided nutrient discharges. Note that this is the value that the community places on reducing nutrient discharges as opposed to the value of the project to the relevant party, which is determined by the financial impact of the project on the relevant party.

The industry cost of abating nitrogen loads (the 'limiting' nutrient in the Lower Brisbane catchment) via an alternative project was assumed to be approximately $23,000 per tonne. Applying a proportion from a study of nutrient abatement costs previously conducted in SEQ results in an estimate of $18,400 per tonne for phosphorus. The following table sets out the benefit estimates (in Present Value (PV) terms) associated with the reduction in nutrients discharged into SEQ waterways and Moreton Bay under the shortlisted options.

The costs identified and assessed in the economic analysis of the shortlisted options were capital costs; ongoing treatment, operating and maintenance (O&M) and energy costs; and the cost of on-farm infrastructure improvements.

The table below presents the results of the cost-benefit analysis of the shortlisted options.

Table E2 Summary of results of cost-benefit analysis (PV terms)

Impact	Option A	Option B	Option C	Option D
Economic benefits				
Increased value of agricultural production (Lockyer Valley)	$157.8m	$157.8m	$157.8m	$157.8m
Increased value of agricultural production (Darling Downs)	$327.0m	$327.0m	$327.0m	$277.5m
Avoided environmental costs	$176.0m	$159.8m	$150.8m	$144.5m

Impact	Option A	Option B	Option C	Option D
Avoided 'care and maintenance' costs	$16.5m	$10.2m	$1.6m	$12.3m
Increased environmental flows	Qualitative	Qualitative	Qualitative	Qualitative
Increased water security	Qualitative	Qualitative	Qualitative	Qualitative
Total economic benefits	**$677.3m**	**$654.8m**	**$637.2m**	**$592.1m**
Economic costs				
Capital costs	$1,920.4m	$1,496.9m	$1,378.0m	$1,612.1m
Treatment and O&M costs	$327.2m	$206.1m	$61.4m	$137.6m
Energy costs	$635.4m	$510.5m	$454.5m	$451.8m
WCRWS recommissioning costs	Nil[a]	Unquantified	Unquantified	Unquantified
On-farm infrastructure costs	$18.3m	$18.3m	$18.3m	$15.7m
Total economic costs	**$2,901.3m**	**$2,231.8m**	**$1,912.2m**	**$2,217.2m**
NET ECONOMIC IMPACT	**($2,224.0m)**	**($1,577.0m)**	**($1,275.0m)**	**($1,625.1m)**
Benefit Cost Ratio[b]	**0.23**	**0.29**	**0.33**	**0.27**

a Initial recommissioning costs are included in the upfront capital costs. Option A assumes continual production of PRW and no further recommissioning works.

b The Benefit Cost Ratio is calculated by dividing the PV estimates for total benefits by total costs.

Note: PV estimates have been derived based on a discount rate of 7 per cent.

Source: Synergies modelling.

The significant negative Net Present Values (NPVs) of the shortlisted options are driven by the substantial capital costs incurred in developing the infrastructure required to supply recycled wastewater to agricultural users and the significant ongoing treatment and energy costs incurred in maintaining supply. Option C results in the most favourable NPV and Benefit Cost Ratio (BCR) due to the lower up-front capital and ongoing treatment costs, however the BCR under this option is still significantly below 1.

Sensitivity and scenario analysis were undertaken to understand the impact of changes to various parameters on the NPVs of the shortlisted options. The sensitivity analysis demonstrated that whilst several parameter estimates have a material impact on the NPV under several options, in particular the discount rate and capital cost, the impact is not significant under any of the scenarios assessed. Applying an increase of 50 per cent to the economic value derived from the use of water for agricultural production resulted in only a marginal improvement in the NPVs of the shortlisted options (i.e. 11.2 per cent to 19.6 per cent). Similarly, whilst the NPVs were sensitive to scenarios in which there is stronger demand in the Lockyer Valley, the NPVs of all shortlisted options remain significantly negative for all shortlisted options across all scenarios modelled.

Financial and commercial analysis

A financial and commercial analysis was undertaken to assess the financial implications and budgetary impacts of the shortlisted options by assessing the cashflows for each option.

The financial costs included in the financial and commercial analysis were the capital costs; treatment and O&M costs; and energy costs.

One source of revenue was identified being water charges levied on water users (i.e. agricultural users in the Lockyer Valley and on the Darling Downs). Based on the outcomes of the demand assessment, it was concluded that a price for water from the project that could be sustained by agricultural businesses was likely to range from $300 to $500 per ML per year (financial modelling was undertaken using a base price of $400 per ML per year).

The table below sets out the results of the financial and commercial analysis.

Table E3 Results of financial and commercial analysis of shortlisted options (PV terms)

Costs and revenues	Option A	Option B	Option C	Option D
Costs				
Capital costs	$1,920.4m	$1,496.9m	$1,378.0m	$1,612.1m
Treatment and O&M costs	$283.4m	$178.5m	$53.2m	$119.2m
Energy costs	$550.1m	$442.0m	$393.5m	$391.2m
Total costs	**$2,753.9m**	**$2,117.4m**	**$1,824.7m**	**$2,122.5m**
Revenues				
Revenue from water charges	$221.7m	$221.7m	$221.7m	$191.1m
Total revenues	**$221.7m**	**$221.7m**	**$221.7m**	**$191.1m**
Financial Net Present Value	**($2,532.2m)**	**($1,895.7m)**	**($1,603.0m)**	**($1,931.4m)**

Note: PV totals have been calculated based on a nominal discount rate of 9.7 per cent (consistent with the real discount rate of 7 per cent applied in the economic analysis). Results calculated based on demand of 7,500 ML per annum in the Lockyer Valley (remaining volumes supplied to the Darling Downs).

Source: Synergies modelling.

As with the results of the economic analysis, the significant negative Financial Net Present Values (FNPVs) are driven by the significant costs associated with developing the necessary infrastructure and supplying recycled wastewater to growers.

A financial risk assessment indicated that an overrun in capital costs is the key financial risk to each of the shortlisted options. Minimising this risk should be a key focus area for the Detailed Business Case and is to be considered in the project design, selection of delivery model and commercial framework for the development of the infrastructure.

The results from the financial and commercial analysis demonstrate that, for all shortlisted options, the revenues derived from the project will be insufficient to recover the financial costs to be incurred. The project will therefore require significant government funding in order to be financially viable (noting that no additional revenue sources beyond water users have been identified).

As noted above, the FNPV of the shortlisted options range from ($1,603.0 million) to ($2,532.2 million). As such, the project will require significant government funding in order to be financially viable. The magnitude of government funding required will be determined by the

option that is adopted and the level of demand in the Lockyer Valley (in addition to any up-front capital contribution derived from external parties).

In terms of the relative affordability of the shortlisted options, Option C is clearly more affordable relative to the other options. This option has both the lowest capital cost requirement (total of $1,592.7 million in nominal terms) and the most favourable FNPV estimate, being ($1,603.0 million). Whilst this option would still require significant government funding to be financially viable, the magnitude of the contribution would be lower than for the other shortlisted options.

Abbreviations

Acronym/Abbreviation	Description
ACH	Aboriginal Cultural Heritage
AHD	Australian Height Datum
AWTP	Advanced Water Treatment Plant
BQ	Business Queensland
BCR	Benefit Cost Ratio
CAPEX	Capital Expenditure
CDIL	Central Downs Irrigators Limited
CHMP	Cultural Heritage Management Plan
CSG	Coal Seam Gas
DEHP	Department of Environment and Heritage Protection (now DES)
DES	Department of Environment and Science
DEWS	Department of Energy and Water Supply (now DNRME)
DNRM	Department of Natural Resources and Mines (now DNRME)
DNRME	Department of Natural Resources Mines and Energy
DSD	Department of State Development
DTMR	Department of Transport and Main Roads
EA	Environmental Authority
ECI	Early Contractor Involvement
EDQ	Economic Development Queensland
EIS	Environmental Impact Statement
EMP	Environmental Management Program
EPBC	Environment Protection and Biodiversity Conservation
ERA	Environmentally Relevant Activity
ETI	Early Tenderer Involvement
FNPV	Financial Net Present Value
GHD	GHD Pty Ltd
GL	Gigalitre
IROL	Interim Resource Operations Licence
IPR	Indirect Potable Reuse
LOS	Level of service
LVRC	Lockyer Valley Regional Council
MCA	Multi Criteria Analysis
ML	Megalitres
ML/d	Megalitres per day
MNES	Matters of National Environmental Significance
MSES	Matters of State Environmental Significance
NC	National Conservation
NPMC	NuWater Project Management Committee
NPC	Net Present Cost
NPV	Net Present Value
NWI	National Water Initiative
NWIDF	National Water Infrastructure Development Fund
ONRA	Offsite Nutrient Reduction Action
OPEX	Operational Expenditure

Acronym/Abbreviation	Description
PBC	Preliminary Business Case
PFD	Process Flow Diagram
PM	Project Manager
PPP	Public-Private Partnership
PRW	Purified Recycled Water
PS	Pump Station
PV	Photovoltaic
PV	Present Value (economic/financial)
QBWOS	Queensland Bulk Water Opportunities Statement
QFF	Queensland Farmers' Federation
QUU	Queensland Urban Utilities
RE	Regional Ecosystem
RO	Reverse Osmosis
ROC	Reverse Osmosis Concentrate
ROI	Return on Investment
ROP	Resource Operations Plans
SDL	Sustainable Diversion Limit
SEQ	South East Queensland
SPV	Special Purpose Vehicle
STP	Sewage Treatment Plant
TEC	Threatened Ecological Community
TN	Total Nitrogen
TP	Total Phosphorus
TRC	Toowoomba Regional Council
TSBE	Toowoomba Surat Basin Enterprise
VFM	Value For Money
WCRWS	Western Corridor Recycled Water Scheme
WP	Water Plan
WRP	Water Resource Plan
WSS	Water Supply Scheme

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1. Governance

1.1 Overview

Queensland Farmers' Federation (QFF) is responsible for delivery of the NuWater project through the Preliminary Business Case phase. QFF's guiding principles include:

- Ensure members are well-informed on issues of strategic importance
- Demonstrate leadership and a positive approach to policy
- Work together to seek positive outcomes on issues of common interest
- Seek outcomes that meet positive economic, social, environmental and regional matters
- Recognise and embrace diversity within the QFF membership in achieving acceptable solutions for all members
- Foster a culture which recognises that responsible natural resource management is an integral part of sound farm business management
- Work cooperatively and respectfully with all stakeholders.

Figure 1-1 presents the overall governance structure for the project's delivery.

QFF is working in close liaison with a NuWater Project Management Committee (NPMC) who have advised on underlying matters informing the development of the Preliminary Business Case and assisted with engaging stakeholders.

In managing this NuWater project, QFF and the NPMC is supported by Badu Advisory Pty Ltd who was appointed as QFF's project manager for the project.

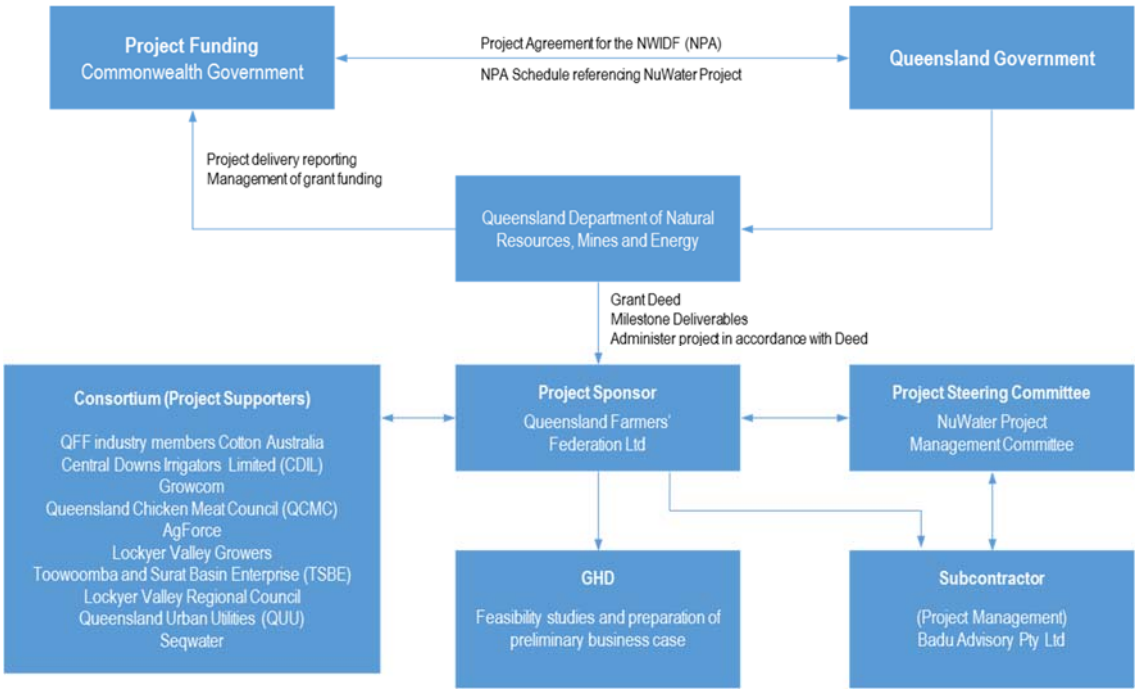


Figure 1-1 Governance structure for the Project

1.2 Assumptions

Major assumptions that have been made are recorded in the Assumptions Register shown as Appendix L (Volume 2). Some additional assumptions made based on judgements have been included throughout the report.

1.3 Proposal owner

QFF is the proposal owner through to the delivery of the Preliminary Business Case. The QFF is the united voice of intensive agriculture in Queensland. It is a federation that represents the interests of 17 of Queensland's peak rural industry organisations, which in turn collectively represent more than 13,000 primary producers across the state. QFF engages in a broad range of economic, social, environmental and regional issues of strategic importance to the profitability, sustainability and growth of the agricultural sector. QFF's mission is to secure a strong and sustainable future for Queensland primary producers by representing the common interests of their member organisations, which include:

- CANEGROWERS
- Cotton Australia
- Growcom
- Nursery and Garden Industry Queensland
- Queensland Chicken Growers Association
- Queensland Dairyfarmers' Organisation
- Burdekin River Irrigation Area Committee
- Bundaberg Regional Irrigators Group
- Central Downs Irrigators Limited
- Fitzroy Basin Food and Fibre
- Flower Association of Queensland Inc.
- Pioneer Valley Water Board
- Pork Queensland Inc.
- Queensland Chicken Meat Council
- Queensland United Egg Producers
- Australian Organic
- Queensland Aquaculture Industries Federation.

Through QFF, rural industry resources are pooled to ensure powerful representation and effective strategy development on important issues. QFF unites its membership through a Council of members that sets the strategic direction and overarching policy, with this forum acting as the primary mechanism for member participation. The Council selects an executive board that is responsible for corporate governance. QFF has a long-established Governance Charter, which clearly defines the respective roles, responsibilities and authorities of the Board, its Chairperson, Board members, committees, and management.

It is anticipated that project ownership will transfer as the project transitions to the preparation of the Detailed Business Case i.e. to a Special Purpose Vehicle or under the direct ownership/control of another relevant party (as discussed in Section 18).

Table 1-1 Roles and accountabilities

QFF		
Responsibility for project delivery	Project definition	In consultation with the relevant members (and other stakeholders) agencies and Government Departments, develop a sustainable model for the development of a viable and supported development option that meets project objectives. Define the Project so as to achieve the required outcomes (including within budget, time, environmental provisions and other associated approvals). Enter into high-level agreements with key agencies such as QUU and Seqwater to support the advancement of the Project and maintain ongoing relationships.
	Project delivery	Develop a Preliminary Project Business Case that supports advancement of the project.
	Project reporting and liaison	Provide regular reports to DNRME, DAWR and other relevant agencies on Project progress/performance.
	Corporate governance	Annual Reports Corporate Plans Reporting against Funding Contract/Deed: • Milestone Reports • Monthly Progress reports • Evaluation Report.
	Local Government and regional stakeholders	Engage with Local Government, Community Groups, and other key regional agencies to ensure social, economic and environmental benefits as a result of the Project are identified and captured.
	Stakeholder engagement	Develop and implement stakeholder engagement plan. Engage with Local Government, Community Groups, and other key regional agencies to ensure social, economic and environmental benefits as a result of the Project are identified and captured.
NPMC		
Responsibility for project oversight/guidance	Stakeholder engagement	Provided input to the stakeholder engagement plan.
	Review of project materials	Provided input during workshops and assisted with reviewing deliverables and option ranking.
Badu Advisory Pty Ltd		
Project Management	Project coordination	Project Management on behalf of QFF and direct interface between GHD and the NPMC
GHD		
Responsibility for Delivering the Preliminary Business Case	Project delivery	Identify long list of options in consultation with key stakeholder (i.e. NPMC, irrigators, QUU, Seqwater and Unity Water). Assessment and ranking of options in association with NPMC. Needs analysis, economic and financial assessment of preferred options. Delivery of Preliminary Business case.

1.4 NuWater Project Management Committee

The project is directly overseen by the NuWater Project Management Committee (NPMC), which is made up of representatives from:

- QFF
- Cotton Australia
- AgForce
- Lockyer Valley Regional Council (LVRC)
- Queensland Urban Utilities (QUU)
- Seqwater
- Toowoomba Surat Basin Enterprise (TSBE)
- Several local landholders / irrigators / business representatives from the Darling Downs and Lockyer Valley.

1.5 Acknowledgement

This study is supported by funding from the Australian Government National Water Infrastructure Development Fund, an initiative of the Northern Australia and Agricultural Competitiveness White Papers.

2. Methodology

2.1 Overview

Feasibility Studies undertaken as part of the NuWater Project informed the preparation of this Preliminary Business Case through:

- Assessment of available water for recycling, its quality and location
- Assessment of existing water recycling assets
- Assessment of treatment levels required i.e. fit-for-purpose needs of end users
- Assessment of key areas of agricultural demands, and the characteristics and timing of that demand
- Detailed assessment of the regional economic benefits of the project including consideration of direct and indirect existing and future beneficiaries of utilizing recycled water
- A high-level conceptual design of the engineering of the scheme including estimated costings for capital expenditure and annual operating costs
- Estimation of offtake demand at various locations across the Lockyer Valley and Darling Downs
- Investigation and development of options for financing the construction of the scheme and business model for the operation of the scheme
- Specific consideration and addressing of the following questions:
  - What is the potential size of the wastewater resource and its suitability for treatment to a standard suitable for a variety of agricultural uses?
  - How much water is – or is likely to be – available in the future (including timing and reliability)?
  - What current and future demands are likely (including their spatial distribution) associated with a range of potential supply cost scenarios?
  - Is the water affordable (taking into consideration, for example, technological innovations, water market mechanisms, alternative energies, multi-use of pipeline, co-location of services, uses etc.)?
  - What is a roadmap of the preconditions that need to be met and/or actions required of stakeholders before reuse may happen?
  - What are the risks to wastewater reuse and disposal, the ways that these risks might be managed, and the opportunities that potentially arise out of addressing these risks?
  - Who are the potential beneficiaries (i.e. not just the direct consumers of water) associated with the project?

With and without Project assessments are important to this study and the current state was used as a baseline to assess the benefits of the proposal. Feasibility studies also included assessment of (for both with and without the project):

- The level of the nutrient loads discharged from point and diffuse sources both today and 30 years from now
- WCRWS asset value/reliability/integrity

- The timing of potable water supply infrastructure investments (assuming the Project expedites the substitution of high quality potable water that is currently used for agriculture with new supplies of treated effluent).
- The above elements together with the following are discussed in detail throughout this document:
  - Economic and financial analysis
  - Water resource regulatory environment
  - Environmental impacts
  - Laws, regulations and other standards.

2.2 Risk approach

Project related risks were discussed at the initial workshop with NPMC representatives on 18 July 2017 with a risk assessment framework subsequently populated in accordance with the Australian Standard AS NZS ISO 31000: 2009 Risk Management principles and guidelines. This has been further reviewed by NPMC members to confirm and quantify/qualify risks. The risk assessment framework is shown as Appendix M (Volume 2).

The key drivers of Project Risk are a combination of:

- Effectiveness of planning, project management (including budget controls), scheduling and coordination
- Delivery of quality project elements
- Timely and successful engagement with stakeholders.

Risk identification, assessment and mitigation was undertaken at whole of project level. Each risk mitigation and monitoring activity was assigned a single point of accountability within the project team and documented for subsequent project phases.

The values and behaviour that QFF focused on to help make risk management instinctive include:

- *Risk awareness* – consistently thinking about risk as part of everyday role
- *No surprises through honesty and transparency* – sharing information and experiences quickly and openly across the project delivery team, Executive, Steering Committee and the Board
- *Teamwork* – individuals within the team looking for ways to help ensure that the overall Project risk profile is managed as well as their own direct area of responsibility
- Leading by example and taking accountability for actions, within approved level of delegation
- *Rigorous conversations*, between the right people, on the risks, costs and benefits which need consideration before making key Project decisions
- *Collaboration* – a collaborative engagement style with third parties e.g. contractors and land holders.

Study elements supporting this Business Case were contracted to industry recognised specialists GHD. This assisted ensure value for money and quality outcomes whilst minimising risks associated with time or budget overruns.

The NuWater Project Risk Register is shown as Appendix M (Volume 2).

2.2.1 Cost estimation risk

This risk captures cost estimates may be inaccurate or overrun.

Whilst a significant amount of work has been done in estimating costs, drawing on recent learnings from similar projects and market knowledge, a risk remains that the estimates are over or under a realistic assessment.

A brief description of the cost estimation risks identified are shown in the Table 2-1 below. For further description of the risks, please refer to Appendix M (Volume 2).

Table 2-1 Cost estimation risk

Key Risk and Description	Potential Control Measures/Mitigation Strategies
Costs escalate beyond Project budget and contingencies through insufficient challenge or interrogation by QFF and GHD	Recent learnings from similar works, provides QFF/GHD with a level of confidence in the completeness and accuracy of the estimated costs. Cost estimates have been further reviewed by a specialist quantity surveyor.
Costs escalate beyond Project budget and contingencies through unanticipated market or supplier escalation, including: • Foreign exchange risk on imported material (e.g. pumps) • Price of raw materials (e.g. aluminium, steel).	Refine cost price and quantity assumptions within the financial modelling.
Financial model has inaccuracies or errors	GHD's involvement in the cost estimating process and familiarity with similar assets reduce the likelihood of inaccuracies of additional works required.
Water costs leads to uneconomic project	Keep options open. Maintain commercial tension. Commenced commercial negotiations with QUU and Seqwater over purchase of water allocation and potential offsetting benefits.
Project economics is sensitive to commodity price	Business case assesses sensitivity to change in price for key ag products and a range of other factors.
Market sensitivity to water price including purchase of water allocation and annual usage charges	Background data based on crop models (gross margins etc.). Review of willingness to pay. Sensitivity testing in business case.
On-farm customer connection costs are estimated inaccurately or inconsistently, resulting in landholder/irrigator claims or disputes.	Formal landholder meetings and agreements. Lump sum prices to be generated for connections to water distribution system. Clear understanding of any additional need for on-farm storage etc.
Ability of the project to obtain water allocation	Negotiation with government stakeholders (Seqwater, QUU, DEWS) and noting State Government Bulk Water Opportunities Statement (*reducing barriers to using available water…..*and *….use existing water resources more efficiently*).
Development of an option that isn't flexible and is expensive	Careful assessment of options through MCA with criteria considering flexibility and staging.
Development of an option that is over engineered (gold plated)	Consider options that fit the needs of the project and have appropriate design criteria – fit for purpose.
Operations and maintenance costs may be higher than expected	Design to minimise delivery costs and complexity.
Ownership of water supply assets leads to commercial risk and/or overpriced water	Careful consideration of commercial arrangements for water supply. Consideration of Seqwater, SPV or relevant party owning distribution network.

Key Risk and Description	Potential Control Measures/Mitigation Strategies
Planning and environment conditions of approval and management and mitigation requirements not confirmed	Quantify and monetise as far as possible and/or allow contingencies

QFF is ultimately accountable for driving completion of risk mitigation activities for the Preliminary Business Case phase of the project.

2.2.2 QFF Interface management risk – delivery agent

This reflects the risk that QFF's interface with Project delivery agents (Consultants) results in misunderstandings, poor coordination, planning or delays, insufficient access or other unanticipated issues.

QFF's delivery interface and governance involves a number of entities, including the dedicated Project Management resource (sub-consultant) and the consultant for delivery of the feasibility studies supporting the preparation of the Preliminary Business Case for the project. Management of the information flow, governance of agreements, integration of teams, may impact the optimisation of the delivered program of works.

A brief description of the interface management risks identified are shown in Table 2-2 below.

Table 2-2 Interface management risk

Key Risk and Description	Potential Control Measures/Mitigation Strategies
Complex interface model with Consultant, key stakeholders, landholders and regional community delays securing clear project direction impacting schedule and budget.	Clear definition and communication of Project roles and accountabilities in commercial agreements.
Level of landholder and irrigator acceptance and management of potential landholder disruptions.	Well-structured stakeholder engagement plan.

2.2.3 QFF capability risk

This reflects the risk that QFF resources (number and/or capability) are sub-optimal to effectively manage planning and delivery of the next phase of the NuWater Project.

QFF could potentially retain the services of a dedicated Project Management resource to co-ordinate the next phase of the project.

2.2.4 External stakeholder management risk

The risk that Project Objectives (and priorities) are unclear or are changed / influenced by external stakeholders (e.g. Government or community).

QFF manages multiple stakeholders, as described in Section 1.2. All stakeholders have some level of input and influence on the Project Objectives. Government policy, legislation and funding will also directly affect the Project.

A brief description of the external stakeholder management risks identified are shown in Table 2-3.

Table 2-3 External stakeholder management risk

Key Risk and Description	Potential Control Measures/Mitigation Strategies
External stakeholders influence proposed program of works, resulting in sub-optimal project outcomes and/or slippage in timeframes. These stakeholders can include: • Public / Regional Community / Irrigators • Other landholders • Local governments • Lobby groups or industry groups with large regional interests • Government (Seqwater, QUU, Unity Water, DNRM, DEWS, SunWater, etc.)	A detailed stakeholder map has been created, with a number of stakeholder consultation forums held. Execution of a communication plan with external stakeholders. Specifics such as clarity in the region included, the scope of works and how landholders are contacted and involved with the project are all part of the communication plan.
Government policy or legislation changes.	Changes in government policy will be monitored, implications considered and stakeholders consulted as relevant.

2.2.5 Landholder/irrigator consultation risk

This reflects risk that landholders and/or irrigators input and involvement is sub-optimal resulting in delays and animosity towards the project.

Landholder and/or irrigator consultation and negotiation is required to support the project, secure access to land to support the development and define potential irrigation water supply arrangements (acceptable water quality, flow rates etc).

A brief description of the landholder/irrigator consultation risks identified are shown in Table 2-4 below.

Table 2-4 Landholder/irrigator consultation risk

Key Risk and Description	Potential Control Measures/Mitigation Strategies
Insufficient or inaccurate information is provided to landholder/irrigators	A range of project information prepared and reviewed for circulation to stakeholders and available on QFF and other relevant parties' web site/s. QFF landholder/irrigator consultation, both proactive and reactive, to engage with the community.
Landholders/irrigators are not provided with sufficient time to review information and assess their options/support	Landholders/irrigators engagement well advanced.
Landholders/Irrigators view consultation process as limited, feeling their views, ideas and concerns are not considered sufficiently (collaborate vs. dictate).	Limited number of landholders /irrigators involved directly in the project and acceptance on a broad base must be reached for the project to move forward.
Insufficient resources are available to consult with irrigators prior to planned construction work.	QFF and Consultant dedicate resources to this function to build on engagement undertaken in delivering this Preliminary Business Case as part of the Detailed Business Case development.

2.2.6 Capturing and reporting risks to the project

All project team members are responsible for reporting any new or changed risks that could impact on the delivery of the Detailed Business Case phase of the project. The project team members, consultants and contractors shall notify these to the Project Manager/Consultant for capture in the Risk Register.

For significant risks, these will be escalated to the QFF PM immediately for direction; other risks will be notified to QFF via the monthly report. Similarly, the QFF PM shall escalate to the NPMC where necessary for immediate action.

The NuWater Project Risk Register and the Risk Matrix are included in Appendix M (Volume 2). It is noted that relevant stakeholder organisations that contribute to the development of the risk register and matrix such as Seqwater and relevant parties should be involved in its review and revision as future phases of the NuWater Project evolve.

2.3 Stakeholder Engagement Approach

The stakeholder engagement approach adopted by the Project was based on transparent and consistent communication and an inclusive consultation process.

To support this approach, The Project Team developed a high level Consultation and Engagement Plan that defined the strategic stakeholder engagement objectives, and identified key engagement activities throughout the various stages of Project implementation. The Plan also included a comprehensive stakeholder mapping and identification process, stakeholder issues assessment and the development of key communication activities to support the engagement process.

The feasibility study supporting the preparation of this Preliminary Business Case was initiated at a workshop of NPMC members held at Tathra Station (near Norwin) on the Darling Downs in Queensland. Workshop outcomes included:

- Agreed Project Objectives, High-level scope, milestones and High-level schedule
- Established Project Control and Reporting processes, procedures and protocols
- Identified Project Stakeholders their roles, interests in the project, potential sources of information and involvement in the options identification process
- Identified Project Risks and consequences and proposed control measures
- This workshop provided the basis for the development of the Consultation and Engagement Plan and activities undertaken as part of the Preliminary Business Case process
- Further detail on the consultation and engagement activities and outcomes may be found in Section 6.5 – Public Interest Considerations.

2.4 Options selection approach

As part of the feasibility study, a series of steps were identified to support the identification, evaluation and selection of options to address the project objectives. Initially, an Options Identification Workshop, involving key stakeholders and project personnel, was held with the purpose of identifying potential options to deliver recycled water from Brisbane to the Lockyer Valley and Darling Downs agricultural areas. Options for consideration were required to address the project's Problem Statements, which has been reproduced below.

- Costs of managing environmental impacts associated with treating South-East Queensland's wastewater and disposing the effluent to sea are expected to continue to increase driven by growing SEQ population and increasingly more stringent environmental standards that are in response to the communities' expectations for a maintaining the environmental health of Moreton Bay; and
- Growth in agricultural and industrial production and associated regional economic benefits (particularly as measured in regional jobs) in the Lockyer Valley and the Darling Downs is being significantly constrained by the lack of opportunities and access to traditional water source supplies and need to develop alternate supplies for the region.

A report was prepared detailing the outputs from the Options Identification Workshop, which included the options identification workshop process and outputs, a description of option elements and the envisaged process for options assessment. The Options Identification Workshop Report is included in Appendix B (Volume 2).

A three step process for options review and refinement followed the initial identification of options:

- Stage 1 – Hurdle Criteria/Long-listing process
  - Assessment against capacity to address Problem Statements
- Stage 2 – Short-listing process
  - Assessment based on select criteria including total capital and operating cost (high level estimate) per mega litre of yield ($/ML) at the farm
- Stage 3 – Multi-criteria Assessment
  - Assessment based on economic/viability, environmental and social goals.

The processes, assumptions and outcomes arising from each of Stage 1, Stage 2 and Stage 3 of the options assessment are provided in Sections 5, 7 and 15 respectively.

3. Proposal background

3.1 Project history

The feasibility of re-directing Brisbane's urban wastewater, from outfall into Moreton Bay, to the agricultural regions of the Lockyer Valley and Darling Downs, was considered during the late 1990's and early 2000's due to the growing and sustained demand for water for agriculture. Over $2 million of Federal Government and private investment funds were spent, with a business case being developed by Ernst and Young, entitled "NuWater - South East Qld Recycled Water Project" (Ernst and Young, 2003), which concluded "*the project has reached a point of commercial, economic, and environmental feasibility and is now in a position to negotiate a commercial outcome*".

However, a decision by the Queensland Government in the mid-2000's to reserve the wastewater for indirect potable reuse and the subsequent building of the $2.4 Billion Western Corridor Recycled Water Scheme (WCRWS) effectively stopped further consideration of NuWater at the time.

In 2015, the WCRWS was placed into a care and maintenance mode of operation.

Issues are also emerging in regard to the cost associated with maintaining and recommissioning of the WCRWS which currently remains in 'standby' mode until water levels in Wivenhoe Dam fall approximately 40% capacity. As such, the WCRWS remains an under-utilised major asset that could provide multiple benefits, which are further outlined in this Business Case.

Key issues surrounding the NuWater Project delivery environment include:

- Water security for South East Queensland (SEQ)
- Water quality in watercourses and the receiving waters of Moreton Bay and the Pumicestone Passage.

With regard to water security for SEQ, the *Water Act 2000* requires Seqwater to develop a Water Security Program to plan SEQ's water future for the next 30 years (2015 to 2045). The State Government has given guidance on the long-term objectives for water security planning through a regulatory framework – the level of service (LOS) objectives. The LOS objectives provide a measure of performance that the bulk water supply system must meet. The document, *Water for life, South East Queensland's Water Security Program* is Seqwater's blueprint for achieving those objectives[1]. Seqwater's water security portfolio includes a mix of supply, demand and system operation options including commencing the recommissioning of the WCRWS once the combined storage volume in Seqwater's key storages falls below 60% capacity. In drought scenarios, this would likely result in purified recycled water being placed in Lake Wivenhoe when the combined storage volume in Seqwater's key storages drops below approximately 40%. The prioritisation of the Water Security Program requirements introduces a level of interruptibility in any alternative irrigation supply arrangements.

With regard to water quality, *the Resilient Rivers Initiative was launched in December 2014 with the aim of improving the health of SEQ's waterways by delivering a coordinated approach to catchment management. Signatories include the Council of Mayors (SEQ), Queensland Government, Seqwater, Healthy Land and Water, Unitywater and Queensland Urban Utilities.*

[1] *Water for life, South East Queensland's Water Security Program, 2015-20145*, Seqwater July 2015

The initiative aims to improve the health of our [SEQ] *waterways by achieving the following goals:*

- *To promote partnerships with strong leadership to deliver a coordinated approach to catchment management in SEQ*
- *To keep soil on our land and out of our waterways*
- *To help protect our region's water security so it can support the current and future population of SEQ*
- *To improve the climate resilience of our region.*

The final outcome of the Resilient Rivers Initiative will be a coordinated program of works that focuses on innovative approaches to achieving these goals. It is recognized that there is no one single solution to these issues and it requires a collaborative and multi-pronged approach, across state and local government agencies, water utilities, regional partners and the community[2].

The above initiative has driven the development of a number of Catchment Action Plans and also aligns with the State's, 'The Healthy Country Program', which is funded by DEHP to assist lift water quality parameters in Moreton Bay.

QFF sought funding under NWIDF to assess the potential size of the wastewater resource, its suitability for treatment to a standard suitable for a variety of agricultural uses, and to update the 2003 Business case, primarily to test the economic feasibility, and the cost/benefit of the project from 2016 and beyond.

3.2 The region

Water has always been a key factor in supporting regional development and the economic prosperity across the Lockyer Valley, Darling Downs and surrounding region.

The Darling Downs region accounts for around one quarter of Queensland's total agricultural production. The region is supported by access to strategic transport networks and service hubs and possesses key inter-regional linkages. Well-established regional centres in the Darling Downs, in particular Toowoomba, provide critical value adding and support services for the region's agricultural industry. Access to State, national and international markets, enabled by the region's road and rail networks and land transport connectivity with major east coast ports, has also facilitated growth in the industry. Agricultural opportunities have been further enhanced through the development of Wellcamp Airport and Business Park, which broadens market opportunities though opening up airfreight catchments around Australia and overseas.

The region contains a broad range of agricultural activities, including intensive livestock and cattle grazing and broadacre cropping, primarily cotton, wheat, barley, etc. Livestock production in the region is primarily beef, but also includes sheep, pork and poultry products. Intensive livestock industries are concentrated around local feed grain supply.

The Lockyer Valley, known as "Australia's salad bowl" and is a region with highly fertile soils. Vegetable crops, including beans, broccoli, cabbage, capsicum, carrots, cauliflower, celery, Chinese cabbage, lettuce, onions, pumpkins, sweet corn, tomatoes and potatoes, dominate agricultural production in the Lockyer Valley. Based on an assessment conducted in 2013, 6,700 hectares of land within the region is used for vegetable production, cereals for grain accounting for 1,950 hectares, orchard trees using 400 hectares.

[2] http://seqmayors.qld.gov.au/project/resilient-rivers-initiative/ (Accessed 10 October 2017)

The abovementioned regions contain considerable natural resources that can support economic development through large-scale private sector investment. A myriad of development opportunities exist in the region that could realise significant economic potential. These are discussed in more detail in following sections. However, we believe that Government has an important role to play in complementing private sector investment through facilitation, including activities that address many of the high-risk knowledge gaps that impede the flow of private sector funds to drive project development.

The Lockyer, Darling Downs and surrounding region is characterised by the depth of opportunity for economic development and the magnitude of constraints on this development. In some instances, the opportunity and constraints are intertwined by complex internal and external forces, most notably with respect to water availability, access to markets, approvals, project lead-time to achieve a positive cash flow and downstream impacts of irrigation development e.g. water quality.

Stimulation of private sector investment in a manner that addresses constraints on the regional economy by creating significant agricultural related jobs growth is a key driver in advancing this project as this in turn will provide a catalyst for further economic development opportunities and diversity whilst enhancing community resilience.

3.3 Recycled water supply

QFF has successfully secured significant funding under the NWIDF to undertake a feasibility study into utilising recycled water from SEQ sources to improve water supply reliabilities and support the expansion of irrigated agriculture and processing related opportunities in the region (and including the resource sector and potential pumped hydro related opportunities).

Options associated with the redirecting of treated wastewater from SEQ (and outfalls to Moreton Bay) to support irrigation production have been previously explored and culminated in the preparation of a business case (Ernst and Young, 2003). Since this time, additional potential supply options have emerged, including the WCRWS.

3.3.1 Western Corridor Recycled Water Scheme

Options are to include potential utilisation of the WCRWS. The WCRWS was constructed between 2006 and 2010 to produce purified recycled water (PRW) suitable for indirect potable consumption, primarily through release to Wivenhoe Dam, which is the largest storage in the region's raw water supply system.

The total nominal capacity of the WCRWS is 232 ML/day, though the current transfer capacity is 180 ML/d.

Advanced Water Treatment Plants (AWTPs) are located at Luggage Point, Gibson Island and Bundamba and use source water from six sewage treatment plants (STPs) (Luggage Point, Gibson Island, Oxley, Wacol, Goodna and Bundamba), all owned by QUU. The capacity of the AWTPs was based on wastewater flow data from approximately March 2006. As the millennium drought progressed, water consumption and wastewater generation rates declined by up to 40%; these rates remain below pre-drought rates.

To date, the WCRWS has not delivered PRW for indirect potable reuse, however, under the Water Security Program (Version 2) (Seqwater, 2017a) released by Seqwater in March 2017, the recommissioning process for the WCRWS will be commenced when key SEQ bulk water supplies reach 60%, with the scheme commencing operation once supplies drop to approximately 40%.

Access to PRW has the potential to unlock irrigated, agriculture-led development opportunities in the Lockyer Valley, Darling Downs and surrounding regions whilst providing downstream positive environmental outcomes (including potentially to the Murray Darling Basin).

3.3.2 Sourcing recycled water from AWTPs and STPs

The quantity and quality of recycled water produced from each of the STPs and AWTPs was considered in advancing the options identification process which is discussed in detail in Section 5.3. Although the AWTPs supply water of the highest quality and consistency (i.e. potable water quality), the operation of the plants is scalable. There are three AWTPs and multiple process trains throughout the plants that can be added or removed (with varying degrees of complexity and cost implications) to meet demand requirements and reduce overall operational costs. There is also potential, with careful consideration, to bypass certain process streams within the plants to produce water of varying quality depending on the target parameters, or alternative operational modes such as lower PRW production rates allowing reduced AWTP recovery and unit production operating costs. The location of potential sources of recycled water are shown in Figure 3-1 below.

Figure 3-1 Recycled water source locations (Sewage Treatment Plants) around Moreton Bay

3.4 Review of the strategic business case

The NuWater business case (Ernst and Young, 2003) was reviewed as part of the current project in preparing this Preliminary Business Case. Whilst many of the fundamentals that underpinned the 2003 business case remain, a number have also changed. For example, key factors that represent significant change since 2003, include but are not limited to:

- Brisbane and surrounding satellite cities' continued urban growth
- Increased controls and requirements for the disposal of treated wastewater into the Brisbane River system and Moreton Bay
- Significant treatment infrastructure investment at STPs by QUU (and previous organisations) to improve nutrient abatement reflective of increased environmental regulation
- Construction of the WCRWS
- Variations in the cost of energy
- Improved pipeline laying technology and capacity for reduced costs
- Potential opportunity to include a hydro-electric component to offset energy costs
- The Toowoomba Second Range Crossing project could provide an alternative and cheaper route to the Darling Downs
- The adoption of the Murray-Darling Basin Plan
- The review of a number of Water Plans (Refer to Sections 3.4.1 and 3.4.2)
- The release of the Queensland Bulk Water Opportunities Statement
- Increased demand for intensive horticulture and animal industries on the Darling Downs
- The construction of the Toowoomba Wellcamp Airport
- Resource industry development on the Darling Downs.

3.4.1 Regulatory change in the Lockyer Valley

Together, the Water Plan (Moreton) 2007 (Moreton WP) and Moreton Resource Operations Plan (Moreton ROP) provide the strategic and operational framework for sustainable management of water resources in the Moreton plan area. Water resources in the Moreton plan area comprise three large water storages: the Somerset, Wivenhoe and North Pine Dams, and six water supply schemes that supply water for irrigation and urban purposes. Unsupplemented water and overland flow are also managed under the Moreton WP, while groundwater is also extensively managed within the plan area through the regulation of groundwater take in three defined groundwater management areas.[3]

The Queensland Government released a Statement of Proposals to amend the Water Resource Plan 2007 and Moreton Resource Operations Plan 2009 in October 2015 (as prescribed under Section 39 of the Water Act 2000) with the stated intention of improving the water allocation and management arrangements in the Central Lockyer Valley Water Supply Scheme (WSS). This is the only remaining water supply scheme in the Moreton plan area still managed under interim arrangements. The proposed amendment are intended to result in the implementation of stronger, more efficient and more flexible water management arrangements that better meet the

[3] *Statement of Proposals to amend the Water Resource (Moreton) Plan 2007 and Moreton Resource Operations Plan 200*9, Queensland Government (DNRM), October 2015 P2

community's needs and support sustainable agricultural development in the Central Lockyer Valley. Amongst other things, this process will finalise the conversion of water entitlements in the Central Lockyer Valley WSS (to address Queensland Competition Authority recommendations). These are currently specified in one of three ways i.e.:

- Surface water interim water allocations that describe an area that can be irrigated (hectares)
- Groundwater licences that state land parcels that may be irrigated (expressed as Lot on Plan)
- An entitlement volume for those supplied by the Morton Vale Pipeline.
- The Statement of Proposals outlines the scope of proposed amendments and identifies the key issues in relation to the matters being considered for amendment, which include:
- Converting all water entitlements supplemented by the operation of the Central Lockyer Valley WSS to tradeable, volumetric water allocations. This will create consistent water entitlement specifications across the scheme as well as providing water users with the option for water trading.
- Define water allocation security objectives for both groundwater and surface water in the Central Lockyer Valley WSS to ensure allocation holders are protected when changes are considered to the scheme's management arrangements.

Lockyer Valley irrigators' have expressed concern as to retaining access to what has historically been accessed at certain times as a result of the proposed amendments. However, the results of the Plan amendment process is not likely to be finalised until the first half of 2018.

Central Lockyer Valley WSS

The Central Lockyer Valley WSS was established in the 1980's and comprises two off-stream storages (Lake Clarendon and Bill Gunn Dam) and nine recharge weirs that together function as infrastructure to support irrigation in the Central Lockyer Valley. The two storages are filled by diverting water from nearby creeks during significant flow events. The scheme supplies water for the Morton Vale Pipeline, recharges groundwater areas adjacent to Lockyer and Laidley creeks, and supplies downstream surface water entitlements. Seqwater own and operate the scheme and manage the infrastructure according to the rules and requirements of an Interim Resource Operations Licence (IROL).

The water supply scheme supplies approximately 315 water entitlements, comprising 115 interim water allocations to take surface water, 150 licences to take groundwater, and 50 landowners on the Morton Vale pipeline (supplied under water supply agreements with Seqwater).

Groundwater entitlement holders in Implementation Area 1 outside the supplemented area are regarded as unsupplemented and are managed by the department (refer to Figure 3-2)[4].

[4] *Statement of Proposals to amend the Water Resource (Moreton) Plan 2007 and Moreton Resource Operations Plan 200*9, Queensland Government (DNRM), October 2015 P3

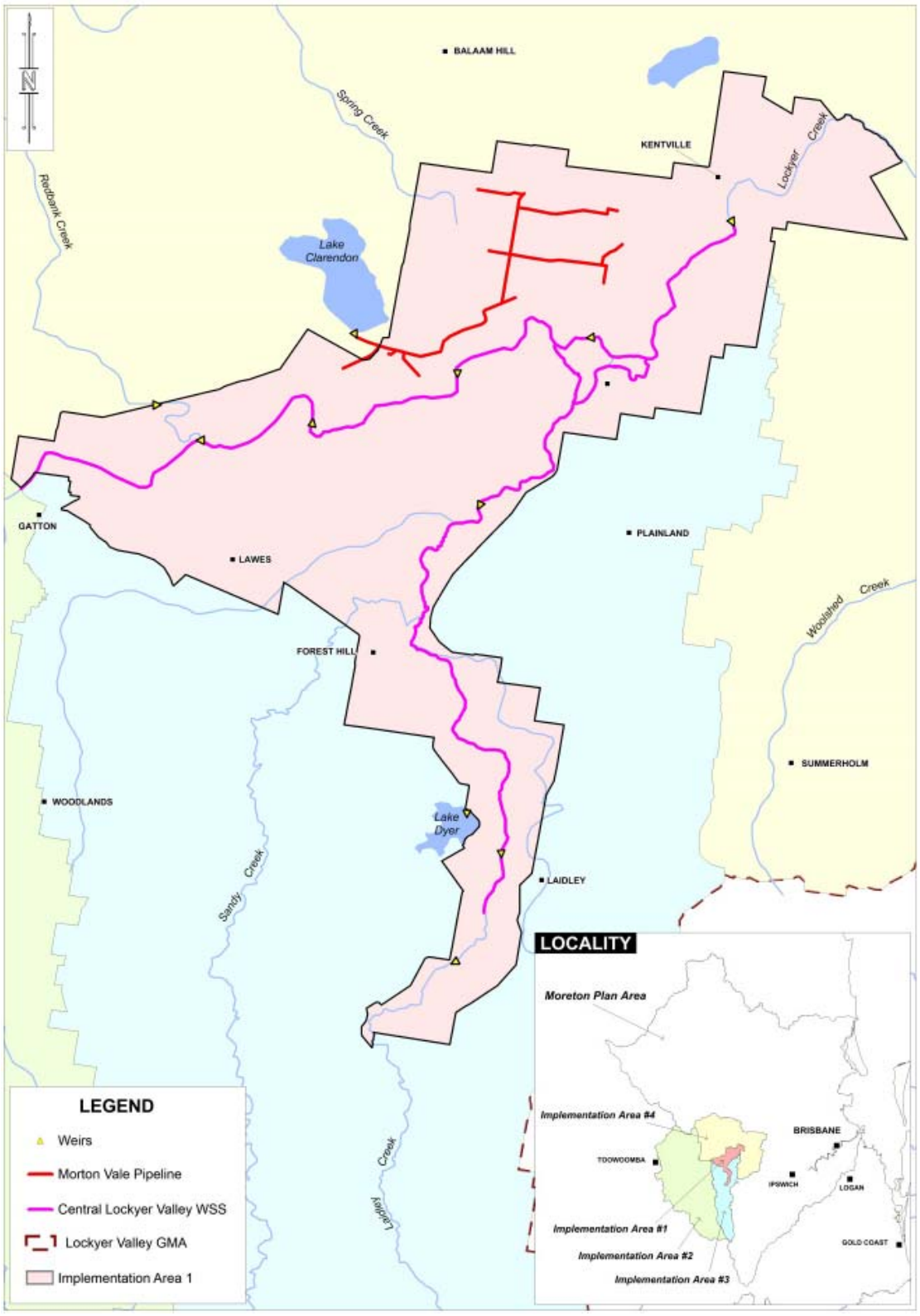


Figure 3-2 Central Lockyer Valley water supply scheme[5]

Identified irrigation water demand in the Central Lockyer Valley WSS

Irrigator surveys and meetings undertaken as part of the NuWater Project have suggested that there is extremely limited additional irrigation water demand as existing supplies largely meet needs. In the event that amending the Water Plan results in reductions to historical surface and

[5] *Statement of Proposals to amend the Water Resource (Moreton) Plan 2007 and Moreton Resource Operations Plan 2009*, Queensland Government (DNRM), October 2015 P4

groundwater access then demand is likely to reflect the commensurate reduction. Unfortunately, the timeline for delivery of the NuWater Feasibility Study and finalising amendments of the Water Plan are poorly aligned in achieving a more definitive irrigation water demand projection for the Central Lockyer WSS area. However, it is conceivable that water supplied through the NuWater project could largely offset any reduction in current groundwater supplies to sustainable limits. Irrigation water demand and aspects associated with potential pricing of additional supplies are further discussed in Appendix C (Volume 2).

3.4.2 Regulatory Change associated with the Condamine Alluvium Aquifer

The Murray–Darling Basin Plan requires governments to manage groundwater in the Alluvium at a lower, more sustainable rate, to ensure supply is available to all users now and into the future. The Australian and Queensland governments are considering a proposal from industry representatives on how to reduce water use.

Evidence shows that consumptive water use must be reduced to preserve the resource, storage volume, water levels and quality.

The Murray–Darling Basin Plan sets out how much water needs to be 'recovered'. The Basin Plan requires that 40.5 GL of groundwater licences be recovered in the Alluvium by 30 June 2019[6]. Recovering this water will bring groundwater use within the Alluvium within its Sustainable Diversion Limit (or 'SDL').

Progress has been slow to date. Since 2014, the Australian Government has purchased just 3.5 GL of groundwater licences through open tenders. A further 37 GL is needed (i.e. approximately 50% of the current groundwater allocation).

Industry Representatives and governments are working together to find the best way to protect the Alluvium's highly valuable and productive groundwater.

The reduction in water allocations are perceived by some as a threat whereas it also presents an opportunity with potential compensation payments made by the Australian Government being a potential source of funding to assist bring offsetting water to the region via the NuWater project.

It is anticipated that a preferred approach to recover the necessary water allocation will be initiated over the next few months.

3.4.3 Queensland Bulk Water Opportunities Statement

The Queensland Bulk Water Opportunities Statement (QBWOS) provides a framework through which the Queensland Government can support and contribute to sustainable regional economic development through better use of existing bulk water infrastructure and investment in new infrastructure. The QBWOS has four key objectives:

1. Safety and reliability of dams and urban water supplies
2. Use existing water resources more efficiently
3. Support infrastructure development that provides a commercial return to bulk water providers
4. Consider projects that will provide regional economic benefit[7].

The NuWater Project clearly has a close alignment with objectives 2 and 4 identified above.

[6] https://www.mdba.gov.au/report/basin-plan-annual-report-2015-16/working-together/recovering-water (accessed 4/10/2017)
[7] *Queensland Bulk Water Opportunities Statement, Queensland Government (DEWS)*, July 2017, P3

3.4.4 Investment logic map

A workshop was held with QFF and NPMC members to review and document the fundamentals of the project. The outcomes of this workshop are shown in the Investment Logic Map below.

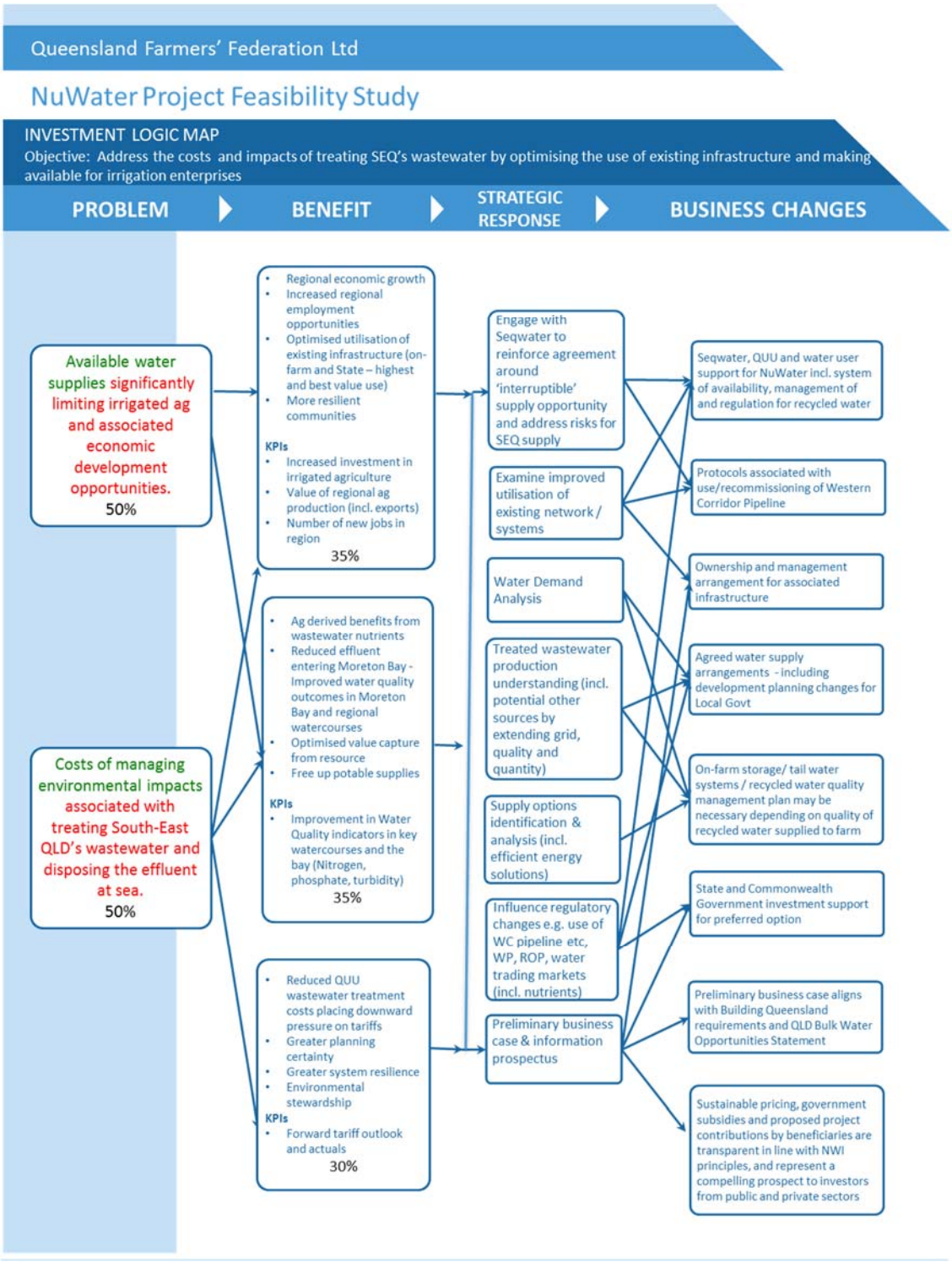


Figure 3-3 NuWater investment logic map

3.5 Supporting investigations

3.5.1 Seqwater

Water Security Planning

The Western Corridor Recycled Water Scheme, including Advanced Water Treatment Plants, pump stations, pipelines, storages and associated infrastructure, was established to supplement traditional surface water supplies in the event of bulk water shortages in South East Queensland.

Water for Life: South East Queensland's Water Security Program[8] outlines the drought response triggers and planned arrangements for operation of the WCRWS as part of its overall water security planning. Water security planning is a dynamic and ongoing responsibility and Seqwater has commenced the preparation the next version of Program (Version 3), which includes options to optimally improve water security, which will include additional demand management strategies, different operational strategies and supply options.

Each of the options considered maintain the core function of the WCRWS in delivering PRW to Wivenhoe Dam when required as part of the overall approach to provide adequate water security for South East Queensland. Accordingly, when required for use as part of the potable water supply system, irrigation supply would be "interrupted" until flow from WCRWS is no longer needed or optimal to meet water security needs.

Seqwater has provided information through the course of this study relating to the current approach for recommissioning the WCRWS along with long term forecast periods of usage based on a range of climatic scenarios to enable estimation of the potential interruptibility of the system. This has enabled the Study to include an estimate of the frequency and duration of periods when irrigation supply is unavailable.

It is noted that these figures are forecast estimates only and will be subject to actual bulk water supply variations and climatic conditions, changes to Seqwater planning and operations and other externalities.

Western Corridor Recycled Water Scheme

Seqwater has a number of studies currently underway at present to provide guidance on the immediate and long term actions relating to the WCRWS. These include the following studies/reports:

- WCRWS Source Water and Demand Assessment
- WCRWS Recommissioning Report
- WCRWS Long Term Planning Report.

Seqwater has provided updates on these investigations as far as known, however these studies are continuing at present. Outcomes from the investigations including the plans for WCRWS usage will be taken into account as part of future NuWater Project phases.

[8] *Water for life, South East Queensland's Water Security Program, 2015-20145*, Seqwater July 2015

3.5.2 Queensland Urban Utilities

Offsite Nutrient Reduction Projects

QUU has implemented a number of projects in its efforts to improve South East Queensland's waterways, including the Beaudesert Nutrient Offsets Project and Laidley Nutrient Offsets Project. The Beaudesert Nutrient Offsets Project,[9] delivered in 2014, involved stabilising and revegetating 500m of severely eroded riverbank to prevent an estimated 5 tonnes of total nitrogen (TN) and 5 tonnes of sediment from entering the Logan River annually. By stabilising sediment loads in the river, the infrastructure project was able to offset impacts has avoided the need for an $8 million upgrade of the Beaudesert STP.

Similarly the Laidley Nutrient Offsets Project[10] involved rehabilitating over 2km of eroded riverbanks along Laidley Creek with more than 20,000 native trees and grasses and six structures to stabilise the waterway. The anticipated outcome from the works is to prevent 11 tonnes of total nitrogen (TN) and 22 tonnes of total phosphorus (TP) from entering the waterway each year due to erosion. The project avoids the need for an upgrade to Laidley STP.

These Offsite Nutrient Reduction Projects used streambank restoration best management practices (bank erosion prevention only) to generate nutrient pollution credits that were attached to a STP environmental authority to provide a compliance buffer during years when recycled water demand is low (and releases to waterways increase).

These projects established an economic mechanism for quantifying nutrient offset and benefits arising from nutrient reduction initiatives, as well as demonstrating the Department of Environment and Heritage Projection (DEHP) implementation framework and policy for applying environmental offsets (obtaining nutrient pollution credits) to licenced activities.

Bubble Licence for STPs

The operation of STPs with the Brisbane River and Moreton Bay as the receiving environment are part of QUU's "bubble licence", which is an Environmental Authority (EA) to undertake environmentally relevant activities (sewage treatment) with an aggregate discharge limit across the relevant STPs. The nutrient bubble licence condition in the EA sets a single aggregated TN and TP annual mass load for the nine (9) STPs, with local waterway toxicity impacts caused by STP discharges (if any exist) to be addressed within a reasonable investment timeframe.

To date, QUU has not progressed any Offsite Nutrient Reduction Actions (ONRA) within the bubble licence. The current focus is internally trading nutrient pollutant credits between the STPs using traditional STP nutrient abatement technologies to achieve best management practice (BMP) across all STPs. The bubble license master plan is currently being developed to determine if and when ONRAs are required and could cost-effectively replace a traditional upgrade.

Utility of the Future

QUU recognises its purpose to be to "enrich quality of life", with a key focus area in the future to transition to a position of environmental leadership.[11] This is emphasised by a greater emphasis on "green infrastructure" projects which are cost-effective, resilient and provide multiple community benefits.

[9] https://www.urbanutilities.com.au/newsroom/articles/f/2/5/0/f/queensland%20urban%20utilities%20wins%20healthy%20waterways%20awards (accessed 26/11/17)
[10] https://www.urbanutilities.com.au/newsroom/articles/b/8/4/c/0/landmark%20project%20improving%20water%20quality%20throughout%20the%20south%20east (accessed 26/11/17)
[11] Enriching Quality of Life, Queensland Urban Utilities Annual Report 2016/17 (QUU, 2017).

3.5.3 Lockyer Valley Regional Council – Pre-feasibility study – Water for agriculture productivity and sustainability (NWIDF)

Lockyer Valley Regional Council (LVRC) was successful in obtaining a grant through the National Water Infrastructure Development Fund (NWIDF) to identify supply options for securing water for the region for further consideration for later full feasibility studies.

The study aims "to identify a long list of potential water supply options and screen these options against criteria including availability, reliability, costs to supply (fixed and variable), environmental impacts, social impacts, regulatory constraints to generate a short list of options that will be progressed to the full feasibility study."[12]

An agreement to share information across this Study and the LVRC Pre-feasibility study to enable consideration of options resolving the common issue of supplying additional irrigation water demand in Lockyer Valley agricultural regions.

[12] Lockyer Valley Regional Council, Draft options development report, Pre-feasibility study – Water for agriculture productivity and sustainability (Cardno, 19 May 2017), P1.

4. Service needs

There are two key drivers of the NuWater project – diverting wastewater effluent and thus reducing the quantity of nutrients discharged to SEQ waterways and Moreton Bay from STPs operated by SEQ service providers and deriving economic value for the beneficial reuse of recycled wastewater for agricultural and industrial production in the Lockyer Valley and on the Darling Downs.

Water quality levels and the environmental condition of SEQ waterways and Moreton Bay are constantly under pressure from sediment and nutrient loads. This has an adverse impact on both the use and non-use values derived from these resources, in particular Moreton Bay. It is expected that, with increasing population and urban development in SEQ, nutrient levels, and thus the associated adverse consequences, in waterways and Moreton Bay will continue to increase in the future.

These increasing nutrient loads are, in part, attributable to the discharge of wastewater effluent (and associated nutrient content) into SEQ waterways.[13] The project aims to address the need to reduce the quantity of nutrients being discharged into SEQ waterways and Moreton Bay by diverting the wastewater effluent produced at relevant STPs for beneficial re-use in the Lockyer Valley and on the Darling Downs.

In addition to addressing this need, there is also an opportunity to transport the recycled wastewater from SEQ service providers' STPs to the Lockyer Valley and/or the Darling Downs for beneficial re-use, including agricultural and industrial production. The key non-urban water uses in these regions is for irrigated crop production (vegetable crops in the Lockyer Valley and broadacre crops on the Darling Downs). There is the opportunity for recycled wastewater to generate a significant increase in the value of agricultural production in these regions, in addition to the positive flow-on impacts (including employment).

The Problem Statement for the project identifies the need for additional water supply in the Lockyer Valley and Darling Downs to support agricultural and industrial production growth. Representatives from established agricultural areas in both areas were involved in the options identification workshop and assisted with clarifying the extent and specifics of demand that may be serviced by this new recycled water product.

4.1 Current state

4.1.1 Previous reports

In 2003, a business case was completed for the project. A decision by the Queensland Government in the mid-2000's to reserve treated wastewater for potable (or indirect potable) use, and the subsequent construction of the $2.4 billion WCRWS, resulted in the NuWater project not being subject to further assessment.

The 2003 business case was conducted on the following project:

- A network of wastewater collection points in and around the greater Brisbane region that would direct and transport wastewater from Luggage Point, Gibson Island, Oxley Creek and Wynnum wastewater treatment plants to a water reclamation plant at the West Bank WTP site at Mt Crosby for treatment and storage
- A bulk water pipeline that would transport treated wastewater from Mt Crosby west to the Lockyer Valley and Darling Downs

[13] Noting the range of point and non-point sources that contribute to nutrient loads in SEQ waterways.

- A wastewater reticulation and distribution network in and around the Lockyer Valley and Darling Downs for direct distribution to growers and other customers.

The business case identified two primary benefits associated with the project:

- The provision of an increased reliability water source to agricultural producers
- The diversion of effluent from discharge into the waterways and bays in and around SEQ to a more economically efficient and ecologically responsible use.

The economic benefits attributed to the supply of additional water to agricultural producers included the following based on a delivery pipeline capacity of between 85,000 to 100,000 ML/annum:

- Increased operational efficiency and production for growers resulting from access to a highly secure water supply
- Increased regional economic activity by at least $195 million per annum (based on a multiplier of 3.1 and an estimated increase in the long run gross value of farm production of approximately $63 million per annum).

As assessment conducted by Psi-Delta found that the project would result in an increase in agricultural production in the Lockyer Valley of $17.33 million, with water to be applied to vegetable crops, lucerne, tomatoes, fruits and nuts, pumpkins, beans, melons, sweet corn, and pasture for grazing.

Increased agricultural production on the Darling Downs was estimated at the time to be $45.67 million per annum, with water to be primarily applied to cotton, in addition to maize and other cereal crops. An economic multiplier of 3.1 was applied to the combined total value resulting in a total estimate for the increase in regional economic activity as a result of the project of $195 million.

Whilst the 2003 business case and the estimates derived for the increase in agricultural production resulting from the project provide an indication as to the potential economic benefits achievable from the reuse of recycled wastewater for agricultural production in the Lockyer Valley and on the Darling Downs, the demand assessment underpinning the benefit estimates are unlikely to be sufficiently robust to satisfy the requirements under Building Queensland's Business Case Development Framework or Preliminary Business Case Guidelines.

Satisfying the requirements set out in these guidelines requires a robust and comprehensive consideration of project need. In this case, the economic value of the reuse of recycled wastewater for agricultural production is one of two key drivers of the NuWater project. This study satisfies this requirement by presenting the outcomes of a comprehensive assessment of agricultural water demand relevant to the project.

4.1.2 Water supply-demand balance

As part of the water demand assessment, a review was undertaken of the water supply-demand balance in the region. The key outcomes from this assessment were as follows:

- Water use in both the Lockyer Valley and on the Darling Downs is dominated by agricultural production, in particular irrigated crop production. In the Lockyer Valley, industrial water use is limited predominantly to agricultural support activities and is supplied by reticulated networks, whilst on the Darling Downs, coal mines and electricity generators have established water supply arrangements. In terms of future industrial water demand, the future 'make good' requirements of CSG producers on the Darling Downs are the most likely source of demand
- In terms of agricultural water use in the Lockyer Valley:

  - Whilst it is difficult to determine total water use for agricultural production in the Lockyer Valley, recent estimates of around 60,000 ML per annum have been generated, with around 44,000 ML (73 percent) sourced from unregulated (and mostly unmetered) groundwater resources (the remainder being sourced from supplemented surface water resources that have low levels of reliability)
  - There is uncertainty over the long-term sustainability of current groundwater use in the region and the management arrangements that are to apply to these resources, with the Moreton Water Plan currently under review. It is possible that as a result of this review, groundwater use in the Lockyer Valley will become subject to regulation, with users required to comply with volumetric entitlements that constrain usage at below current levels
- In terms of agricultural water use on the Darling Downs:
  - As in the Lockyer Valley, water for agricultural production on the Darling Downs is primarily sourced from groundwater resources, with supplementary supply accessed from surface water supplies. There is also considerable reliance on on-farm storage of water, which provides producers significant flexibility in managing water supplies. In 2015/16, water use by agricultural businesses in the Darling Downs-Maranoa region was estimated at around 487,000 ML (noting that these figures will be greater than those for the region directly relevant for this demand assessment). It is estimated that the annual average diversion of water by irrigators in the area east of Chinchilla is in the order of 100,000 ML[14]
  - Insufficient access to water supplies is a key constraint on the expansion of production for several crops on the Darling Downs. The significant on-farm storage capacity on the central Darling Downs, estimated at around 300,000 ML (within the Condamine Catchment upstream of Chinchilla), provides an indication as to the potential expansion of irrigation water use in the region, i.e. water reforms in the Murray Darling Basin and access to groundwater resources has resulted in reduced access to water for irrigation use resulting in significant existing over capacity with regard to on-farm water storage
  - Water use for intensive animal production is small relative to the volume of water used for irrigated crop production.

4.1.3 Nutrient loads in Moreton Bay

The release of nitrogen and phosphorus into SEQ waterways and Moreton Bay results in a reduction in water quality levels and a deterioration in the environmental condition of waterways and the Bay. This adversely impacts on the health and resilience of plant and animal species, the benefit derived from commercial fishers and recreational users, and human health. In particular, high nitrogen levels can result in harmful algal blooms in Moreton Bay.

Water quality levels in Moreton Bay have deteriorated significantly in recent years, largely due to increased nutrient levels.[15] Water quality levels and the environmental condition of SEQ waterways and Moreton Bay are expected to continue to decline due to further increases in the population of SEQ and increasing pressure from urban development and intensive land uses. As such, without intervention, the economic cost imposed by increasing nutrient loads on SEQ waterways and Moreton Bay is expected to increase.

The wastewater effluent discharged from a number of STPs contains nutrients that are currently contributing to the nutrient loads of SEQ waterways and Moreton Bay. The following

[14] Consultation with growers,
[15] EHMP (2009). Report Card 2009 for the waterways and catchments of SEQ. Ecosystem Health Monitoring Program, South East Queensland Healthy Waterways Partnership.

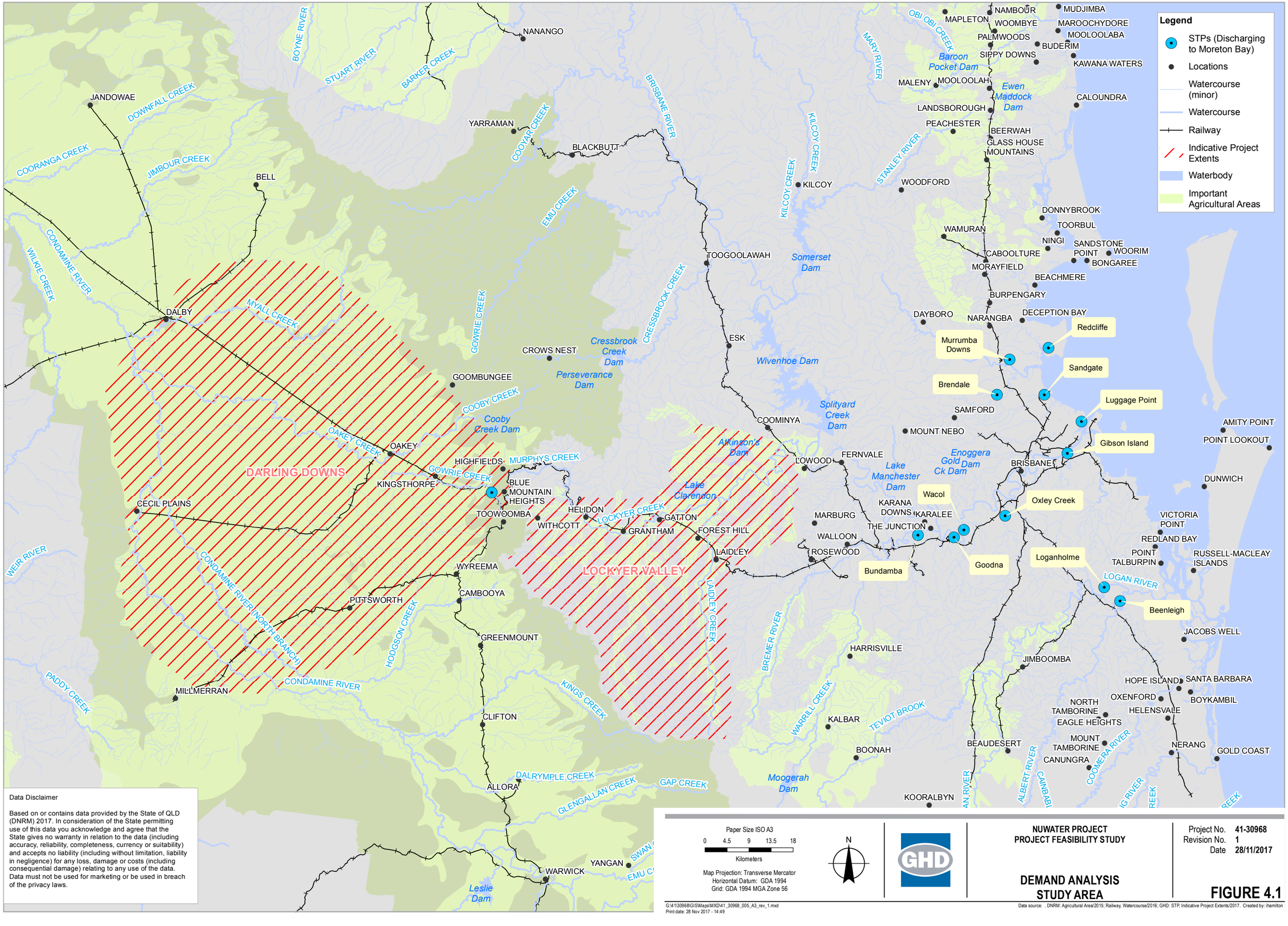
table sets out, for each STP relevant for the shortlisted options, the volume of wastewater effluent to be sourced from the respective STPs and the nitrogen and phosphorus content of effluent at each plant.

Table 4-1 Wastewater effluent and nutrient content by STP

STPs	ML wastewater effluent sourced per day				kg per ML	
	Option A	Option B	Option C	Option D	Nitrogen	Phosphorus
Luggage Point	126	120	108	101	6.2	4.7
Gibson Island	40	40	40	40	2.5	2.8
Oxley	47	47	51	51	3.8	1.9
Wacol	5	5	5	5	3.0	3.0
Goodna	13	13	13	13	2.5	0.9
Bundamba	15	15	15	15	4.1	0.6
Redcliffe	19	-	-	-	2.0	1.5
Sandgate	18	-	-	-	2.0	1.5
TOTALS	**283**	**240**	**232**	**225**		

4.1.4 Geographic and demographic reach

Through consultation with stakeholders, including relevant representatives for irrigation industry entities for the Darling Downs and Lockyer Valley areas, the study extent was defined within which the demand assessment would be targeted. The study extent is outlined in Figure 4-1. It is noted that demand survey responses were received from areas outside the identified study area and have been included in relevant reporting (refer Appendix C (Volume 2)).



Data Disclaimer

Based on or contains data provided by the State of QLD (DNRM) 2017. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

Paper Size ISO A3

0 4.5 9 13.5 18

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

NUWATER PROJECT
PROJECT FEASIBILITY STUDY

DEMAND ANALYSIS STUDY AREA

Project No. **41-30968**
Revision No. **1**
Date **28/11/2017**

FIGURE 4.1

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Print date: 28 Nov 2017 - 14:49

Data source: . DNRM: Agricultural Area/2015; Railway, Watercourse/2016; GHD: STP, Indicative Project Extents/2017. Created by: ihamilton

4.2 Stakeholders

A detailed stakeholder consultation process was undertaken as part of the demand assessment. The stakeholder consulted with as part of this assessment included:

- Peak industry groups and irrigator representatives, including Central Downs Irrigators Limited (CDIL), Gowrie-Oakey Creek Irrigators, Cotton Australia, AgForce, Lockyer Valley Growers, Queensland Chicken Growers Association, Queensland Dairyfarmers' Organisation, and the Toowoomba and Surat Basin Enterprise; and
- Crop producers in both the Lockyer Valley and the Darling Downs, through both open grower consultation days in Gatton, Cecil Plains and Dalby, and through a survey distributed to growers through peak industry groups and irrigator representatives.

More detail is provided on the stakeholder consultation undertaken as part of the demand assessment in Appendix C (Volume 2).

The Project's stakeholders have been identified, consulted and their issues documented. The Project's consultation process commenced with the development of the 2003 Business Case.

Since the commissioning of feasibility studies to support the preliminary business case, ongoing stakeholder communication has taken place regarding the Project, the role of QFF and the expected community benefits.

4.2.1 Stakeholders and their issues

The following Table 4-2 identifies key stakeholders and a high-level summary of the expectations of each stakeholder.

Table 4-2 High level stakeholder mapping

(a) Who are the key stakeholders?	(b) What are their expectation/interest/concern with the project?	(c) How/when they should be engaged /informed?
Federal government	• Money well spent • Have a good project that they can sell • Looking for genuine development opportunities • Proper consideration of risks • Innovation	• Formally through the state • Formal consultation on drafts
State government	• Job creation (social benefit/ML) • Risks covered wrt water supply and sewage • Minimal financial exposure • Sceptical about the project (departments) • Supportive of project (some Ministers)	• Formal reporting through DEWS • Formal consultation on drafts
Local government	• Social-economic impacts • Jobs growth • Environmental improvements (i.e. to the bay for Brisbane) • Reducing wastage of resource • Regional collaboration	• Keep them informed • Engage with the Council of Mayors through the TSBE • TRC, LVRC
QUU	• How the project will feed into the Strategic Plan • Impact on future effluent management • Reduce bills or demonstrate and ROI for the community by using the water and by using the asset	• On the Steering Group

(a) Who are the key stakeholders?	(b) What are their expectation/interest/concern with the project?	(c) How/when they should be engaged /informed?
	• Sustainability of supply	
Lockyer Valley growers	• Supplementary water supply • Volume, quality and reliability of water • Location of distribution systems • Cost of water (maintenance/operations) • Life of pipeline/channel in the scheme • Look at options for delivery (not just pipelines) • As per Lockyer except lower quality expectation, higher cost likely, lower reliability can be handled	• Information fed (two-ways) through local groups (Lockyer Valley Users Forum)
Darling Downs growers	• As per Lockyer except lower quality expectation, higher cost likely, lower reliability can be handled	• Information fed (two-ways) through local groups (Central Downs Irrigators Ltd, Agforce and Cotton Australia, QFF (and member associations), Gowrie-Oakey Creek Irrigators
DNRM (now DNRME)	• Regulatory impacts are managed • Lockyer ROP implications managed (benefitted water)	• Input to the project
DEWS (now DNRME)	• As the relevant State government agency administering the NWIDF • Involved in as the responsible for government agency for Seqwater's operations.	• Formal reporting relationship
Healthy Waterways (now Healthy Land and Water)	• Nutrient offsets • Benefits to waterways	• Input to the project

(a) Who are the key stakeholders?	(b) What are their expectation/interest/concern with the project?	(c) How/when they should be engaged /informed?
DEHP (now DES)	• Improved effluent • Enforcing QUU's bubble licence and Environmental Authority obligations • Aspire to achieving zero net nutrients in the long terms	• Invite input on drafts
Seqwater	• Strategic Plan re managing the water supply security for SEQ • Western Corridor Plan and management of statutory issues • Management of effluent quality inputting to their plants • Lead times to start up plant (e.g. from Agricultural to potable supply	• Invite on to the Steering Group
QFF	• Delivery of project (as owner) • Options to progress agriculture across all industries	• Through the Steering Group • As partner to the deed and owner of project
Cotton Australia	• Is the project a goer and worthy of further investment	• Steering Group
Agforce	• Want project to go ahead – investment and development follows water • Long-term sustainable price that is industry neutral • Allow Water to go to where the demand for water is	• Steering Group
TSBE	• Linkage to other developments into the Toowoomba region	• On the Steering Group

(a) Who are the key stakeholders?	(b) What are their expectation/interest/concern with the project?	(c) How/when they should be engaged /informed?
	• Advocacy of jobs, regional development, innovation • Encourage commercial and industrial development • Providing information to its members about the project • Economic benefits (including input from USQ e.g. Steve Raine)	
Resources Sector	• CSG, QGC, Origin, New Hope Mine • Limited overlap with the project • Energy retailers • Technology providers	• Media releases • Via TSBE
Department of State Development	• Limited interest at present • Ripley Valley users (EDQ)	• Invite input on drafts
SunWater	• Water use agreements with some of the customers • Experience in pipelines and water delivery • Commercial	• Media releases
Renewable industries	• Supplier of technologies	• QUU energy strategist
RDA Groups	• Darling Downs • Ipswich and West Moreton	• Through Steering Group Members • Information group briefing

4.2.2 Communication and consultation strategy

A communication and consultation strategy is critical to assist mitigate project delivery risk to both QFF, key stakeholders (e.g. Seqwater) and Government through a highly targeted, communication and consultation campaign, with the focus on face-to-face consultation where appropriate.

The Communications Strategy has been developed to provide a framework for future actions and is also flexible enough to allow for actions to be prioritised as and when necessary.

The Communications Strategy provides for ongoing stakeholder involvement and extensive consultation focused on those who will be directly impacted by the NuWater project, namely landholder/irrigators and SunWater.

Refer to Appendix A (Volume 2) for the detailed Communications and Consultation Strategy adopted by QFF.

4.2.3 Stakeholder management plan

A Stakeholder Management Plan has been developed by QFF and has incorporated several special interest groups into the QFF Stakeholder map included in Table 4-2.

4.3 Benefits sought

The NuWater Project targets three core groups of beneficiaries i.e. landholders, QUU customers and all users of Moreton Bay.

The shortlisted options will result in the following economic benefits:

- The additional economic value from the use of recycled wastewater for irrigated agricultural production, both in the Lockyer Valley and on the Darling Downs
- The avoidance of the cost associated with increased nutrient loads in SEQ waterways and Moreton Bay as a result of the continued discharge of wastewater effluent from STPs in SEQ
- The avoidance of costs associated with the maintenance of WCRWS infrastructure in ‘care and maintenance’ and ‘hot standby’ modes during periods in which the WCRWS is not required for Indirect Potable Reuse (IPR) (noting that these costs would need to be incurred under the base case)
- The environmental benefits associated with increased flows in the Murray Darling Basin
- Increased water security for other water users in the region.

The project will also result in positive wider economic impacts for the regional and State economies as a result of the increased value of production, and associated income and employment, generated by the beneficial reuse of recycled wastewater.

A more detailed description of these benefits is provided in Appendix F (Volume 2).

Critical project dependencies include:

- Securing necessary agreements with Seqwater and relevant parties in terms of identifying potential contribution to the project and consideration of access opportunities and issues associated with utilising the WCRWS
- Proximity of future pump stations to the existing electricity grid and available spare capacity at the relevant substations

The support of the State Government will be critical to advance more detailed feasibility studies

4.4 Potential initiatives

Potential initiatives typically relate to the service needs identified in the Problem Statements in isolation. That is, initiatives identified to maintain the environmental health of Moreton Bay (in through managing impacts of treating South-East Queensland's wastewater) are generally independent of initiatives that address irrigation demand and development in both Lockyer Valley and the Darling Downs high-value agricultural areas. Accordingly, initiatives that address the service need as defined in the Problem Statements have been described separately below.

Potential initiatives that address the discharge of nutrients to Moreton Bay associated with sewage treatment include the following:

- On-site sewerage facilities education and compliance program
- Targeted reductions in nutrient concentration associated with sewage treatment plant discharges, generally under the responsibilities of water utilities.
- Potential off-set activities that target sediment and nutrient removal from other more diffuse sources, such as:
  - Targeted gully and bank stabilisation
  - Soil stabilisation from damage where the hill-slope meets the floodplain
  - Removal of sediment build-up areas in main channels and tributaries through physical means
  - Removal of flood debris in locations where bank erosion is occurring
  - Best management practice grazing and horticultural practices via industry programs
  - Riparian management in tributaries through assistance for landholders and tree planting programs
  - Coordinated fire, weed and pest management to reduce soil exposure and stabilise riparian zones
  - Urban stormwater best management practice initiatives for pollution control associated with surface water discharge in urban catchments, generally under the responsibility of regional and city Councils.

Potential initiatives addressing the development of agricultural and industrial production through increased access to water may include the following:

- New surface water and groundwater sources, through changes to existing resource arrangements, typically requiring changes to Water Plans. This could include changes to existing resource allocations (water security objectives, environmental flow objectives, etc.) or be associated with new infrastructure such as dams, weirs and offstream storages
- Recycled water from sources such as the Western Corridor Recycled Water Scheme or other sewage treatment plants in South East Queensland
- Improved water management practices to do "more with less", which has greater relevance to immature industries
- Sourcing water from industrial sources with excess water management issues, such as coal seam gas and mining.
- Inter-catchment and inter-basin transfers of water sources from other areas.

The above initiatives address the service needs with varying degrees of suitability and viability. Further there is limited ability for many of the initiatives to address the needs of both of the Problem Statements. This suggests that the targeted project scope, aiming to use recycled water from sewage treatment plants discharging to Moreton Bay to supplement irrigation water

sources in Lockyer Valley and Darling Downs, presents the initiative most worthy of more detailed investigation and evaluation.

4.5 Base case

The Base Case assumes that the NuWater project does not proceed and that Seqwater, QUU, QFF and other key stakeholders proceed with a range of existing and proposed initiatives to manage/reduce the nutrient load on Moreton Bay and support agricultural production across the Lockyer and Darling Downs.

Given that water is a key limiting factor on the expansion of agricultural production across the region, it is likely that ongoing on-farm investment in improved irrigation technologies will be the key initiative to optimise the opportunity from existing water supplies. However, the broader production benefits of these types of initiatives may be offset by potential changes to the Moreton and Condamine and Balonne Water Plans as discussed in Sections 3.4.1 and 3.4.2 with potential reductions made in the consumptive use of groundwater translating through to reductions in agricultural production and subsequent flow on impacts to the wider community.

Assessing the economic and financial and commercial impacts of the shortlisted options requires a base case to be defined against which the identified impacts and cashflows are to be assessed. The key characteristics of the base case were defined as follows:

- For the Lockyer Valley, non-urban water use in the region will continue to be dominated by horticultural producers, however the base case with regards to water use will be largely determined by the outcomes of the current water planning process. Either:
  - Current groundwater management arrangements will be maintained and water use practices and volumes for vegetable crop production will remain relatively stable
  - Groundwater use will be significantly reduced as a result of the outcomes of the review of the Moreton Water Plan, resulting in a significant decrease in agricultural production in the region (unless an alternative source of water supply can be secured)
- For the Darling Downs, the continuation of the use of water sourced from groundwater resources and unsupplemented surface water allocations, for the production of broadacre crops, predominantly cotton, wheat and sorghum as well as chickpeas and corn, primarily for supply into export markets
- The continued deterioration in water quality levels and environmental conditions of SEQ waterways and Moreton Bay due to increased nutrient loads, partly due to ongoing increases in the volumes of wastewater effluent discharged from STPs.

See Appendix H (Volume 2) for additional detail on the base case defined for the economic and financial and commercial assessments.

4.6 Ongoing existing initiatives

These initiatives are discussed further below and include:

- As described in Section 3.5.2, QUU is undertaking a range of “green infrastructure” projects which target a net reduction in nutrients entering South East Queensland waterways and Moreton Bay. Further, QUU are investigating offsite nutrient reduction actions (ONRA) environmental initiatives as part of STP planning and operating to achieve the conditions under QUU’s bubble licence
- Lockyer Valley Regional Council is undertaking a pre-feasibility study to investigate options for securing water for the region through its NWIDF grant. This will be the subject of further investigation as part of future study stages

- The Department of Environment and Science provides funding for the Growcom Hort360 Best Management Program for horticulture in South East Queensland. This voluntary industry led program is seeking to reduce nutrient emissions from existing agricultural areas in SEQ, including the Lockyer catchment, to improve on current water quality in these catchments
- Irrigators are continually targeting improved farming practices associated with irrigation application technology, soil and nutrient management, crop and species selection and a range of other aspects of agricultural operations
- The Resilient Rivers Initiative, launched in December 2014, aims to improve the health of SEQ's waterways by delivering a coordinated approach to catchment management.[16] As part of this initiative, a number of relevant Catchment Action Plans have been developed including the Mid Brisbane Catchment Action Plan and Lockyer Catchment Action Plan. Each of the plans:
  - Provides a commitment to enact change based on the "best of our knowledge and understanding" which reflects the values of the local community
  - Identifies specific actions to mitigate risks in the catchment within the context of the Resilient Rivers Initiative
  - Assists the preparation of a package of coordinated and consolidated investments based on agreed prioritised actions[17]
- These plans provide a pathway to identify and prioritise actions to support improved water quality outcomes in catchments discharging to Moreton Bay.

[16] http://seqmayors.qld.gov.au/project/resilient-rivers-initiative/
[17] Mid-Brisbane Catchment Action Plan 2015 – 2018 (Council of Mayors (SEQ), May 2016); Lockyer Catchment Action Plan 2015 – 2018 (Council of Mayors (SEQ), May 2016)

5. Options generation

The objective of the options identification exercise is to identify:

- A water infrastructure solution (distribution and potential distribution) that supports the expansion of irrigated agricultural production across the Lockyer Valley and Darling Downs by beneficially utilising treated wastewater and reducing the nutrient load on Moreton Bay
- A water infrastructure solution that aligns with the Moreton and Condamine and Balonne Water Plans and does not adversely impact other water users (water allocation security objectives) or environment factors
- An infrastructure option that in turn could be supported by a sustainable irrigation water tariff regime
- A water product that is fit for purpose in terms of water quality and reliability and provides adequate certainty for crop planting and management decisions.

5.1 Approach

The approach for generating options revolved around conducting an Options Identification Workshop which involved key stakeholders and project personnel. The workshop was held with the purpose of identifying a broad range of potential options to deliver recycled water from Brisbane to the Lockyer Valley and Darling Downs agricultural areas. Options for consideration were required to address the project's Problem Statement (described in Section 2.4).

A report was prepared detailing the outputs from the Options Identification Workshop, which included the options identification workshop process and outputs, a description of option elements and the envisaged process for options assessment. The Options Identification Workshop Report is included in Appendix B (Volume 2).

5.2 Assumptions

The following assumptions were made in the generation of options:

- No site investigations have been conducted. This study was purely of a desktop nature using the available information and stakeholder inputs
- The size, capacity and suitability of existing infrastructure, including QUU Sewage Treatment Plants (STPs), Seqwater Advanced Water Treatment Plants (AWTPs), the WCRWS, etc. have not been validated by the respective infrastructure owners at this stage of the project. Therefore the production and delivery quantities indicated in this report are indicative only and will be subject to further investigation
- It is assumed that Seqwater's AWTPs can be modified to produce alternative water quality products. This will be the subject of further investigation at future project phases
- The size/scale of water supply (and/or treatment) options will ultimately be tailored to site conditions and a wide range of other factors. These and other aspects may be the subject of further studies
- It has been assumed that Lockyer Valley growers are unlikely to be able to accept low quality (e.g. Class B, C) recycled water due to limitations upon appropriate uses for such application. This has not been formally verified and will be the subject of further investigation and consultation with relevant stakeholders and regulatory bodies
- It has been assumed that release of lower quality water products (e.g. Class B, C) to watercourses is not environmentally acceptable given the substantial increase in waterway

volumes this is likely to represent and other potential environmental impacts. Conversely, it has been assumed that the release of higher quality water products (e.g. PRW, Class A+) to watercourses will be suitable. Both assumptions will be subject to further investigation and consultation with relevant stakeholders and regulatory bodies

- Potential areas able to be served with recycled water have not been defined beyond broad areas at this stage and would be subject to further investigations
- The identification and initial development of options has been restricted to bulk transportation of recycled water only and does not currently include recycled water distribution infrastructure. This will be undertaken subject to the outcomes of the demand analysis process and further assessment of existing water distribution infrastructure (channels, storages, etc.) as part of the options development phase.

5.3 Option elements

5.3.1 Recycled water product alternatives

Appropriate use of recycled water

Attendees at the options identification workshop identified a broad difference in irrigation water quality needs between the Lockyer Valley and the Darling Downs. This appears to be largely driven by market requirements e.g. broad acre crops such as cotton, grains in the Darling Downs versus horticulture crops, etc. in the Lockyer Valley. The degree to which recycled water undergoes further treatment has a broad range of implications for existing infrastructure, potential modifications and ongoing operational costs, and if the WCRWS is part of the solution, the duration the system may be unavailable due to potable water supply requirements for South East Queensland.

There are regulatory requirements applying to the use of recycled water for some crop types, specifically minimally processed food crops. The Queensland Public Health Regulation 2005 provides an indication of 'fit for purpose' uses in addition to providing definition both of the crop types and the technical definition of recycled water classes; refer to Table 5-1.

Table 5-1 Standards for quality of recycled water for irrigating minimally processed food crops[18]

Crop type	Example	Spray	Drip	Flood/ furrow	Sub-surface
Root crops	Onion, carrot	A	A	A	A
Crops with produce grown on or near the ground – skin typically removed	Pumpkin	B	C	C	C
Rockmelon	-	A+	A+	A+	A+
Crops with produce grown on or near the ground – skin typically retained	Tomato, broccoli, cabbage	A+	A	A+	C
Crops with produce grown away from the ground – skin typically removed	Mango, avocado, banana	B	C	C	C
Crops with produce grown away from the ground– skin typically retained	Apple, olive, peach	A+	B	B	C

[18] Adapted from Schedule 3E, Public Health Regulation (Qld) 2005. Refer to Schedule 3D for recycled water class definitions.

Crop type	Example	Spray	Drip	Flood/ furrow	Sub-surface
Crops for produce grown in hydroponic conditions	Lettuce, herb	A+	A+	A+	A+

The Regulation also recognises a lesser standard for irrigation use on other than minimally processed food crops, which may include:

- Irrigation of non-food crops such as cotton
- Irrigation of heavily processed food crops such as cereal crops grown for flour production (e.g. wheat, rice and corn) and crops grown for oil production (e.g. sunflower, canola and flax seed).

A number of other minimally processed food crops are grown on the Darling Downs, including mung beans, feed corn, chickpeas, sunflowers (for uses other than oil production), barley and sorghum. For many of these crops, irrigation is not applied once flowering has commenced, thereby minimising risk of contamination from recycled water. The appropriate level of treatment required for individual applications would be subject to risk assessment relevant to the water quality and confirmation of irrigation practices.

For lesser quality treated water streams, irrigators may be required to produce Customer Site Management Plans. Landholders will generally be required to describe how they will manage the application of recycled water and what measures they have implemented to monitor potential impacts on their property. In the majority of cases, these will be prepared by the supplier of the recycled water in conjunction with the landholder[19].

A further consideration in supplying recycled water from STPs is the concentration of salt retained following the treatment process. Indicative salt concentrations for each of the STPs currently supplying the WCRWS have been included in Table 5-2.

Table 5-2 Salt content of STP effluent

Sewage Treatment Plant	Total Dissolved Solids (mg/L)	Salinity (µS/m)
Luggage Point	1,500	2,340
Gibson Island	1,000	1,560
Oxley Creek, Wacol, Bundamba, Goodna	500	780

It is noted that historical salt concentration records derived from sampling at the STPs, in particular for Luggage Point STP (the largest STP in South East Queensland (SEQ)), have been found to vary considerably, aligned with Brisbane River flushing, tidal and lunar variations and sewerage catchment rainfall.

During the options identification workshop, it was identified that a salt concentration of around 1100-1300 mg/L may be acceptable for some irrigation applications. It was also noted that there was potential to mix supplied water with other water sources within farm operation, which could dilute the concentration of salt prior to application.

There are potential options to treat all or part of water sourced from STPs with higher salt content through treatment processes included in the AWTPs to create a composite water product with a lower salt concentration, which will be considered as part of the study if consultation with irrigators reveals this to be a significant issue requiring a solution.

[19] http://www.recycledwater.com.au/uploads/File/Pasture%20and%20Fodder%20Manual.pdf P5 (Accessed 2/8/17)

Proposed water product qualities

In terms of water product alternatives, three applicable products have been determined that would meet the project objectives, to varying degrees, which also have some specific opportunities and limitations. It is planned to assess the relative merits of each in conjunction with associated infrastructure requirements and costs to deliver each water quality product to relevant demand locations consistent with appropriate use of the water. Table 5-3 provides some commentary around each product and a number of key considerations associated with each.

Table 5-3 Water product alternatives

Water Product	Description	Key considerations
Purified Recycled Water (PRW)	Recycled water produced from Seqwater AWTPs (source water supplied from STPs)	Potential to release to environment (e.g. channels, watercourses) Water quality (potable water standard) suitable for use by all customers Requires further treatment of reject stream to remove nutrients (broadly nutrients continue to be discharged to Moreton Bay if the scheme is commissioned as is) Nutrients (N, P) removed from product water and not available to offset agricultural nutrient demand Limited modifications to existing WCRWS infrastructure Limited rectification works to return WCRWS to IPR water supply
Class A+	Recycled water produced from STPs is treated to Class A+ standard; this nominally could involve some treatment processes in place at AWTPs	Potential to release to environment (e.g. channels, watercourses), although subject to more stringent controls than PRW Water quality suitable for use by almost all customers Potential issues with salt content Potentially significant modifications to existing WCRWS (AWTP) infrastructure Potentially significant rectification works to return WCRWS to IPR water supply
Untreated Effluent (Class B/C)	Recycled water produced from STPs	Potential for significant controls placed on release to environment (e.g. channels, watercourses) Water quality may not be suitable for many uses in the Lockyer Valley Potential issues with salt content Limited modifications to existing WCRWS infrastructure (bypass works only) Potentially significant rectification works to return WCRWS to IPR water supply
Combination of Untreated Effluent (Class B/C) and Class A+ (end of pipe treatment)	Product water treated depending on end use	Potential for significant controls to be placed on release to environment (e.g. channels, watercourses) Water quality suitable for use by all customers Potential requirement for further treatment of reject stream Limited modifications to existing WCRWS infrastructure (bypass works only)

Water Product	Description	Key considerations
		Limited rectification works to return WCRWS to IPR water supply
Wivenhoe water (offset by PRW)	Recycled water produced from Seqwater AWTPs (source water supplied from STPs) used to offset release of Wivenhoe Dam water.	Potential to release to environment (e.g. channels, watercourses) Water quality (dam water) suitable for use by all customers Requires further treatment of reject stream to remove nutrients (broadly nutrients continue to be discharged to Moreton Bay if the scheme is commissioned as is) Elevated nutrients (N, P) not in product water and not available to offset agricultural nutrient demand Limited modifications to existing WCRWS infrastructure Nil rectification works to return WCRWS to IPR water supply

It is understood there will be extended periods when a scheme involving the use of WCRWS assets will be unavailable for irrigation supply as the WCRWS is required to be used to supplement the drinking water supply. The recommissioning process for the WCRWS is commenced when key SEQ bulk water supplies reach 60%, with the scheme commencing operation for indirect potable reuse when recommissioning is complete, which is expected to be at a level of approximately 40%. Key to the assessment of options and determining the viability and commercial attractiveness of options will be understanding the limitations of options in terms of availability and variability, including:

- The time and cost to recommission the WCRWS back to PRW supply if a lower quality product is required
- The predicted frequency and duration of use of PRW to supplement drinking water supply in SEQ
- Whether regulators will accept the use of the WCRWS pipelines to transport water at a quality other than PRW and what limitations that may present. This may include consideration of public perceptions associated with this aspect.

Engagement with Seqwater and relevant regulatory bodies will enhance understanding of these issues and inform the assessment of options.

5.3.2 Recycled water source alternatives

Sewage treatment plants (STPs)

Options need to deliver a reduction of nutrients discharged to Moreton Bay, which can be achieved by taking treated wastewater (effluent) from municipal STPs that would ordinarily be discharging directly into Moreton Bay or waterways connected to Moreton Bay. This does not exclude the use of other recycled water sources to supplement supply volumes, however reducing nutrients from point source discharges is a fundamental requirement of the project (refer to the problem statements in Section 2.4).

Nutrient load point sources associated with STPs that ordinarily discharge to Moreton Bay and relevant to the project include:

- STPs operated by QUU predominantly located in the Brisbane City Council, Ipswich City Council, Lockyer Valley Regional Council and Scenic Rim Regional Council areas
- STPs operated by Unitywater located in Moreton Bay Regional Council area

- STPs operated by Logan City Council
- When the WCRWS is operating, AWTP Reverse Osmosis Concentrate (ROC) from Luggage Point AWTP and Gibson Island AWTP (Bundamba AWTP is further treated to remove nutrients).

With respect to QUU-operated STPs, the following STPs are part of the WCRWS:

- Luggage Point STP
- Gibson Island STP
- Oxley Creek STP
- Wacol STP
- Goodna STP
- Bundamba STP.

As these STPs are already connected to the WCRWS, they present a relatively efficient means to collect and transfer effluent west towards the demand areas of the Lockyer Valley and Darling Downs. These plants also present the potential for blending with other sources including PRW, other surface water sources and groundwater.

In addition to the abovementioned STPs, a number of other plants are part of QUU's "bubble licence", which is an Environmental Authority to undertake environmentally relevant activities (sewage treatment) with an aggregate discharge limit across the relevant STPs. STPs operated by Unitywater, Logan City Council and City of Gold Coast have also been considered as potential supplementary supplies.

A full list of STPs to be considered in the study, along with the approximate effluent produced from each, is included in Table 5-4 below.

Table 5-4 Potential sources of STP effluent that discharge (directly or indirectly) to Moreton Bay

Sewage Treatment Plant	Operating Authority	Average Annual Volume (ML/a)	Daily flow (ML/day)
Luggage Point STP	QUU	45,990	126
Gibson Island STP	QUU	14,600	40
Oxley Creek STP	QUU	17,155	47
Wacol STP	QUU	1,825	5
Goodna STP	QUU	4,745	13
Bundamba STP	QUU	5,475	15
Wynnum STP	QUU	1,095	3
Sandgate STP	QUU	6,570	18
Carole Park STP	QUU	1,278	3.5
Karana Downs STP	QUU	110	0.3
Fairfield STP	QUU	548	1.5
Brendale STP	Unitywater	3,103	8.5
Murrumba Downs STP	Unitywater	7,300	20
Redcliffe STP	Unitywater	6,935	19
Loganholme STP	Logan City Council	16,060	44
Beenleigh STP	Logan City Council	TBC	TBC

The WCRWS Source Water and Demand Assessment (Seqwater, Jacobs 2017) identified Sandgate STP as one of the most promising sources of potential water, with reasonable volume and within reasonable proximity to the WCRWS.

The locations of potential sources of recycled water is provided in Table 5-5.

Table 5-5 Potential sources of recycled water (AWTPs)

Advanced Water Treatment Plant	Operating Authority	Average Annual Volume (ML/a)	Daily flow (ML/day)
Luggage Point AWTP	Seqwater	24,090	66
Gibson Island AWTP	Seqwater	36,500[1]	100[1]
Bundamba AWTP	Seqwater	22,995	63

[1] Membranes were only installed and commissioned to achieve half the nominal 100 ML/d capacity; it must also be noted that effluent source water is currently limited to a maximum of 80 ML/d

It is noted that some of the treatment plants identified have existing recycled water supply agreements already in place (e.g. Fairfield, Wynnum, and Murrumba Downs). Such agreements will be confirmed as the project progresses and any constraints included in the assessment of options.

Advanced water treatment plants (AWTPs)

The AWTPs (part of the WCRWS) are a potential source of recycled water. It is noted that to fully achieve the objectives of the project, it would be necessary to introduce treatment of the reject stream at both Luggage Point AWTP and Gibson Island AWTP to produce a reduction in nutrients discharging to Moreton Bay; Bundamba AWTP already includes such treatment. The maximum production rate for each of the three AWTPs is included in Table 5-5.

The general process design across the three AWTPs relevant to this project involves the following processes, as illustrated in Figure 5-1:

- Coagulation
- Membrane filtration (MF/UF)
- Reverse osmosis
- Advanced oxidation (UV/peroxide)
- Stabilisation
- Residual disinfection.

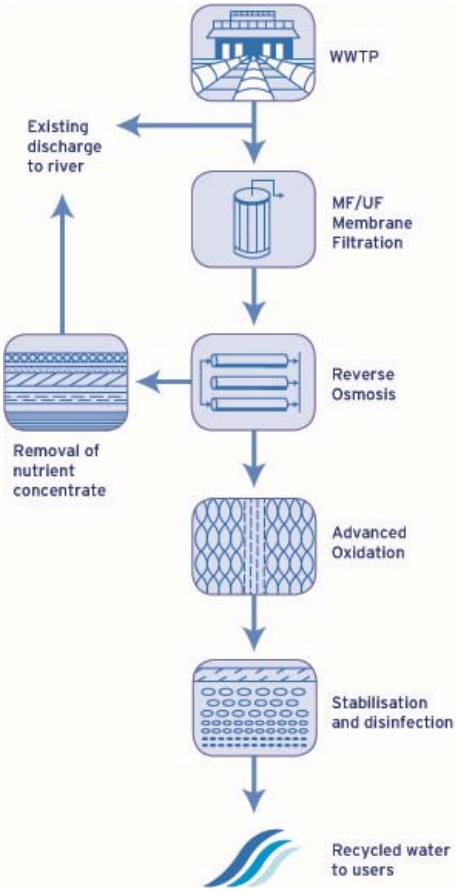

Figure 5-1 AWTP treatment process

It is anticipated that to effect Class A+ level treatment of STP effluent, membrane filtration (MF/UF) and residual disinfection only would be required. The potential to use part of the AWTP process stream requires a thorough understanding of process and issues, e.g. recommissioning; this will be subject to more detailed evaluation as part of the detailed business case.

Other sources

There are a number of other direct and diffuse sources of nutrients that discharge into Moreton Bay, including urban and rural surface water runoff, licenced discharges from industrial and commercial facilities and bank erosion in contributing waterways. To address another of the project Problem Statements, options are to provide an additional water supply to the Lockyer Valley and Darling Downs along with improved associated water security. As such, the project is focused on being able to efficiently capture, treat (if required) and transport water to the subject areas.

Capture of a diffuse source such as stormwater presents the following issues:

- Typically infrastructure-intensive
- Limited impact on reducing nutrient load
- Significant investment required in diversion and storage at constrained locations to enable capture and pumped transfer
- Subject to weather events (potentially providing water at a time when demand is low).

There are very few stormwater harvesting schemes currently in operation due in part to the constraints identified above. Given the opportunities presented by recycled water from STPs to address the project Problem Statements, this project will focus on STP point sources at relevant

locations. It is noted that there may be opportunities in the future to supplement this supply with additional sources should this present a beneficial outcome in meeting the project objectives.

5.3.3 Recycled water delivery alternatives

Recycled Water Demand

Irrigator meetings and surveys were conducted as part of the project, with further detail of the outcomes of irrigator consultation included in Appendix C (Volume 2). The consultation suggested:

- Indicatively substantial water demand exists in both Lockyer Valley and Darling Downs
- A greater capacity to take a range of water qualities on the Darling Downs
- A capacity to take large volumes of treated wastewater on the Darling Downs and use existing on-farm systems as balancing storages to manage the 'constant-flow' water characteristics of the supply source with temporarily variable water demands
- There exists an ability to store and move water about between adjacent farms
- Over 90% of farms on the Darling Downs have tail water drains/recycle systems to capture runoff assist contain on-farm (Cotton BMP recommend the ability to capture 25 mm of runoff off the irrigated area of a farm). This also provides greater capacity to manage water quality issues
- Increased flexibility around cropping decisions on the Darling Downs where producers utilise broad-acre commodity markets i.e. greater capacity to accommodate interruptions in water supply with less market driven pressures
- Broad requirement for higher quality water for irrigation use in the Lockyer Valley
- More market sensitive issues that would impact potential treated wastewater supplies to the Lockyer Valley
- Supply uncertainties as a result of current reviews of groundwater management in the Lockyer Valley and review of the Moreton Water Plan (affecting Lockyer Valley groundwater and surface water sources) contributed to the conversation in terms of where additional demand may result from changes to current supply arrangements.

Key areas of potential demand are shown on Figure 4-1.

Bulk water transportation

The use of WCRWS infrastructure forms the basis for all options; refer to Section 5.3.6 for additional information on the WCRWS. It is noted that to reach the design capacity of 232 ML/d, construction of a booster pump station located at Heathwood is required, as this was not included in the original WCRWS commissioned works.

Additional pipeline arrangements have been considered as part of early options identification to identify potential links between recycled water sources and demand locations. These options have been included either as part of the recycled water system including existing infrastructure or potentially a supplementary means to increase supply as part of an expanded scheme.

Wynnum STP was also considered as a potential source augment supply to the WCRWS; however, given the low quantity at issue and the existing agreement QUU holds with Caltex to deliver recycled water, this option was not progressed.

It is noted that the diameters and pipeline lengths are high level and for indicative scale purposes only. Further, in each case, the pipeline would need to be supplied by a new pump station. In subsequent project stages, a more detailed review of pipeline routes, connection

requirements and relevant delivery system sizing will be undertaken. In addition, for each of the identified pipeline/delivery options, a high-level summary of potential operating cost elements has been prepared, which will include items such as:

- Pumping costs for new source water (i.e. delivery from STPs)
- Advanced Water Treatment Plant costs, whether for PRW production or a modified process requirement. This will include power costs for pumping (i.e. MF/UF membrane filtration, reverse osmosis (RO)) and additional consumables
- Pumping costs associated with WCRWS pump stations (if applicable)
- Pumping costs with transferring water from WCRWS or other source locations to other demand areas.

Recycled water distribution

In delivering a new water product to the Lockyer Valley and Darling Downs areas, distribution infrastructure will be required to take water from the bulk water pipelines to the local points of demand. It is understood that a distribution network exists at the regional and farm level to efficiently transfer water within each area.

The demand analysis will identify where the water needs to go and the quality of water product required and/or desired. The ability to leverage existing infrastructure to distribute water to individual farms or local water networks (channels, storages, etc.) will be subject to this analysis. As this assessment had not been completed at the time of the options generation and the distribution infrastructure will be common to all options, the distribution infrastructure was not included in the estimated costs.

5.3.4 Water storage

It is anticipated that when operating, the NuWater Project recycled water scheme will be delivering water to the demand areas as it is being produced (notwithstanding interruptions when used for IPR), meaning that excluding unforeseen outages and planned maintenance, water will be supplied “24/7.” The detailed distribution system will include examining the means to store recycled water for use as needed.

Each of the Lockyer Valley and Darling Downs areas have existing water storage resources, which can be included in the scheme depending on the water product and potentially other mitigating arrangements to manage multiple water sources. This evaluation will be undertaken as part of further options development and be subject to the demand analysis and the location of demand relevant to storage infrastructure.

Lockyer Valley

The Central Lockyer contains a number of potentially relevant water storages and distribution assets, which are generally part of existing water supply schemes operating in the area. These include the following:

- Bill Gunn Dam (Lake Dwyer)
- Clarendon Dam (Lake Clarendon)
- Atkinson Dam
- Kentville Weir
- Jordan 1 and 2 Weirs
- Wilson Weir

- Clarendon Weir
- Glenore Grove Weir
- Laidley Creek Diversion Weir
- Showgrounds Weir
- Crowley Vale Weir
- Morton Vale Pipeline[20].

Darling Downs

It is also understood that approximately 300,000 ML of on-farm water storage exists in the Condamine River catchment between Warwick and Chinchilla of which approximately 50% is under-utilised.[21] Individual storages may range in size from less than 10 ML to over 20,000 ML. There is often the capacity to move water between adjoining farms or with minimal modification connect systems into a local area scheme. These systems are well adapted to receive constant flows from treatment plants with sufficient 'air space' to store supply during periods of no irrigation requirement. It is further noted that these systems are generally closed in nature through elevated embankments (i.e. turkey's nest storages), tail-water returns and flow capture arrangements.

5.3.5 Power supply

All options have significant energy requirements, with options supplying the Darling Downs involving substantial pumping head to traverse the Toowoomba Range.

The use of a pilot tunnel associated with investigative works for the Toowoomba Second Range Crossing road improvement project for the delivery pipeline has been flagged as a potential opportunity to reduce pumping requirements by avoiding a high point of the range. This is being investigated further in consultation with the Department of Transport and Main Roads (DTMR).

In order to feed the power requirements of the various pump stations, the capacity of the existing supply grid will require investigation. In addition, this new power demand presents an opportunity to explore alternative power supply options including renewable supplies. A number of potential options have been identified for addressing potential power supply demand, including:

- Traditional power supply grid network connection, including upgrades
- Solar energy, including battery storage
- Solar/diesel hybrid generators/power stations
- Hydro-power generation (including Spit-Yard Creek)
- Wind energy supply, plus battery storage or potentially pumped storage.

The feasibility of above options to meet the supply requirements have been reviewed as part of the project.

5.3.6 Western corridor recycled water scheme (WCRWS)

WCRWS Infrastructure

WCRWS infrastructure includes the following assets:

[20] *Central Lockyer Valley Water Supply Scheme, Network Service Plan, 2013-2017 Irrigation Pricing Submission to the QCA*, Seqwater
[21] Personal comment Graham Clapham June 2017

- AWTPs
  - Luggage Point
  - Gibson Island
  - Bundamba
- Eastern Pipeline (Luggage Point AWTP to Bundamba AWTP)
- Western Pipeline (Bundamba AWTP to Caboonbah Balance Tank including the discharge to Lake Wivenhoe)

Water Product Quantities

A summary of the indicative source water quantities (i.e. STP average dry weather flows, AWTP treatment capacity) and transfer infrastructure capacity for the WCRWS is represented schematically in Figure 5-2. This shows that, indicatively, there is sufficient source water and system delivery capacity to transfer close to the system design rate of 232 ML/d, though it is noted that, to reach this design rate, construction of the Heathwood booster pump station is required.

Other system configuration considerations include potentially bypassing AWTPs or specific treatment processes depending on the desired water quality and increasing the transfer rate at some pump stations. Evaluation of source water quantity, system delivery capacity, required system modifications and estimates of costs required to deliver the selected recycled water products will be undertaken to review the feasibility of individual infrastructure elements.

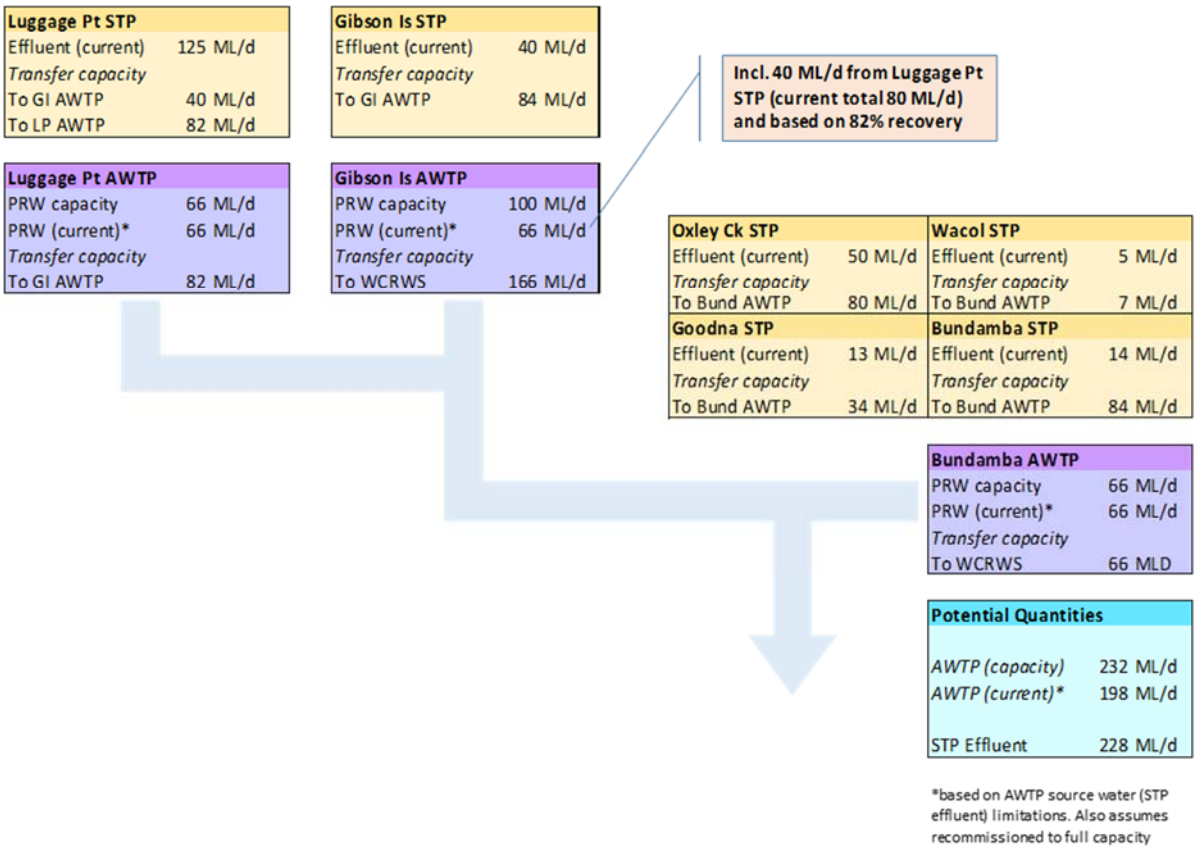

Figure 5-2 Indicative WCRWS transfer schematic

Water Transportation

The WCRWS transfer system is divided into two sections: the Eastern and Western pipelines. Balance storage tanks with 5 ML capacity are located at Mt Petrie, Lowood and Esk.

The Eastern Pipeline is designed to transfer PRW from Luggage Point and Gibson Island AWTPs to the Mt Petrie Tank and then to the Bundamba AWTP. The current scheme can transfer up to 112 ML/d to Mt Petrie Tank using only the Gibson Island Pumps; with the assistance of the Paringa Rd Booster Pump Station this capacity increases to 166 ML/d. The Bundamba Booster pumps can transfer 112 ML/d from the Mt Petrie tank and deliver to the Lowood tank. With the assistance of the Kuraby Booster Pump station this capacity increases to 133 ML/d. The ultimate transfer case of 166 ML/d requires the installation of the Heathwood Booster pump station situated between Kuraby and Bundamba Boosters; this pump station is yet to be constructed.

Figure 5-3 shows the Western Pipeline, which is designed to transfer PRW from Bundamba AWTP to Lowood, Esk and Caboonbah for delivery to Tarong Power Station and discharge into Lake Wivenhoe. The Bundamba Transfer Pumps have capacity to transfer 120 ML/d from Bundamba to the Lowood Tank. The pipeline between Bundamba and Lowood is designed for an ultimate flowrate of 232 ML/d (66 ML/d from Bundamba Transfers and 166 ML/d from Bundamba Boosters). The Lowood Booster Pumps draw from the Lowood Tank and can transfer 80 ML/d to Caboonbah to connect to the pre-existing Wivenhoe-Tarong pipeline. The total flow can be directed to Lake Wivenhoe through the IPR pipeline, via gravity.

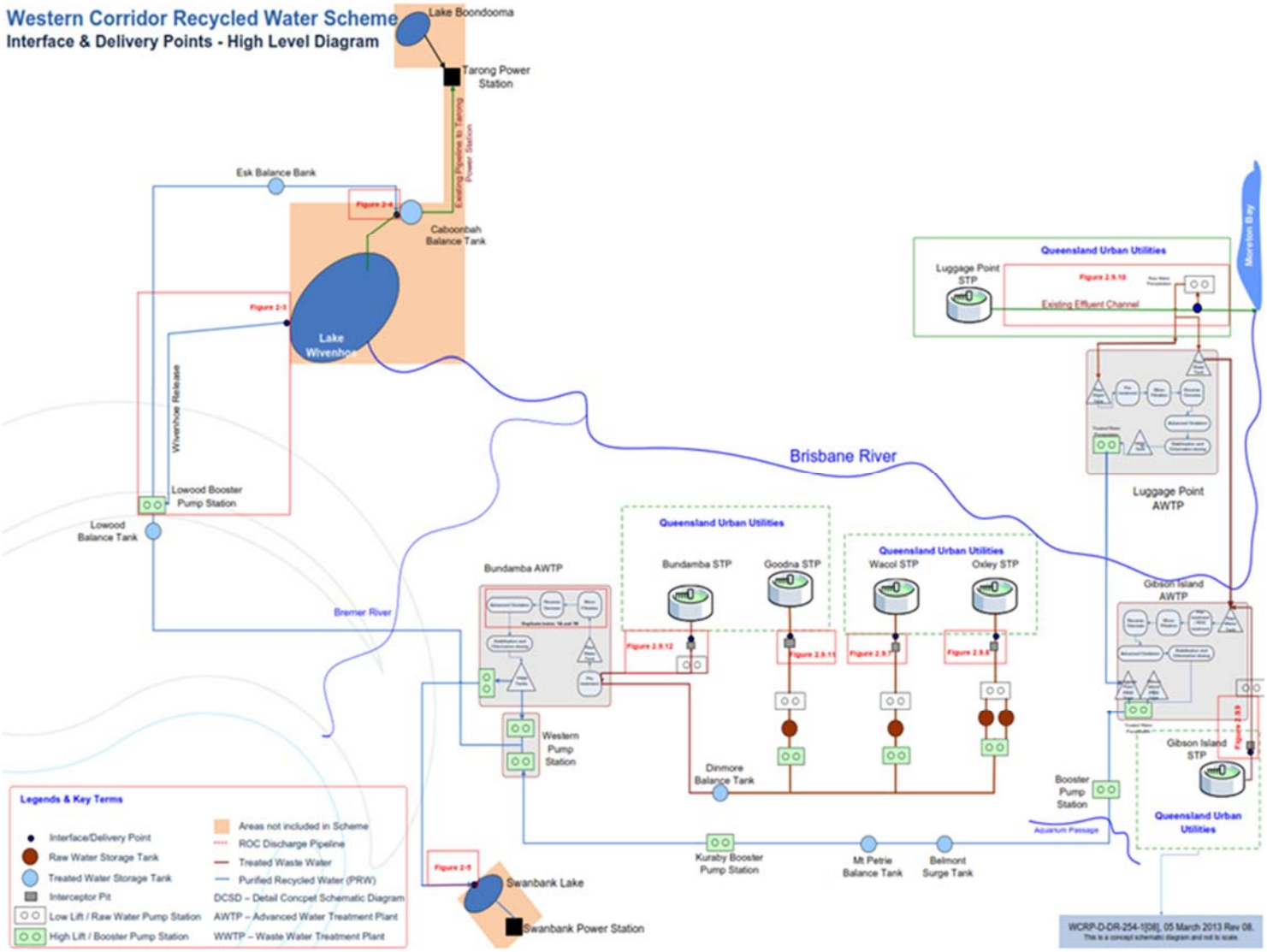

Figure 5-3 Western Corridor Recycled Water Scheme – schematic (Seqwater)

A summary of the network design parameters as reported by the Veolia is provided in Table 5-6.

Table 5-6 WCRWS summary scheme (data provided by Veolia, 2017)

Section - Pipeline	Pipe leg component	Current network capacity (theoretical) (ML/day)	Current Network capacity (constrained by AWTP) (ML/day)
Eastern Pipeline	Luggage Point to Gibson Island	82[1]	70
	Gibson Island to Mt Petrie tank	170[1]	120
Western Pipeline	Mt Petrie tank to Lowood tank	133[1] + 60[2]	120 + 60
	Lowood tank to Esk/Wivenhoe	250 (to Wivenhoe)[3]	180 (to Wivenhoe)[3]
	Esk to Caboonbah	80	80
	Bundamba to Swanbank	25	25

Notes (Veolia, 2017):

1 Current installed capability of EPIPE [Eastern Pipeline] components is higher than the AWTP output (noted that documented design flow for Mt Petrie to Lowood pipeleg (with Bundamba transfers input to system) ranges from 125-135 ML/d)

2 Bundamba transfer pump input to pipeline (from Bundamba AWTP) is able to supply instantaneous equivalent of 90-120ML/d depending on the flows from EPIPE.

3 Flows to Wivenhoe (only) are assessed to up to 250ML/d; whereas for flows to Esk (and on to Caboonbah) the pipeline is designed to achieve 80ML/d to Esk with 152ML/d to Wivenhoe pipeline.

5.4 Options long list

In selecting the long list of options, the following is noted:

- Numerous combinations of option elements are possible; however, an assessment process has been identified to comparatively review the benefits afforded by option elements. In this way, certain option elements may be removed from further assessment if found to be relatively costly (CAPEX, OPEX) or not deliver a meaningful quantity of water. A description of the proposed assessment process is included in Section 2.4
- An overall recovery rate of 82% has been used for all AWTPs to produce PRW, with the remainder being losses (mainly ROC discharge). This figure of 82% has been drawn from WCRWS Source Water Demand Assessment (Seqwater, Jacobs 2017). A recovery rate of 96.5% has being used for the production of Class A^+
- All options include the bulk water transfer from the WCRWS (Lowood Booster PS) to Lockyer Valley (Gatton) and from Lockyer Valley (Gatton) to the Darling Downs
- The described option elements include the bulk transportation of water only and do not specifically include the works required to distribute water to individual farms or local water networks (channels, storages, etc.)
- The outcomes of the demand analysis will be used to refine the extent of water distribution and storage infrastructure (i.e. from bulk water infrastructure to farm gate) and determine the extent to which existing infrastructure can be leveraged
- Power supply requirements and energy costs will be a fundamental consideration for all options. It is proposed that, when required, more detailed investigation of options for additional supply of power will be developed on the basis of short-listed option

requirements. Operating costs (i.e. energy consumption and energy price estimates) will be used for higher level comparative assessment of options (refer Section 2.4).

- Options are detailed in the sections below, with a summary of the options is included in Table 5-7.

Table 5-7 Long list options

Option	Product	Sub-option	Delivery Option Description	Quantity (ML/d)	Quantity (ML/annum)
1	PRW	1.1	WCRWS pipeline (current capacity)	182	66,430
		1.2	WCRWS pipeline, construction of Heathwood PS and upgrade of Gibson Island AWTP	198	72,270
		1.2.1	Pipeline from Sandgate STP to Luggage Point STP	212	77,380
		1.2.2	Pipelines from Redcliffe STP to Sandgate STP to Luggage Point STP	228	83,220
		1.2.3	Pipelines from Murrumba Downs STP to Sandgate STP to Luggage Point STP	226	82,490
2	Class A+	2.1	WCRWS pipeline (current capacity)	182	66,430
		2.2	WCRWS pipeline, construction of Heathwood PS and upgrade of Gibson Island AWTP	232	84,680
3	Untreated Effluent (Class B/C)	3.1	WCRWS pipeline (current capacity)	182	66,430
		3.2	WCRWS pipeline, construction of Heathwood PS	232	84,680
4	Untreated Effluent (Class B/C)	4.1	Pipeline from Bundamba AWTP to Lowood Booster PS (enables the WCRWS pipeline to remain solely for PRW transfer)	84	30,660
		4.1.1	Pipeline from Loganholme STP to Goodna STP to add source water (44 ML/d) to Bundamba AWTP	128	46,720
		4.1.2	Pipelines from Loganholme STP to Goodna STP and Brendale STP to Lowood Booster PS	137	50,005
		4.1.3	Pipelines from Loganholme STP to Goodna STP / Murrumba Downs STP to Brendale STP to Lowood Booster PS	153	55,845
5	Wivenhoe water	5.1	WCRWS pipeline (current capacity)	182	66,430
		5.2	WCRWS pipeline, construction of Heathwood PS and upgrade of Gibson Island AWTP	198	72,270
		5.2.1	Pipeline from Sandgate STP to Luggage Point STP	212	77,380
		5.2.2	Pipelines from Redcliffe/Murrumba Downs STPs to Sandgate STP to Luggage Point STP	228	83,220
		5.2.3	Pipelines from Murrumba Downs STP to Sandgate STP and from Sandgate STP to Luggage Point STP	226	82,490
6	Separate Systems	6.1	Wivenhoe Water / WCRWS pipeline (current capacity)	116	42,340
		6.2	Pipeline from Bundamba AWTP to Lowood Booster PS	84	30,660

5.4.1 Option 1

Option 1 uses WCRWS infrastructure to produce PRW; as such, the full costs associated with restarting and operating the WCRWS are incurred for these options. All options include treatment of ROC from Luggage Point and Gibson Island AWTPs.

A new booster PS will be required at Lowood, as well as new infrastructure west of Lowood, including:

- Pipeline from Lowood Booster PS to Gatton
- Pipeline from Gatton to Toowoomba Range (bottom)
- Pipeline from Toowoomba Range (bottom) to Toowoomba Range (top)
- Pump stations near Gatton and the bottom of the Toowoomba Range.

Option 1.1

This option uses existing WCRWS infrastructure to produce 182 ML/d of PRW (i.e. to use the WCRWS in its current state for its intended purpose).

Option 1.2

Option 1.2 includes the upgrade of the Luggage Point to Gibson Island PS, providing additional source water to Gibson Island AWTP, which will be upgraded to maximum production based on available source water. This option also includes the construction of the Heathwood Booster PS (situated between Kuraby and Bundamba Boosters) to increase the transfer capacity of the WCRWS to 207 ML/d.

Option 1.2.1

This option builds off 1.2, with additional source water provided to Gibson Island AWTP via an additional pipeline from Sandgate STP to Luggage Point STP.

This option will require larger upgrades of the Luggage Point to Gibson Island PS and Gibson Island AWTP to deal with the increased quantities of PRW.

Option 1.2.2

This option builds off 1.2, with additional source water provided to Gibson Island AWTP via additional pipelines from Redcliffe STP to Luggage Point STP via Sandgate STP.

This option will require larger upgrades of the Luggage Point to Gibson Island PS and Gibson Island AWTP to deal with the increased quantities of PRW.

Option 1.2.3

This option builds off 1.2, with additional source water provided to Gibson Island AWTP via additional pipelines from Murrumba Downs STP to Luggage Point STP via Sandgate STP.

This option will require larger upgrades of the Luggage Point to Gibson Island PS and Gibson Island AWTP to deal with the increased quantities of PRW.

5.4.2 Option 2

Option 2 uses WCRWS infrastructure, with modifications to the AWTPs to produce Class A^+ recycled water. These modifications include the removal and bypass of the reverse osmosis, advanced oxidation and stabilisation processes. All options include treatment of concentrate from Luggage Point and Gibson Island AWTPs.

A new booster PS will be required at Lowood, as well as new infrastructure west of Lowood, including:

- Pipeline from Lowood Booster PS to Gatton
- Pipeline from Gatton to Toowoomba Range (bottom)
- Pipeline from Toowoomba Range (bottom) to Toowoomba Range (top)
- Pump stations near Gatton and the bottom of the Toowoomba Range
- Additional storages are also required in the Lockyer Valley.

Option 2.1

This option uses existing WCRWS infrastructure to produce 182 ML/d of Class A^+ recycled water.

Option 2.2

Option 2.2 includes the upgrade of the Gibson Island AWTP, which will be upgraded to maximum production based on available source water. This option also includes the construction of the Heathwood Booster PS (situated between Kuraby and Bundamba Boosters) to increase the transfer capacity of the WCRWS to 207 ML/d.

5.4.3 Option 3

Option 3 uses WCRWS pipelines and pump stations to transport treated effluent (i.e. Class B/C recycled water) from STPs, bypassing the AWTPs. Due to the quality requirements in the Lockyer Valley, end-of-pipe treatment to produce Class A^+ is required for this option; this includes include treatment of concentrate produced. Additional storages are also required in the Lockyer Valley.

A new booster PS will be required at Lowood, as well as new infrastructure west of Lowood, including:

- Pipeline from Lowood Booster PS to Gatton
- Pipeline from Gatton to Toowoomba Range (bottom)
- Pipeline from Toowoomba Range (bottom) to Toowoomba Range (top)
- Pump stations near Gatton and the bottom of the Toowoomba Range.

Option 3.1

This option uses existing WCRWS infrastructure to produce 182 ML/d of Class B/C recycled water, with end-of-pipe treatment to Class A^+ for water to the Lockyer Valley.

Option 3.2

Option 3.2 includes the construction of the Heathwood Booster PS (situated between Kuraby and Bundamba Boosters) to increase the transfer capacity of the WCRWS to 232 ML/d.

5.4.4 Option 4

Option 4 does not use any WCRWS infrastructure, instead using new pipelines to transfer treated effluent (i.e. Class B/C recycled water) from STPs. Due to the quality requirements in the Lockyer Valley, end-of-pipe treatment to produce Class A^+ is required for this option; this includes include treatment of concentrate produced. Additional storages are also required in the Lockyer Valley.

A new booster PS will be required at Lowood, as well as new infrastructure west of Lowood, including:

- Pipeline from Lowood Booster PS to Gatton
- Pipeline from Gatton to Toowoomba Range (bottom)
- Pipeline from Toowoomba Range (bottom) to Toowoomba Range (top)
- Pump stations near Gatton and the bottom of the Toowoomba Range.

Option 4.1

Option 4.1 consists of a new pipeline from the intake at Bundamba AWTP to Lowood Booster PS (i.e. using the source water for Bundamba AWTP), transferring 84 ML/d.

Option 4.1.1

This option builds off 4.1, with additional effluent sourced from Loganholme STP via a new pipeline connecting into Goodna STP.

Option 4.1.2

This option builds off 4.1, with additional effluent sourced from Loganholme STP via a new pipeline connecting into Goodna STP, as well as a new pipeline from Brendale STP to Lowood Booster PS.

Option 4.1.3

This option builds off 4.1, with additional effluent sourced from Loganholme STP via a new pipeline connecting into Goodna STP, as well as new pipelines from Murrumba Downs STP to Brendale STP to Lowood Booster PS.

5.4.5 Option 5

Option 5 is the same as Option 1, including all sub-options, with the one difference being that all PRW will be transferred to Lake Wivenhoe, as per the original intention of the WCRWS.

5.4.6 Option 6

Option 6 consists of separate systems for the Locker Valley and Darling Downs, due to their differing requirements in terms of quality of recycled water.

Lockyer Valley

The Lockyer Valley component of this option uses WCRWS infrastructure, excluding Bundamba AWTP, to produce 116 ML/d of PRW (i.e. only PRW produced at Luggage Point and Gibson Island AWTPs is used). Treatment of ROC from Luggage Point and Gibson Island AWTPs is also included.

A new booster PS will be required at Lowood, as well as a new pipeline from Lowood Booster PS to Gatton.

Darling Downs

The Darling Downs component of this option does not use any WCRWS infrastructure; instead, a new pipeline from the intake at Bundamba AWTP to Lowood Booster PS will be constructed (i.e. using the source water for Bundamba AWTP), transferring 84 ML/d.

A new booster PS will be required at Lowood (separate to the PS required for the Lockyer Valley component described above), as well as new infrastructure west of Lowood, including:

- Pipeline from Lowood Booster PS to Gatton
- Pipeline from Gatton to Toowoomba Range (bottom)
- Pipeline from Toowoomba Range (bottom) to Toowoomba Range (top)
- Pump stations near Gatton and the bottom of the Toowoomba Range.

5.5 Cost estimates approach

The cost estimation process supporting the evaluation of the long list options was undertaken including a range of sources including:

- Seqwater advised cost allowances for WCRWS recommissioning and operational costs
- GHD cost database information and other industry sources for typical supply and construction unit rates for treatment, pumping, storage and linear infrastructure
- Information drawn from previous relevant reports
- Typical operational cost estimates, including treatment consumables, energy and regular operations and maintenance allowances for identified infrastructure.

It is noted that the intent of the cost estimates was to provide a comparative assessment of the options using a common estimate basis, thereby focusing on relative differences between options rather than the total option cost. As such, some common option elements (i.e. distribution networks, transmission and power supply) were left undefined at this stage of the investigation.

Further description of the basis of cost estimates used for this stage of options assessment have been included in Appendix F (F1) (Volume 2).

6. High level considerations/options filter

A large number of options were generated through the process described in Section 5. To more effectively direct resources, a filtering process was applied to the long list of options to refine the list of options to those that best met the key project Problem Statements (refer Section 2.4).

The review of long list options incorporated social, economic, environmental and financial assessments. The following sections describe the review outcomes focusing on differentiating elements associated with individual options to support the selection of an options short list.

6.1 Strategic considerations

6.1.1 Strategic alignment and policy issues

The project aligns with National Water Infrastructure Development Fund objectives by:

- Increasing the knowledge base for informed decision making
- Providing the detailed planning necessary to support development
- Maintaining a clear focus on water infrastructure.
- Complying with National Water Initiative to achieve:
  - economically efficient water use and related investment that maximise the economic, social and environmental value of Australia's water resources
  - improved environmental water outcomes, including the identification and effective and efficient delivery of water to sustain the health of water-dependent ecosystems of waterways and wetlands.

This project also aligns with Commonwealth Government policy objectives of:

- Doubling Australia's agricultural production
- 'Jobs and growth.'

Supporting State policy initiatives include:

- Broad alignment with the State Government's, *Queensland Bulk Water Opportunities Statement* (QBWOS, July 2017) which amongst other things seeks to use existing water resources and infrastructure more efficiently
- DSD will investigate opportunities for non-urban water infrastructure development that supports regional economic development[22].
- State Planning Policy 2017, in particular planning for economic growth by protecting State interests in and supporting agriculture
- The South East Queensland Healthy Waterways Partnership led by the not-for-profit organisation, Healthy Land and Water, aims to improve the sustainable use of land and waterways in South-East Queensland
- Generation of regional jobs and economic development through the sustainable development of the State's natural resources (i.e. water and land)
- Alignment with the Queensland Climate Adaptation Strategy which will build on the innovation and action already underway by fostering partnerships between government, sectors, and within regions[23].

[22] Queensland Bulk Water Opportunities Statement, Queensland Government, July 2017 P7
[23] http://www.ehp.qld.gov.au/assets/documents/climate/climate-change-adaptation-paper.pdf (Accessed 6/2/2017)

- Consistent with Moreton and Condamine and Balonne Water Plans
- Consideration of the Environmental Values and Water Quality Objectives under the Environmental Protection (Water) Policy 2009
- DEHP encourages innovative ideas to manage the disposal of treated effluent to ensure the environmental values of Queensland waters are protected. The proposed NuWater project presents as an innovative solution with the potential to contribute to the improvement of water quality within the Brisbane River and Moreton Bay. Additionally the proposal to redirect treated effluent disposal from the Brisbane River and Moreton Bay to an irrigation scheme is supported as a preferred option within the management hierarchy for surface or groundwater stated in the Environmental Protection (Water) Policy 2009.
- Alignment with the Resilient Rivers Initiative which aims to improve the health of SEQ's waterways by delivering a coordinated approach to catchment management.

Against this background this project's strategic approach draws together short term initiatives such as further adoption of best management practice on-farm, transitioning to more efficient irrigation systems (further mitigating off-farm impacts) with an opportunity to establish a long-term management approach to reducing sewage discharge to the environment through effective use of a resource (recycled water) to benefit agricultural and community development.

The objective of the reference project is to provide:

- A water infrastructure solution (storage and distribution) that supports the ramping up of irrigated agricultural production in the Lockyer and Darling Downs regions to produce
- A water infrastructure solution that largely aligns with the Moreton and Condamine and Balonne Water Plans and doesn't adversely impact other water users (water allocation security objectives) or water for the environment (environmental flow objectives)
- An infrastructure solution that in turn is supported by a sustainable irrigation water tariff regime
- A mix of water products (reliability) that provides adequate certainty for crop planting and management decisions.

The reference project will align with:

- Moreton and Condamine and Balonne Water Plans
- NWI commitments as outlined in the Agricultural Competitiveness White Paper[24], the Australian Government's plan to grow the agriculture sector, including the $500 million National Water Infrastructure Fund
- State Planning Policy 2017, in particular planning for economic growth by protecting State interests in and supporting agriculture as a state interest.
- Assisting achieve Australian and Queensland Government targets of increasing agricultural production, regional jobs, increasing exports and delivering sustainable growth in the farming sector.

The options identified as part of the options generation process all meet the core requirements outlined by the key project Problem Statements (refer Section 2.4).

6.2 Legal and regulatory considerations

Delivery of the infrastructure required for the irrigation scheme will necessitate consideration of the project against a range of legal and regulatory approvals. Particular legislation will include:

[24] http://agwhitepaper.agriculture.gov.au/white-paper

- Commonwealth
  - *Environment Protection and Biodiversity Conservation Act 1999*
  - *Native Title Act 1993*
- State
  - *Aboriginal Cultural Heritage Act 2003*
  - *Environmental Offsets Act 2014*
  - *Environmental Protection Act 1994*
  - *Fisheries Act 1994*
  - *Nature Conservation Act 1992*
  - *Planning Act 2016*
  - *Public Health Act 2005*
  - *Queensland Heritage Act 1992*
  - *Regional Planning Interests Act 2014*
  - *State Development and Public Works Organisation Act 1971*
  - *Vegetation Management Act 1999*
  - *Water Act 2000*
  - *Water Supply (Safety and Reliability) Act 2008*
- Local Government

The majority of approvals arising from the above legislation will be required regardless of the option due to common option elements. Considerations with differences between the selected long list of options include the following:

- Options requiring additional source water include transfer of treated effluent from STPs not currently part of the WCRWS. This will necessitate new pump stations and pipelines from these STPs. In the case of Redcliffe STP and Sandgate STP, this will include crossing of major waterways and estuarine works, tunnelling beneath areas of concern in terms of marine environments, urban areas and close to critical infrastructure (bridges, Brisbane International Airport)
- The supply and appropriate use of recycled water is controlled through the *Public Health Act 2005 (Qld)*, with relevant recycled water quality standards applicable for different agriculture types outlined in Schedule 3E of the *Public Health Regulation 2005 (Qld)* (refer Table 5-1). Appropriate application of lower quality recycled water will either limit potential customers or require end of pipe treatment (and approval) suitable to the intended irrigation use. The Department of Health is responsible for administering the requirements of the *Public Health Act 2005 (Qld)*
- The WCRWS is an approved scheme to deliver high quality recycled water (PRW) for indirect potable reuse (IPR) under approvals obtained through the *Water Act 2000 (Qld)* as well as *Environmental Protection Act 1994 (Qld)* authorities for the operation of the relevant AWTPs. The potential for this scheme to be appropriated for a use other than its intended purpose, in particular conveyance of high quality PRW, will be subject to approval from DEWS, Seqwater and DEHP as the responsible statutory authorities for the WCRWS and its operation. Options including conveyance of lower quality recycled water (i.e. Class A+, Class B/C).
- The *Environmental Protection Act 1994 (Qld)* provides for the granting of environmental authorities for sewage treatment activities (Environmentally Relevant Activity (ERA) 63 – Sewage Treatment), which includes permitted releases of treated wastewater and the

circumstances under which this can occur. The controls and approvals for proposed changes to the licenced discharge points associated with supply recycled water to customers, particularly Class A+ and Class B/C products, will be subject to review and approval from DEHP and potentially changes to QUU's current bubble licence.

The above specific considerations, along with any risks and mitigation actions, have been taken into account as part of the comparative evaluation of options.

6.3 Other legal matters

The delivery of any of the irrigation scheme options will require the definition of the asset owner and operator, or proponent. This could be in the form of existing utilities/entities such as Seqwater, other relevant party, or be a Special Purpose Vehicle specific to the project. The legal or policy requirements associated with delivering the project will depend on the particular legal requirements and obligations specific to that entity. The identification of the proponent will be part of further investigation in the next phase of the project (Detailed Business Case) and be catered to the details and delivery requirements of the Reference Project. This will require establishing with greater certainty necessary legal and regulatory arrangements, including but not limited to:

- Accessing source waters produced from QUU (and Unitywater) STPs
- Accessing Seqwater infrastructure, particularly the WCRWS, and any associated conditions
- Confirming specific project requirements and limitations with regulatory authorities charged with administering approvals for recycled water schemes and specifically the WCRWS, Obtaining land access and acquisition for the overall projects infrastructure footprint
- Obtaining expressions of interest and ultimately commitment from potential irrigation customers to take water in the event the irrigation scheme is established.

6.4 Market considerations

In terms of general industry capacity, there is a strengthening outlook in non-mining infrastructure projects however this is focused on transport sector works. A decline in mining infrastructure projects over the past few years has meant there is capacity in the construction industry for major infrastructure delivery.

This project represents a significant program of works to deliver the infrastructure required to transfer recycled water from the WCRWS through to the Lockyer Valley and the Darling Downs. Depending on the option, this will include hundreds of kilometres of pipelines, major pump stations, power supply upgrades/facilities and storages.

There are a number of major irrigation enhancement projects ongoing in NSW (Murrumbidgee Irrigation Area Renewal Alliance) and Victoria (Goulburn Murray Water Connections Project) and some industry capacity is bound up in these projects. Locally, there are few planned major water infrastructure projects that would be providing resource competition (pipeline constructors) should this project proceed.

6.4.1 Assessment of market capability

A range of factors require consideration with regard to alternative project procurement and delivery options including:

- The degree of complexity involved in the design and construction of the project
- The size of the project in dollar & physical terms
- Project Risks and who is best able to manage them

- Time constraints on project delivery
- Experience, skills and capability available within the Principal
- The experience, capability and availability of designers and construction contractors to be engaged in delivery of the project
- Greenfield or Brownfield site
- Existing site ownership and/or need for land procurement and construction access
- Existing infrastructure ownership
- Interaction and/or integration into existing other project works and/or operations
- Ownership, Financing and/or longer term operations and maintenance considerations
- What approach will accordingly deliver overall best 'value-for-money'.

There is expected to be adequate skills and experience available to deliver this project. However, given the nature and characteristics of the project, including its high capital cost it is expected that additional costs will be incurred in subsequent project phase to assess market factors.

As the project proceeds to the Detailed Business Case, more direct market sounding will depend largely upon the delivery mechanism for the project. For example, should the delivery and operation of the NuWater Project infrastructure be the responsibility of Seqwater, procurement of the infrastructure may need to follow Seqwater's internal procurement policies and procedures. Additionally, depending on the funding contributions, the procurement pathway may be dictated by relevant policies relating to those organisations providing funding (i.e. Queensland Government funded infrastructure may need to be delivered through Building Queensland).

6.5 Public interest considerations

6.5.1 Community consultation/stakeholder engagement

Initial consultation and engagement activities have focused on stakeholders identified in the project Engagement and Consultation Plan. This group primarily comprises relevant State Agencies and Authorities, Local Government, relevant industry associations, and individual irrigators and agricultural enterprises from the Lockyer Valley and Darling Downs

The consultation and engagement approach has been designed to identify key stakeholder issues, constraints, risks and opportunities to inform the development of a preferred Options Short List.

The consultation activities included a number of project briefings and meetings with key stakeholders, focus groups, Options Identification Workshops and regional, web-based surveys of primary producers.

Stakeholder consultation indicated broad support for the objectives of the NuWater Project. However, the majority of stakeholder support was conditional upon a number of factors, such as economic cost to end water users, security of potable water supply and the cost of infrastructure, including ongoing operational costs. A wider consultation process, encompassing communities within the Lockyer Valley and Darling Downs will occur as part of the Detailed Business Case.

6.5.2 Impact on stakeholders

- The six options and sub-options identified in the Options Long List present consistent themes in terms of opportunities and impacts for the community and stakeholders.
- The primary benefit for the general public is related to the increase in employment opportunities generated by construction activities associated with the proposed works and longer term employment opportunities generated by the ongoing operation and maintenance of new infrastructure. This benefit is consistent across all six options, with degree of benefit to the community determined by the extent of works and infrastructure required.
- Similarly, the potential negative community impacts are consistent across the identified options. The primary long-term impact to the community relates to the acquisition of land for new facilities, pipeline easements or water storage. This impact may have ramifications for land tenure around new or existing facilities, and in the case of pipeline easements, may impact land use and farm management practices. This is particularly relevant to areas of intensive agricultural production, such as the Lockyer Valley.
- The extent of this impact varies between the options, with options utilising existing infrastructure posing the least disturbance or impact to the community.
- Ultimately, negative impacts associate with land acquisition may be largely mitigated through early consultation with potentially impacted landholders to fully understand the implications for individual properties and agricultural operations. In addition to consultation, a fair and transparent acquisition process will be further minimise real or perceived negative impacts to landholders and communities.
- All identified options would also have a short term impact on communities through the construction or upgrading of facilities and the construction of new pipelines and associated supporting infrastructure. This impact may be managed by the development and implementation of a Community Engagement Plan throughout the construction phase of the project.

6.5.3 Public access and equity

The WCRWS is part of South East Queensland's bulk water supply network. All options being considered leverage as far as practicable WCRWS infrastructure, with a varying degree of alignment with the current operational constraints depending on the option. For example, options delivering a Class B/C water product (treated effluent) would involve the pipeline conveying water with a lesser quality than PRW.

Water security is a key function of Seqwater which is delivered through the management and operation of the water grid and inter-related sources. The WCRWS is considered to be a community asset providing the core purpose of additional water security. The degree to which options align with this function and the means by which risks that may impact this function may be mitigated were taken into account in selecting the Reference Project and be subject to further investigation in subsequent project phases.

The delivery of recycled water to specific locations and individual operations will be primarily dependent on later project phases where customer interest, commercial arrangements and technical feasibility will be further developed in support of the Reference Project. In principle, the water will be delivered to its highest order use influenced by commercial opportunities presented by additional irrigation water.

6.5.4 Consumer rights

No options being considered would impinge on consumer rights i.e.:

- right to safety
- right to be informed
- right to choose
- right to be heard.

6.5.5 Safety and security

The delivery and operation of the preferred irrigation scheme will be subject to usual controls in terms of construction and farmplace workplace health and safety.

Among the options being considered, there are options where varying degrees of direct and in-direct contact with the product water (less than PRW) has potential to cause health-related issues. The appropriate management of conveyance, storage and distribution of water to irrigation customers, plus the appropriate regulation/licencing and use of recycled water by customers, will be the subject of legal/regulatory mechanisms such as recycled water management plans, recycled water agreements and other control mechanisms to manage health and safety risks.

In terms of security of supply, the system will be designed to provide an optimal balance of efficiency, functionality and redundancy such that the system is robust and resilient in delivering its design function. The nature of the water product (source water from STPs) is such that any variability encountered would be minor in nature. More significantly, the likelihood of interruptibility is dependent on the regional urban water security outlook. It is acknowledged that aligned with the benefits of leveraging the WCRWS is the potential that it is returned to its core function as a potable water source (when pumping to Wivenhoe Dam) and that the duration will be subject to bulk water storage levels and Seqwater's operational plan.

6.5.6 Privacy

It is not expected that the project will compromise any privacy requirements i.e. as such will align with Government obligations as defined at:
www.business.qld.gov.au/business/starting/legal.

6.6 Sustainability considerations

The Infrastructure Sustainability Council of Australia defines infrastructure sustainability as: 'Infrastructure that is designed, constructed and operated to optimise environmental, social and economic outcomes of the long term'.

Furthermore, it notes: 'Infrastructure is crucial to sustainability in both its role in configuring society and the way it functions as well as the way infrastructure is planned, designed, constructed, operated and adapted'.

The process for comparative assessment of options includes reviewing each option against sustainability criteria developed to characterise the economic, environmental and social benefits associated with the project outcomes. The criteria used to assess and review the options long list is described in Section 6.7, which takes into account each option's contribution to sustainability goals.

General project benefits associated with addressing the problem statements (refer Section 2.4) align with sustainability objectives, and options align with these objectives to varying degrees. Given the similarity in the project outcomes generated across the full suite of options identified in the long list, there is limited difference between options in terms of sustainability outcomes. These primarily relate to:

- Economic viability of options in terms of capital investment required to deliver the necessary infrastructure along with ongoing operational costs associated with treating and transferring source and product water
- The marketability of specific water products is impacted by limitations on its use or additional treatment requirements associated with different recycled water qualities
- Some options deliver a lesser quantity of water below the WCRWS capacity, not making best use of existing infrastructure
- Options requiring additional source water have a greater infrastructure footprint and therefore a more significant impact during the construction phase
- Options including lower quality water products have a greater potential for accidental or uncontrolled release causing environmental harm.

Further consideration and discussion of the above is included in the option long list evaluation (refer Section 6.8).

6.7 Option short listing process

The second stage of options assessment involved a short-listing process to comparatively review and refine the long list options focused on criteria that best represented the project Problem Statements (refer Section 2.4). The review aimed to filter out potential development options or option variations that were demonstrably less beneficial or viable by assessing their relative merits against the criteria outlined in Table 6-1.

Table 6-1 NuWater Project short-listing criteria

Primary Goals	Criteria	Sub-criteria 1	Measurable rating
Economic	Project viability	Project at a scale able to drive significant increase in irrigated agricultural production that is regionally significant	Rank by system yield supporting farmland development
		Total capital cost per megalitre of yield ($/ML) at the farm. Factors in water distribution losses and cost of water storage and distribution system (This will provide relativity between options and a coarse indication of the potential need for transparent subsidy)	Ranked by capital cost per megalitre supplied ($/ML)
		Operating cost (e.g. energy cost, treatment costs - relativity between options)	Ranked by operating cost per megalitre supplied ($/ML)
	Regional Impact	Increased utilisation of regional/community infrastructure (asset utilisation e.g. alignment with State Government Bulk Water Opportunities Statement)	High to low (factor of scale and diversity of potential offerings - including Wellcamp airport etc.)

Primary Goals	Criteria	Sub-criteria 1	Measurable rating
Environmental	Water values	Improvements to water quality in Moreton Bay against relevant water quality objectives, reflecting the level of nutrient removal from discharges.	Low to high impact
Social	Community	Capacity of local communities to take advantage of opportunities, including jobs	High to low

It is noted that the evaluation of long list options was focused on comparative option elements, including:

- Water quality and water product being produced
- Delivery infrastructure required to delivery source water to treatment facilities if required
- Wastewater treatment requirements, including modifications to the AWTPs and end-of-pipe treatment for water products not able to meet user requirements
- Delivery infrastructure for product water, meaning transfer of product water to the high level demand location (i.e. Lockyer Valley or Darling Downs).

It is acknowledged that the quantum of the capital and operational cost estimates used to compare options did not include a number of key elements, including:

- Distribution infrastructure for product water
- Centralised and decentralised (on-farm) storage
- Power consumption and supply.

These were viewed to be common option elements, and as such were defined and refined based on the short list options and outcomes of the demand survey and analysis.

6.8 Options filter summary

Each of the options was scored using the criteria identified in Table 6-1 and provided a relative ranking. A sensitivity review was also conducted using a range of modified scoring parameters and assessment types. A summary report was prepared outlining the short-listing process and outcomes of both the options review, which has been included as Appendix D (Volume 2).

Based on the outcomes of the short-listing process, the options that were progressed to more detailed assessment are described in Table 6-2.

Table 6-2 NuWater Project short-listed options

Option	Project Option	Sub-Option	Description	Quantity (ML/day)	Quantity (ML/annum)
A	PRW	1.2.2	WCRWS pipeline + construction of Heathwood PS and upgrade of Gibson Island AWTP, including pipelines from Redcliffe STP to Sandgate STP and from Sandgate STP to Luggage Point STP	232	84,680
B	Class A+	2.2	WCRWS pipeline + construction of Heathwood PS and upgrade of Gibson Island AWTP	232	84,680
C	Class B/C (as produced)	3.2	WCRWS pipeline + construction of Heathwood PS	232	84,680

Option	Project Option	Sub-Option	Description	Quantity (ML/day)	Quantity (ML/annum)
D	PRW (LV) / Class B/C (DD)	6.1	WCRWS pipeline (current capacity)	116	42,340
		6.2	Pipeline from Bundamba AWTP to Lowood Booster PS	84	30,660

An outcome of the selection process was that each of the three water product quality options are represented in the short listed options. Option D is a composite product delivering a water product suitable for end user requirements, i.e. higher quality water for Lockyer Valley.

The remaining options were not progressed beyond this project stage on the basis of relative merit compared to the short list options.

7. Options short list

7.1 Overview

This section outlines the further evaluation of technical and costing aspects of the short listed options to extend and update analysis previously undertaken.

The scope included undertaking preliminary engineering design investigations for the project and comprised the following tasks:

- Summarising the short list of potential options
- Developing distribution network (pipework) infrastructure layouts reflecting the outcomes of the demand analysis and locations of registered demand
- Completing preliminary treatment plant modification design to produce the relevant water quality products, as well as preliminary hydraulic designs to size all required water supply infrastructure capacities: pump stations, rising mains, reservoirs/tanks
- Preliminary power supply investigations including grid connection and transmission works to supply major infrastructure components and potential incorporation of renewable energy supplies
- Undertaking preliminary mapping of the proposed options
- Preparing preliminary cost estimates for project budget setting purposes (for business case only)
- Providing recommendations.

7.2 Short List Options

Each of the short list options address the Problem Statements (refer Section 2.4). That is, all short listed options aim to maximise the reduction of nutrients from waterways associated with Moreton Bay and supply irrigation water to the agricultural precincts in Lockyer Valley and Darling Downs.

Options were developed based on the components of the defined long list options along with additional elements such as power supply and distribution networks to provide a comprehensive view of all infrastructure elements required to implement the delivery system. The short list options have been listed in Section 6.8 and are described in greater detail in the following sections. Additional technical details relating to each option can be found in Appendix G (Volume 2).

Process Flow Diagrams (PFDs) of the short list options are included as an attachment; refer to Appendix E (Volume 2).

7.2.1 Option A

7.2.1.1 Overview

Option A comprises largely of the components mentioned in the long list Option 1, which utilise the extent of the WCRWS infrastructure to produce 232 ML/d of PRW (i.e. to use the WCRWS in its ultimate design state for its intended purpose). It includes an upgrade to the Gibson Island AWTP to maximum production and providing additional source water via additional pipelines from Redcliffe STP, Sandgate STP and a transfer from Luggage Point STP to Gibson Island AWTP. This option also includes the construction of the Heathwood Booster PS (situated

between Kuraby and Bundamba Boosters) to increase the transfer capacity of the WCRWS to 232 ML/d.

7.2.1.2 Scope

The scope for Option A includes:

- Re-start of WCRWS including AWTPs, pipelines, tanks and pump stations
- Upgrade to Gibson Island AWTP to maximum production of PRW (100 ML/d)
- New booster pump station and transfer pipeline from Redcliffe STP to Sandgate STP
- New booster pump station and transfer pipeline from Sandgate STP to Luggage Point STP
- Upgrade to the existing Effluent Diversion pump station at Luggage Point AWTP to increase capacity to 83 ML/d
- New transfer pipeline from Luggage Point AWTP Effluent Diversion pump station to Gibson Island AWTP
- Construction of the Heathwood Booster PS (situated between Kuraby and Bundamba Boosters)
- New booster pump station at Lowood and transfer pipeline from Lowood to Gatton
- New Lockyer Valley distribution network to deliver recycled water to customers/users
- New booster pump station at Gatton and transfer pipeline from Gatton to the base of the Toowoomba Range
- New booster pump station at the base of the Toowoomba Range and transfer pipeline to the commencement of the Darling Downs distribution network (top of Toowoomba Range)
- New Darling Downs distribution network to deliver recycled water to customers/users
- Power supply upgrades to meet additional energy demand.

7.2.1.3 Key benefits and dis-benefits

- Requires significant infrastructure to increase source water to maximise WCRWS capacity
- High operating cost associated with full PRW treatment process to produce irrigation water
- WCRWS operation is consistent with its designed purpose
- Quality of water is likely to be suitable for disposal and meet end-user needs in both Darling Downs and Lockyer Valley
- Marginally reduced interruptibility due to reduced time to recommission WCRWS for Wivenhoe discharge.

7.2.1.4 Key risks

- Complex crossings in transferring source water from Redcliffe STP and Sandgate STP subject to significant approvals processes and technical feasibility.

Legend

- Option A Delivery System
- New Booster Pump Station
- New Reservoir/Tank
- STPs providing additional source water
- Western Corridor Recycled Water Scheme STPs (source water)/AWTPs
- New Delivery Pipeline
- Western Corridor Recycled Water Scheme Pipeline
- Redcliffe to Sandgate Source Water Pipeline
- Sandgate to Luggage Pt Source Water Pipeline
- Watercourse
- Railway
- State Controlled Road
- Locations
- Local Government Areas
- Water Body
- Potential Benefited Area

Redcliffe STP
(source water - 19 ML/d)
New Transfer PS

Sandgate STP
(source water - 18 ML/d)
New Transfer PS

Luggage Point STP
(source water - 126 ML/d)
Luggage Point AWTP (PRW - 66 ML/d)
Upgrade Effluent PS to 83 ML/d

Gibson Island STP (source water - 40 ML/d)
Gibson Island AWTP (PRW - 50 ML/d)
Upgrade AWTP to 100 ML/d

Bundamba STP
(source water - 15 ML/d)
Bundamba AWTP
(PRW - 66 ML/d)

Wacol STP
(source water - 5 ML/d)

Oxley STP (source water - 51 ML/d)

Goodna STP
(source water - 13 ML/d)

New Heathwood PS

New Lowood Booster PS

New Gatton Booster PS

New Toowoomba Range Balancing Storage (top of range)

New Toowoomba Range Booster PS (base of range)

To Darling Downs Distribution Network Potential Benefited Area is shown in Figure 7.6

Potential locations of distribution of offtakes

Potential locations of distribution of offtakes

WAMURAN
NINGI
SANDSTONE POINT
WOORIM
BONGAREE
CABOOLTURE
MORAYFIELD
BEACHMERE
BURPENGARY
DECEPTION BAY
NARANGBA
DAYBORO
MORETON BAY REGIONAL COUNCIL
TOOGOOLAWAH
Somerset Dam
STANLEY RIVER
ESK
SOMERSET REGIONAL COUNCIL
Wivenhoe Dam
BRISBANE RIVER
NORTH PINE RIVER
PINE RIVER
Cressbrook Creek Dam
CRESSBROOK CREEK
Perseverance Dam
Cooby Creek Dam
Splityard Creek Dam
COOMINYA
SAMFORD
MOUNT NEBO
BRANCH CREEK
Atkinson's Dam
LOWOOD
FERNVALE
Lake Manchester Dam
Gold Ck Dam
Enoggera Dam
BRISBANE
BRISBANE CITY COUNCIL
REDLAND CITY COUNCIL
Lake Clarendon
KINGSTHORPE
HIGHFIELDS
TOOWOOMBA
WITHCOTT
HELIDON
GATTON
GRANTHAM
FOREST HILL
MARBURG
WALLOON
IPSWICH
ROSEWOOD
IPSWICH CITY COUNCIL
LOCKYER VALLEY REGIONAL COUNCIL
Bill Gunn Dam
LAIDLEY
LAIDLEY CREEK
WYREEMA
HODGSON CREEK
CAMBOOYA
LOGAN RIVER
LOGAN CITY COUNCIL
GREENMOUNT
WEST HALDON
EAST HALDON
BREMER RIVER
MARRILL CREEK
HARRISVILLE
SCENIC RIM REGIONAL
JIMBOOMBA
KINGS CREEK

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Paper Size ISO A1

0 2 4 6 8

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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NUWATER PROJECT
FEASIBILITY STUDY

RECYCLED WATER DELIVERY SYSTEM - OPTION A

Project No. 41-30968
Revision No. D
Date 08/11/2017

FIGURE 7.1

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Print date: 21 Feb 2018 - 15:38

Data source: Google/Landsat/Copernicus: Imagery/2018; DNRM: LGA, Waterbody/2015; Seqwater: Layers/2017 . Created by: ACJackson

7.2.2 Option B

7.2.2.1 Overview

Option B comprises largely the components mentioned in the long list Option 2, which utilises WCRWS infrastructure with modifications to the AWTPs to produce 232 ML/d of Class A^{+} recycled water. These modifications include bypass and removal of the reverse osmosis, advanced oxidation and stabilisation processes from Luggage Point, Gibson Island and Bundamba AWTPs. Gibson Island AWTP is to be upgraded to maximum production using available source water. This option includes the construction of Heathwood Booster PS (situated between Kuraby and Bundamba Boosters) to increase the transfer capacity of the WCRWS to 232 ML/d.

7.2.2.2 Scope

The scope for Option B includes:

- Re-start of WCRWS with modifications to the AWTPs to remove and bypass the reverse osmosis, advanced oxidation and stabilisation processes. The remaining pipelines, tanks and pump stations can be re-started without modifications
- Upgrade to Gibson Island AWTP to maximum production for Class A+ water (100 ML/d)
- Construction of Heathwood Booster PS (situated between Kuraby and Bundamba Boosters)
- New booster pump station at Lowood and transfer pipeline from Lowood to Gatton
- A number of recycled water storages located in Lockyer Valley (4GL in total)
- New Lockyer Valley distribution network to deliver recycled water to customers/users
- New booster pump station at Gatton and transfer pipeline from Gatton to the base of the Toowoomba Range
- New booster pump station at the base of the Toowoomba Range and transfer pipeline to the commencement of the Darling Downs distribution network (top of Toowoomba Range)
- New Darling Downs distribution network to deliver recycled water to customers/users
- Power supply upgrades to meet additional energy demand.

7.2.2.3 Key benefits and dis-benefits

- Avoids need to increase source water capacity due to high recovery rate of Class A+ compared to PRW
- Reduced operating cost associated with modified AWTP operation
- WCRWS operated using lower quality water than its designed purpose meaning
- Quality of water is suitable to meet end-user needs in both Darling Downs and Lockyer Valley
- Additional storage capacity will be required in Lockyer Valley to receive Class A+ water and keep it separate from other water scheme assets
- Marginally increased interruptibility due to conversion from Class A+ to PRW in recommissioning WCRWS for Wivenhoe discharge.

7.2.2.4 Key risks

- Using the WCRWS to transfer a lower quality product and, more importantly, about changing from a lower quality product back to PRW, which would require revalidation and recertification, disposal of validation water and seeking approval by the relevant

government agencies. Risks relate both to time and delay of recommissioning for drought response as well as absolute approval to convert to PRW, which would be subject to approval from DEWS (along with Seqwater, Department of Health, public testing, etc.)

- Management of Class A+ water required to prevent uncontrolled release in relevant catchments.

Legend

- Option B Delivery System
- New Booster Pump Station
- New Reservoir/Tank
- Western Corridor Recycled Water Scheme STPs (source water)/AWTPs
- New Delivery Pipeline
- Western Corridor Recycled Water Scheme Pipeline
- Watercourse
- Railway
- State Controlled Road
- Locations
- Local Government Areas
- Water Body
- Potential Benefited

New Toowoomba Range Balancing Storage (top of range)

New Toowoomba Range Booster PS (base of range)

To Darling Downs Distribution Network Potential Benefited Area is shown in Figure 7.6

New Gatton Booster PS

Potential locations of distribution of offtakes

Potential locations of distribution of offtakes

New Lowood Booster PS

Luggage Point STP (source water - 126 ML/d) Luggage Point AWTP (Class A+ production)

Gibson Island STP (source water - 40 ML/d) Gibson Island AWTP (Class A+ production) Upgrade AWTP to 100 ML/d

Bundamba STP (source water - 15 ML/d) Bundamba AWTP (Class A+ production)

Wacol STP (source water - 5 ML/d)

Oxley STP (source water - 51 ML/d)

Goodna STP (source water - 13 ML/d)

New Heathwood PS

Somerset Dam

Wivenhoe Dam

Splityard Creek Dam

Atkinson's Dam

Lake Clarendon

Bill Gunn Dam

Cressbrook Creek Dam

Perseverance Dam

Cooby Creek Dam

Lake Manchester Dam

Gold Ck Dam

Enoggera Dam

TOOGOOLAWAH

ESK

COOMINYA

LOWOOD

FERNVALE

HIGHFIELDS

KINGSTHORPE

TOOWOOMBA

WITHCOTT

HELIDON

GATTON

GRANTHAM

FOREST HILL

LAIDLEY

MARBURG

ROSEWOOD

WALLOON

IPSWICH

WYREEMA

CAMBOOYA

GREENMOUNT

WEST HALDON

EAST HALDON

HARRISVILLE

JIMBOOMBA

MOUNT NEBO

SAMFORD

DAYBORO

MORAYFIELD

CABOOLTURE

BURPENGARY

NARANGBA

DECEPTION BAY

BEACHMERE

SANDSTONE POINT

BONGAREE

WOORIM

NINGI

WAMURAN

BRISBANE

SOMERSET REGIONAL COUNCIL

TOOWOOMBA REGIONAL COUNCIL

LOCKYER VALLEY REGIONAL COUNCIL

SCENIC RIM REGIONAL COUNCIL

MORETON BAY REGIONAL COUNCIL

BRISBANE CITY COUNCIL

IPSWICH CITY COUNCIL

REDLAND CITY COUNCIL

LOGAN CITY COUNCIL

GOLD COAST CITY COUNCIL

BRISBANE RIVER

STANLEY RIVER

CRESSBROOK CREEK

COOBY CREEK

NORTH PINE RIVER

PINE RIVER

BRANCH CREEK

BREMER RIVER

LOGAN RIVER

LADLEY CREEK

WARRILL CREEK

HODGSON CREEK

KINGS CREEK

Google Earth

Data SIO, NOAA, U.S. Navy, NGA, GEBCO

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Paper Size ISO A1

0 2 4 6 8

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

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NUWATER PROJECT
FEASIBILITY STUDY

RECYCLED WATER DELIVERY SYSTEM - OPTION B

Project No. 41-30968
Revision No. D
Date 08/11/2017

FIGURE 7.2

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Print date: 21 Feb 2018 - 15:38

Data source: Google/Landsat/Copernicus: Imagery/2018; DNRM: LGA, Waterbody/2015; Segwater: Layers/2017 . Created by: ACJackson

7.2.3 Option C

7.2.3.1 Overview

Option C uses WCRWS pipelines and pump stations to transport treated effluent from STPs (i.e. Class B/C recycled water), bypassing the AWTPs (long list Option 3). Due to the quality requirements in the Lockyer Valley, end-of-pipe treatment to produce Class A^+ is required for this option; this includes include treatment of concentrate produced. Additional storages are also required in the Lockyer Valley. This option also includes the construction of the Heathwood Booster PS (situated between Kuraby and Bundamba Boosters) to increase the transfer capacity of the WCRWS to 232 ML/d.

7.2.3.2 Scope

The scope for Option C shall include:

- Re-start of WCRWS pipelines, tanks and pump stations. AWTPs shall be bypassed such that treated effluent from the STPs is diverted to the PRW Treated Water Tanks and transferred to the pipelines
- Construction of the Heathwood Booster PS (situated between Kuraby and Bundamba Boosters)
- New booster pump station at Lowood and transfer pipeline from Lowood to Gatton (Lockyer Valley)
- A number of recycled water storages located in Lockyer Valley (4GL in total)
- New Class A+ Water treatment plant located in the Lockyer Valley (sized for 21 ML/d) include treatment of concentrate produced
- New Lockyer Valley distribution network to deliver recycled water to customers/users
- New booster pump station at Gatton and transfer pipeline from Gatton to the base of the Toowoomba Range
- New booster pump station at the base of the Toowoomba Range and transfer pipeline to the commencement of the Darling Downs distribution network (top of Toowoomba Range)
- New Darling Downs distribution network to deliver recycled water to customers/users
- Power supply upgrades to meet additional energy demand.

7.2.3.3 Key benefits and dis-benefits

- Avoids need to increase source water capacity due to high recovery rate of Class A+ compared to PRW
- Lowest operating cost associated with bypassing the AWTPs
- WCRWS operated using lower quality water than its designed purpose meaning
- Quality of water requires end-of-pipe treatment for users in Lockyer Valley
- Marginally increased interruptibility due to conversion from Class B/C to PRW in recommissioning WCRWS for Wivenhoe discharge (less time than Option B as the AWTPs are bypassed rather than modified in this option)

7.2.3.4 Key risks

- Using the WCRWS to transfer a lower quality product and, more importantly, about changing from a lower quality product back to PRW, which would require revalidation and recertification, disposal of validation water and seeking approval by the relevant government agencies. Risks relate both to time and delay of recommissioning for drought

response as well as absolute approval to convert to PRW, which would be subject to approval from DEWS (along with Seqwater, Department of Health, public testing, etc.)

- Management of Class B/C water required to prevent uncontrolled release in relevant catchments.

Legend

- Option C Delivery System
- New Booster Pump Station
- New Reservoir/Tank
- Western Corridor Recycled Water Scheme STPs (source water)/AWTPs
- New Delivery Pipeline
- Western Corridor Recycled Water Scheme Pipeline
- Watercourse
- Railway
- State Controlled Road
- Locations
- Local Government
- Water Body
- Potential Benefited

WAMURAN
NINGI
SANDSTONE POINT
WOORIM
BONGAREE
CABOOLTURE
MORAYFIELD
BEACHMERE
BURPENGARY
DECEPTION BAY
NARANGBA
DAYBORO
MORETON BAY REGIONAL COUNCIL
TOOGOOLAWAH
STANLEY RIVER
Somerset Dam
ESK
SOMERSET REGIONAL COUNCIL
Wivenhoe Dam
BRISBANE RIVER
NORTH PINE RIVER
PINE RIVER
CRESSBROOK CREEK
Cressbrook Creek Dam
Perseverance Dam
TOOWOOMBA REGIONAL COUNCIL
COOBY CREEK
Cooby Creek Dam
Splityard Creek Dam
SAMFORD
MOUNT NEBO
COOMINYA
BRANCH CREEK
Atkinson's Dam
New Lowood Booster PS
FERNVALE
LOWOOD
Potential locations of distribution of offtakes
Gold Ck Dam
Enoggera Dam
Lake Manchester Dam
BRISBANE
BRISBANE CITY COUNCIL
Luggage Point STP (source water - 126 ML/d)
Luggage Point AWTP (bypass, Class B/C)
Gibson Island STP (source water - 40 ML/d)
Gibson Island AWTP (bypass, Class B/C)
New Toowoomba Range Balancing Storage (top of range)
HIGHFIELDS
KINGSTHORPE
New Toowoomba Range Booster PS (base of range)
New Gatton Booster PS
Lake Clarendon
To Darling Downs Distribution Network Potential Benefited Area is shown in Figure 7.6
WITHCOTT
HELIDON
GATTON
TOOWOOMBA
GRANTHAM
Potential locations of distribution of offtakes
FOREST HILL
MARBURG
WALLOON
IPSWICH
ROSEWOOD
LAIDLEY
Bill Gunn Dam
Bundamba STP (source water - 15 ML/d)
Bundamba AWTP (bypass, Class B/C)
Wacol STP (source water - 5 ML/d)
Oxley STP (source water - 51 ML/d)
Goodna STP (source water - 13 ML/d)
New Heathwood PS
IPSWICH CITY COUNCIL
REDLAND CITY COUNCIL
LOGAN RIVER
WYREEMA
HODGSON CREEK
CAMBOOYA
LOCKYER VALLEY REGIONAL COUNCIL
LAIDLEY CREEK
BREMER RIVER
GREENMOUNT
WEST HALDON
EAST HALDON
WARRILL CREEK
HARRISVILLE
SCENIC RIM REGIONAL
LOGAN CITY COUNCIL
GOLD COAST CITY COUNCIL
JIMBOOMBA
KINGS CREEK
Google Earth
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat / Copernicus

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Paper Size ISO A1

0 2 4 6 8

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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NUWATER PROJECT
FEASIBILITY STUDY

RECYCLED WATER DELIVERY SYSTEM - OPTION C

Project No. 41-30968
Revision No. D
Date 08/11/2017

FIGURE 7.3

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Print date: 21 Feb 2018 - 15:38

Data source: Google/LandsatCopernicus: Imagery/2018; DNRM: LGA, Waterbody/2015; Sequwater: Layers/2017 . Created by: ACJackson

7.2.4 Option D

7.2.4.1 Overview

Option D consists of separate systems for the Locker Valley and Darling Downs, due to their differing requirements in terms of quality of recycled water (long list Option 6).

The Lockyer Valley component of this option uses WCRWS infrastructure to produce 116 ML/d of PRW from Luggage Point and Gibson Island AWTPs only (excluding Bundamba AWTP). This also includes a new booster PS at Lowood and new pipeline from Lowood Booster PS to Gatton.

Lower quality product water obtained by bypassing the Bundamba AWTP and servicing Darling Downs demand does not use any WCRWS infrastructure. A new pipeline from the intake at Bundamba AWTP to Lowood Booster PS will be constructed (i.e. using the source water for Bundamba AWTP) which will transfer 84 ML/d to Lowood. A new booster PS will be required at Lowood (separate to the PS required for the Lockyer Valley component described above), which will also take the proportion of PRW exceeding the demand in Lockyer Valley (total of 179 ML/d) and deliver to Darling Downs.

7.2.4.2 Scope

The scope for Option D shall include:

- Re-starting of the Luggage Point and Gibson Island AWTPs only (excluding Bundamba AWTP), including the pipelines, tanks and pump stations
- New booster pump station at Lowood and transfer pipeline from Lowood to Gatton
- New booster pump station at Lowood and transfer pipeline from Lowood to Gatton
- New Lockyer Valley distribution network to deliver recycled water to customers/users
- New booster pump station and transfer pipeline from Bundamba AWTP intake to Lowood
- New booster pump station at Gatton and transfer pipeline from Gatton to the base of the Toowoomba Range
- New booster pump station at the base of the Toowoomba Range and transfer pipeline to the commencement of the Darling Downs distribution network (top of Toowoomba Range)
- New Darling Downs distribution network to deliver recycled water to customers/users
- Power supply upgrades to meet additional energy demand.

7.2.4.3 Key benefits and dis-benefits

- WRCWS infrastructure upgrades not required beyond recommissioning works (not including Bundamba AWTP
- Avoids need to increase source water capacity due to high recovery rate of Class A+ compared to PRW
- WCRWS operation is consistent with its designed purpose
- Quality of water will meet end-user needs in both Darling Downs and Lockyer Valley, although management of Class B/C water to prevent uncontrolled release required in Darling Downs
- WCRWS operated using lower quality water than its designed purpose meaning
- Marginally reduced interruptibility due to minimal works required to recommission WCRWS to PRW delivery (coastal AWTPs are operating, Bundamba AWTP is bypassed rather than modified in this option)

- Although Darling Downs customers/users are able to accept Class B/C, due to the product mix, they will receive a significant proportion of PRW in the product water and associated increased operational costs.

7.2.4.4 Key risks

- Management of Class B/C water required to prevent uncontrolled release required in Darling Downs.

Legend

- Option D - PRW Delivery System
- Option D - Class B/C Delivery System
- New Booster Pump Station
- New Reservoir/Tank
- Western Corridor Recycled Water Scheme STPs (source water)/AWTPs
- New Delivery Darling Downs
- New Delivery Lockyer Valley
- Western Corridor Recycled Water Scheme Pipeline
- Watercourse
- Railway
- State Controlled Road
- Location
- Local Government Areas
- Water Body
- Potential Benefited Area

WAMURAN
NINGI
SANDSTONE POINT
WOORIM
BONGAREE
CABOOLTURE
MORAYFIELD
BEACHMERE
BURPENGARY
DECEPTION BAY
NARANGBA
DAYBORO
MORETON BAY REGIONAL COUNCIL
TOOGOOLAWAH
Somerset Dam
STANLEY RIVER
ESK
SOMERSET REGIONAL COUNCIL
Wivenhoe Dam
BRISBANE RIVER
NORTH PINE RIVER
PINE RIVER
CRESSBROOK CREEK
Cressbrook Creek Dam
Perseverance Dam
COOBY CREEK
Cooby Creek Dam
Splityard Creek Dam
COOMINYA
SAMFORD
MOUNT NEBO
BRANCH CREEK
Atkinson's Dam
New Lowood Booster PS (PRW)
New Lowood Booster PS (Class B/C)
FERNVALE
Gold Ck Dam
Enoggera Dam
Lake Manchester Dam
BRISBANE
BRISBANE CITY COUNCIL
Luggage Point STP (source water - 126 ML/d)
Luggage Point AWTP (PRW - 66 ML/d)
Gibson Island STP (source water - 40 ML/d)
Gibson Island AWTP (PRW - 50 ML/d)
Potential locations of distribution of offtakes
New Gatton Booster PS (PRW)
New Gatton Booster PS (Class B/C)
Lake Clarendon
LOWOOD
New Lowood Balancing Storage for duplicate Class B/C line
New Toowoomba Range Balancing Storage (top of range)
HIGHFIELDS
KINGSTHORPE
New Toowoomba Range Booster PS (base of range)
To Darling Downs Distribution Network Potential Benefited Area is shown in Figure 7.6
TOOWOOMBA
WITHCOTT
HELIDON
GATTON
GRANTHAM
Potential locations of distribution of offtakes
FOREST HILL
LAIDLEY
Bill Gunn Dam
MARBURG
WALLOON
IPSWICH
ROSEWOOD
Bundamba STP (source water - 15 ML/d)
Bundamba AWTP (bypass, Class B/C)
Wacol STP (source water - 5 ML/d)
Oxley STP (source water - 51 ML/d)
Goodna STP (source water - 13 ML/d)
IPSWICH CITY COUNCIL
BREMER RIVER
REDLAND CITY COUNCIL
LOGAN RIVER
LOCKYER VALLEY REGIONAL COUNCIL
LAIDLEY CREEK
HODGSON CREEK
CAMBOOYA
WYREEMA
GREENMOUNT
WEST HALDON
EAST HALDON
KINGS CREEK
WARRILL CREEK
HARRISVILLE
LOGAN CITY COUNCIL
GOLD COAST CITY COUNCIL
JIMBOOMBA
SCENIC RIM REGIONAL CO

Google Earth
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat / Copernicus

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Paper Size ISO A1

0 2 4 6 8

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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NUWATER PROJECT
FEASIBILITY STUDY

RECYCLED WATER DELIVERY SYSTEM - OPTION D

Project No. 41-30968
Revision No. D
Date 08/11/2017

FIGURE 7.4

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Print date: 21 Feb 2018 - 15:38

Data source: Google/Landsat/Copernicus: Imagery/2018; DNRM: LGA, Waterbody/2015; Sequater: Layers/2017. Created by: ACJackson

7.3 Additional project elements

The following elements of the each project are generally common and were evaluated in greater detail as part of the short list options review.

7.3.1 Distribution infrastructure for product water

A demand assessment (refer Appendix C (Volume 2)) was completed in determining the service needs for the project, and survey and modelling work to identify and quantify demand for irrigation water in each of the Lockyer Valley and Darling Downs agricultural areas.

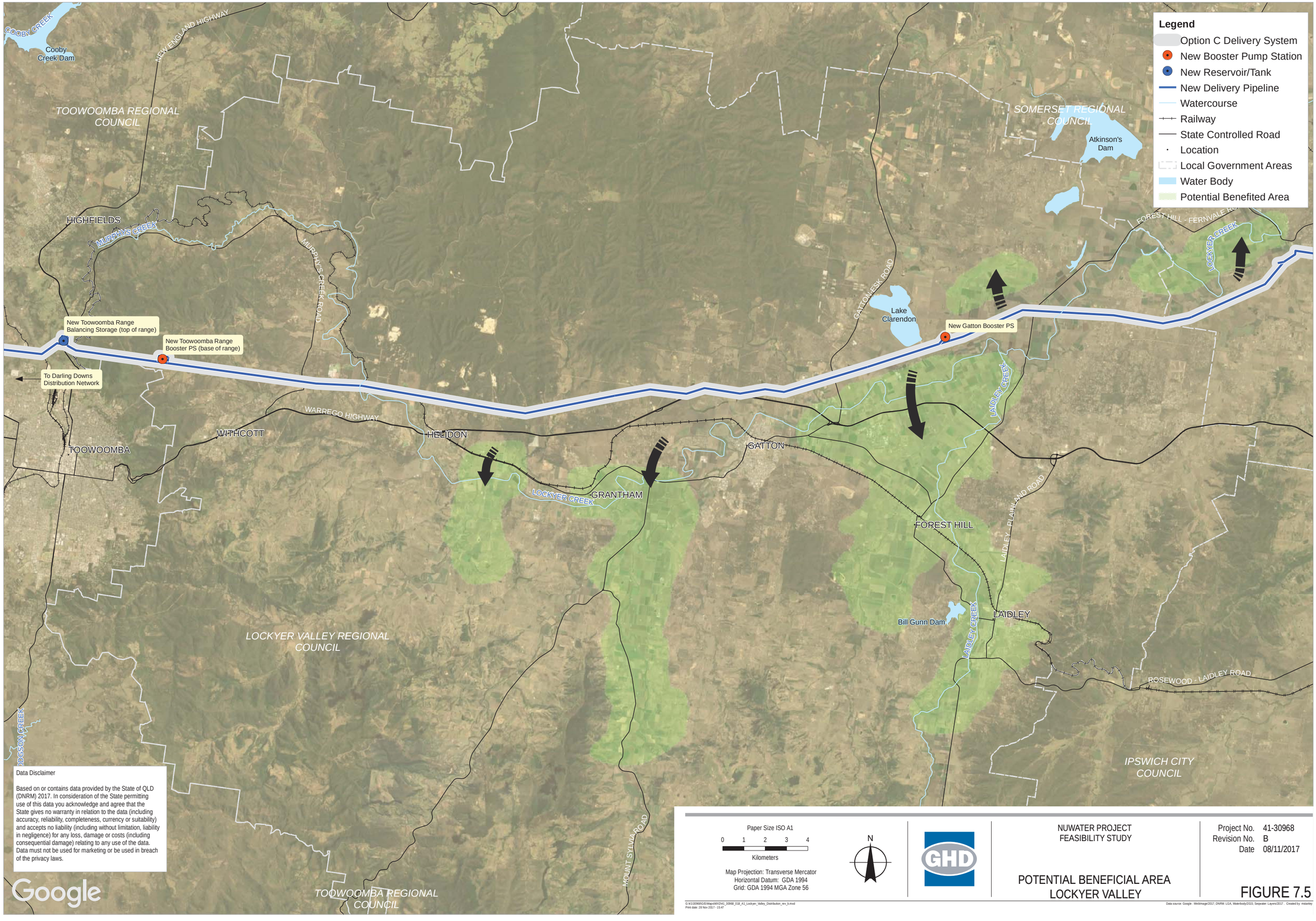
This identified and substantiated varying degrees of demand in each of the subject agricultural areas. In summary, it concluded:

- Estimates of a total water use in the Lockyer Valley for agricultural production have been estimated to be around 60,000 ML per annum, with around 44,000 ML (73 per cent) sourced from unregulated groundwater resources
- Potential additional demand in the Lockyer Valley was estimated to be 7,500 ML per annum, with this increasing to 25,000 ML per annum under a scenario in which groundwater resources become regulated and subject to volumetric allocations
- Survey responses received on the Darling Downs identified a demand of over 46,000 ML across a range of locations, quantities and water prices. Based on demand analysis outcomes, a significantly greater demand is estimated beyond specific survey responses.

Based on the outcomes of this work, potential distribution networks for each area were devised to enable cost estimation and high level consideration of the impacts of infrastructure construction and operation. In determining the distribution networks for each area, the following points are noted:

- The Lockyer Valley distribution system, in delivering just 7,500 ML per annum, represents a relatively small portion of the overall distribution network. The majority of flow is delivered to the Darling Downs.
- Registered demand in the Darling Downs covered an extensive area from the upper reaches of the Condamine River and west to Chinchilla. The network devised to distribute flow to the Darling Downs focused on an efficient delivery network delivering flow to a smaller irrigation area (relative to the area comprising all registered interest) to reflect a more sustainable development approach for the irrigation system.
- Details of the relevant networks have not been presented at this stage as the actual distribution system will be designed reflective of detailed interest from potential customers and efficient design practices.

Figures displaying the potential benefitted areas are included for the Lockyer Valley (Figure 7-5) and Darling Downs (Figure 7-6).



Data Disclaimer

Based on or contains data provided by the State of QLD (DNRM) 2017. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

Paper Size ISO A1

0 1 2 3 4

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

NUWATER PROJECT
FEASIBILITY STUDY

POTENTIAL BENEFICIAL AREA
LOCKYER VALLEY

Project No. 41-30968
Revision No. B
Date 08/11/2017

FIGURE 7.5

G:\41\30968\GIS\Maps\MXD\41_30968_018_A1_Lockyer_Valley_Distribution_rev_b.mxd
Print date: 28 Nov 2017 - 15:47

Data source: Google - Webimage2017; DNRM: LGA, Waterbody2015; Sepwater: Layers2017 . Created by: mstanley

Legend

- Option C
- New Booster Pump Station
- New Reservoir/Tank
- Distribution Pipeline
- Western Corridor Recycled Water Scheme Pipeline
- Railway
- Watercourse
- State Controlled Road
- Locations
- Local Government Areas
- Water Body
- Potential Benefited

DALBY
MYALL CREEK
WESTERN DOWNS REGIONAL COUNCIL
OAKEY CREEK
CONDAMINE RIVER
OAKEY
GOO
COOBY CREEK
HIGHFIELDS
MURPHYS CREEK
KINGSTHORPE
New Toowoomba Range Balancing Storage (top of range)
New Toowoomba Range Booster PS (base of range)
TOOWOOMBA REGIONAL COUNCIL
CECIL PLAINS
CONDAMINE RIVER (NORTH BRANCH)
TOOWOOMBA
WITHCOTT
LOCKYER VALLEY REGIONAL COUNCIL
WYREEMA
HODGSON CREEK
CAMBOOYA
PITTSWORTH

Paper Size ISO A1

0 1 2 3 4 5

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

NUWATER PROJECT
FEASIBILITY STUDY

POTENTIAL BENEFICIAL AREA
DARLING DOWNS

Project No. 41-30968
Revision No. B
Date 08/11/2017

FIGURE 7.6

G:\41\30968\GIS\Maps\MXD\41_30968_018_A1_Darling_Downs_Distribution_rev_b.mxd
Print date: 28 Mar 2018 - 08:12

Data source: Google : WebImage2017; DNRM: LGA, Waterbody2015; Seqwater: Layers2017 . Created by: ACJackson

7.3.2 Centralised and decentralised (on-farm) storage

It has been noted that significant on-farm storage capacity exists on the central Darling Downs, estimated at around 300,000 ML (of which only about 50% is actively used on an annual basis, i.e. water reforms in the Murray Darling Basin and access to groundwater resources has resulted in reduced access to water for irrigation use resulting in significant existing over capacity with regard to on-farm water storage). A key assumption of the project is that the necessary 24 hours a day, 365 days a year nature of the schemes operation is well suited to servicing the Darling Downs by taking advantage of local storage infrastructure. The ability to utilise available air space in these storages will enable continual acceptance of flow, which is necessary to realise the benefits to Moreton Bay; if the system were to be operated intermittently (i.e. not continual), it would be necessary to discharge treated wastewater to waterways consistent with current operations. Given the storages are part of farm operations and essentially operate as a closed system (i.e. usually with tailwater returns as part of irrigation works) this is suited to all product water qualities provided the potential for release to the environment is well controlled and managed.

Similar storage capacity exists in the Lockyer Valley as part of the Central Lockyer Water Supply Scheme (refer Section 5.3.4). This is complicated by the connection of these storages to downstream waterways including Lockyer Creek, Brisbane River and the raw water intake for the Mt Crosby Water Treatment Plant. As such, the capacity for these storages to be used for storage of water qualities other than PRW will be impacted as the use of these storages effectively represent an effluent discharge. In the case of PRW, given the significant operational cost associated with its production and its extremely high water quality standard, the prospect of discharging this water to the environment and mixing with surface waters of variable water quality seems inconsistent with sustainability objectives.

To address the issue of managing the effective delivery of water and need for storage infrastructure specific to the water products investigated, a number of independent storages have been included as part of the indicative distribution infrastructure system. These are nominally 1GL earthen storages to be located as a central point of distribution in demand areas. The storages have been included for Class A+ and Class B/C water products only, with the view that the PRW could be mixed with on-farm waters of any quality with little impact on appropriate end uses.

7.3.3 Power consumption and supply

Investigation into potential power supply options included the following:

- Supply of power from the grid
- Solar photovoltaic (PV) generation to offset grid purchases
- Wind generation to offset grid purchases
- Diesel generation to offset grid purchases
- Battery storage in combination with solar PV to increase renewable penetration.

A summary of the investigation of power supply options has been included in Appendix J (Volume 2). The investigation identified the following in respect of the above alternatives:

- The two pump station locations with large enough loads to justify behind-the-meter wind farms are Gatton and the Toowoomba Range. The smaller nature of the remaining sites would likely make a wind project cost-prohibitive as the individual installation costs would be far higher than a typical large-scale wind farm

- Desktop assessment of the wind resource in the vicinity of the two sites indicate that wind power is unlikely to be favourable in this area, and so is unlikely to be favourable as a behind-the-meter option
- Diesel power generation is typically more expensive that purchasing power from the grid, and usually advantageous if connecting to the grid is not an option (i.e. remote sites). Grid connection is possible in this case
- Hydro power opportunities directly linked to project infrastructure, including pumped hydro and mini-hydro applications, were reviewed with limited opportunity identified associated with the transfer pipeline due to the 24-hour pumping requirement of the scheme. An investigation into the potential benefits of a mini-hydro power turbine located on the gravity section delivering product water west of the Toowoomba Range (towards Darling Downs) was conducted. This indicated the additional upfront capital cost associated with increasing the pipe diameter along with the turbine and power transmission infrastructure significantly outweighed the long term revenue generated from the energy produced.
- In terms of other hydro power generation opportunities, it is noted that the introduction of hydro-power would be a stand-alone arrangement and would be compared with other potential power sources. Based on the significant installation costs and that no obvious sites were identified (Split-Yard Creek was viewed to be fully utilised), other forms of renewable energy were viewed to present a more cost-effective opportunity.
- Power supply from the grid is feasible for all sites despite the significant new loads imposed by the major booster pump stations at Gatton and the base of the Toowoomba Range.
- It is noted that the electricity tariff is a key factor in the cost of operating a load as large as that being considered in this study. Large industrial power consumers are often able to negotiate better tariffs than a typical consumer, especially when the load is consistent or predictable. This is typically addressed on a case-by-case basis with electricity retailers and would be considered in detail as part of future project phases
- Installation of solar PV 'behind-the-meter' at the pump station sites was considered along with grid supply and the addition of lithium ion battery storage to determine the optimum arrangement (lowest net present cost) of power generation infrastructure. Examples of the outcomes of the assessment of this review are included in Figure 7-7 and Figure 7-8 below.
- The potential revenue case (refer Figure 7-8) takes into account revenue from power generated in excess of the direct pump station demand, with an allowance of approximately $40/MWh for Large-scale Generation Certificates (LGCs) and a feed-in tariff rate of $40/MWh for electricity sold to the grid. It is noted that revenue generated from LGCs is expected to diminish over time as renewable capacity approaches the Renewable Energy Target prior to being fully phased out in 2030.
- The amount of solar PV installed in the configurations selected through the optimisation process was approximately 150% of the maximum load for the 'no revenue' case and approximately 450% of the maximum load for the potential revenue case.
- Despite the lowest lifecycle cost/net present cost (NPC) option for the potential revenue case being at 69 MW installed PV, the NPC line is almost flat from approximately 30 MW onward (for the example case provided above). This indicates that there is potential to increase capital costs and further drive down operational costs with a greater amount of installed PV. This would be subject to further investigation and assessment of the sensitivity of potential LGCs and feed-in tariff revenue.
- The approximate CAPEX for the solar PV installations identified for the new delivery pump stations (delivering from WCRWS) was estimated to be $99M for the 'no revenue' case

(total of 49MW achieving 32% renewables penetration) and around $285M for the 'potential revenue' case (142MW achieving 61-62% renewables penetration). Note this does not include transmission line connections to enable energy to be supplied back to the grid. Further assessment was completed to identify the amount of solar PV required to fully offset the projects energy needs. For a nominal overall power demand of 60 MW, it was found that a 550 MW facility, assuming the potential revenue case, representing an approximate Capex of $1.1B, would essentially offset the projects energy supply costs and solar farm operating costs through revenue generated by renewable energy. This is achieved through a combination of offsetting high power purchase prices with renewable energy during daylight hours, and by generating revenue through sale of excess electricity to offset power costs at other times.

- The aforementioned offsetting of operating and power costs is heavily dependent on the potential revenue streams arising from feed-in tariffs and the sale of Largescale Generation Certificates (LGCs). Changes to these revenue streams or changes within these commodity markets presents a risk to a power generation project of this size. Large power generation projects typically mitigate these risks through contracting arrangements, such as a Power Purchase Agreement (PPA) with a retailer. This has not been considered in this assessment, but would need be investigated if this concept is taken further.
- It is noted that the assumed revenue estimates (feed-in tariffs) from excess power, in addition to tariffs for grid supply, could be subject to significant variation dependent on commercial negotiation with relevant energy supplier/s.

For the purposes of this options assessment, the 'potential revenue' case was adopted, which represents the best NPC outcome in supplying power to the new pump stations.

Figure 7-7 CAPEX, OPEX and NPC trade-off – Gatton PS example– no revenue case

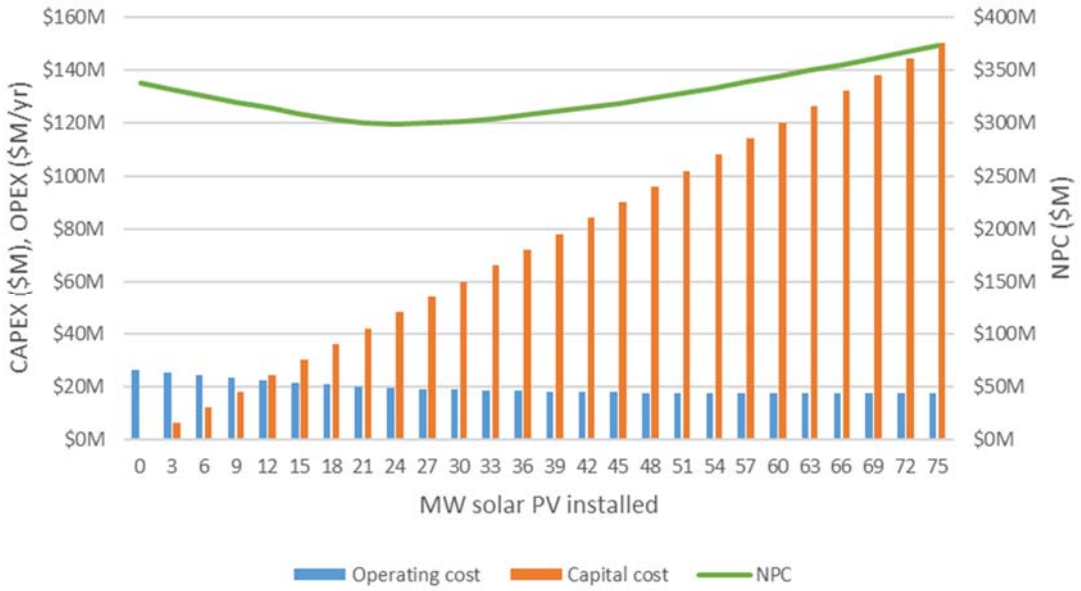
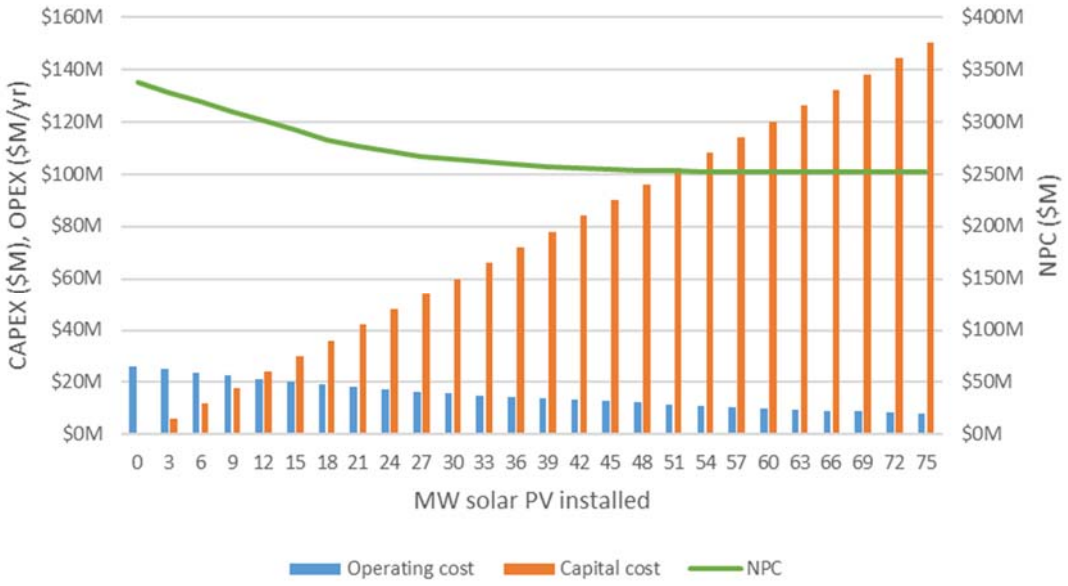


Figure 7-8 CAPEX, OPEX and NPC trade-off – Gatton PS example– potential revenue case



8. Social impact evaluation

8.1 Social benefits and impact considerations

Social impact considerations include:

- Identification of the study area
- Preparation of a social baseline
- High level identification of potential social benefits and impacts arising from the construction and operation of the project.

The information sourced to prepare the baseline and identify benefits and impacts include:

- Project description for each of the options
- Land use maps
- Environmental impact assessment report prepared for this preliminary business case
- Stakeholder engagement undertaken for the options analysis.

8.2 Social baseline

8.2.1 Study area

The study area includes two separate areas based on the phase of the project:

- Construction study area – the options footprint and areas within proximal to the footprint. This includes Brisbane City Council LGA, Moreton Bay Regional Council LGA, Somerset Regional Council LGA, Lockyer Valley Regional Council LGA, and Toowoomba Regional Council LGA
- Operations
  - the distribution area for the project, which includes Lockyer Valley and Toowoomba regional councils
  - the area that the water will be removed from, which includes the Moreton Bay Regional Council, which would see the removal of significant volumes of recycled water, which is currently (October 2017) released to Moreton Bay.

8.2.2 Regional development

The regional development baseline has considered the potential distribution areas and the source area, which as stated above, would benefit through the removal of recycled water release to Moreton Bay.

The regional councils within the distribution area are largely agricultural, with the exception of Toowoomba, which has a significant services industry to meet the needs of the region's agricultural sector. The distribution area regional development summary is provided in Table 8-1.

Table 8-1 Regional development summary

LGA	Regional development summary
Lockyer Valley	• Largest industry: agriculture, forestry and fishing (18% or 2,228 employees in 2016)[25] • The LGA accounts for approximately 28% of SEQ's agricultural production • Economic development within the region is focused on broadening the agricultural market base and diversifying the product base[26]. • The *Lockyer Valley Regional Food Sector Strategy* notes that reliability of water supply is key challenge for agricultural growth in the region, making long-term planning and investment decisions commercially risky[27]
Toowoomba	• Largest industry: construction (14% or 5,219 in 2016)[28] • Population and economic activity is concentrated in Toowoomba, which provides services and support to the broader regional economy. Agriculture continues to play an important economic role, contributing approximately 9.4% of Queensland's agricultural value-add[29]. • The need for adequate water infrastructure for the range of users was noted in the *Toowoomba Regional Community Plan – Mid Term Review[30].*
Western Downs Regional Council	• Largest industry: agriculture, forestry and fishing (18% or 3,412 employees in 2016)[31] • According to the *Economic Development 2017-2022 Strategy, k*ey economic drivers in terms of the agricultural industry over the next five years within this region include investment in broad acre cropping and intensive livestock. Consequently, access to water is recognised as core to economic development.[32]

[25] .idcommunity. 2017. *Lockyer Valley Regional Council Employment by industry (Total).* http://economy.id.com.au/lockyer-valley/employment-by-industry
[26] Lockyer Valley Regional Council. 2013. *Economic Development Plan.* http://www.lockyervalley.qld.gov.au/our-region/economic-and-regional-development/Documents/Economic%20and%20Development/lockyer%20valley%20economic%20development%20plan%20final.pdf
[27] Lockyer Valley Regional Council. 2013. *Lockyer Valley Regional Food Sector Strategy.* http://www.lockyervalley.qld.gov.au/our-region/economic-and-regional-development/Documents/Economic%20and%20Development/lockyer%20valley%20regional%20food%20sector%20strategy%20final.pdf
[28] ABS, 2017. *2016 Census.* http://www.censusdata.abs.gov.au/census_services/getproduct/census/2016/communityprofile/LGA36910?opendocument
[29] Toowoomba Regional Council, 2015, 'Toowoomba Regional Council Economic Profile', http://www.tr.qld.gov.au/community-business/business-support/economic-development/7260-economic-profile
[30] Toowoomba Regional Council, 2014. *Toowoomba Regional Community Plan – Mid Term Review.* http://www.tr.qld.gov.au/about-council/council-governance/plans-strategy-reports/3092-community-plan
[31] .idcommunity. 2017. *Western Downs Regional Council Employment by industry (Total).* http://economy.id.com.au/western-downs/employment-by-industry
[32] Western Downs Regional Council. 2017. *Economic Development 2017-2022 Strategy.* http://www.wdrc.qld.gov.au/wp-content/uploads/2017/05/Economic-Development-Strategy-2017-2022.pdf

LGA	Regional development summary
	• Community planning was last undertaken during 2009 and projected strong population and economic growth based on resource sector development in the Surat Basin[33]. • Community growth was noted within the *Western Downs Community Plan 2050* to be reliant on reliable water supply across the region[34].
Darling Downs Regional Plan[35]	• The *Darling Downs Regional Plan* covers the Toowoomba Regional Council Area and the Western Downs Regional Council area. • Economically, the Plan identifies the State's interest in enabling opportunities for economic growth and diversity, in particular through identifying infrastructure outcomes that will drive economic growth. • Priority outcomes for water resources include improving security and reliability of community water supplies in the region and their preparedness for future industry and population growth.
South East Queensland Regional Plan[36]	• The *SEQ Regional Plan* covers the Brisbane City Council, Ipswich City Council, Moreton Bay Regional Council, Lockyer Valley Regional Council, and Toowoomba Regional Council (urban extent) areas (as relevant to this project). • Economically, the Plan identifies the State's interest in enabling opportunities for economic growth and diversity, in particular through identifying infrastructure outcomes that will drive economic growth. • Managing impacts on Moreton Bay identified as key to developing the regional sustainability.

Moreton Bay hosts a significant commercial fishing industry, including the Moreton Bay otter trawl fishery and about 60 commercial fishers[37], making Moreton Bay one of the most commercial fishery areas in the state[38]. Any impacts on the sustainability of commercial fishing in this area has flow on effects to a range of businesses and that forward and backward linkages with the Moreton Bay commercial fishing sector. Consequently, increasing the health and resilience of waterways anad coastal areas is a core component of the *Moreton Bay Regional Community Plan 2011-2021[39].*

[33] Western Downs Regional Council. 2009. *Western Downs 2050 Community Plan.* http://www.wdrc.qld.gov.au/wp-content/uploads/2015/09/WD2050-Community-Plan.pdf
[34] *Ibid.*
[35] DSDIP, 2013. *Darling Downs Regional Plan.* https://dilgpprd.blob.core.windows.net/general/darling-downs-regional-plan.pdf
[36] State of Queensland, 2017. *Shaping SEQ: South East Queensland Regional Plan 2017.* https://dilgpprd.blob.core.windows.net/general/shapingseq.pdf
[37] Murphy, S. 2016. "Recreational fishing sector pushes for ban on commercial net fishing near major centres" *ABC News.* http://www.abc.net.au/news/2016-11-18/recreational-fishing-sector-pushes-net-fishing-ban-major-centres/8033432 Murphy, S. 2016."Recreational fishing sector pushes for ban on commercial net fishing near major centres" *ABC News.* http://www.abc.net.au/news/2016-11-18/recreational-fishing-sector-pushes-net-fishing-ban-major-centres/8033432
[38] SEQCatchments. 2015. "Fisheries" *SEQ Catchments.* http://www.naturalassetsseqyoursay.com.au/seq-nrm-plan-beneficiaries/fisheries
[39] Moreton Bay Regional Council. 2011. *Moreton Bay Regional Community Plan 2011-2021.* https://www.moretonbay.qld.gov.au/uploadedFiles/common/publications/Community-plan-2021-published-document-Full-version-FINAL.pdf

In addition, Moreton Bay's tourism and recreational values (discussed in Section 8.2.3) have considerable economic value: for example, tourism value add in the Moreton Bay Regional Council in 2015-16 equated to approximately $353 million[40].

8.2.3 Amenity and recreational value of Moreton Bay

Moreton Bay holds significant amenity and recreational values both for the local population, SEQ residents and more broadly.

The amenity values of Moreton Bay is one of the SEQ's greatest assets and contributes to the tourism industry and quality of life[41]. These values extend from beachscapes and ocean views to underwater heritage and marine life.

Moreton Bay hosts a range of recreational activities, including recreational fishing, leisure boating (e.g. motorised and yacht), swimming, and marine life watching. Recreational fishing is one of the most prevalent recreational activities in SEQ, with around 15.5% of the SEQ involved in recreational fishing in 2012[42], and a large number of fishing competitions are held in the Bay.

The mixture of scenic, natural and recreational values within Moreton Bay results in significant tourism value and activities, as discussed in Section 8.2.2. The Moreton Bay Marine Park is the most visited park by domestic tourists in Queensland[43].

8.2.4 Amenity – construction area

The construction footprint and immediate surrounds (construction area) were reviewed in order to understand the amenity impacts for each regional council area. The existing amenity and receptors are outlined at a high level in Table 8-2.

Table 8-2 Amenity and sensitive receptors

Local government area	Amenity and sensitive receptors[44]
Moreton Bay Regional Council	The construction area is largely placed over wetlands, waterways and native vegetation areas. There is a small area of low density residential development along the banks of the North Pine River, with reasonable amenity values. The construction area intercepts a number of areas that may be considered by the community to have amenity, recreation and conservation values, including Hays Inlet Conservation Park and Michael Island.
Brisbane City Council	The construction area intersects a range of land uses, including industrial, grazing, conservation areas, transport corridors and residential areas. Where the project intersects residential areas, the density is generally low to medium, as is typical of much of SEQ's urban character.

[40] REMPLAN. 2017. "Moreton Bay Region Tourism Value Add". *Moreton Bay Economy Profile.* http://www.economyprofile.com.au/moretonbay/tourism/value-added
[41] SEQCatchments. 2015. "Tourism" *SEQ Catchments*. http://www.naturalassetsseqyoursay.com.au/seq-nrm-plan-beneficiaries/tourism
[42] SEQCatchments. 2015. "Fisheries" *SEQ Catchments.* http://www.naturalassetsseqyoursay.com.au/seq-nrm-plan-beneficiaries/fisheries
[43] SEQCatchments. 2015. "Tourism" *SEQ Catchments*. http://www.naturalassetsseqyoursay.com.au/seq-nrm-plan-beneficiaries/tourism
[44] Queensland Government, 2015. *Queensland Land Use Mapping Program.* *https://www.qld.gov.au/environment/land/vegetation/mapping/qlump*

Local government area	Amenity and sensitive receptors[44]
	The construction area intercepts or is proximal to a number of areas that may be considered by the community to have amenity, recreation and conservation values, including Third Lagoon, Albert Edward Paddon Park, Pinkenba Recreational Reserve, Belmont Hills Reserve, Mount Petrie, and Karawatha Forest.
Ipswich City Council	The construction area intersects a range of land uses, including industrial, grazing, conservation areas, transport corridors and residential areas. Where the project intersects residential areas, the density is generally low to medium, as is typical of much of SEQ's urban character. The construction area intercepts or is proximal to a number of areas that may be considered by the community to have amenity, recreation and conservation values, including Leslie Park, Czarnecki Park, Richardson Park, Kholo Botanical Gardens, Walter Zimmerman Park.
Somerset Regional Council	The construction area generally intercepts areas used for native vegetation, recreation, and public services, and large areas of agricultural land. The limited areas of residential land it is proximal to are low density, and in some cases rural residential or large lots. The construction area intercepts or is proximal to a number of areas that may be considered by the community to have amenity, recreation and conservation values, including Lowood recreational reserve and the Lowood golf course.
Lockyer Valley Regional Council	The construction area generally intercepts areas used for native vegetation, and public services, and large areas of agricultural land. The limited areas of residential land it is proximal to are low density, and in some cases rural residential or large lots. The construction area intercepts or is proximal to a number of areas that may be considered by the community to have amenity, recreation and conservation values, including White Mountain Forest Reserve.
Toowoomba Regional Council	The construction area generally intercepts areas used for native vegetation, and public services, and large areas of agricultural land. The limited areas of residential land it is proximal to are low density, and in some cases rural residential or large lots. There are limited areas of amenity, recreation or conservation values proximal to the construction area.

8.2.5 Community views on recycled water

Attitudes to recycled water in Australia appear to generally be related to end-use, with:

- Low acceptance of recycled water for high personal contact uses (e.g. drinking, bathing)
- High acceptance for low personal contact uses (e.g. watering the garden, toilet flushing)[45]. For example, Toowoomba voted against the development of a water recycling plant. Public opposition to the development was led by the community group 'Citizens Against Drinking Sewage' dominated national media[46].

The use of water for agriculture has been established in a number of other areas (e.g. Werribee); however, as the end use is within the mid-range (that is, it is used to water crops which is a low personal contact use, but may be consumed, which is a high personal contact use), general community acceptance is can range between 60-80%[47]. However, it has generally been found that agricultural users are more likely to accept the use of recycled water for agricultural uses[48].

No direct consultation or engagement with end users was undertaken as part of this project. Consequently, there is potential that the views of end users may differ to the more general discussion provided in this report.

8.3 Social benefits and impacts

Table 8-3 provides a summary of social benefits and impacts for each of the options. The social indicators used to assess social impacts during the potential construction and operation phase for each of the options are:

- Regional development
- Sustained amenity and recreational value of Moreton Bay
- Impacts of land requirement on properties and landholders
- Impacts of amenity changes on landholders and community.

[45] Hurlimann, A and Dolnicar, S. 2010. *Acceptance of water alternatives in Australia.* Water Science and Technology, 61 (8), 2137-2142. http://ro.uow.edu.au/cgi/viewcontent.cgi?article=1746&context=commpapers
[46] Dolnicar, Sara, Anna Hurlimann, and Bettina Grün. "What affects public acceptance of recycled and desalinated water?." *Water research* 45.2 (2011): 933-943. http://www.sciencedirect.com/science/article/pii/S0043135410006858
[47] Marks, June, Bill Martin, and Maria Zadoroznyj. "Acceptance of water recycling in Australia: national baseline data." *Water* 33.2 (2006): 151-157. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.1019.2031&rep=rep1&type=pdf
[48] Ibid.

Table 8-3 Social benefits and impacts

Values	Stage	Option A	Option B	Option C	Option D
Regional development	Construction Operation	Overall it is expected that the construction and operation of the project will generate employment opportunities and business opportunities, promote growth of agriculture in Lockyer Valley, Toowoomba and Darling Downs region. This in turn, in the longer term is likely to provide incentive for population retention and growth in the regional areas.	Overall it is expected that the construction and operation of the project will generate employment opportunities and business opportunities, promote growth of agriculture in Lockyer Valley, Toowoomba and Darling Downs region. This in turn, in the longer term is likely to provide incentive for population retention and growth in the regional areas.	Overall it is expected that the construction and operation of the project will generate employment opportunities and business opportunities, promote growth of agriculture in Lockyer Valley, Toowoomba and Darling Downs region. This in turn, in the longer term is likely to provide incentive for population retention and growth in the regional areas.	Overall it is expected that the construction and operation of the project will generate employment opportunities and business opportunities, promote growth of agriculture in Lockyer Valley, Toowoomba and Darling Downs region. This in turn, in the longer term is likely to provide incentive for population retention and growth in the regional areas.
Sustained amenity and recreational value of Moreton Bay	Operation	Once operational overall the project will maintain and in the longer term reduce the nutrient discharge into the Moreton Bay, which in turn will assist in sustaining and potentially improving the amenity and recreational value of the bay area.	Not relevant	Not relevant	Not relevant
Impacts of land requirement on private properties and landholders	Construction	Location of project infrastructure would require potential access and acquisition of private land. Acquisition of private land is likely to give raise to the follow social impacts: • The land negotiation, compensation and acquisition process with private landholders often causes stress and anxiety for the landholders. The project will need to develop an early engagement strategy with landholders and developing fair land acquisition and compensation process and protocols which are communicated to the landholders from the outset. • Temporary or permanent loss of land or loss of access to parts of the property can disrupt existing operations on the property, potentially reducing productivity of the land if it is an agricultural property. • Construction activities on private properties may damage property infrastructure like fences, access roads, such impacts are likely to result in inconvenience to the landholders and users of the property. Additional land will be required for the construction of the additional new pipeline component. See next row for details.	Location of project infrastructure would require potential access and acquisition of private land. Acquisition of private land is likely to give raise to the follow social impacts: • The land negotiation, compensation and acquisition process with private landholders often causes stress and anxiety for the landholders. The project will need to develop an early engagement strategy with landholders and developing fair land acquisition and compensation process and protocols which are communicated to the landholders from the outset. • Temporary or permanent loss of land or loss of access to parts of the property can disrupt existing operations on the property, potentially reducing productivity of the land if it is an agricultural property. • Construction activities on private properties may damage property infrastructure like fences, access roads, such impacts are likely to result in inconvenience to the landholders and users of the property.	Location of project infrastructure would require potential access and acquisition of private land. Acquisition of private land is likely to give raise to the follow social impacts: • The land negotiation, compensation and acquisition process with private landholders often causes stress and anxiety for the landholders. The project will need to develop an early engagement strategy with landholders and developing fair land acquisition and compensation process and protocols which are communicated to the landholders from the outset. • Temporary or permanent loss of land or loss of access to parts of the property can disrupt existing operations on the property, potentially reducing productivity of the land if it is an agricultural property. • Construction activities on private properties may damage property infrastructure like fences, access roads, such impacts are likely to result in inconvenience to the landholders and users of the property.	Location of project infrastructure would require potential access and acquisition of private land. Acquisition of private land is likely to give raise to the follow social impacts: • The land negotiation, compensation and acquisition process with private landholders often causes stress and anxiety for the landholders. The project will need to develop an early engagement strategy with landholders and developing fair land acquisition and compensation process and protocols which are communicated to the landholders from the outset. • Temporary or permanent loss of land or loss of access to parts of the property can disrupt existing operations on the property, potentially reducing productivity of the land if it is an agricultural property. • Construction activities on private properties may damage property infrastructure like fences, access roads, such impacts are likely to result in inconvenience to the landholders and users of the property. Additional land will be required for the construction of the additional new pipeline component. See next row for details.

Values	Stage	Option A	Option B	Option C	Option D
Impacts of land requirement on general community	Construction	Construction of the new sections of the pipeline from Redcliff to Luggage Point will require additional land. It is likely that construction will be along or near public use areas such as in the Moreton Bay area and along road easements this would likely disrupt traffic or usual use of the areas causing temporary inconvenience to road users and near neighbours.	Not relevant	Not relevant	Construction of the new sections of the pipeline from Lowood Booster Pump Station to Lake Clarendon will require additional land. It is likely that construction will be along or near public use areas such as along road easements this would likely disrupt traffic or usual use of the areas causing inconvenience to road users and near neighbours.
Impacts of amenity changes on landholders and community	Construction	Construction activities will generate noise and clearing of vegetation and earthworks potentially temporarily impacting on the noise levels and visual amenity of the landholder, near neighbours or general community using the areas. The impact is likely to be more pronounced in rural/semi-rural areas where the community is more use to a quiet rural lifestyle. Amenity changes are likely to impact on the recreational use of the Moreton Bay area.	Construction activities will generate noise and clearing of vegetation and earthworks potentially temporarily impacting on the noise levels and visual amenity of the landholder, near neighbours or general community using the areas. The impact is likely to be more pronounced in rural/semi-rural areas where the community is more use to a quiet rural lifestyle.	Construction activities will generate noise and clearing of vegetation and earthworks potentially temporarily impacting on the noise levels and visual amenity of the landholder, near neighbours or general community using the areas. The impact is likely to be more pronounced in rural/semi-rural areas where the community is more use to a quiet rural lifestyle.	Construction activities will generate noise and clearing of vegetation and earthworks potentially temporarily impacting on the noise levels and visual amenity of the landholder, near neighbours or general community using the areas. The impact is likely to be more pronounced in rural/semi-rural areas where the community is more use to a quiet rural lifestyle.

9. Environmental assessment

9.1 Approach

The environmental assessment provides a desktop review of environmental factors and seeks to supplement and consolidate previous environmental investigations and reference material with current State and Commonwealth environmental data layers to provide a description of the existing environment and environmental values within and surrounding the project footprint. Appendix I (Volume 2) provides the full Review of Environmental Factors and is summarised here.

9.2 Environmental assessment

The environmental impacts for Options B and C are considered to be the very similar and include potential impacts on endangered flora and fauna, as well as a number of regional ecosystems. Option A has the same impacts as the options B and C, however, it also impacts on a marine park, tidal waterways, fish habitat area and a legally secured offset area. Option D impacts on additional areas of vegetation and additional watercourse crossings.

The mitigation of environmental impacts will require an effective management framework and implementation. The project will require detailed EMPs.

Table 9-1 provides a summary of the potential environmental impacts from each option and potential costs associated with further investigations or mitigation measures. Table 9-2 provides a summary of approvals potentially triggered by the project options. The full Review of Environmental Factors report is provided in Appendix I (Volume 2).

Table 9-1 Environmental impacts and potential costs

Option	Environmental impact	Potential costs: Investigations required or potential mitigation
All options	Pipeline easement will sterilise some portions of public and private property.	Compensation to land owners.
Option A	Pipeline will potentially impact on a legally secured offset area for Option A (section 13).	Investigation required into avoidance of the offset area or options to replace.
All options	Potential erosion and sedimentation impacts during construction and operation.	Implementation of erosion and sediment control plan.
Option C	Increased salinity hazard through the application of Class B/C water.	Salinity investigation and management
All options	Net benefit to Moreton Bay from reuse of water from the STPs and AWTPs.	Net benefit
All options	Pipeline crossings of between 78 and 90 waterways for waterway barrier works.	Potential approval requirements Requirements for HDD and bores to minimise environmental impacts.

Option	Environmental impact	Potential costs: Investigations required or potential mitigation
	Erosion and sedimentation impacts reducing water quality during construction.	
Option B and C	Storage of Class A+ or Class B/C water in storage dams in the Lockyer Valley. This water has the potential to discharge into nearby waterways during high rainfall events. The storage of Class B/C water poses a human health risk through exposure, spray drift and the public potentially accessing the dam.	Management plans for the storage of Class A+ or Class B/C water.
All options	Recycling Brisbane's wastewater will be a benefit. It will improve and secure reliable water supplies and reduce current reliance on surface and groundwater. This will decrease stress on natural systems within the Lockyer Valley and Darling Downs.	Net benefit
All options	• Vegetation clearing and excavation will lead to: • Removal or impacts to REs or TECs as a result of vegetation clearing. • Impacts on connectivity. • Weed invasion potential. • Disturbance to essential habitat for koala and wallum froglet.	Species management programmes will be required for disturbance to breeding places. Potential approval and offset requirements. Weed and pest management implementation. Fauna spotter required. Rehabilitation costs.
Option A	Removal, destruction or damage to a marine plant	Potential approval and offset requirements.
All options	Temporary waterway barrier works leading to short-term impacts to aquatic ecology, and to fish passage. Fauna injury and mortality. Disruption to fauna behaviour.	Species management programmes will be required for disturbance to breeding places (Aust. Lungfish, Mary River Cod, Silver Perch).
All options	Short-term localised dust impacts during construction.	Standard air quality management measures.

Option	Environmental impact	Potential costs: Investigations required or potential mitigation
All options	Short-term localised noise impacts during construction. Potential pump station noise impacts during operation.	Standard noise and vibration management measures. Option A may require additional measures in residential areas. Noise assessment for pump station
All options	Short-term, localised visual impacts as a result of clearing and excavation works.	Rehabilitation of cleared Right of Way.
All options	There are a significant amount of Indigenous Cultural Heritage sites within the buffer zone of the project. Option A has additional Cultural Heritage parties and a section of coastal environment that contains a high number of Cultural Heritage sites.	Development of Cultural Heritage Management Plan (CHMP). Negotiations with traditional owner groups required. Additional traditional owner groups for Option A.
All options	Based on searches of relevant national and state heritage registers, one item of historical heritage is located within 300m of the project area for all options.	Heritage listed items will be avoided during route selection. Construction impacts include vibration and management will be put in place during this stage.
Option A	There were six items of historical heritage within proximity to Option A (sections 13 and 14).	Heritage listed items will be avoided during route selection. Construction impacts include vibration and management will be put in place during this stage.
Option D	There were numerous heritage listings for Option D in Ipswich and surrounds however it is assumed that the pipeline in this section will follow the existing WCRWS easement and impact the historical heritage through vibration will be minimised.	Heritage listed items will be avoided during route selection. Construction impacts include vibration and management will be put in place during this stage.

Table 9-2 Approvals Summary

Approval	Option A	Option B	Option C	Option D
EPBC Referral	✓	✓	✓	✓
Assessment if deemed a controlled action:	✓	✓	✓	✓

Approval	Option A	Option B	Option C	Option D
• Controlled action – to be assessed on preliminary documentation or by EIS.				
Infrastructure Designation	Approvals pathway option	Approvals pathway option	Approvals pathway option	Approvals pathway option
Material Change of Use (if no Infrastructure Designation)	✓	✓	✓	✓
Reconfiguration of a Lot (if no Infrastructure Designation)	✓	✓	✓	✓
Environmental Authority for an Environmentally Relevant Activity (ERA)	✓	✓	✓	✓
Regulated structure and Hazardous waste dam. Regulated under the Environmental Authority for ERA 64 above.	X	✓	✓	X
Operational work for constructing or raising a waterway barrier works or compliance with the accepted development guideline	✓	✓	✓	✓
Operational work for clearing of native vegetation	✓	✓	✓	✓
Operational works for tidal works (prescribed tidal works), or work within a coastal management district.	✓	X	X	X
Operational work for the removal, destruction or damage of a marine plant	✓	X	X	X
Development permit for the removal of quarry material in a watercourse	TBD	TBD	TBD	TBD
Operational works for taking or interfering with water from a watercourse, lake or spring	TBD	TBD	TBD	TBD
Building work	✓	✓	✓	✓
High-Risk Species Management Programme	✓	✓	✓	✓
Cultural Heritage Management Plan (CHMP) compliance Duty of care compliance	✓	✓	✓	✓
Riverine protection permit	Yes unless	Yes unless	Yes unless	Yes unless

Approval	Option A	Option B	Option C	Option D
	exemption can be met	exemption can be met	exemption can be met	exemption can be met
Quarry material allocation notice	TBD	TBD	TBD	TBD
Permit to clear native plants (NC Act) or exemption notifications	✓	✓	✓	✓
Offsets	✓	✓	✓	✓
Filling or excavation under the local planning scheme for on farm dam storages	X	✓	✓	X
Referable dam development approval	X	X	X	X
Preparation/amendment of Recycled Water Management Plan	✓	✓	✓	✓

10. Economic analysis

The economic analysis of the shortlisted options adopts standard cost-benefit analysis techniques. This approach estimates the net economic impact of a project by comparing all economic benefits that are measurable, material and attributable to the project with the identified economic costs. The results of an economic cost-benefit analysis demonstrate whether the reference project will result in a net economic benefit for the community.

10.1 Approach

The approach adopted to undertaking the economic cost-benefit analysis was as follows:

- Define the base case (i.e. the scenario in which the project does not proceed) for each entity/asset/resource that will be impacted under the shortlisted options, being:
  - Agricultural and industrial water users in the Lockyer Valley
  - Agricultural and industrial water users on the Darling Downs
  - Water infrastructure owners (i.e. STPs and pipeline infrastructure)
  - Moreton Bay
- Identify the shortlisted options for which the economic impacts of the project are to be assessed
- Identify all impacts to be considered under each shortlisted option, having regard to the base case that has been defined
- Where economic impacts are material and quantifiable, quantify the economic benefits and costs under each of the shortlisted options relative to the base case
- Estimate the net economic impact, in terms of both the Benefit Cost Ratio (BCR) and the Net Present Value (NPV) of the shortlisted options relative to the base case.

The benefits associated with the use of water for agricultural production in the Lockyer Valley and on the Darling Downs have been estimated by developing detailed model of the value of production to be derived from the identified applications and the costs associated with production. This enables robust estimates to be derived for the net economic value (i.e. gross value of production less all costs incurred, including opportunity cost of land) that is to be derived from the use of water for agricultural production.

The modelling of economic benefits from the expansion of agricultural production is consistent with the water demand assessment undertaken for the project (see Appendix F (Volume 2)).

The key assumptions applied in undertaking the economic analysis are as follows:

- Discount rate of 7 per cent (as per Building Queensland's guidelines, with sensitivity analysis to be undertaken at rates of 4 and 10 per cent)
- Starting date of 31 December 2017
- A 30-year evaluation period, as per Building Queensland's guidelines.

10.2 Benefits

The key economic benefits identified and assessed for the shortlisted options were:

- The additional economic value from the use of recycled wastewater for irrigated agricultural production, both in the Lockyer Valley and on the Darling Downs

- The avoidance of costs associated with the maintenance of WCRWS infrastructure in 'care and maintenance' and 'hot standby' modes
- The avoidance of the cost associated with increased nutrient loads in Moreton Bay as a result of the continued discharge of wastewater effluent from STPs in SEQ.

The additional value of agricultural production in the Lockyer Valley and on the Darling Downs was quantified based on the results of the crop modelling undertaken as part of the demand assessment. Table 10-1 sets out the annual volumes of water use and the Present Value (PV) of the total economic benefit derived from crop production under each shortlisted option.

Table 10-1 Economic benefits from increased agricultural production (PV terms)

Crop type and region	Economic benefits (PV terms)		
	Existing crops	New crops	Total benefit
Options A, B and C			
Vegetable crops – Lockyer Valley	N/a[a]	$157.8 million	$157.8 million
Broadacre crops – Darling Downs	$228.0 million	$99.0 million	$327.0 million
Total benefits	**$228.0 million**	**$256.8 million**	**$484.8 million**
Option D			
Vegetable crops – Lockyer Valley	N/a[a]	$157.8 million	$157.8 million
Broadacre crops – Darling Downs	$193.5 million	$84.0 million	$277.5 million
Total benefits	**$193.5 million**	**$241.8 million**	**$435.3 million**

a Consultation with growers identified that additional water would be applied to expand the area of crop production and that increasing the intensity of irrigation on existing crops was not considered feasible.

Notes: PV totals are calculated based on a real discount rate of 7 per cent and include terminal values in year 30. Benefits were estimated assuming demand of 7,500 ML per annum in the Lockyer Valley, with remaining volumes to be supplied to the Darling Downs. The benefits were also adjusted for the supply disruptions attributable to the recommissioning of the WCRWS for Indirect Potable Reuse (IPR) based on annual probabilities provided by Seqwater.

Source: Synergies modelling.

Table 10-2 presents the estimated benefits from the avoidance of 'care and maintenance' costs to be incurred under the base case. These costs would be avoided under the shortlisted options.

Table 10-2 Avoidance of 'care and maintenance' costs under the shortlisted options

Option	Proportion of costs to be avoided	Annual avoided costs (2018 dollars)	Total avoided costs (PV terms)[a]
Option A	100.0%	$10.3 million	**$16.5 million**
Option B	62.0%	$6.4 million	**$10.2 million**
Option C	10.0%	$1.0 million	**$1.6 million**
Option D	74.4%	$7.7 million	**$12.3 million**

a The total PV estimate is calculated over the evaluation period taking into account the probabilities of supply disruptions provided by Seqwater and applying the multiplicative probabilistic approach.

Note: PV estimates are calculated based on a real discount rate of 7 per cent.

Source: Proportions provided by GHD.

As described above, the reduction in nutrients (nitrogen and phosphorus) discharged into SEQ waterways and Moreton Bay from relevant STPs including those operated by QUU, and subsequently the avoidance of adverse water quality and environmental impacts, is a key benefit of the shortlisted options.

Marginal nutrient abatement costs were applied as a 'proxy' value for the economic benefit of avoided nutrient discharges. It is important to note that this benefit is assessed from a societal perspective (i.e. the value the community places on reduced nutrient discharges) as opposed to the financial impact on the relevant party.

Based on a review of industry available information, the cost of abating nitrogen loads (the 'limiting' nutrient in the Lower Brisbane catchment) via an alternative project would be approximately $23,000 per tonne. Applying a proportion from a study of nutrient abatement costs previously conducted in SEQ results in an estimate of $18,400 per tonne for phosphorus. The following table sets out the benefit estimates (in PV terms) associated with the reduction in nutrients discharged into SEQ waterways and Moreton Bay under the shortlisted options.

Table 10-3 Economic benefits from reduced nutrient loads in Moreton Bay under shortlisted options

Option	Avoided nutrient loads (tonnes p.a.)		Annual avoided costs (2018 dollars)		Total benefit (PV terms)[a]
	Nitrogen	Phosphorus	Nitrogen	Phosphorus	
Option A	454	323	$10.4 million	$5.9 million	**$176.0 million**
Option B	413	292	$9.5 million	$5.4 million	**$159.8 million**
Option C	391	275	$9.0 million	$5.1 million	**$150.8 million**
Option D	376	263	$8.6 million	$4.8 million	**$144.5 million**

a PV estimates have been calculated based on a real discount rate of 7 per cent and include a terminal value in year 30.

Note: It is important to note that benefits have been assessed over the entire evaluation period regardless of interruptions to supply. This means that the assumption has been adopted that under the base case, current discharge rates for nitrogen and phosphorus will remain unchanged, regardless of whether the WCRWS is re-commissioned for IPR. Were the infrastructure upgrades to be undertaken as part of the recommissioning process to include works to avoid the discharge of nutrients into SEQ waterways and Moreton Bay from these STPs, the economic benefits attributable to the shortlisted options would be reduced.

Source: Synergies modelling.

In respect of increased intensity of irrigated agricultural production in the Lockyer Valley and Darling Downs and the potential for additional nutrient discharges into waterways, the following is noted:

- Irrigation farming enterprises on the Darling Downs effectively operate as closed systems as a result of their tail-water return/recycling systems largely containing run-off and associated nutrients within the farm boundaries
- It has been assumed that best practice nutrient management processes would be applied in any expansion of agricultural production in the Lockyer Valley. There is also the potential for requirements around nutrient management processes and practices to be incorporated into the water supply agreements to apply to the project
- It is unlikely that the economic cost associated with an increase in nutrient loads resulting from an increase in agricultural production in the Lockyer Valley would be material relative to the overall reduction in nutrient discharges attributable to the shortlisted options (particularly as the demand assessment indicates the majority of water would be supplied to the Darling Downs).

Other benefits identified (although not quantified) were:

- The environmental benefits associated with increased flows in the Murray Darling Basin
- Increased water security for other water users in the region (including intensive animal producers and industrial producers).

10.3 Shortlisted options costs

10.3.1 Estimate cost summary of costs – infrastructure

For the selected shortlist of options described in Section 7, concept construction cost estimates have been prepared by WT Partnership. All assumptions, risks and scope of work adopted are included in Appendix F. Additional critical path construction program and risk analysis to define contingency have been conducted and included in Appendix F (Volume 2).

The estimate summary of cost is shown in Table 10-4.

Table 10-4 Estimated cost for shortlisted options

Item	Option A	Option B	Option C	Option D
Establishment	$2,529,400	$1,779,400	$1,779,400	$2,529,400
Treatment	$231,643,900	$139,229,600	$57,070,600	$124,786,000
Pipelines (delivery and distribution)	$615,606,000	$531,217,900	$531,217,900	$572,632,700
Pump Stations	$62,071,800	$51,388,200	$51,250,400	$64,530,200
Storage	Nil	$2,520,000	$2,520,000	Nil
Crossings	$121,216,000	$16,860,000	$16,860,000	$22,580,000
Power	$295,990,000	$292,990,000	$292,990,000	$328,611,000
Indirect Costs	$890,468,200	$694,110,000	$638,971,200	$747,498,400
TOTAL	**$2,219,525,300**	**$1,730,095,100**	**$1,592,659,500**	**$1,863,167,700**

10.3.2 Cost profiles

The costs identified and assessed in the economic analysis of the shortlisted options were capital costs; ongoing treatment, operating and maintenance (O&M) and energy costs; and the cost of on-farm infrastructure improvements.

The capital cost estimates derived for the shortlisted options are set out in Table 10-5.

Table 10-5 Capital cost profiles for shortlisted options

Option	2018	2019	2020	2021	Totals	Totals (PV terms)
Option A						
LV	$33.0m	$74.1m	$34.8m	$11.6m	$153.5m	**$132.8m**
DD	$443.5m	$997.4m	$468.8m	$156.3m	$2,066.0m	**$1,787.6m**
Total	$476.5m	$1,071.5m	$503.7m	$167.9m	$2,219.5m	**$1,920.4m**
Option B						
LV	$22.2m	$49.9m	$23.5m	$7.8m	$103.4m	**$89.5m**
DD	$349.2m	$785.3m	$369.1m	$123.0m	$1,626.7m	**$1,407.4m**
Total	$371.4m	$835.2m	$392.6m	$130.9m	$1,730.1m	**$1,496.9m**
Option C						
LV	$19.6m	$44.1m	$20.7m	$6.9m	$91.3m	**$79.0m**
DD	$322.3m	$724.8m	$340.7m	$113.6m	$1,501.4m	**$1,299.1m**
Total	$341.9m	$768.9m	$361.4m	$120.5m	$1,592.7m	**$1,378.0m**
Option D						
LV	$38.4m	$86.4m	$40.6m	$13.5m	$179.0m	**$154.9m**
DD	$361.6m	$813.1m	$382.2m	$127.4m	$1,684.2m	**$1,457.2m**
Total	$400.0m	$899.5m	$422.8m	$140.9m	$1,863.2m	**$1,612.1m**

Note: Annual cost estimates are in 2018 dollars. The Present Value estimates have been calculated based on a real discount rate of 7 per cent.

Source: Capital cost estimates refer Table 10-4.

There is also a significant ongoing cost associated with supplying recycled wastewater from STPs in SEQ to agricultural producers in the Lockyer Valley and on the Darling Downs. In particular, the cost of treating water to the necessary water quality standard (particularly for users in the Lockyer Valley) and the energy costs incurred in supplying users on the Darling Downs are significant. The total operating and maintenance costs are summarised (in PV terms) in the table below.

Table 10-6 Total operating and maintenance costs (PV terms) by shortlisted option

Cost	Option A	Option B	Option C	Option D
Lockyer Valley				
Energy	$51.3m	$40.2m	$40.2m	$58.1m
Treatment and O&M	$28.5m	$17.6m	$17.6m	$23.2m
Total	**$79.8m**	**$57.8m**	**$57.8m**	**$81.3m**
Darling Downs				
Energy	$584.1m	$470.3m	$414.3m	$393.7m
Treatment and O&M	$298.7m	$188.5m	$43.8m	$114.4m
Total	**$882.8m**	**$658.8m**	**$458.1m**	**$508.1m**
Total operating costs	**$962.6m**	**$716.6m**	**$515.9m**	**$589.4m**

Note: PV estimates are based on a real discount rate of 7 per cent and contain terminal values in year 30.

Source: Unit cost estimates provided by GHD. Total PV estimates derived based on Synergies modelling.

For some growers, increasing irrigation water use will require capital investment in on-farm infrastructure improvements, including additional on-farm storage capacity and additional irrigation application equipment and water reticulation infrastructure.

Additional on-farm costs could also potentially be imposed through:

- Upgrades to farm storage and licenced discharge points arising from approvals for the supply of Class B/C recycled water
- Additional on-going salinity management costs arising from the salt content in recycled water.

At this stage, it has been assumed that existing closed system storage arrangements in the Darling Downs and provision for on-farm infrastructure costs provide sufficient coverage. Further assessment in this regard will be completed as part of the Detailed Business Case.

The table below sets out the estimates derived for on-farm and irrigation infrastructure costs under the shortlisted options.

Table 10-7 Cost of additional on-farm storage and capacity and irrigation infrastructure and equipment (PV terms)

Option	Cost of on-farm storage (PV terms)[a]	Cost of irrigation infrastructure (PV terms)[a]	Total additional on-farm costs (PV terms)[a]
Options A, B and C	$6.9 million	$11.4 million	**$18.3 million**
Option D	$5.9 million	$9.8 million	**$15.7 million**

a Calculated based on a real discount rate of 7 per cent.

Note: It has been assumed that 25 per cent of growers in both regions will need to invest in additional on-farm storage capacity and additional irrigation equipment and infrastructure.

Source: Synergies modelling.

In addition to these quantified costs, there is also the potential for the shortlisted options to result in an increased cost associated with the recommissioning of the WCRWS for IPR. This cost has not been quantified given the uncertainty associated with the magnitude of the additional recommissioning costs and also the potential for some of the recommissioning costs to be avoided under the shortlisted options. The impact of the project on the cost of recommissioning the WCRWS for IPR is to be assessed in the development of the Detailed Business Case.

10.4 Cost benefit analysis results

Table 10-8 presents the results of the economic analysis of the shortlisted options. The results are based on demand of 7,500 ML per annum for the Lockyer Valley, with remaining volumes supplied to users on the Darling Downs.

Table 10-8 Summary of results of cost-benefit analysis (PV terms)

Impact	Option A	Option B	Option C	Option D
Economic benefits				
Increased value of agricultural production (Lockyer Valley)	$157.8m	$157.8m	$157.8m	$157.8m
Increased value of agricultural production (Darling Downs)	$327.0m	$327.0m	$327.0m	$277.5m
Avoided environmental costs	$176.0m	$159.8m	$150.8m	$144.5m
Avoided 'care and maintenance' costs	$16.5m	$10.2m	$1.6m	$12.3m
Increased environmental flows	Qualitative	Qualitative	Qualitative	Qualitative
Increased water security	Qualitative	Qualitative	Qualitative	Qualitative
Total economic benefits	**$677.3m**	**$654.8m**	**$637.2m**	**$592.1m**
Economic costs				
Capital costs	$1,920.4m	$1,496.9m	$1,378.0m	$1,612.1m
Treatment and O&M costs	$327.2m	$206.1m	$61.4m	$137.6m
Energy costs	$635.4m	$510.5m	$454.5m	$451.8m
WCRWS recommissioning costs	Nil[a]	Unquantified	Unquantified	Unquantified
On-farm infrastructure costs	$18.3m	$18.3m	$18.3m	$15.7m
Total economic costs	**$2,901.3m**	**$2,231.8m**	**$1,912.2m**	**$2,217.2m**
NET ECONOMIC IMPACT	**($2,224.0m)**	**($1,577.0m)**	**($1,275.0m)**	**($1,625.1m)**
Benefit Cost Ratio[b]	**0.23**	**0.29**	**0.33**	**0.27**

a Initial recommissioning costs are included in the upfront capital costs. Option A assumes continual production of PRW and no further recommissioning works.

b The Benefit Cost Ratio is calculated by dividing the PV estimates for total benefits by total costs.

Note: PV estimates have been derived based on a discount rate of 7 per cent.

Source: Synergies modelling.

The significant negative NPVs of the shortlisted options are driven by the significant capital costs incurred in developing the infrastructure required to supply recycled wastewater to agricultural users and the significant ongoing treatment and energy costs incurred in maintaining supply. Option C results in the most favourable NPV and Benefit Cost Ratio (BCR) due to the lower up-front capital and ongoing treatment costs, however the BCR under this option is still significantly below 1.

10.5 Sensitivity and scenario analysis

Sensitivity analysis shows how the results of the economic analysis are affected by changes to key parameters and assumptions. This provides decision makers with an indication of the level of certainty associated with the modelled results in addition to identifying critical parameters and assumptions in terms of the impact of the net economic impact of the project.

Parameters were identified for inclusion in the sensitivity analysis based on their significance in relation to the results of the cost-benefit analysis (i.e. the NPV and BCR estimates for the shortlisted options) and the level of uncertainty associated with the parameter estimates.

The following parameters have been subject to sensitivity analysis:

- Discount rate
- Capital cost
- Economic value derived from agricultural production (i.e. return per ML)
- Economic cost of discharge of nutrients into Moreton Bay.

It is noted that the economic return derived from water use varies across growers, depending on soil type and storage capacity, irrigation equipment and infrastructure, and production characteristics. As such, some growers may derive higher economic returns from the use of additional water than indicated by the crop modelling results. Modelling the economic impact of the shortlisted options under the scenario in which the economic value derived per ML of water use is increased by 50 per cent accounts for this variability across these individual factors.

The results of the sensitivity analysis are summarised in Table 10-9 below.

Table 10-9 Results of sensitivity analysis

Sensitivity	Present Value estimates (% change from base NPV)			
	Option A	Option B	Option C	Option D
Base NPV	($2,224.0m)	($1,577.0m)	($1,275.0m)	($1,625.1m)
Discount rate				
Low (4%)	($2,580.8m) (-16.0%)	($1,717.0m) (-8.9%)	($1,249.0m) (+2.0%)	($1,720.5m) (-5.9%)
High (10%)	($2,016.2m) (+9.3%)	($1,470.5m) (+6.8%)	($1,239.3m) (-2.8%)	($1,533.8m) (+5.6%)
Capital cost				
Low (-20%)	($1,839.9m) (+17.3%)	($1,277.6m) (+19.0%)	($999.3m) (+21.6%)	($1,302.7m) (+19.8%)

Sensitivity	Present Value estimates (% change from base NPV)			
	Option A	Option B	Option C	Option D
High (+20%)	($2,608.1m) (-17.3%)	($1,876.4m) (-19.0%)	($1,550.5m) (-21.6%)	($1,947.6m) (-19.8%)
Economic value from agricultural production				
Low (-50%)	($2,473.6m) (-11.2%)	($1,826.6m) (-15.8%)	($1,524.5m) (-19.6%)	($1,849.3m) (-13.8%)
High (+50)	($1,974.4m) (+11.2%)	($1,327.4m) (+15.8%)	($1,025.3m) (+19.6%)	($1,401.0m) (+13.8%)
Cost of nutrient discharges into Moreton Bay				
Low (-50%)	($2,312.0m) (-4.0%)	($1,656.9m) (-5.1%)	($1,350.3m) (-5.9%)	($1,697.4m) (-4.4%)
High (+50%)	($2,136.0m) (+4.0%)	($1,497.1m) (+5.1%)	($1,199.5m) (+5.9%)	($1,552.9m) (+4.4%)

The above table demonstrates that whilst several parameter estimates have a material impact on the NPV under several options, in particular the discount rate and capital cost, the impact is not significant under any of the scenarios assessed. Applying an increase of 50 per cent to the economic value derived from the use of water for agricultural production resulted in only a marginal improvement in the NPVs of the shortlisted options (i.e. 11.2 per cent to 19.6 per cent).

Scenario analysis was also undertaken to assess the impact of the following on the results of the cost-benefit analysis:

- The level of demand for water in the Lockyer Valley – the modelling was undertaken based on demand of 7,500 ML per annum for the Lockyer Valley, based on the continuation of existing groundwater management arrangements, however there is considerable uncertainty associated with future groundwater use in the region
- The interruptibility of supply attributable to the WCRWS being recommissioned for IPR – the modelling was undertaken based on the annual probabilities of supply disruption provided by Seqwater. In addition to the uncertainty associated with these probabilities, there is also uncertainty in relation to the extent to which the WCRWS will be used for IPR over the evaluation period.
- Whilst the scenario demonstrated that the results of the economic analysis are sensitive to the strength of demand in the Lockyer Valley, the NPVs of the shortlisted options remain significantly negative for all shortlisted options across all scenarios modelled.

11. Financial and commercial analysis

The objective of financial and commercial analysis is to assess the financial implications and budgetary impacts of the shortlisted options by assessing the cashflows for each option. This includes an assessment of the risks associated with the identified cashflows and, where possible, the quantification of the impact of the identified risks on the financial and commercial viability of the project. This enables the shortlisted options to be rated in terms of their financial and commercial impact and also ranked against each other.

11.1 Approach

The approach adopted to conducting the financial and commercial analysis of the shortlisted options was as follows:

- Establish the key assumptions and inputs to be used in undertaking the financial and commercial analysis, including the discount rate to be applied, the demand and water use assumptions to be adopted, and the pricing framework to be applied
- Identify all revenues and costs, including capital costs, one-off operating costs and ongoing operating and maintenance costs, for all shortlisted options
- Model the financial cashflows for each shortlisted option in order to calculate the Financial NPV (FNPV) by applying an appropriate discount rate
- Adjust the FNPV results to account for key risks to revenues and costs
- Consider budgetary impacts of the project based on the results of the financial and commercial analysis in addition to potential funding sources
- Report the results of the analysis, including the FNPV and risk-adjusted FNPV for each of the shortlisted options.

The key assumptions applied in the financial and commercial model are as follows:

- A 30-year evaluation period, consistent with both the economic analysis and the Building Queensland guidelines
- A three-year construction period for each option
- A nominal discount rate of 9.7 per cent[49]
- An inflation rate of 2.5 per cent, being the mid-point of the Reserve Bank of Australia's long-term inflation target
- Water use assumptions have been based on the findings of the demand assessment report.

11.2 Pricing approach and assumption

A key consideration for the financial and commercial analysis is the pricing framework to apply to the supply of water to users in the Lockyer Valley and on the Darling Downs. There are two options available in terms of the pricing approach to be adopted:

- Users pay for water allocations up-front, in addition to an annual charge for the supply of water from the project

[49] This was calculated by applying the Fisher equation to the real discount rate of 7 per cent applied in the economic analysis. It is noted that in the Building Queensland guidelines, it is stated that Queensland Treasury is to be consulted with regarding the appropriate discount rate to be applied in the financial and commercial analysis. It is proposed that this occur as part of the development of the Detailed Business Case.

- Users pay an annual ‘take-or-pay’ charge for water in each year.

Based on the characteristics of the project, in particular the interruptibility of supply and high ongoing operating costs required to supply water to users, levying an annual charge under ‘take-or-pay’ agreements is considered the preferred option. Given the risk of regular and prolonged supply disruptions, it is likely users would be reluctant to purchase up-front water allocations from the project.

11.3 Financial costs

This section assesses all financial costs to be incurred under the shortlisted options.

11.3.1 Capital expenditure

The capital expenditure estimates for each shortlisted option are set out in Section 10.3. The total costs are the same in PV terms for the financial and commercial analysis, being:

- For Option A, a total of $1,920.4 million, including:
  - $132.8 million for the Lockyer Valley
  - $1,787.6 million for the Darling Downs
- For Option B, a total of $1,496.9 million, including:
  - $89.5 million for the Lockyer Valley
  - $1,407.4 million for the Darling Downs
- For Option C, a total of $1,378.0 million, including:
  - $79.0 million for the Lockyer Valley
  - $1,299.1 million for the Darling Downs
- For Option D, a total of $1,612.1 million, including:
  - $154.9 million for the Lockyer Valley
  - $1,457.2 million for the Darling Downs.

11.3.2 Ongoing operating and maintenance costs

The ongoing operating and maintenance expenditure required to supply water to users under the shortlisted options is set out in Section 10.3. The PV totals for these costs are lower for the financial and commercial analysis as the totals do not include terminal values at the end of year 30. The totals for each shortlisted option are as follows:

- For Option A, a total of $833.5 million, including:
  - $69.1 million for the Lockyer Valley
  - $764.4 million for the Darling Downs
- For Option B, a total of $620.5 million, including:
  - $50.1 million for the Lockyer Valley
  - $570.4 million for the Darling Downs
- For Option C, a total of $446.7 million, including:
  - $50.1 million for the Lockyer Valley
  - $396.6 million for the Darling Downs
- For Option D, a total of $510.4 million, including:
  - $70.5 million for the Lockyer Valley
  - $439.9 million for the Darling Downs.

11.4 Residual values

As the lives of the assets will exceed the 30-year evaluation period, it is necessary to include an allowance for the residual value of assets in the financial and commercial analysis of the shortlisted options. The residual values are calculated at the conclusion of year 30 and are discounted back at the discount rate (9.7 per cent nominal) to derive the PV estimate for the residual value of the assets. The estimates derived for the residual values are as follows:

- $137.0 million under Option A
- $106.8 million under Option B
- $98.3 million under Option C
- $115.0 million under Option D.[50]

11.5 Revenues

One source of revenue has been identified from the project, being water charges levied on water users.

Based on the outcomes of the demand assessment, it was concluded that the price at which it would be viable for end users to purchase water from the project was likely to range from $300 to $500 per ML per annum (financial modelling was undertaken using a base price of $400 per ML per annum).[51] The financial modelling was undertaken based on a uniform price applying to all water users, noting that the cost of supply will differ across the customer base. Table 11-1 summarises the revenues to be derived from water charges.

Table 11-1 Revenue to be derived from water charges (PV terms)

Option	Annual water price		
	$300 per ML	$400 per ML	$500 per ML
Options A, B and C	$166.3m	$221.7m	$277.2m
Option D	$143.4m	$191.1m	$238.9m

There is a wide range of potential beneficiaries from the project including existing infrastructure owners and large industrial water users. It is common for beneficiaries to make up-front contributions to the capital cost of major water supply projects. Whilst it has not been possible to identify parties willing to contribute to the up-front capital cost of the project as part of this preliminary business case, there is the potential for revenue to be derived from up-front contributions from external parties (in particular large industrial water users). To the extent that such contributions are secured, this would need to be reflected in the revenues for the project options and thus the assessment of the financial and commercial viability of the project options.

11.6 Financial Net Present Value

The table below sets out the results of the financial and commercial analysis.

[50] Residual values were calculated based on an assumed 50 year asset life.
[51] The estimated economic return per ML for all of the crops in the demand profile exceeded $400 per ML per annum. Crops for which the economic return was estimated at below $400 per ML per annum were excluded from the demand profile.

Table 11-2 Results of financial and commercial analysis of shortlisted options (PV terms)

Costs and revenues	Option A	Option B	Option C	Option D
Costs				
Capital costs	$1,920.4m	$1,496.9m	$1,378.0m	$1,612.1m
Treatment and O&M costs	$283.4m	$178.5m	$53.2m	$119.2m
Energy costs	$550.1m	$442.0m	$393.5m	$391.2m
Total costs	**$2,753.9m**	**$2,117.4m**	**$1,824.7m**	**$2,122.5m**
Revenues				
Revenue from water charges	$221.7m	$221.7m	$221.7m	$191.1m
Total revenues	**$221.7m**	**$221.7m**	**$221.7m**	**$191.1m**
Financial Net Present Value	**($2,532.2m)**	**($1,895.7m)**	**($1,603.0m)**	**($1,931.4m)**

Note: PV totals have been calculated based on a nominal discount rate of 9.7 per cent (consistent with the real discount rate of 7 per cent applied in the economic analysis). Results calculated based on demand of 7,500 ML per annum in the Lockyer Valley (remaining volumes supplied to the Darling Downs).

Source: Synergies modelling.

As with the results of the economic analysis, the significant negative Financial Net Present Values (FNPVs) are driven by the significant costs associated with developing the necessary infrastructure and supplying recycled wastewater to growers.

11.7 Value capture

Opportunities for value capture have been explored in the financial and commercial analysis by:

- Assessing, through consultation with growers and farm-level modelling, the maximum prices that growers would be willing to pay for water to be supplied from the project
- In addition to water users, the other beneficiary from the project is the wider community, through the improved water quality levels and environmental conditions in SEQ waterways and Moreton Bay and also the additional regional economic activity to be generated by the increased value of agricultural production in the Lockyer Valley and on the Darling Downs. It is not possible to capture these values through the commercial framework to apply to the project.

11.8 Financial risk assessment

In assessing the financial and commercial viability of a project it is important to identify the key commercial risks and to assess the potential impact of the risks on the viability of the project, having regard to the likelihood of the risk materialising.

The key financial and commercial risks identified in relation to the shortlisted options are as follows:

- Capital cost overrun

- Increases to energy costs
- A shortfall in the revenue derived from water users due to user default.

A quantitative risk assessment was undertaken of each of the above risks by assessing the impact of the materialisation of these risks on the FNPVs of the shortlisted options. The results of this assessment (see Appendix H (Volume 2)) demonstrate that an overrun in capital costs is the key financial risk under all four shortlisted options. Whilst increases to energy costs and default from water users does adversely impact on the FNPVs under the shortlisted options, the magnitude of the impact of these risks is minimal relative to an overrun in capital costs (particularly an overrun of 50 per cent). Minimising the risk of a capital cost overrun should be a key focus area for the Detailed Business Case and is to be considered in the project design, selection of delivery model and commercial framework for the development of the infrastructure.

11.9 Funding sources and budgetary impacts

The results from the financial and commercial analysis demonstrate that, for all shortlisted options, the revenues derived from the project will be insufficient to recover the financial costs to be incurred. The project will therefore require significant government funding in order to be financially viable (noting that no additional revenue sources beyond water users have been identified).

The NWIDF is a potential source of funding for the project. The capital component of the NWIDF has been established to support long-term regional economic growth and development by providing secure and affordable water through investments in economically viable water infrastructure to be managed in accordance with the NWI. The provision of funding under the NWIDF is contingent upon several criteria being met, including that projects be 'construction ready' and that funding applications have the support of the State Minister responsible for water.

As noted above, the FNPV of the shortlisted options range from ($1,603.0 million) to ($2,532.2 million). As such, in order to be financially viable, the project is likely to require significant government funding in addition to funding secured under the NWIDF. The magnitude of the government funding requirement will be determined by the option that is adopted and the level of demand in the Lockyer Valley. The commercial arrangements for the provision of government funding to the project, including the form and timing of the funding (e.g. up-front grant, ongoing contribution), is to be assessed in the Detailed Business Case.

11.10 Analysis summary

In summary, the results of the financial modelling show that significant government funding is required for the project to be financially viable, noting that the FNPV of Option C, which has the most favourable commercial outcome, is $1,603.0 million.[52] For the project to be financially viable, this shortfall would need to be alleviated through the provision of government funding. This is discussed in further detail in Section 14.

[52] Noting that the level of demand in the Lockyer Valley will also impact on the financial cost of the shortlisted options and hence the government funding required, however it has not been possible as part of this preliminary assessment to allocate costs between the two regions.

12. Regional economic impacts

A regional economic impact analysis was conducted by applying the input-output method, utilising a multi-regional model with non-linear properties. The purpose of regional economic impact analysis is to estimate the impact of the project on the level of economic activity in the region during both the construction and operational phase. This is achieved through an analysis of the inter-industry relationships within the regional economy.

The regional economic impact analysis report is included as Appendix N (Volume 2). Key findings from the regional economic impact analysis of the shortlisted options were as follows:

- During the construction phase of the project, the shortlisted options will generate annual increases in total gross output ranging from $1,332 million to $1,646 million and additional value added (i.e. Gross State Product) ranging from $814 million to $1,006 million
- Operational impacts of the shortlisted options were modelled based on the volume of water to be made available for agricultural use (and the associated demand profiles) under Options A, B and C. This resulted in the following annual impacts being estimated
  - An increase in total gross output of $109.6 million in the Lockyer Valley, $84.6 million from increased cotton production on the Darling Downs, and $20.9 million from the production of other broadacre crops on the Darling Downs
  - An increase in value added of $55.2 million in the Lockyer Valley, $49.2 million from increased cotton production on the Darling Downs, and $10.6 million from the production of other broadacre crops on the Darling Downs
- The project has a significant impact on employment, particularly during the construction phase, with modelling estimating the shortlisted options will generate employment ranging from 3,584 FTEs to 4,142 FTEs. In the operating phase, employment generated is estimated at 1,934 FTEs across both regions (under Options A, B and C).

13. Delivery model analysis

The majority of the project infrastructure to be delivered can be well defined, is common to major pump station (including solar power and battery storage), pipeline and irrigation projects and widely understood, capable of clear definition and documentation but offers scope or opportunity for innovation or technological development. There is not expected to be any unusual or significant technical risks associated with the construction and delivery of the infrastructure (refer also to Section 6.4.3).

A wide range of packaging options could be adopted for the design, construction and operation of the Project Works, or combinations of, using what is generally considered to be traditional delivery models e.g.:

- Design and construct (D and C)
- Design then construct (D then C)
- Design, construct and maintain (D, C and M)
- Design, construct, maintain and operate (D, C, M and O)
- Alliance
- Competitive alliance
- Early contractor involvement (ECI)
- Early tenderer involvement (ETI)
- Managing contractor.

In developing alternative packaging options for delivery of the project works it needs to be borne in mind that generally speaking the greater the number of parties involved then the greater the total amount of overheads that will be paid in doing so.

Additionally, the greater the number of contracting parties involved the greater the number of contract interfaces and the opportunity for disruptions, delays and disputes.

However, resolving a preferred delivery model would first be contingent on securing funding (including defining project proponent) and or project commitments from key stakeholders including Governments (State and Commonwealth), Seqwater and/or other relevant parties. This is a critical step prior to analysis potential delivery models as in addition to potential funding commitments organisations also need to form a view as to their level of control and influence over the project roll-out.

13.1 PPP delivery model assessment

PPPs as a procurement method are part of the broader spectrum of contractual relationships between the public and private sectors to produce an asset and/or deliver a service. They are distinct from early contractor involvement, alliancing, managing contractor, traditional and other procurement methods.

The aim of a PPP is to deliver improved services and/or better value for money primarily through appropriate risk transfer, encouraging innovation, greater asset utilisation and integrated whole-of-life management, underpinned by private finance.

Proposals to adopt a PPP procurement approach need to be based upon a rigorous value for money assessment. It also needs to be based upon a sound review of the proposed projects suitability for doing so and the Markets interest/appetite for such a Project.

At this stage no VFM assessment has been made or market sounding been carried out and would be subject to first achieving in principle support for the project by the key stakeholders i.e. Governments (State and Commonwealth), Seqwater and other relevant parties.

14. Affordability analysis

The purpose of this section is to assess the affordability considerations relevant to each shortlisted option, building on the analysis undertaken in the preceding sections of the business case (in particular the financial and commercial analysis).

14.1 Approach

The approach to undertaking the affordability analysis can be summarised as follows:

- Assessment of the financial costs to be incurred in the construction of the infrastructure under each option and the ongoing costs to be incurred in supplying water to users over the duration of the evaluation period
- Consideration of the available sources of revenue, being water charges to be levied on water users
- Assessment of the alternative funding sources available for the project, including Commonwealth Government funding via the NWIDF
- A comparative assessment of the affordability of the shortlisted options.

14.2 Affordability assessment

The results of the financial and commercial analysis indicate that for the project to be financially viable, a significant up-front government funding contribution will be required. As discussed in Section 11.6, this is attributable to the significant capital and ongoing operating and maintenance costs to be incurred under the shortlisted options and the comparatively limited revenue that is able to be derived from water users (due to their capacity to pay).

Noting the uncertainty in the funding that could potentially be received via the NWIDF, the FNPVs for the shortlisted options range from ($1,603.0 million) to ($2,532.2 million). This represents a significant under-recovery in terms of the revenues that can be derived under the shortlisted options. These FNPVs provide an indication as to the funding contribution that would be required from government.

In terms of the relative affordability of the shortlisted options, Option C is clearly more affordable relative to the other options. This option has both the lowest capital cost requirement (total of $1,592.7 million in nominal terms) and the most favourable FNPV estimate, being ($1,603.0 million). Whilst this option would still require significant government funding to be financially viable, the magnitude of the contribution would be lower than for the other shortlisted options. The potential for the affordability of the project to be improved through either scaling or staging of the project is to be investigated in the Detailed Business Case for the project (in addition to the potential funding available through the NWIDF).

15. Select option/s for further development

The purpose of this section is to assess of the shortlisted options to identify a preferred option for further development in the Detailed Business Case (DBC). This represents the culmination of all assessments and reviews considered to develop the PBC.

15.1 Approach

The options identified in Section 7.2 that could potentially meet the needs outlined in Section 2.3 were considered in the MCA assessment process.

A Multi-Criteria Assessment (MCA) tool was developed to firstly filter and ultimately rank preferred options by using both qualitative and quantitative information to achieve the best balance between:

- Economic/viability Goals
- Environmental Goals
- Social Goals.

This approach is consistent with the Building Queensland and Infrastructure Australia requirements.

The evaluation of the projects was undertaken using a five-level ranking/scoring system, with score of 1 indicating that the project/scenario contributes poorly to the criterion outcome while a score of 5 would indicate a significant contribution beyond that required to just meet the criterion outcome.

The assessment criteria and criteria weightings have been included in Appendix K.

15.2 Selection of preferred option/s

The evaluation of short-listed options was focused on comparative option elements, including:

- Scale to be able to increase the irrigated production (current WCRWS capacity or increasing it)
- Total capital cost per megalitre of yield ($/ML) at the farm
- Total operating cost per megalitre of yield ($/ML) at the farm
- Improvement of water quality in Moreton Bay and water product being produced
- Utilisation of wastewater treatment plants STPs, including modifications to the AWTPs and existing WCRWS pump stations and pipelines.

Each of the short-listed options was scored using the criteria identified in Appendix K (Volume 2) and provided a relative ranking.

The assessment criteria, criteria weightings and outcomes of the MCA are described in Table 14 and summarised in Appendix K (Volume 2).

Table 15-1 Summary of MCA Scoring

Primary Goals	Criteria	Sub-criteria 1	Option			
			A	B	C	D
Economic	Project viability	Project at a scale able to drive significant increase in irrigated agricultural production that is regionally significant	5	5	5	4
		Total capital cost per megalitre of yield ($/ML) at the farm. Factors in water distribution losses and cost of water storage and distribution system (This will provide relativity between options and a coarse indication of the potential need for transparent subsidy)	1	2	4	1
		Operating cost (e.g. energy cost, treatment costs - relativity between options)	1	2	5	1
	Project risks	Commercial failure - capacity to attract commercial interest/investment (landholders, Seqwater (e.g. doesn't compromise planning for SEQ water supply), QUU, Govt, etc.), market risk - capacity of beneficiaries to pay	2	1	1	1
		Approvals pathway - ability to address planning requirements, organisational/govt support and social licence	2	3	2	2
		Reliability of water supply (anticipated periods of interrupted supply), e.g. reduced period required for recommissioning	2	1	1	1
		Quality of product water (e.g. salt loads, public health, constraint to applicable crops, market access)	5	4	2	3
		Compliance requirements for product water	1	2	3	2
		Construction risks (including geological, tunnel, infrastructure footprint, etc.)	2	4	4	3
	Regional impact	Offsetting chemical fertiliser needs (function of scale and treatment level)	1	3	5	4
		Impacts on regional infrastructure (e.g. roads, rail, power etc.)	1	2	2	1
		Employment (direct operation including irrigation and related activities)	5	4	3	4
		Increased utilisation of regional/community infrastructure (asset utilisation e.g. alignment with State Government Bulk Water Opportunities Statement)	5	5	4	4
Environmental	Ecology	Net biodiversity (based on biodiversity mapping) Rare and threatened ecosystems, habitats and taxa of high conservation value (based on RE database mapping) Protected Areas (conservation areas, wetlands, etc. mapping) Potential to change or improve existing seasonal flow pattern (changes to aquatic habitats)	1	3	3	2
	Water values	Opportunity to replace potable water sources, sustainable use of water resources	5	5	5	4
		Improvements to water quality in Moreton Bay against relevant water quality objectives, reflecting the level of nutrient removal from discharges.	5	4	3	4
		Potential to affect salinity levels	5	4	2	3

Primary Goals	Criteria	Sub-criteria 1	Option			
			A	B	C	D
Social	Community	Potential employment opportunities and regional population growth	4	4	4	3
		Community support	3	3	3	3
		Consistency with planning intents of other government authorities	4	4	4	4
		Health and safety risk (construction and operation)	3	4	3	2
		Community amenity	2	3	3	3
		Land requirements and private property impacts	2	3	3	3
		Cultural heritage impact	3	4	4	4
TOTAL SCORES			**2.77**	**3.17**	**3.27**	**2.72**

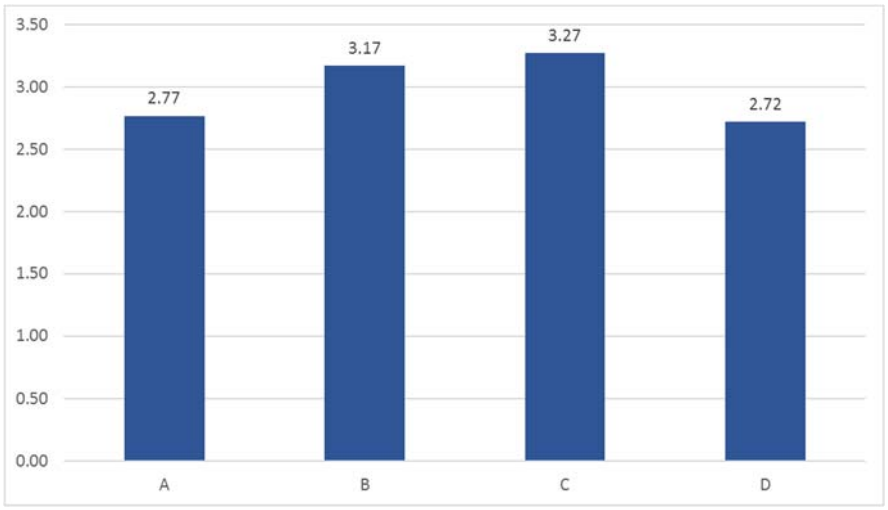


Figure 15-1 MCA Scoring summary

The relative significance of each criterion is provided in the following figures, summarising economic, environmental and social criteria and the respective weightings.

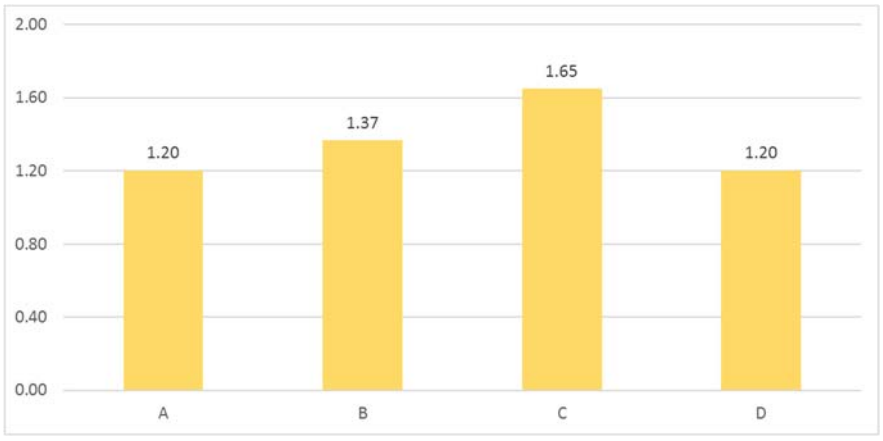


Figure 15-2 MCA Economic Goal (weight 50%)

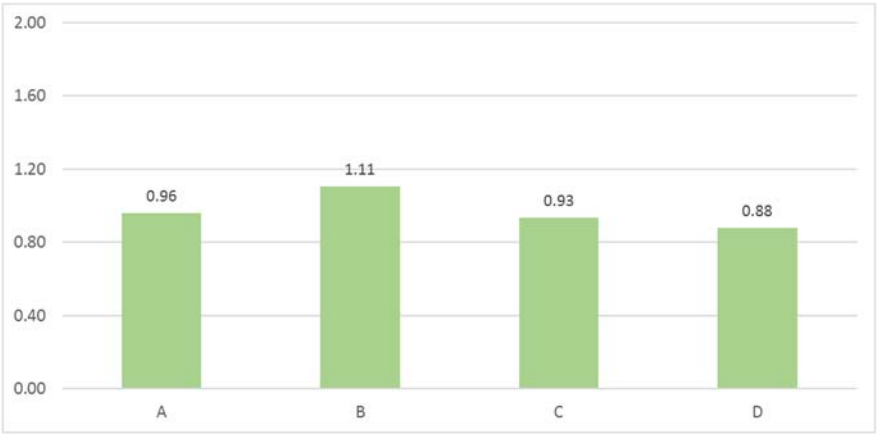


Figure 15-3 MCA Environment Goal (weight 30%)

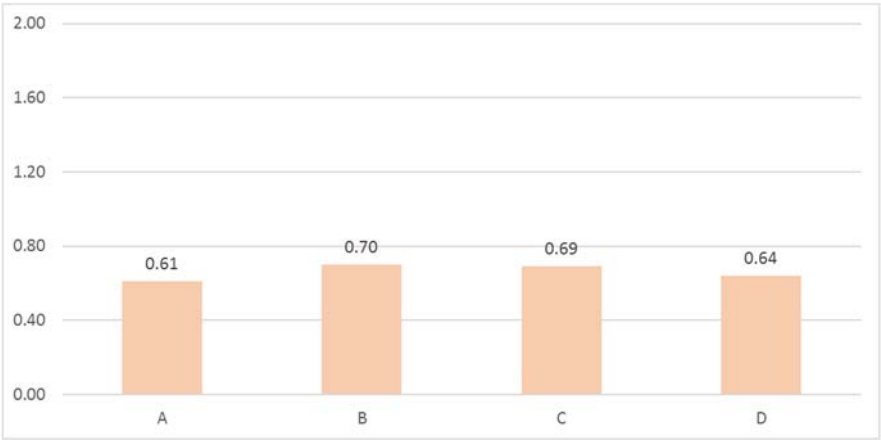


Figure 15-4 MCA Social Goal (weight 20%)

The findings of the MCA process are summarised as follows:

- On the basis of economic criteria, Option C is preferred followed by Option B. This is largely due to the reduced CAPEX and OPEX related to the reduced treatment requirement for these water products. Option A is impacted by infrastructure required to add source water and operational costs of producing PRW. Option D comprises some duplicate delivery pipeline sections (between Bundamba and Helidon) and incurs OPEX associated with delivering a significant quality of PRW.
- On the basis of environmental criteria, Option B is preferred. Impacting Option A is the additional waterway crossings for source water pipelines and associated high ecological significance areas. This is countered to a degree by the fact that this option utilises the highest quantity of source water, thereby creating the greatest benefit to Moreton Bay. Option C scoring is impacted by a low score in terms of potential to exacerbate salinity impacts. Option D scoring is impacted by additional pipelines along with higher resource consumption.
- On the basis of social criteria, all options scored very similar, with some minor reductions assigned to those options with a greater infrastructure footprint.

Based on the weightings assigned to the MCA criteria, Option C scores as the preferred option followed by Option B. This underlines the relatively importance of the economic criteria in determining the most viable Reference Project.

15.3 Impacts of preferred option/s

A summary of the key benefits and dis-benefits of the preferred option, Option C, as well as recommendations for further action, are described below.

15.3.1 Strategic impact

Option C delivers a lower quality product (Class B/C) to Lockyer Valley (7,500 ML/a) and Darling Downs (77,180 ML/a), with end-of-pipe treatment included for Lockyer Valley to elevate the water quality to Class A+.

Bypassing the AWTPs enables operational costs to be greatly reduced however the acceptance of transferring a lower quality water product using WCRWS infrastructure will be subject to review and approval from organisations including Seqwater, DEWS and Department of Health. This is a significant risk potentially impacting the approval pathway for this option and hence its feasibility.

The quantity of water product will support economic growth in both the Lockyer Valley and the Darling Downs through irrigation led development and enhanced crop production. Additionally the quantity of source water will deliver a reduction in nutrients discharging to Moreton Bay, with those nutrients used for a beneficial purpose in land application.

15.3.2 Economic impact

The key economic benefits identified and assessed for Option C were:

- The additional economic value from the use of recycled wastewater for irrigated agricultural production, both in the Lockyer Valley and on the Darling Downs
- The avoidance of costs associated with the maintenance of WCRWS infrastructure in ‘care and maintenance’ and ‘hot standby’ modes
- The avoidance of the cost associated with increased nutrient loads in Moreton Bay as a result of the continued discharge of effluent from STPs in SEQ.
- Economic costs identified and assessed in the economic analysis of the shortlisted options were capital costs; ongoing treatment, operating and maintenance (O&M) and energy costs; and the cost of on-farm infrastructure improvements.

Option C resulted in the most favourable NPV and Benefit Cost Ratio (BCR) due to the lower up-front capital and ongoing treatment costs, however the BCR under this option is still significantly below 1.

15.3.3 Social and environmental impact

The preferred option, option C, requires less pipelines compared to option A and D and therefore has a reduced environmental impact on vegetation, fauna, connectivity, heritage, the marine environment and waterways. Option C has the least amount of waterway crossings which minimises waterway barrier works applications, erosion and sedimentation impacts and water quality impacts.

Option C requires the storage of Class B/C water in dams in the Lockyer Valley. This water storage/s has the potential to discharge into nearby waterways during high rainfall events impacting on local water quality. The storage of Class B/C water poses a human health risk through exposure, spray drift and the public potentially accessing the dam. Management plans will be required for the storage of Class B/C water.

The use (including storage and reticulation) of Class B/C water in the Darling Downs increases the risk of salinity in the area. Salinity investigation and management will be required prior to use.

The construction of the dams is likely to trigger approval requirements including filling or excavation under the local planning scheme. The end of pipe treatment of B/C water in the Lockyer Valley may require an Environmental Authority for Environmental Relevant Activity 64 (water treatment for advanced treatment of the B/C water) if treating more than 5ML/day.

From a social assessment point of view all the four options faired equally in the MCA, with options B and C scoring higher than options A and D. This was mainly because construction of the additional new pipeline component was not required in options B and C. Option B scored marginally higher than option C due to the potential of reduced health and safety risk.

15.3.4 Financial and commercial impact

The results of the financial and commercial analysis indicate that for the project to be financially viable, a significant up-front funding contribution will be required from the Queensland Government. This is attributable to the significant capital and ongoing operating and maintenance costs to be incurred under the preferred option and the comparatively limited revenue able to be derived from water users (due to their capacity to pay).

The preferred option has both the lowest capital cost requirement (total of $1,592.7 million in nominal terms) and the most favourable FNPV estimate, being ($1,603.0 million). This represents a significant under-recovery in terms of the revenues that can be derived under the preferred option.

The potential for the affordability of the project to be improved through either scaling or staging of the project should be investigated in the Detailed Business Case for the project (in addition to the potential funding available through the NWIDF).

15.3.5 Procurement approach

Resolving a preferred procurement approach would be contingent on first securing in principle funding agreements (including defining the project proponent) and or project commitments from key stakeholders including Governments (State and Commonwealth), Seqwater and other relevant parties. The ultimate proponent is likely to need to align with their own procurement policies and also with Building Queensland given the likely need for a significant financial contribution from the State Government.

15.3.6 Timeframe

The project timeframe will ultimately be driven by the project proponent for the next phase of the project. However, fundamental to identifying the project proponent will be achieving in principle agreement from potential funding partners for advancing the project (e.g. State and Commonwealth Governments, irrigators, Seqwater and other relevant parties) and aligning with water security objectives for South East Queensland. It could be expected that achieving these initial key milestones may take in excess of 12 months to achieve.

A high level Draft Construction Project Program and Cash Flow has been presented in Appendix F2 (Volume 2) (refer Appendix C of Indicative Estimate Report (WT Partnership, November 2017)). The overall construction phase is estimated to be approximately 3.5 years subject to the procurement approach and devised approach to multiple construction fronts. The critical path package of work relates to the procurement, delivery and installation of the major booster pump equipment for the Gatton and Toowoomba Range pumps stations.

15.4 Criteria for success

The Investment Logic Mapping workshop identified a range of key performance indicators which would be used to monitor project success. These included:

- Increased investment in agriculture across the Lockyer Valley and Darling Downs and value of regional ag production
- New jobs in the Lockyer Valley and Darling Downs
- Improvement in key water quality indicators in Moreton Bay (nitrogen, phosphate and turbidity
- Recycled water tariffs (for irrigation use).

Clearly with a project of this scale it could be expected that other standard measures of success would also apply e.g. minimise social disruption and amenity, security and safety etc.

15.5 Priority

The potential for the affordability of the project to be improved through either scaling or staging of the project should be investigated in the Detailed Business Case for the project (in addition to the potential funding available through the NWIDF).

In determining the priority of the project it will be first necessary to define the potential asset owner and operator, or proponent. This could be in the form of existing utilities/entities such as Seqwater, or be a Special Purpose Vehicle specific to the project or another relevant party. The identification of the proponent will be a key task in the next phase of the project (Detailed Business Case). This will require establishing with greater certainty necessary legal and regulatory arrangements, including but not limited to:

- Accessing source waters produced from QUU (and Unitywater) STPs
- Accessing Seqwater infrastructure, particularly the WCRWS, and any associated conditions
- Confirming specific project requirements and limitations with regulatory authorities charged with administering approvals for recycled water schemes and specifically the WCRWS, Obtaining land access and acquisition for the overall projects infrastructure footprint

Obtaining expressions of interest and ultimately commitment from potential irrigation customers to take water in the event the irrigation scheme is established would be contingent on first resolving the above matters.

15.6 Future drivers of change to improve the feasibility of NuWater Project

The outcomes of the economic and financial/commercial analyses indicate that, based on the benefits and costs identified in this Feasibility Study, the preferred NuWater Project option (Option C) has a Benefit Cost Ratio of 0.35 and a FNPV of ($1,578.5 million).

This section identifies some of the key future step-changes in current policy, technology or other settings that, if they were to occur, might present significant opportunities for improving the economic viability of the project. These changes include:

- Additional source water arising from future treated effluent discharge point sources. For example, additional growth in the western Ipswich districts (such as Ripley Valley) is planned to be serviced by a new treatment facility. The treated effluent from this location may provide an additional source of product water that can be more efficiently delivered to meet the identified demand compared to delivery of product water from the Luggage Point and Gibson Island treatment plants. This could also apply to additional expansion in the regional centres in the Lockyer Valley and Toowoomba Regional Council areas.
- Population growth placing additional pressure on existing environmental licences. For example growth in existing catchments may mean that substantial treatment infrastructure upgrades are required to maintain environmental compliance with existing licences. This may lead to the identification of significant additional CAPEX/OPEX funding that could be used as a contribution to this project to offset these requirements.
- Pressure placed on the receiving environment (Moreton Bay and associated waterways) associated with continued urbanisation and agricultural development in South East Queensland may lead to more stringent environmental protection and increased discharge licence constraints being placed over licence holders by Government and its regulatory bodies. In this event, additional capital and operational expenditure will be required to either provide treatment infrastructure to manage additional growth obligations or wastewater transfers to alternative discharge locations. Potential CAPEX/OPEX avoidance presented by the NuWater Project through diverting treated effluent to the Lockyer Valley and Darling Downs could provide additional benefits (environmental cost avoidance).
- New industries creating increased demand for water and an associated capacity to pay the relevant price for water produced by the NuWater Project. Examples may include intensive feed-lotting/animal production, dairy operations and new mine/resource developments as well as new or existing farm conversions to higher-value horticulture.
- Significant increase in crop value improves the revenue generated from irrigation led development.
- Continuous improvement in farming practices presenting improved capacity to pay. It is noted, for example, that recent innovations such as automated/remote/unmanned equipment, improved crop varieties and genetic modification and enhanced monitoring and data analysis have improved gross margins for primary producers.
- Improved renewable energy technology producing lower cost energy either directly for the project or for the energy market in general. This could include:
  - Further development of existing renewable energy technologies (such as the rapid improvements in battery storage materials and technology improving the viability/feasibility of renewables with intermittent generation characteristics such as solar PV, wind, hydro)
  - New technologies not currently approved or established in Australia or as yet unknown.

- Significant reduction in energy costs through means such as either government intervention/regulatory change, and/or additional power sources coming on line (e.g. solar farms) being integrated with the power supply grid. The price of energy significantly affects project feasibility and as such the viability of the scheme will improve if this cost component reduces.
- Additional regulation of surface water and groundwater creating demand for a new water source sufficient to improve existing irrigator's willingness to pay.
- Additional regulation of surface water and groundwater resulting in compensation arrangements for relinquishing existing entitlements with capital being made available to support the project.
- New subsidies or grant funding for capital works supporting agricultural development. This would be subject to the basis of such grants aligning with the NuWater Project objectives and economic impact outcomes.
- New subsidies for renewable or alternative energy supplies providing a source of capital investment to install ongoing power generation alongside project infrastructure.

The above items represent potential step-changes that, if/when they occur, may warrant re-evaluation of the economic and financial/commercial analyses for the project and, consequently, updating of the feasibility study and preliminary business case.

The materiality of each of the above items in terms of their impact on the benefit to cost ratio for the project depends on hypothetical and unquantifiable changes and therefore cannot be quantified at this stage.

16. Conclusions

There are two key drivers of the NuWater project – diverting wastewater effluent and consequently reducing the quantity of nutrients discharged from STPs operated by SEQ service providers including QUU (and nutrient load on Moreton Bay) and deriving economic value for the beneficial reuse of recycled wastewater for agricultural and industrial production in the Lockyer Valley and on the Darling Downs.

The Problem Statement for the project identifies the need for additional water supply in the Lockyer Valley and Darling Downs to support agricultural and industrial production growth. Representatives from established agricultural areas in both zones were involved in the options identification workshop and assisted with clarifying the extent and specifics of demand that may be serviced by this new recycled water product.

All shortlisted options present significantly negative NPVs which is driven by the significant capital costs incurred in developing the infrastructure required to supply recycled wastewater to agricultural users and the significant ongoing treatment and energy costs incurred in maintaining supply. Option C results in the most favourable NPV and Benefit Cost Ratio (BCR) due to the lower up-front capital and ongoing treatment costs, however the BCR under this option is still significantly below 1.

In terms of the relative affordability of the shortlisted options, Option C is clearly more affordable relative to the other options. This option has both the lowest capital cost requirement and the most favourable NPV estimate. Whilst this option would still require a significant funding contribution from the State Government to be financially viable, the magnitude of the contribution would be lower than for the other shortlisted options.

The potential for the affordability of the project to be improved through either scaling or staging of the project is to be investigated in the Detailed Business Case for the project (in addition to the potential funding available through the NWIDF).

17. Assurance

Given the high capital costs (need for significant public funding) and risk associated with progressing the NuWater Project it is expected that the project will be subjected to independent review prior to proceeding to a Detailed Business Case phase with additional reviews undertaken to review the:

- Final business case and procurement strategy before any formal approaches are made to prospective suppliers or partners – confirm readiness for market
- Updated final business case and confirms that project is still required, affordable and achievable – confirm investment decision
- Readiness of the agency to transition from project delivery to the live environment – confirm the readiness for service
- Desired benefits of the project are being achieved and business changes are operating smoothly – confirm benefits realisation with this review repeated at regular intervals during the lifetime of the new service or facility.

However, the initial review would be first contingent upon achieving in-principle agreement from potential funding partners for advancing the project (e.g. State and Commonwealth Governments, irrigators, Seqwater and other relevant parties) and identifying the project owner/proponent accountable for the delivery of the project.

This review/s would help ensure that the project (and associated investment) meets strategic objectives, achieves value for money, and identifies opportunities to improve the delivery of project to ensure the best possible outcome. The Queensland Government has endorsed the use of Gateway for major infrastructure programs and projects.

18. Implementation plan

18.1 Detailed business case plan

18.1.1 Governance

Negotiations for the potential funding arrangements to advance the project have yet to be undertaken. Notwithstanding this, the development of this Preliminary Business Case has involved initial discussions with relevant parties with regard to the potential nature of funding contributions outlined in Table 18-1 below. Note that this table is not intended to represent a commitment from any of the sources.

Table 18-1 Nature of potential project funding contributions

Funding Source	Nature of Contribution
Australian Government	Lump sum (up to 50% of the capital cost)
Irrigators	Contribution towards local distribution and reticulation network on the Darling Downs and Lockyer Valley
Private investors	Other investment entities

In terms of Project Governance there are fundamentally three project proponent options available for advancing the NuWater Project i.e.:

- A Special Purpose Vehicle (SPV) involving multiple parties
- Seqwater (noting Seqwater has not developed an organisational position in this regard)
- Other relevant party.

These are discussed further below.

SPV

An SPV is a company with a separate asset/liability structure and legal status. The SPV may be formed through limited partnerships, trusts, corporations, limited liability corporations or other entities. An SPV may be designed for independent ownership, management and funding of a company; as protection of a project from operational or insolvency issues; or for creating a synthetic lease that is expensed on the company's income statement rather than recorded as a liability on the balance sheet. They help companies securitize assets, create joint ventures, isolate corporate assets or perform other financial transactions.

An off-balance-sheet SPV documents its assets, liabilities and equity on its own balance sheet rather than on the parent company's balance sheet as equity or debt. The parent company typically prefers this arrangement due to improved management of assets and liabilities, lower risks, higher credit ratings, lower funding costs, greater financial flexibility and lower capital requirements.

It could be expected that the SPV involve representation from QUU, Seqwater and QFF.

Seqwater

Under a Seqwater project proponent model it would mean an extension of their ownership and management role of water supply assets across South East Queensland (currently totalling over $12 billion). Importantly this would maintain their ultimate control over the SEQ Water Grid and guide enhanced water quality and environmental outcomes across the region.

18.1.2 Project scope, resourcing and milestones

Project scope, resource requirements and project milestones are all contingent upon achieving a project proponent as discussed above. Fundamental to this will be achieving in principle agreement from potential funding partners for advancing the project (e.g. State and Commonwealth Governments, irrigators, Seqwater and other relevant parties).

18.1.3 Cost estimate

The cost estimate is based on carrying out the necessary detailed feasibility studies, stakeholder engagement processes and economic and financial analysis to support the preparation of the Detailed Business Case. It also involves the significant commercial negotiations between the prospective project delivery funders. Based on this the preparation of the Detailed Business Case is expected to cost in the order of $5-10,000,000.

18.2 Communication plan

A comprehensive Communication Plan will be developed if the NuWater Project advances to the Detailed Business Case phase. The Communication Plan will build upon the engagement and consultation framework established through the Preliminary Business Case phase. The specific tools, messages, audience and implementation schedule will be confirmed in the early stages of the Detailed Business Case.

19. Recommendations

For the NuWater project to proceed to the Detailed Business Case phase the following outcomes will need to be achieved:

- Seqwater, as the asset owner of the WCRWS, along with relevant regulatory agencies including Department of Energy and Water Supply and Department of Health, review the potential issues and required actions to facilitate the use of WCRWS infrastructure to transfer Class B/C product water (preferred option). This may include industry and broader regulatory engagement, literature review, research and engagement with research institutions and quality verification/validation process considerations as part of potential future stages of project.
- Undertake more detailed assessment of its potential nutrient abatement contribution.
- Confirm an “in principle” financial contribution for incorporation into economic and financial analysis of the project in subsequent phases.
- Irrigators agree in principle to significant capital investment towards delivery of the project
- Irrigators agree in principle to a defined annual water charge
- The Queensland Government agrees to support the project.

20. Agency Consultation

Under the terms of the Grant Deed, DNRME requires that relevant Government agencies be consulted to seek and receive feedback on the draft Feasibility Study / Preliminary Business Case. A number of State Government agencies were requested to provide general comment on the Preliminary Business Case document (Draft Revision C, 20 December 2017) in addition to a number of specific responses sought from particular departments.

The request was issued to relevant agencies on 21 December 2017 by DNRME. An Agency Consultation document was received from DNRME on 31 January 2018 that collated comments received for relevant agencies requested to provide feedback. This document, along with a register summarising proposed modifications and reasons for making or not making modifications in response to the feedback, has been submitted separately to DNRME.

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22. Glossary of terminology

This glossary should be read in conjunction with the table of abbreviations included in this document (refer pages ix-x).

Announced Allocation: Is the allocation of water for use in a particular irrigation season. Seasonal allocations will depend on how much water is available in storage. As an example, if a seasonal water allocation during a drought was only 50%, a water allocation holder with a 100 ML medium-reliability water share would be allocated 50 ML of water for use.

AHD: Means the Australian height datum adopted by the National Mapping Council of Australia for referencing a level or height back to a standard base level.

Benefit: The measurable improvement resulting from an outcome, which is perceived as an advantage by one or more stakeholders. Note that not all outcomes will be perceived as positive, and outcomes that are positive for some stakeholders may be seen as negative for others.

Bubble Licence: A single licence and nutrient load limit that includes multiple operations i.e. if two or more point sources of discharge are managed by the same regulated entity through an amalgamated authority under section 243 of *Environmental Protection Act 1994* they may combine discharge limits to meet an overall reduced discharge limit—commonly referred to as a 'bubble licence'.

Distribution Losses: Water losses that occur as a result of the distribution of irrigation water. Causes of these losses include evaporation, seepage, metering error and leaks in irrigation infrastructure.

GL or Gigalitre: One GL is equivalent to 100 m of water over a hectare or 1,000 megalitres.

High-Reliability Water Allocation: The highest reliability legally recognised, secure entitlement to a defined share of water. This water has reliability generally greater than 95% (i.e. is supplied 95 years in every 100 years).

Irrigation Area: A defined are to be supplied with irrigation water.

Medium-Reliability Water Allocation: A legally recognised, water entitlement to a defined share of water. This water is available after there is enough water to supply all high-reliability water allocations, losses and reserves.

ML or Megalitre: One ML is equivalent to 100 mm of water over a hectare or 1,000,000 litres.

National Partnership Agreement (NPA): A National Partnership Agreement has been established between the Commonwealth and state and territory governments to facilitate the payment of funds for approved water infrastructure projects.

National Water Initiative (NWI): The NWI, agreed in 2004 by the Council of Australian Government, is the national blueprint for water reform including improving pricing for water storage and delivery.

National Water Infrastructure Development Fund (NWIDF): The NWIDF is an initiative of the Australian Government to accelerate the assessment of water infrastructure options which could stimulate regional economic activity.

Project Manager (PM): QFF's appointed Project Manager to assist co-ordinate delivery of the project between the appointed Consultant and QFF and its members and other stakeholders.

Purified Recycled Water (PRW): Wastewater that has been treated to a very high standard using the world's best technology through an advanced water treatment process. The Public

Health Regulation 2005 and the Australian Guidelines for Water Recycling for recycled water schemes specify the water quality standards that must be met for recycled water and drinking water. (Seqwater (2017a).

Standard of Service: Nominated level of service is a quantification of flow rate, flow rate consistency, command, water ordering time, water delivery period, reliability and water delivery season length.

Supply Point (or Farm Offtake or Outlet or Service Point): Point of delivery from an irrigation water distribution system to an individual farm. A supply point from a pipeline system usually comprises a measurement device (meter).

Total Nitrogen (TN): Sum of the total kjedahl nitrogen (ammonia, organic and reduced nitrogen) and nitrate-nitrite.

Total Phosphorous (TP): Sum of reactive, condensed and organic phosphorous.

Uniformity of flow: The measure of change in water delivery flow rate over the period of an irrigation. Good uniformity is defined as ± 5% over 90% of the time.

WCRWS: Western Corridor Recycled Water Scheme

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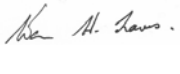
0	J Skene / M Smith / D Culpitt	W Traves		W Traves		28/03/18

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