water forever

SUSTAINABILITY ASSESSMENT

DECEMBER 2008

WATER CORPORATION

CONTENTS

FOREWORD

There is an expectation from the community and more importantly, a commitment from the Water Corporation that our water services will be delivered in a socially, economically and environmentally responsible way. This Sustainability Assessment supports that commitment and will further strengthen planning for our water future.

Providing an essential service like water and wastewater touches every aspect of our community.

The development of a comprehensive sustainability assessment of all water options being considered as part of our 50 year plan, Water Forever, is a significant undertaking. The assessment and prioritisation of each option provides a strong foundation for future planning, research, decisions and investment.

Understanding the strengths and weaknesses of each option from a sustainability viewpoint helps us to develop a portfolio of viable source and efficiency options for the future.

It is encouraging to see the alignment between the outcomes of this assessment and the preferences of the community with respect to future water sources.

Increasing water use efficiency and the recycling of water are priorities to help make Western Australia a great State, well positioned for our water future.

The outcome of this assessment is a major contributor to *Water Forever: Directions for our water future* to be released in February 2009.

Sue Murphy
Chief Executive Officer

EXECUTIVE SUMMARY

"Sustainability is meeting the needs of the current and future generations through integration of environmental protection, social advancement and economic prosperity."

State Sustainability Strategy 2003.

Water Forever is developing a long term plan for Perth integrating water, wastewater and drainage services with land planning. It will create a comprehensive and flexible framework for the Water Corporation to deliver sustainable water services for the next 50 years.

The Water Corporation understands the need to deliver sustainable outcomes when planning for water, wastewater and drainage services. It is our responsibility to provide customers with safe and reliable water services. We aim to provide water solutions that deliver a 'quality of life' for customers and surrounding communities, in an environmentally responsible and affordable way.

The overall aim of the Water Forever sustainability assessment is to identify the most sustainable water options, taking into account a range of issues and impacts.

In developing the assessment process, we have drawn from a number of widely accepted sources including the Water Services Association of Australia Sustainability Framework, International Association for Impact Assessment and our own business principles which focus on delivering positive outcomes.

Multi-criteria analysis was chosen as the tool to enable assessment to be measured against individual criteria and aggregated into an overall ranking or performance matrix of options.

The water source options assessed in this report were identified following a comprehensive and rigorous process including extensive consultation with the community, stakeholders and the Water Forever Science Panel who provided expertise and a national perspective.

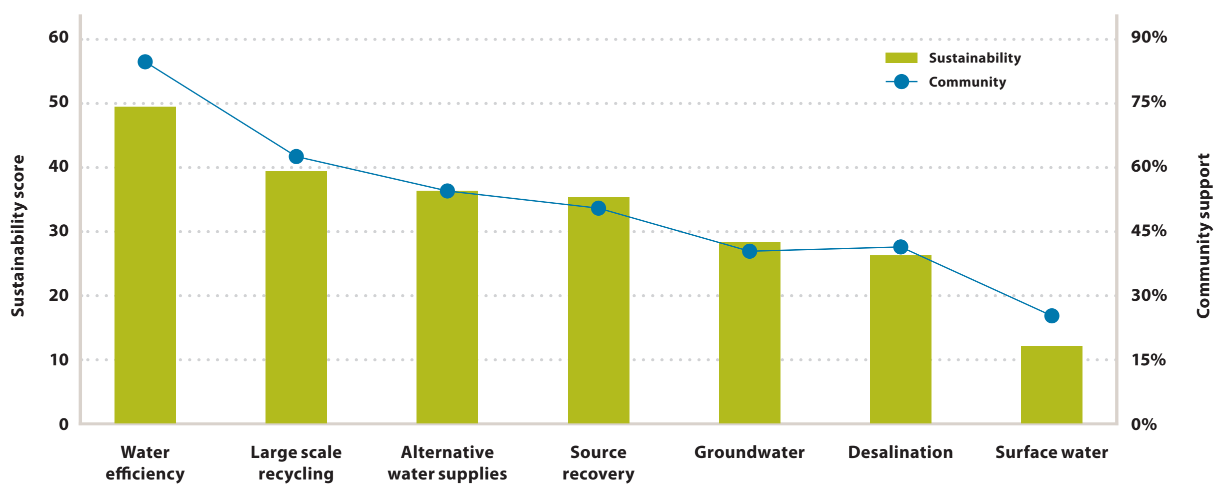
The sustainability assessment of each of the options was conducted in two phases. Firstly, a high level assessment was undertaken based on the three pillars of environment, economic and social to eliminate options that were clearly unviable for further analysis.

Secondly, a more comprehensive assessment of 33 water efficiency and source options was undertaken based on 15 detailed sustainability assessment criteria. The results were compared to community preferences, documented in our community engagement report *Water Forever: Reflections* released in August 2008.

We support a broad portfolio of water options to secure our water future – from more water efficiency to desalination.

The outcomes of the sustainability assessment will be utilised in developing future source options which will be outlined in *Water Forever: Directions for our water future* to be released in February 2009.

Sustainability Assessment & Community Support



01 INTRODUCTION

INTRODUCTION

1.1 WATER FOREVER

Water Forever was launched in October 2007 to develop a 50 year plan to provide water, wastewater and drainage services for Perth and surrounding areas. It will create a framework for the Water Corporation to deliver conservation initiatives and infrastructure to support our water future during a time of predicted high population growth and continued rainfall decline. The plan will be comprehensive and flexible to adapt to our changing environment.

Water Forever is working closely with the community and key stakeholders to develop the draft plan for future water service delivery. The plan has five major stages outlined in Table 1.

The four-month community engagement phase of Water Forever heard from over 2,300 Western Australians who provided their thoughts on planning for our water future. The findings of this phase are summarised in the *Water Forever: Reflections* report released in August 2008.

The views expressed by the community during this phase, together with the technical and sustainability considerations in this report, forms the basis of the *Water Forever: Directions* draft plan to be released in February 2009.

This draft plan will provide further opportunities for community input prior to the finalisation of the Water Forever final plan later in 2009.

1.2 TOWARDS A SUSTAINABLE WATER FUTURE

The Water Corporation understands the need to deliver sustainable outcomes when planning for water, wastewater and drainage services. It is our responsibility to provide our customers with safe and reliable water, drainage and wastewater services. We aim to provide water solutions that deliver a quality of life for customers and surrounding communities, which are environmentally responsible and affordable for current and future generations.

In the past we have considered issues in light of environmental, social and economic impacts. Our purpose is:

"The sustainable management of water services to make Western Australia a great place to live and invest."

In defining 'sustainability', we have adopted the definition outlined in the Western Australian *State Sustainability Strategy*, '*Hope for the Future* (2003)':

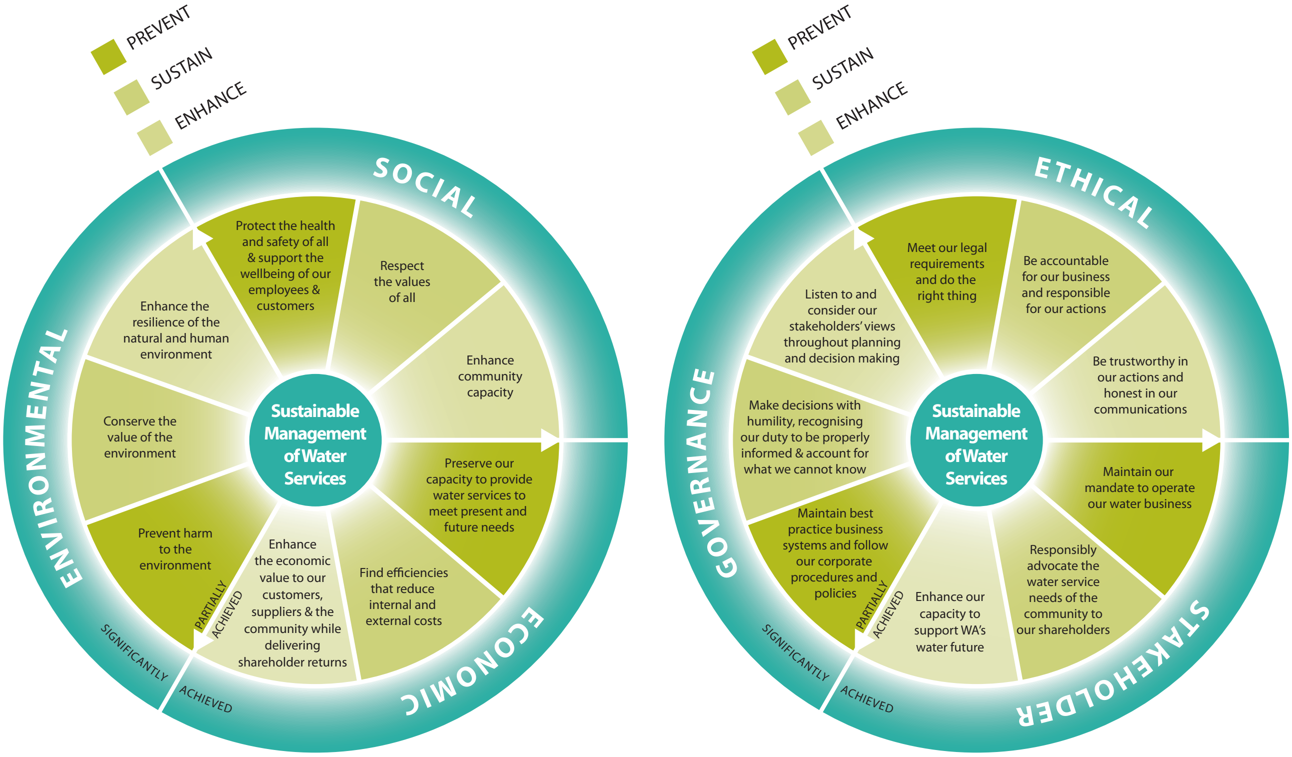
"Sustainability is meeting the needs of the current and future generations through integration of environmental protection, social advancement and economic prosperity."

Our sustainability strategy aims to build awareness and understanding, encourage sustainability thinking in the organisation and embed sustainability principles into decision-making processes.

Water Forever process overview *(table 1)*

Phase 1	Do you want to be involved in making decisions about water and wastewater services for Perth?	Get involved	Throughout the project
Phase 2	What are the major issues that need to be addressed in relation to water and wastewater services for Perth?	Have your say	March - June 2008
Phase 3	Here is a summary of your input into planning to date.	What you said	July - August 2008
Phase 4	Here is a draft plan that indicates where we are heading. Do you agree with the direction we are proposing to take?	What we plan to do	February - May 2009
Phase 5	Developed with your input, here is our final plan and how we will implement the strategy.	How we will do it	Later in 2009

Business Principles *(figure 1)*



Our business principles guide planning and operations by identifying issues, generating options for development, engaging with stakeholders, evaluating options and making decisions. Our business principles are outlined in Figure 1.

These principles have guided Water Forever in engaging with the community and in the development of the draft plan. For example, *Water Forever: Options for our water future* was supported by a series of information sheets which provide a summary of the key sustainability issues identified to date. These issues were identified with reference to the business principles.

Water Forever: Options, the information sheets and the community engagement program all form part of the sustainability assessment process. This assessment will inform the development of the final plan and identify actions for implementation.

1.3 WHAT IS SUSTAINABILITY ASSESSMENT?

The Water Services Association of Australia (WSAA) has recognised the need for the urban water industry to develop a methodology for evaluating the sustainability of the various supply and demand options taking into account economic, environmental, human health, technical and social considerations. As such, WSAA has developed a sustainability framework to guide the adoption of this approach to the evaluation of urban water options (Appendix 1).

The business principles of the Water Corporation have been used to guide the sustainability assessment process.

1.4 LEVELS OF SUSTAINABILITY ASSESSMENT

Sustainability assessment can be used for the purposes of assessing policies, plans, programmes and projects. To provide context for the Water Forever sustainability assessment process, Table 2 outlines other levels of sustainability assessment undertaken with respect to the Water Corporation's activities.

1.5 AIMS AND OBJECTIVES OF WATER FOREVER SUSTAINABILITY ASSESSMENT

The overall aim of the Water Forever sustainability assessment is to identify the most sustainable water options based on criteria developed from the business principles.

In addition, the assessment aims to:

- develop and prioritise a portfolio of sustainable water supply options;
- ensure the integrated assessment of demand (efficiency) and supply (source) options including the use of wastewater as a source;
- ensure early exclusion of options which are unacceptable based on cost, environmental or public health risk;
- demonstrate transparency around the data and analysis available to perform the assessment;
- incorporate stakeholder input into the development of options and criteria, as well as analysis; and
- investigate and implement opportunities to improve the outcomes of options through mitigation and enhancement.

To achieve these aims, the Water Forever sustainability assessment process adopted the critical objectives considered to be best practice by the International Association for Impact Assessment (January 1999):

- purposive;
- focussed;
- relevant and rigorous;
- participative;
- interdisciplinary and integrated;
- transparent;
- efficient;
- systematic;
- credible;
- adaptive;
- practical; and
- understandable.

1.6 CHALLENGES FOR THE SUSTAINABILITY ASSESSMENT PROCESS

Every assessment process has its challenges. As stated by Hall, Kotz and Doherty (2004) in '*Water Proofing Adelaide: Assessment Process for a Sustainable Water Strategy for Adelaide*' there are other factors besides sustainability to consider when developing a strategy. The sustainability assessment process used in Adelaide is summarised in Appendix 2.

Examples of sustainability assessment undertaken by the Water Corporation *(table 2)*

Corporate	Business planning	Corporate Vision 2029
Policy	Strategic water cycle planning	Water Recycling Strategy (2004) Water Forever (2008)
Planning	Planning business case	Planning sustainability framework (2008)
Strategic Issue	Strategic assessment	Wastewater discharges to waterways (2008)
Project	Implementation business case	Project specific assessment e.g. Beenyup co-generation (2007)

Other factors to be considered may include:

- complementary and conflicting nature of actions;
- reliance of one action on another;
- staging/implementation time of actions;
- changes in technology;
- maximising the overall sustainability of the strategy; and
- integration with strategic plans/policy being developed in parallel.

In this case, the breadth of options and the long time horizon provided the following challenges:

- inherent difficulty in integrating qualitative and quantitative criteria;
- generation of new options during the project;
- parallel processes for water and wastewater; and
- different levels of data reliability.

The sustainability assessment is intended to be a tool to inform the strategy. While these challenges are noted, we believe that the sustainability assessment process helps to document options, ensures that a range of issues and impacts are considered in a structured manner and captures knowledge at a point in time.

The assessment process developed is sufficiently detailed and robust to enable the Corporation to eliminate the unviable options.

Following completion of the sustainability assessment process, options will be further refined by the use of decision support tools, modelled scenarios and risk assessment.

02 ASSESSMENT PROCESS

ASSESSMENT PROCESS

2.1 OVERALL PROCESS

The Water Forever sustainability assessment process is shown in Figure 2. This diagram includes the inputs and outputs required to undertake, and arising from, the assessment.

One further key element of this process is the selection of a tool to enable assessment to be measured against individual criteria and aggregated to provide an overall relativity ranking or performance matrix of options.

Consideration was given to the use of monetising economic, social and environmental costs into an "advanced" cost – benefit analysis. The process of monetising can be very powerful when optimising a specific dilemma but was considered too time consuming and resource intensive given the wide range of options considered. Further, many markets for social and environmental externalities are relatively immature in Western Australia, given the lag of policy in some areas and relatively low density and economic activity.

Inputs, outputs and steps in sustainability assessment process *(figure 2)*

Inputs		Steps		Outputs
State Water Plan (2007) Perth's Water Future (1995) Wastewater 2040 (1995) Integrated Water Supply Scheme, Source Development Plan (2005)	→	STEP 1: Identify need and drivers for the project	→	Need, Scope and Drivers
Need, scope, drivers, business principles, boundaries, feedback	→	STEP 2: Option identification for water sources and wastewater management	→	Information sheets, Water Forever: Options
Water Forever: Options, Water Forever: Reflections, information sheets, existing information, business principles	→	STEP 3: Determine criteria for high level assessment/screening and detailed assessment	→	Sustainability criteria
High level sustainability criteria, planning reports, planning studies, other planning data	→	STEP 4: Undertake high level assessment/screening of options	→	Options for detailed assessment, Eliminated options
Detailed sustainability criteria Options for detailed assessment Feedback from consultation	→	STEP 5: Undertake detailed assessment of options which pass high level assessment/ screening test	→	Performance matrix

Multi-criteria analysis (MCA) was chosen as the tool for use in Steps 4 and 5 due to its ability to use a wide range of empirical and qualitative data, resulting in an overall aggregate score. In dialogue with the Water Forever Science Panel and internal stakeholders, it was agreed that the criteria would not be weighted. Weighting may occur in subsequent phases of planning as the sources are assessed in more detail.

2.2 STEP 1 – NEED AND DRIVERS FOR WATER FOREVER

Any sustainability assessment process should begin with the identification of the need and drivers for the project. If these are not well understood the assessment process runs the risk of identifying inappropriate options while dismissing others that could meet the need.

This step also includes developing a good understanding of the real problem to be resolved and the objectives to be met in solving the problem. For this reason a wide range of stakeholders need to be involved in this step.

The effects of a drying climate and prolonged drought across Australia have highlighted the fact that rainfall dependent sources may not provide enough water, or enough certainty to meet the needs of rapid population growth in our cities.

With escalating population growth, there is increasing pressure within cities for land, particularly given the move to create urban growth boundaries in some cities. Infrastructure cost, resourcing and focus on sustainable energy sources due to climate change, add to the pressures of delivering a sustainable water service. These have significant ramifications for the water industry as it moves to rainfall independent sources like desalination that are generally energy intensive.

In the study area covered by Water Forever, the population is expected to increase by over 85 percent by 2060. In addition, since 2001 we have only received a third of the long term average of streamflows into our dams increasing our reliance on groundwater sources. Groundwater levels have also fallen as a result. Water Forever was identified as a priority action under the *State Water Plan*, released by the State Government in 2007, for these reasons.

At the same time, a range of environmental issues is causing us to rethink how we manage our impact on the land, use energy and contribute to biodiversity.

A 50 year plan allows us to consider these three factors:

- robust forecast population growth;
- an even drier climate; and
- our impact on the environment.

Reflecting different climate scenarios and choosing between a number of options requires an effective and dynamic means of evaluating a portfolio of water use efficiency and water supply options.

Over the past fifteen years, the Water Corporation has completed several strategic infrastructure-planning documents that have formed the basis for ongoing investment in new programs and infrastructure:

- '*Perth's Water Future: A water supply strategy for Perth and Mandurah*' (1995);
- '*Wastewater 2040, Strategy for the Perth Region*' (1995); and the
- '*Integrated Water Supply Scheme, Source Development Plan*' (2005).

The *Source Development Plan* adopted an integrated resource planning approach as recommended in the *State Water Strategy*, released by the State Government in 2003.

Integrated resource planning ensures that options to reduce demand on water supplies (such as water use efficiency initiatives) are compared on an equal basis with options that increase supply (such as new water sources). This framework has been developed by urban water utilities across Australia to evaluate a range of options.

The direction provided in the above mentioned planning reports has helped us to keep pace with development. We have been able to meet the water service needs of our customers by implementing a range of water use efficiency and customer service initiatives, coupled with detailed asset planning and development of existing or new water sources. It is now time to review these plans and move forward once more.

Regional areas of Western Australia have very different climates, communities, economic needs, water resources and ecosystems. The water service needs for each region are assessed individually taking into consideration the individual needs of that community. For example, the Water Corporation is currently examining options for the Pilbara.

The Water Forever scope covers the area currently supplied by the Integrated Water Supply Scheme (IWSS), which includes the area supplied by the Goldfields and Agricultural Water Supply Scheme. The wastewater planning area is the current metropolitan area, from Lancelin in the north to Mandurah in the south. The project will consider opportunities for more water recycling in these areas. Drainage catchments in the Perth and Peel areas are also in this scope.

The Water Forever study area covers three quarters of all our customers in Western Australia.

Communities that could be connected to the IWSS water grid or wastewater system are also considered as part of the study scope.

2.3 STEP 2 – OPTION IDENTIFICATION

The process of identifying options to meet the need and objectives should be comprehensive and unconstrained. Options which may appear unworkable under current conditions should still be identified in case circumstances change in the future. Again a wide range of stakeholders should be involved to canvass all possible options.

Water Forever: Options released in April 2008, was a culmination of six months work which:

- identified the need, scope, drivers and boundaries of the project;
- sought input from stakeholders and the community; and
- identified a range of water and wastewater options to 2060.

Along with the views of stakeholders and the community, significant input was received from the Water Forever Science Panel (see Appendix 3 for their Terms of Reference). The deliberations of the Panel added a further 7 options to the suite of options which had already been identified for closer examination.

Further details on these options are provided in Table 3.

2.4 STEP 3 – DETERMINE HIGH LEVEL AND DETAILED SUSTAINABILITY CRITERIA

The development of detailed sustainability criteria should clearly align to the objectives and any higher order principles applying to the project.

Various inputs to this step were used to assist in the identification of high level and detailed sustainability criteria. These inputs included *Water Forever: Options*, external and internal feedback and the associated information sheets which include a brief overview of the sustainability considerations for various options.

Other important inputs included:

- *Water Corporation Business principles* (see section 1.2);
- *'WSAA Sustainability Framework' (WSAA Occasional Paper No. 17, February 2008)* (Appendix 1);
- '*Water Proofing Adelaide: Assessment Process for a Sustainable Water Strategy for Adelaide', WSUD2004 (Hall et al, 2004)* (Appendix 2);
- *'Towards Sustainability' Position Statement No. 6 (Environmental Protection Authority, August 2004)*
- *'The use of LCA in the water industry and the case for an environmental performance indicator', Water SA Vol.33 No. 4 (Friedrich et al, July 2007)*; and
- feedback from the Water Forever Science Panel.

The three primary criteria from our business principles were used to define the detailed assessment, together with feedback from community and stakeholder engagement activities (table 4).

Future Water Sources / Initiatives *(table 3)*

Option number	Grouping and description	Details
	Water use efficiency	
1	Changing water use behaviour	Water efficiency programs designed to help customers use less water.
2	Technological advancement	Various initiatives such as WELS, Five Star Plus, retrofits for residential and business, water efficiency management plans, leakage, pressure and metering management.
3	Increased urban density	Increased density leads to smaller lot sizes and smaller garden spaces requiring less watering.
4	Urban form	Various initiatives such as waterwise programs, lawn buyback programs, water efficiency measures, waterwise land developments, waterwise councils and urban form options.
	Alternative water supplies	
5	Greywater systems	Individual household greywater systems from simple bucketing to more complex systems involving storage and treatment. Used for non-potable purposes.
6	Garden bores	Individual garden bores to water lawns and gardens. Used for non-potable purposes.
7	Rainwater tanks	Individual rainwater tanks to water lawns and gardens. Used for non-potable purposes.
8	Community bore systems	Shared bores pumping groundwater into a storage tank and through a reticulation network to local residences for non-potable purposes.
9	Community greywater systems	Distributing treated greywater / wastewater from a treatment plant via a "third pipe" distribution network into the community to provide an alternative water supply for internal uses, such as toilet flushing, and external uses, such as garden watering.
10	Sewer mining systems	Sewer mining is the process of tapping directly into a main sewer and extracting raw wastewater for treatment and reuse as recycled water. A facility would typically consist of: • connection to the main sewer to extract the raw wastewater; • transport raw wastewater to the treatment plant; • wastewater treatment plant; • connection back to the main sewer for residual wastes; • system to remove any other by-products that can't be returned to the sewer; and • system to transfer the treated effluent to the beneficial use. The treated effluent can be used for a variety of purposes such as watering sporting fields and golf courses, parks and gardens, irrigation and industrial uses. It is not suitable for potable drinking water supplies.

Option number	Grouping and description	Details
	Large scale recycling	
11	Industrial recycling	Supply of treated wastewater for industrial customers.
12	Groundwater replenishment	A process where water from Perth's wastewater treatment plants is treated to the highest standard through a process involving micro filtration, reverse osmosis and UV disinfection, before being pumped into groundwater. This high quality water mixes with existing groundwater supplies and can be taken out many years later and treated again for use in Perth's drinking water system.
13	Direct potable recycling	Direct potable recycling is a process where treated wastewater from Perth's wastewater treatment plants would be further treated by reverse osmosis and then supplied to Perth's drinking water system. As an example, treated wastewater from Subiaco WWTP could be recycled as drinking water. This could be achieved by further processing the treated wastewater by: • micro or ultra filtration; • reverse osmosis; • advanced oxidation (Hydrogen Peroxide and high level UV); and • disinfection.
	Source recovery	
14	Harvey water trading	Trading on-farm efficiencies in the Harvey – Waroona areas.
15	Trading Gnangara groundwater	This option allows for the purchase of licensed water allocations from private users within the Gnangara groundwater area. For the purposes of costing, it has been assumed that no additional infrastructure will be required and that any acquired allocation would be utilised from existing bores and treated and distributed with existing assets.
16	Reducing evaporation from dams	There are a number of reservoirs around Perth that contribute to the water supply of the city and its surrounding areas. The losses due to evaporation from these reservoirs are quite significant. Methods to reduce these losses include physical methods such as floating covers, floating objects or chemical retardants which prevent evaporation when applied to the water surface and other methods such as deepening reservoirs, windbreaks and cellular storage.
17	Catchment management	Catchment management includes various techniques to improve the state of the forest and conserve the environment. Catchment thinning is one technique that has been used in the past to improve the environment and increase stream flow. Thinning regrowth forest tends to move the forest back towards its previous natural state. Catchment thinning is best applied to regrowth forests where the tree density is much greater than pre-European or mature old growth forests. Without catchment management, regrowth forests result in less water being available to the environment and reduced flows into streams and drinking water dams.

Option number	Grouping and description	Details
18	Cloud seeding	Cloud seeding attempts to artificially generate rain by implanting clouds with particles such as silver iodide crystals. Given the increasing emphasis on climate change and variability, the science of cloud seeding is gaining prominence. Cloud seeding is usually carried out by sprinkling particles from above by a plane fitted with silver iodide burners mounted under each wing. Using weather forecasting techniques, suitable clouds are identified based on the location of the target area and the prevailing winds. A seeded cloud will take 30 minutes to precipitate and seeding areas are chosen upwind of the target.
	Desalination	
19	Southern Seawater Desalination Plant phase 2	This option is an expansion of the proposed Southern Seawater Desalination Plant (SSDP), located near the town of Binningup. The first phase of the SSDP is scheduled to start construction during 2009.
20	Esperance to Kalgoorlie pipeline and seawater desalination	The concept comprises a seawater desalination plant located at Esperance and the transfer of the product water via a 385 km pipeline to Kalgoorlie. It would supply potable water into the existing storage reservoirs at Kalgoorlie. The Water Corporation would buy water from the proponent and then on-sell it to its customers. The G&AWS scheme would most likely terminate at Southern Cross.
21	Seawater desalination – other	New seawater desalination plants located near the coast, delivering treated water to the IWSS.
22	Geothermal desalination	Geothermal Desalination is a process in which energy from hot water taken from deep below the earth's surface is used to desalinate water usually by Multi Effect Distillation (MED). Geothermal energy is obtained through the use of injection wells which return cooled water into a permeable sediment and production wells which extract the heated water. This hot water is then fed through a heat exchanger, transferring the heat energy to a liquid which is then used to power the MED process. MED is the preferred distillation process for geothermal energy as it is more efficient to use the heat directly than to convert the heat to electricity and then provide energy to an alternate desalination technique such as reverse osmosis.
23	Wellington dam desalination	Utilise water from Wellington Dam. This scheme would most likely require a reverse osmosis desalination plant. For the purposes of this analysis it has been assumed that a 45 GL per annum capacity reverse osmosis plant is constructed to treat Wellington Dam water.

Option number	Grouping and description	Details
	Groundwater	
24	North-West Coastal Groundwater	There is potential to develop new groundwater schemes on the western side of the Gnangara Mound System from the superficial and confined aquifers. This water currently drains to the Indian Ocean. The schemes would be in the vicinity of Perth's North West Corridor and would develop with planned urban expansion identified in the Perth Regional Planning Scheme. The scheme would require treatment plants at both Eglinton and Yanchep.
25	Karnup and Dandalup Groundwater	The Karnup and Dandalup groundwater scheme options were originally proposed as separate, but adjacent schemes, situated approximately 55 kilometres south-east of Perth and 20 kilometres north-east of Mandurah. The Karnup Dandalup groundwater areas cover a surface area of about 300 km^2. The towns of Serpentine, Keysbrook and North Dandalup are situated in the eastern part of the area and the new residential land development, Keralup is in the western part of the area.
26	Gingin and Jurien Groundwater	The proposed Gingin - Jurien Groundwater System intends to extract groundwater from the superficial and confined aquifers in the area north of Moore River towards Badgingarra. The groundwater area is generally between the coast and the Brand Highway. Planning has identified three borefields; Mimegarra, Wedge Island and Badgingarra. The Mimegarra and Wedge Island bores, located closer to the ocean, would extract water from sand and limestone aquifers. The Badgingarra bores would extract water from the Yarragadee aquifer. They could be developed as 3 separate schemes, but there are advantages in mixing the raw water together, treating it and then pumping it via one system into the water grid.
27	South West Yarragadee	The South West Yarragadee Water Supply Development proposal involves the abstraction, treatment and conveyance of groundwater from the Yarragadee Formation from a bore field in the eastern part of the Blackwood Plateau.
28	Collie Coal Basin Groundwater	The Water Corporation is investigating options for accessing groundwater in the Collie River Basin as the groundwater is protected from salinity and contamination risks and is potentially suitable for drinking water. If in the future, water supplies required by power stations came from Wellington Dam a 10 GL per annum scheme could be developed via Stirling Dam (transfers above 10 GL would incur substantial losses through reservoir spills regardless of any upgrades to downstream infrastructure).

Option number	Grouping and description	Details
29	Jandakot Groundwater Expansion	The Jandakot Groundwater Expansion is a southern extension of the Jandakot Groundwater Scheme, extracting water from the southern third of the Jandakot Groundwater Mound. The Jandakot Groundwater Expansion involves approximately 20 km of collector mains, 13 bores in the superficial aquifer and 3 bores in the Leederville aquifer.
30	Mining of confined aquifer (Gnangara)	This option allows for the abstraction of water from the confined aquifers of the Gnangara Mound in excess of existing allocations. The current total allocations (private and Water Corporation) are in excess of the calculated recharge rate. The current abstraction rates already recover stored water from the Leederville and Yarragadee aquifers. At current abstraction rates there are many thousands of years of stored water within these confined aquifers. If increased allocations from the confined Gnangara aquifers were to be utilised, there are a number of potential management options which could be utilised in the future to minimise the effects of declining storage levels. One of these options would be the use of bores to inject water into the aquifer near the coast to manage the salt water interface. It is likely that these management options would not be required for many decades and perhaps even centuries.
	Surface water	
31	Brunswick dam	The recommended option consisted of: • a major dam on the Brunswick River; • a water treatment plant; and • 2 pumping stations. 111 km of 1200 mm trunk main to Tamworth Reservoir to connect to the IWSS
32	Kimberley pipeline	Pipeline from the Fitzroy river
33	Kimberley canal	Canal from the Fitzroy river
34	Kimberley supertanker	Transport of water using conventional 0.5 GL capacity supertankers.
35	Kimberley water bag	Transport of water using very large towed water bags.

Sustainability Criteria *(table 4)*

Pillars / Business principles	Community engagement themes	Criteria	Application level
Environment Conserve the value of the environment Enhance the resilience of the natural and human environment Prevent harm to the environment	Restore the natural environment Use less water Source water locally Move from waste to resource Energy efficiency Integrate with land planning	1. Physical footprint	Detailed
		2. Energy intensity	High detailed
		3. Capacity to enhance the environment	Detailed
		4. Water allocation	Detailed
		5. Water efficiency	Detailed
Social Respect the values of all Enhance community capacity Protect the health and safety of all and support the wellbeing of our employees and customers	Connect to communities	6. Community preference	Detailed
		7. Indigenous heritage (sites)	Detailed
		8. Social amenity	Detailed
		9. Empower customers	Detailed
		10. Source risk (health)	High detailed
Economic Find efficiencies that reduce internal and external costs Enhance the economic value to our customers, suppliers and the community while delivering shareholder returns Preserve our capacity to provide water services to meet present and future needs	Price for efficient use Become more climate resilient	11. Net economic cost	High detailed
		12. Complexity	Detailed
		13. Reliability	Detailed
		14. Rainfall dependence	High detailed
		15. Flexibility and adaptability	Detailed

1. Physical footprint

The physical footprint of an option was chosen as a measure to distinguish between those which involve a high level of clearing and those which do not. Clearing has been used as a measure because it can generally be used as a surrogate for impact on biodiversity, where detailed environmental impact assessment has not been completed.

Importantly, the unit measure for this criterion is the amount of water extracted per hectare of land cleared [i.e. GL/yr/footprint area (ha)]. This enables an appropriate assessment of the productivity of the proposed option as a function of the land required to accommodate it.

2. Energy intensity

The decision to use energy intensity as the environmental measure at this high level was based on various factors including the Water Corporation's Greenhouse Gas Strategy which advocates the pyramid of energy use, avoidance and efficiency, followed by use of renewable energy and then offsets (particularly offsets that provide multiple business benefits).

3. Capacity to enhance the environment

Some options do have the capacity to enhance the environment and hence should be recognised. This criterion reflects the full spectrum of impacts on the environment, from enhancement through to maintenance and then degradation.

Impacts on national parks, nature reserves, State forests, threatened ecological communities, groundwater dependent ecosystems, wetlands and acid sulphate soils are just some of the impacts measured through this criterion.

4. Water allocation

The Department of Water prepares statutory water management plans for surface water and groundwater sources. These provide the overarching framework for allocating water between competing uses such as public water supply, agriculture, mining and other uses.

Before an option can be seriously considered it is important to assess, where applicable, whether it is supported by one of these plans, or where a current allocation / licence to use exists in the absence of a plan.

5. Water efficiency

The Environmental Protection Authority's Position Statement 'Environmental Principles' includes the following hierarchy for the management of waste:

- avoidance;
- reuse;
- recycling;
- recovery of energy;
- treatment;
- containment; and
- disposal.

This hierarchy has been reflected in the assessment of this criterion.

6. Community preference

The Water Corporation has sought feedback from the community on the *Water Forever: Options* through written submissions, an online survey and workshops. These views are reflected in the sustainability assessment as a means of measuring the community's preference for options (as a percentage of support for a particular option).

It is important to note that the values and preferences of the community can change over time. Nonetheless, the views were largely consistent with other market research commissioned by the Water Corporation.

7. Indigenous heritage (sites)

The *Aboriginal Heritage Act 1972* (AHA) protects places and objects that may be of importance and significance to people of Aboriginal descent in Western Australia. These places and objects may be identified as a site and recorded on the Register of Aboriginal sites. All sites are protected under the AHA whether or not they are recorded on the Register. Under section 17 of the AHA it is an offence to disturb a site.

Hence, the assessment will rate each option on a spectrum from having no impact to potentially having a very high impact on sites, requiring authorisation of the Registrar of Aboriginal Sites and/or consent of the Minister for Indigenous Affairs to disturb the site.

8. Social amenity

In relation to water service delivery, social amenity and lifestyle includes both objective and subjective social values. When considering options for the future, the following values are considered to provide social amenity and lifestyle benefits:

- objective – recreation (fishing, camping, walking, water sports) and tourism (which may also have links to economic benefit), land value; and
- subjective – sense of place, lifestyle – strongly related to the environment, deriving pleasure out of something 'because it is there' (proximity to waterways and wetlands, bushland, public open space, visual amenity, having green lawns etc.).

Social amenity and lifestyle can be impacted by many factors including odour, noise, presence of infrastructure (impacting visual amenity), removal of bushland, declining water levels, water restrictions, restricted access and increased cost.

When assessing the options against this criterion it is important to identify which social values are being impacted and whether it is positive or negative impact.

9. Empower customers

This concept reflects the ability of the customer to manage their own supply of water and the choice of how and when to use it, unimpaired by regulatory restrictions. This issue becomes particularly important in times of restricted water use.

There is the potential for adverse outcomes when customers have full control over their water supplies. For example, there is evidence that some people install greywater systems and leave the laundry tap running to maximise the capture of greywater for garden watering, which is otherwise restricted.

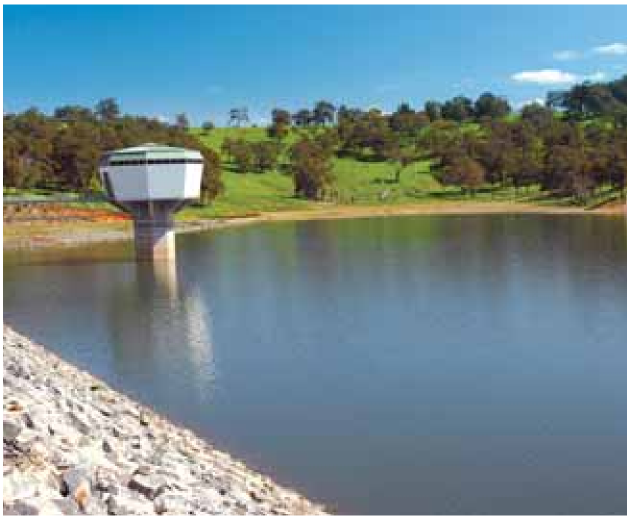
For self supply to work, customers need to possess the skills and resources to manage their own water supply safely. Measurement of this criterion will run the spectrum of giving the individual customer:

- full control of the source and how it is used (rainwater tanks, water use efficiency behavioural change programs);
- high level of control over the source and how it is used (garden bores, individual greywater systems);
- some control over the source and how it is used (third pipe recycling schemes generally subject to fewer restrictions in times of drought);
- little control over the source and how it is used (centrally operated community bore schemes); and
- no control over the source and may be instructed on how/when it can be used (drinking water scheme based sources subject to restrictions).

10. Source risk (health)

The public health risk is evaluated by reference to water quality.

The most desirable and lowest risk sources are dams with protected catchments and deep groundwater. Conversely, the least desirable and highest risk sources are the water recycling options and sources with degraded catchment areas. It has been agreed that alternative water supply systems such as rainwater tanks, garden bores, greywater systems and community based systems are for external uses only rather than drinking.



11. Net economic cost

This criterion considers the:

- capital and operating costs for source development;
- operating costs for water use efficiency initiatives (e.g. behavioural change programs); and
- capital and operating costs to the community for alternative water supplies (e.g. rainwater tanks etc).

12. Complexity

Some options may have technical and/or regulatory complexity in terms of planning, set up and operation. This can affect timing and may create operational issues which could add to the overall cost.

Given that innovative ways of sourcing water or reducing water use are either reliant on new and emerging technologies or changing customer behaviour, it is important to assess the complexity of future source options.

13. Reliability

The reliability of an option to deliver on the expected water volumes, or in the case of water efficiency initiatives the expected water savings, can affect the sustainability of the option.

In the case of physical infrastructure, the reliability can be measured through the expected percentage uptime, but in the case of water efficiency initiatives, reliability is more about how reliable the savings are over time.

14. Rainfall dependence

Rainfall dependence was chosen as a criterion given the pattern of drying winters over the last 30 years in the South West which has resulted in 70 percent less streamflows into our dams and a significant decrease in groundwater recharge.

CSIRO are projecting further reductions in streamflows to the dams in the South West of Western Australia (and less recharge).

In the north of Western Australia however, early predictions from CSIRO indicate an increase in summer rainfall – although significant variability, and therefore uncertainty, is forecast. It is important to understand this in the context of assessing the options to source water from the Kimberley.

15. Flexibility and adaptability

One of the fundamental tenets of sustainability is the ability for an option to adapt or protect the capacity to adapt, as circumstances change. This provides the enduring qualities that are vital for an option to be sustainable.

Six sub-criteria have been identified to assess this criterion. These include:

- multi-use - the capacity can be used in different ways;
- staged construction – option can be developed in stages;
- ability to be moved, turned off/on, reversed, collapsed and recycled;
- susceptibility to incompatible land and marine uses – this includes both water quality and quantity issues;
- accommodate changes in inputs such as chemicals/ membranes, materials availability, energy and skilled labour; and
- ability to adapt to changes in technology.

2.5 STEP 4 – HIGH LEVEL ASSESSMENT

The intent of the high level assessment is to eliminate options that were clearly unsuitable for further detailed analysis. This allows a greater concentration of resources into options considered to be viable for the future. In total, 35 options were assessed as part of this high level assessment.

This step used the four high level sustainability criteria as inputs. Multi-criteria analysis was used, on a rating scale of 1 to 3.

A threshold of 6 was set as the minimum score (50 percent of total available score of 12) to proceed to detailed assessment. This threshold was considered reasonable at this level of strategic assessment, given the very long timeframe for planning (50 years) and the attendant uncertainties.

Kimberley super-tanker and water bag options both received a score of 5 and were eliminated from further consideration as a result.

Information from "*Options for Bringing Water to the Kimberley: An Independent Review*" provided the basis for this assessment. Completed in 2006, it documents a comprehensive study of water source options from the Ord and Fitzroy Rivers. The review found that these two options are the most energy intensive of any of the Kimberley options and have lower rainfall dependence, being sourced entirely from surface water sources.

The State and Federal Governments are working on projects seeking to develop these resources for regional use, including the expansion of the Ord Irrigation Area.

Units of measure and rating scale for high level screening *(table 5)*

Pillars	Criteria	Ratings		
		1	2	3
Environment	Energy intensity (kWhr/kl)	>5	1 - 5	<1
Economic	Net economic cost ($/kl)	>=$5	$2 - $4	<$2
	Rainfall dependence	Rainfall dependent (Surface water)	Partially dependent (Groundwater)	Not rainfall dependent (Desalination /recycling)
Social	Source risk (health)	High	Medium-high	Low

Options Eliminated *(table 6)*

Source option	Energy intensity	Net economic cost	Rainfall dependence	Source risk (health)	High level sustainability score
Super-tanker	1	1	1	2	5
Water bags	1	1	1	2	5

2.6 STEP 5 – DETAILED ASSESSMENT

This step used the detailed sustainability assessment criteria as inputs and used multi criteria analysis to undertake the assessment. The rating scale was extended from 0 to 4. All criteria, units of measure and the detailed rating scale are included in Appendix 4.

In all, 33 water source options were assessed in accordance with the table and the results recorded in spreadsheets. In addition, for each option, data quality was ranked according to the following scale.

Data Quality Rating *(table 7)*

Rating	Description
5	Excellent quality - current planning report or consultants study
4	Good quality - old planning report or consultants study
3	Average quality - external reports, websites
2	Below average quality - incomplete data
1	No data/information available - broad estimates only

Detailed scoring is included in Appendix 5 and discussed in the next section of this report.

03 RESULTS OF ASSESSMENT

RESULTS OF ASSESSMENT

3.1 SUMMARY

Figure 3 shows the raw scores of each option as well as the level of data quality used to assess each option.

It is apparent from these results that there is a hierarchy when it comes to prioritising source options. Similar options have been summarised with the mean scores for each grouping as shown in Figure 4. This Figure also shows the mean community support for each suite of options.

This reflects a hierarchy of preference for water efficiency, reuse and recycling options over the development of new sources. This preference is supported by the sustainability assessment and the community engagement work undertaken by this project.

It is important to note that we believe that a broad portfolio of water options is best placed to secure our water future – from more water efficiency to desalination.

The sustainability assessment helps to highlight key features that should be retained and other aspects that may require mitigation. An example of this could be the use of renewable energy to power rainfall independent sources or locating new treatment plants in areas of low conservation value or degraded landscape.

The following sections examine these groupings in further detail.

3.2 WATER EFFICIENCY

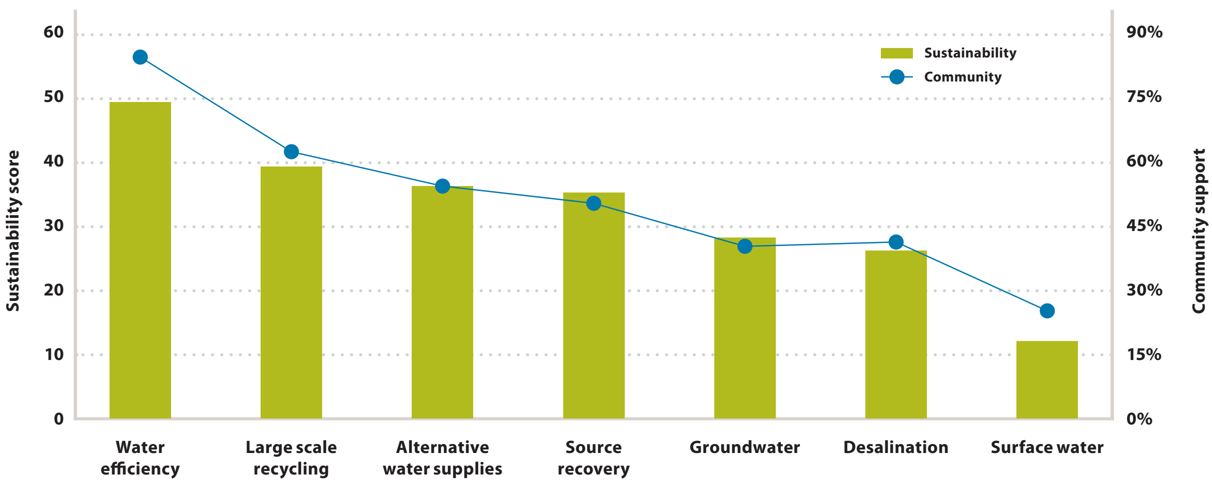
There are many ways in which we can reduce our water use without adversely impacting on our quality of life or artificially constraining business and economic growth.

In Perth, we use about 30 percent of all scheme water outside the home. Influencing the built outdoor environment by promoting the adoption of native gardens, more paving and waterwise developments is critical, particularly in a drier climate.

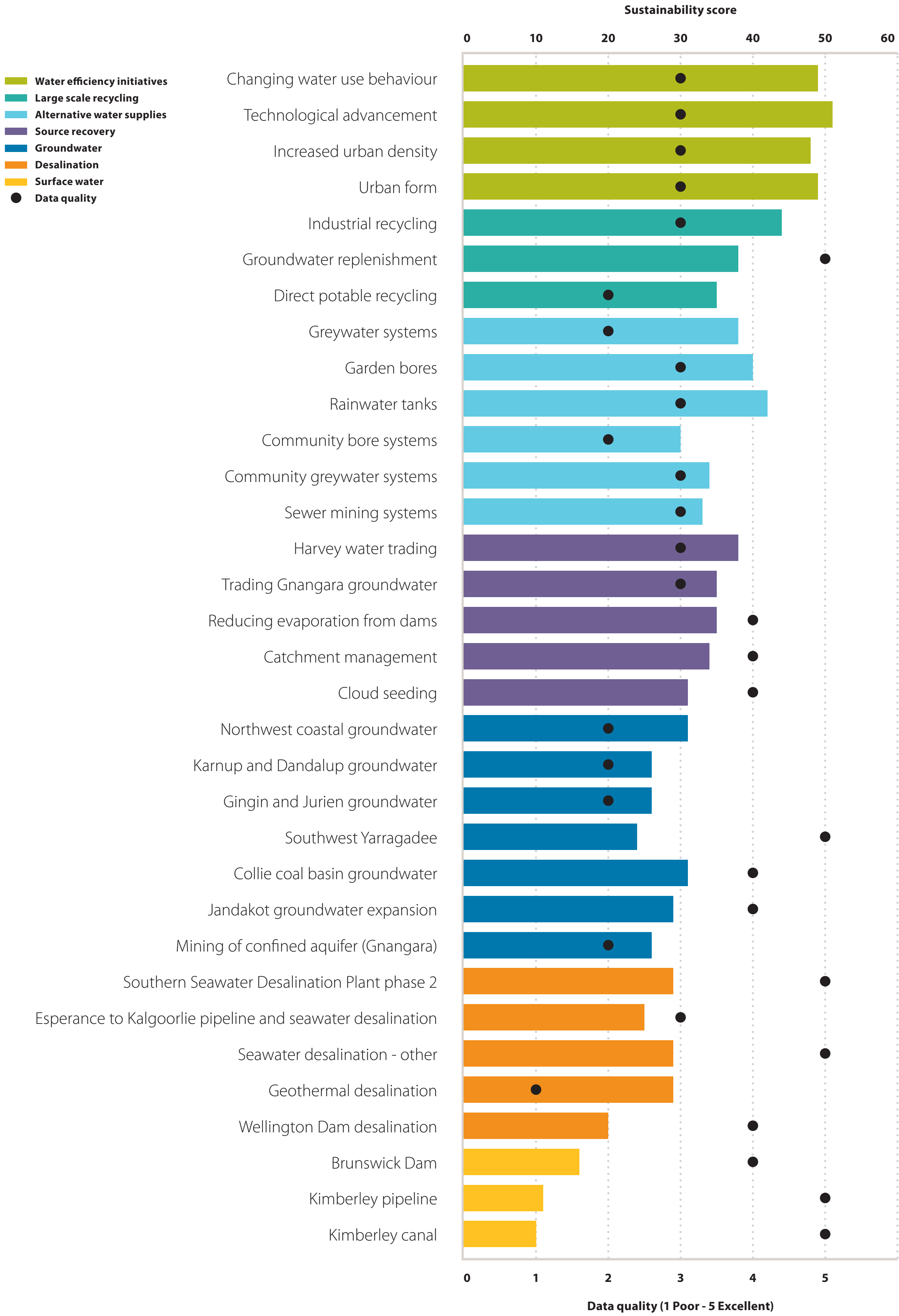
Similarly, there is an opportunity to promote increased urban density. Not only does this decrease water consumption due to smaller outdoor spaces, it can reduce energy use per household, increase the efficiency of public transport and generally improve community resilience. Increased density is not for everyone however – there needs to be a diversity of urban areas to support choice and different uses and aspirations.

There is still scope to improve water use efficiency through technological innovation and improvement. Examples include more water efficient fixtures and fittings, leakage detection, pressure management, metering and even waterless technologies which use little or no water.

Sustainability Assessment & Community Support *(figure 4)*



Detailed Sustainability Assessment of Water Source Options/Initiatives *(figure 3)*



We can also support customers who wish to reduce their water use by funding water audits, providing more detailed billing information and through community education.

Each of these options (urban form, increased density, technological advancement and behavioural change) scored the maximum sustainability score possible on:

- physical footprint;
- energy intensity;
- water efficiency;
- water allocation;
- community preference;
- indigenous sites;
- source risk;
- economic cost; and
- rainfall dependence.

These options do not directly require the building and operation of any water infrastructure like a dam or a desalination plant. Given that they are programs, they can easily be revised to accommodate changes in consumer behaviour or other factors.

However, these options score poorly on sustainability criteria in relation to:

- reliability; and
- complexity.

Reliability is an issue for these programs because they rely to some extent on customer behaviour for short and long term savings.

In addition these programs often require new policy and regulation to support water use efficiency. Hence, the regulatory complexity is significant.

The push for increased densities in Perth may also encounter resistance from land planning policy, developers and consumers given the strong history of Perth developing predominantly through low density, single dwellings with large backyards.

3.3 LARGE SCALE WATER RECYCLING

One of the most prospective water source options is groundwater replenishment.

Groundwater replenishment (GWR) is a process where water from Perth's wastewater treatment plants is treated to the highest standard through a process involving micro filtration, reverse osmosis and UV disinfection and is then pumped back into groundwater. This high quality water then mixes with existing groundwater supplies and can be taken out many years later and treated again for use in Perth's drinking water system.

A trial is being undertaken at the Beenyup site to demonstrate the technology and the safety of injecting water.

There are also many opportunities to recycle more water to industry.

Recycling options achieve very high scores for rainfall dependence, reliability and flexibility. This reflects the lack of any dependence on rainfall making them attractive in a drying climate. Once the infrastructure is in place it can also be used for other purposes (e.g. a water recycling plant could be used to desalinate water with some modification).

However, they score poorly on empowering customers as these options are large, scheme based options where the customer has no control over the source and supply of the water. They are also highly technical and complex from a regulatory perspective, given they are relatively new sources of water.

The groundwater replenishment trial scheduled to commence in 2009 is expected to resolve many of these complex issues, so the score for this option is expected to improve as the trial progresses.

These options also reflect a higher source risk (being sourced from treated wastewater) than more traditional sources such as dams or groundwater in protected catchments. This can be mitigated by higher levels of treatment, management and regulatory control.

3.4 ALTERNATIVE WATER SUPPLIES

These options include the development of alternative sources such as garden bores, rainwater tanks, greywater systems, community bores, third pipe systems and sewer mining.

These options perform well in the areas of:

- empowering customers;
- water allocation;
- rainfall dependence; and
- physical footprint.

This reflects the ability for customers to control these sources and their use. They afford protection against externally imposed restrictions and provide fit for purpose alternatives for outdoor watering, food production (excluding greywater) and other non-drinking water uses.

However, alternative water supplies can be expensive. Greywater, rainwater tanks and sewer mining systems can cost more than $5/kL. The economics of rainwater tanks can be improved where there is a large roof area and if they are plumbed into houses for internal uses (such as toilet flushing).

3.5 WATER SOURCE RECOVERY

Optimising our water sources or water source recovery involves making sure we get the maximum benefit from our existing sources. The assessment considered the following options:

- reducing dam evaporation;
- catchment management;
- trading Gnangara groundwater;
- cloud seeding; and
- Harvey water trading.

These options generally all perform well on energy intensity and economic cost, reflecting the low need for significant infrastructure. As they seek to optimise existing infrastructure, these options, with the exception of catchment management and water trading, generally do not require additional land clearing.

Reducing dam evaporation scores very poorly on economic cost because despite the lack of infrastructure cost there is a significant cost in application of the technology to implement this option.

None of these options empower customers due to their centralised nature. At least two of them (reducing dam evaporation and cloud seeding) have a very low level of reliability.

Furthermore, these options tend to be highly complex from technical, social, commercial or regulatory standpoints.

3.6 GROUNDWATER

In the case of groundwater seven options were assessed in this group:

- Gingin Jurien groundwater;
- North West Coastal groundwater;
- Karnup and Dandalup groundwater;
- South West Yarragadee groundwater;
- Mining Gnangara groundwater;
- Jandakot Groundwater expansion; and
- Collie Coal Basin groundwater.

Importantly these options score well on source risk (particularly where the water is sourced from a confined aquifer). They also score well on energy efficiency and flexibility (reflecting the ability to turn bores off if required and possibly reuse the infrastructure if the bores are shut down permanently).

Groundwater sources are typically highly cost effective (often less than $1 / kl) where they are developed close to the point of use.

In common with all large scale scheme options, they score poorly on empowering customers and represent the development of a new water source (rather than an investment in water efficiency or fit for purpose water).

The option to mine the confined aquifer reflects the abstraction of water without regard to environmental consequences. This is not current practice and is not supported by existing water policy in Western Australia, as determined by the Department of Water.

Where there is adequate water resource management, the sustainable use of groundwater provides a good option for Perth, given proximity to large high quality groundwater reserves at low cost.

3.7 DESALINATION

Five desalination options were assessed:

- Southern Seawater Desalination Plant Phase 2;
- Seawater desalination – other;
- Esperance – Kalgoorlie desalination & pipeline;
- Wellington Dam desalination; and
- Geothermal desalination.

These options have high supply security because, in common with water recycling, desalination does not rely on rainfall and is not dependent on water allocation policy (although environmental approvals are required). Desalination is highly attractive in a drying climate.

Desalination also scores highly on public health criteria – due to the high levels of treatment (membrane filtration rather than chemical). Seawater has a lower source risk than treated wastewater or dams with degraded catchments.

The downside of desalination options is the relatively high physical footprint (especially when distant from demand due to the pipeline and reservoirs) and high energy intensity. Managing land use including biodiversity impacts and energy requirements (including sourcing energy from renewable sources or offsetting greenhouse emissions) are important mitigants where these options are adopted.

3.8 SURFACE WATER

Three options were assessed in this group:

- Brunswick dam;
- Kimberley canal; and
- Kimberley pipeline.

Note that Wellington dam has been included in the desalination options.

It is noted that the Kimberley canal and pipeline options both utilise surface water from a tributary of the Fitzroy river. While rainfalls in the north of Western Australia are generally expected to increase, they are also expected to be highly variable. For this reason, there is a preference for the retention of this water for regional use, particularly to support an expansion of the Ord Irrigation Area, to maintain more agricultural production in the north of Australia.

The Brunswick dam is located in a degraded farming catchment in the south west of Western Australia. Its development was not well supported through community feedback to Water Forever and there are significant issues of environmental impairment, source risk, water security and social issues (e.g. competition with farmers for water) associated with its development for public water supply to Perth.

The distance the water would need to be moved from its source to the IWSS and its customers is significant. This has a significant impact on physical footprint, water efficiency (due to leakage and loss), risk of degradation of the environment and energy use.

3.9 SUSTAINABILITY ASSESSMENT AND OTHER KEY FACTORS

There are a number of specific factors which have traditionally been highly influential in source decisions. These include:

- water quality;
- cost;
- rainfall dependence; and
- reliability.

Another issue that is important to consider with respect to the options is the expected water yield.

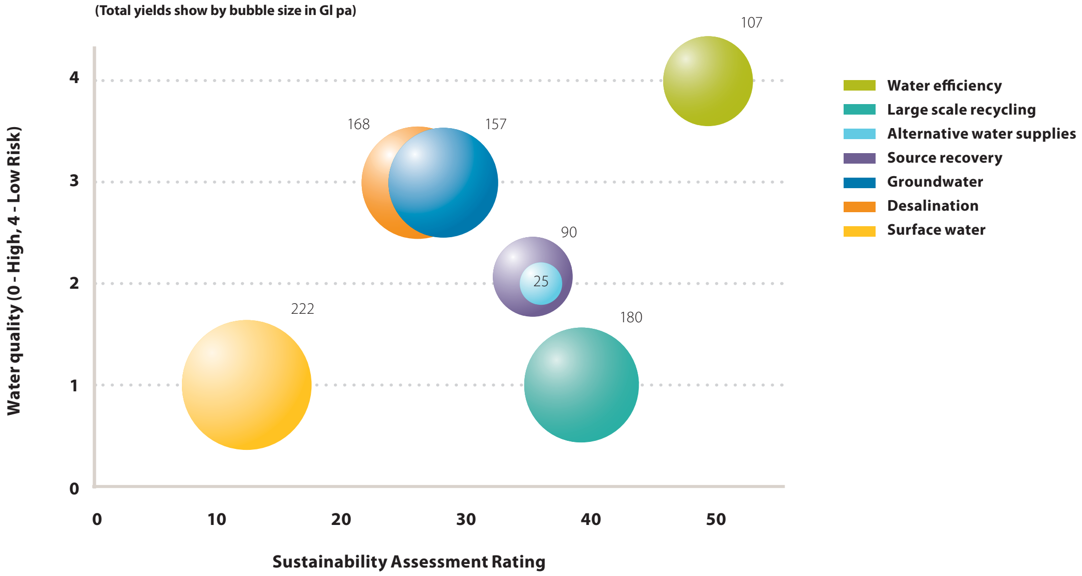
The following graphs demonstrate how water quality, cost, rainfall dependence and reliability rate against the expected water yield (or savings in the case of water use efficiency initiatives) and the overall sustainability score for the options. The water yield is shown by the size of the bubble on the graph.

Water quality and sustainability (figure 5)

The water efficiency options are the standout here with good water yield (or savings) as a group, low risk to water quality and high sustainability scores. The groundwater and desalination options also score highly on the dimension of water quality.

Water quality and sustainability *(figure 5)*

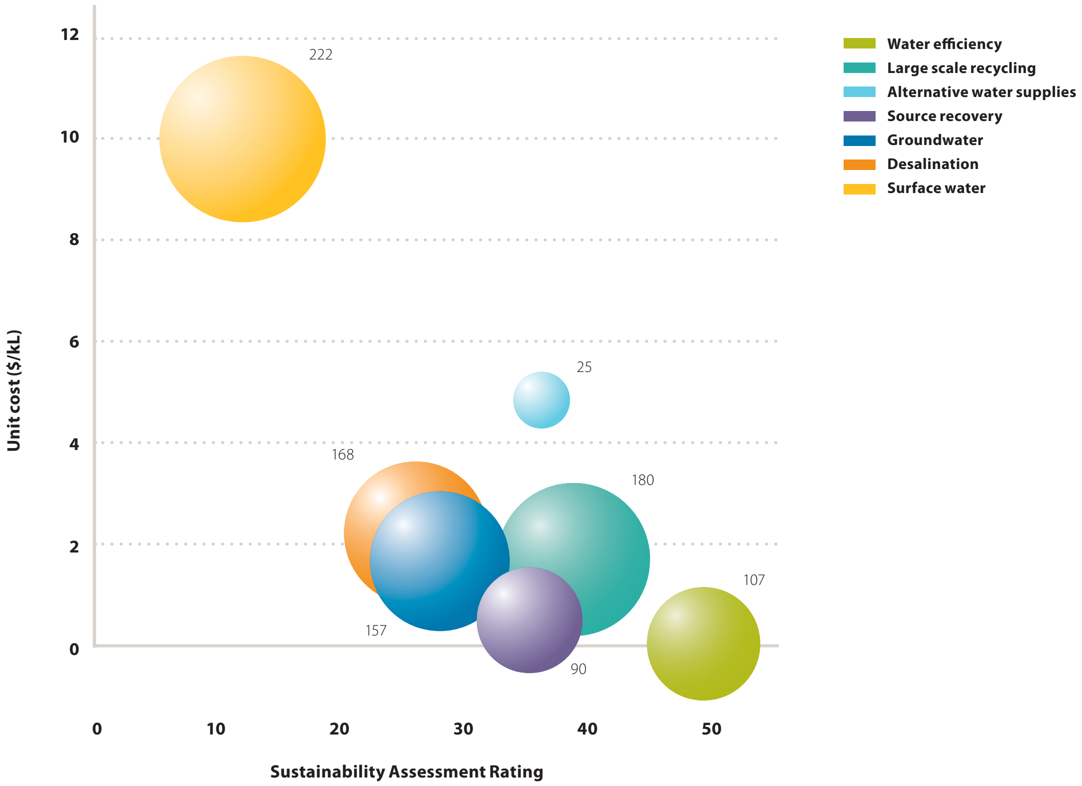
(Total yields show by bubble size in Gl pa)



Cost and sustainability (figure 6)

The water efficiency options perform well in relation to cost and sustainability. For a slightly higher cost and comparable sustainability score, large scale recycling and source recovery options are also favoured.

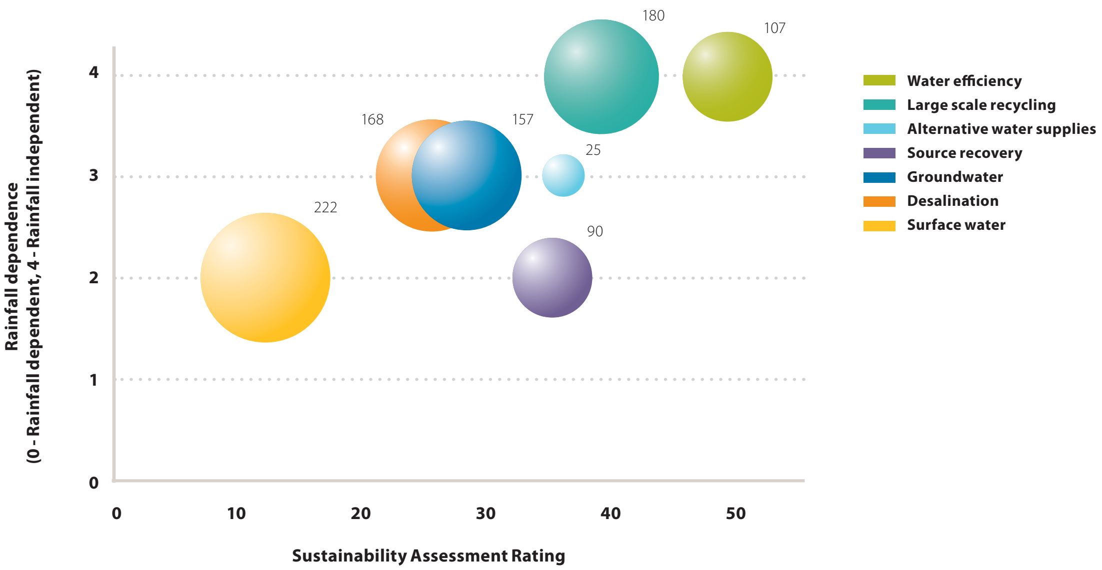
Cost and sustainability *(figure 6)*
(Total yields show by bubble size in Gl pa)



Rainfall dependence and sustainability (figure 7)

Again the water efficiency options stand out here but are closely followed by the higher yielding recycling options. In a drying climate these are attractive options.

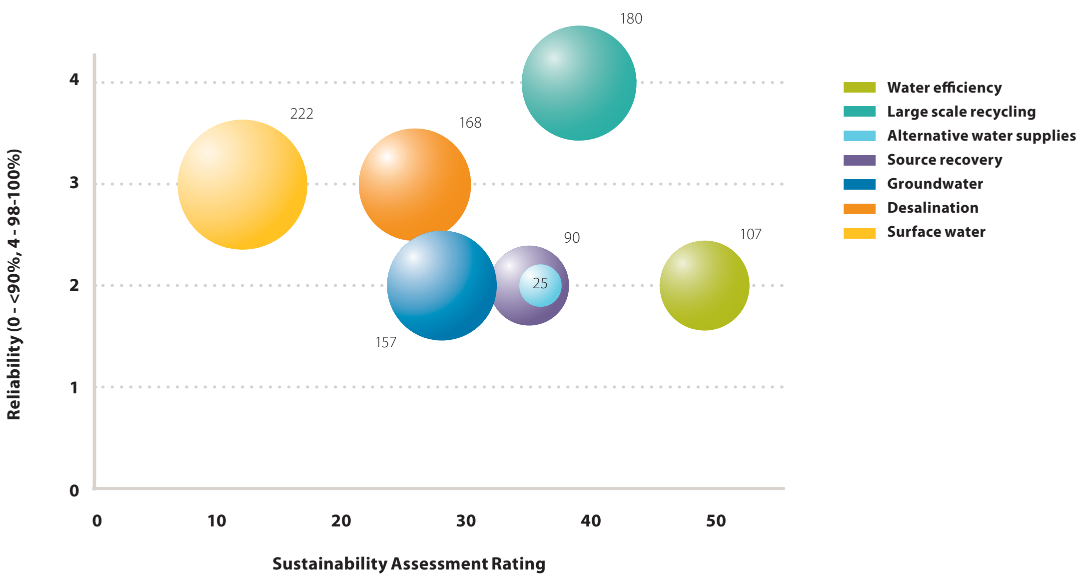
Rainfall dependence and sustainability *(figure 7)*
(Total yields show by bubble size in Gl pa)



Reliability and sustainability (figure 8)

What stands out in this graph is the high reliability, expected water yield and high sustainability score of the three large scale recycling options. Desalination also rates as a highly reliable source. Surface water options are also highly reliable, reflecting extensive experience in this area.

Reliability and sustainability *(figure 8)*
(Total yields show by bubble size in Gl pa)



04 IN CLOSING

IN CLOSING

" We will continue to explore how to shape our water future whilst creating environmental, economic and social capital."

The Water Corporation has undertaken this sustainability assessment of individual options further to our business principles and purpose:

"the sustainable management of water to make WA a great place to live and invest".

We have drawn on previous work undertaken by academics, the Water Services Association of Australia and other water utilities. We wish to thank those whose work has informed ours.

We have also drawn on our experience with sustainability assessment, particularly at program and project levels. By undertaking this assessment as part of Water Forever, an integrated 50 year water services plan for Perth and surrounding areas, we are continuing to explore how to shape our water future while creating environmental, economic and social capital.

During the community engagement phase, and further to discussions with the Water Forever Science Panel, we have broadened the suite of options considered. We have sought to include all options further to the experience elsewhere in Australia, that a transparent evaluation approach is preferred to ruling options out due to short term preferences.

In this way, all options are considered and we can prioritise the portfolio of options that will be progressed.

They may be progressed in a variety of ways:

- investing in research and development;
- securing sites and infrastructure corridors;
- completing more detailed planning;
- undertaking detailed social and environmental impact assessments;
- completing more accurate costings; and / or
- developing new technologies at pilot scales.

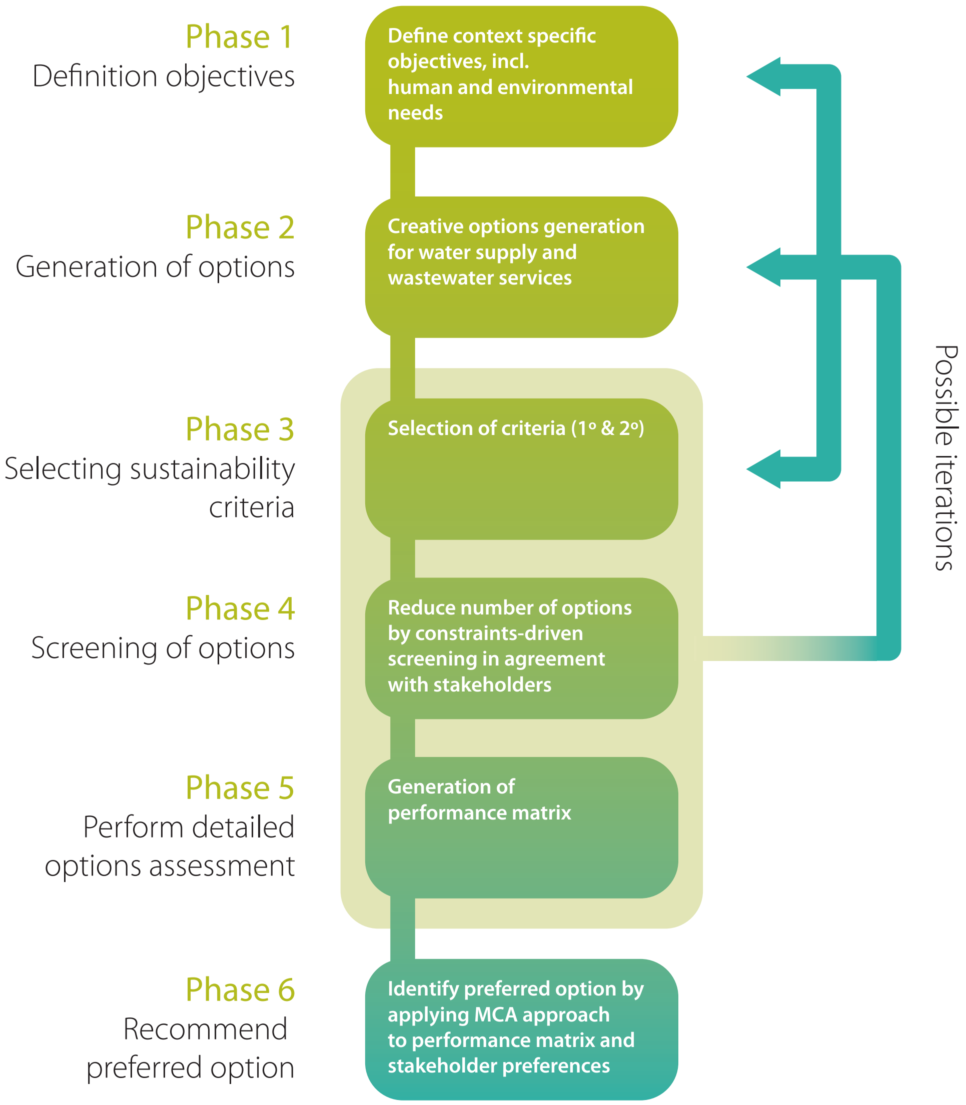
The options prioritised through the sustainability assessment process, will be further investigated and assessed to make sure that they are robust and viable in the long term. For some options, they will need to be reviewed at a later date in light of changing conditions, such as climate change and lowering yields, to determine their suitability for development in the future.

Water Forever: Directions will be released in February 2009 as a draft plan for further comment. It will be significantly informed by this sustainability assessment, together with input from community preferences and the views of the Water Forever Science Panel.

For further information on the Water Corporation's 50 year plan please visit www.watercorporation.com.au/waterforever

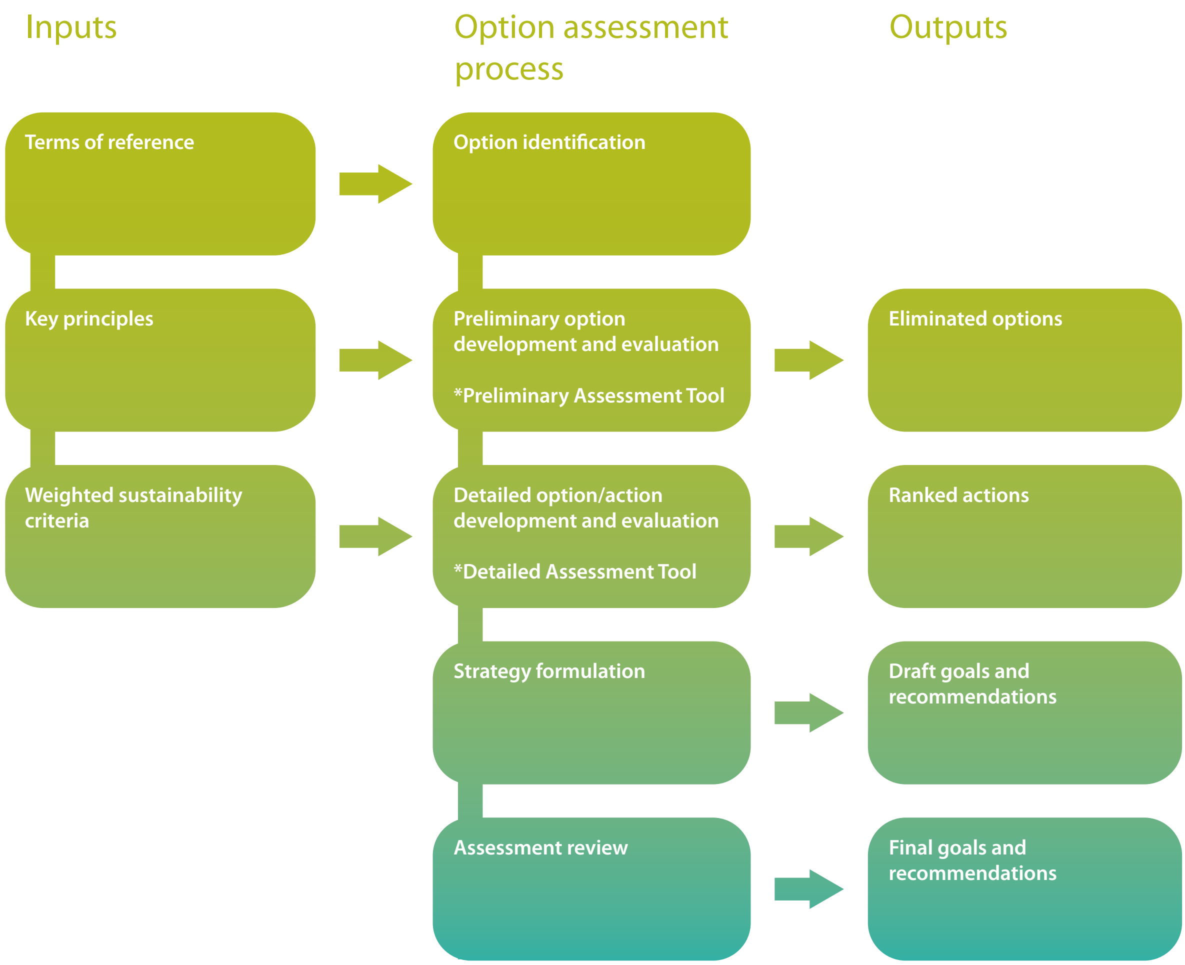
APPENDICES

APPENDIX 1
WSAA SUSTAINABILITY FRAMEWORK



Source: *WSAA Sustainability Framework* (WSAA Occasional Paper No. 17, February 2008)

APPENDIX 2
WATER PROOFING ADELAIDE ASSESSMENT PROCESS



Source: 'Water Proofing Adelaide: Assessment Process for a Sustainable Water Strategy for Adelaide', *WSUD2004 Conference* (Hall et al, 2004)

APPENDIX 3
EXCERPT FROM WATER FOREVER SCIENCE REVIEW

TERMS OF REFERENCE

Purpose

The Water Forever Science Panel will provide independent advice to the Water Corporation on the preparation of Water Forever, a 50-year plan for water services.

Deliverables

Having regard to the objectives of Water Forever, the Science Panel will provide independent advice on the following:

- Identify major future trends that should be considered in the plan horizon;
- Discuss the Options Paper with particular attention to:
  - draft planning assumptions;
  - the completeness and accuracy of options discussed;
  - identifying other options for review and further consideration; and
  - issues and risks not adequately identified in the plan.
- Discuss the Directions Paper (draft plan) with particular attention to:
  - alignment with community input;
  - how proposed plans for each of the three horizons meet the needs of customers and build a sustainable water future;
  - implementation and risk issues; and
  - adequacy of options analysis process.
- Discuss and comment on the final plan.

Membership and reporting

Members will report to Prof. Robert Harvey, member Water Corporation Board of Directors. The Science Panel consists of the following representatives:

- Mr Ross Young Executive Director, WSAA (Chair)
- Dr Tom Hatton Director, Water for a Healthy Country CSIRO
- Dr John Marsden Principal, Marsden Jacobs Associates
- Dr Jenny Pope Director, Integral Sustainability.

Access to information

The Science Panel will be circulated agendas and background papers prior to each meeting.

Water Corporation personnel who are involved with the project will provide presentations and be available to discuss issues as required by the Science Panel. Supplementary information can be provided on request.

Accountability

A synopsis of each meeting will be drafted, generally comprising of:

- meeting conduct;
- discussion points;
- clarification of issues; and
- actions resulting.

The synopsis will be circulated for comment to Panel members by the Chair, following the meetings.

After final signoff by the Chair, the synopsis will be made publicly available on the Water Forever website.

The Science Panel, from left to right, Prof. Robert Harvey, Dr Tom Hatton, Mr Ross Young, Dr Jenny Pope and Ms Rozi Boyle (for Dr John Marsden).

APPENDIX 4
DETAILED SUSTAINABILITY ASSESSMENT
PILLARS, CRITERIA, UNITS OF MEASURE AND RATING SCALE

Pillars	Criteria	Rating Scale				
		4	3	2	1	0
Environment	Physical footprint (GL/ha/yr)	No clearing	<10	5 - 10	1 - 5	<1
	Energy intensity (kWhr/kL)	<0.4	0.4 - 0.8	0.8 - 2.5	2.5 - 5	>5
	Capacity to enhance the environment	Significantly enhances the environment	Enhances the environment	Maintains the environment	Degrades the environment	Significantly degrades the environment
	Water allocation	Supported by water mngt plan/ Not required	Provided for in water mngt plan framework	Current allocation/ licence to use (but no WMP)	May conflict with WMP objectives	Not supported by WMP
	Water efficiency	Waste avoidance/ Reduce water use	Reuse of waste and use of water that has not been treated	Recycling of waste and reuse/recycling of scheme water (treated and untreated)	Recovery of waste to create energy/Recovery of lost water	Treatment, containment and disposal of waste but use of water resources
Social	Community preference (% of support)	>75	61 - 75	50 - 60	40 - 49	<40
	Indigenous heritage (sites)	No impact on sites	Low impact on sites	Medium impact on sites	High impact on sites	Very high impact on sites
	Social amenity	Significantly enhances social amenity/lifestyle	Enhances social amenity/lifestyle	Maintains/preserves social amenity/ lifestyle	Reduces social amenity/lifestyle	Significantly reduces social amenity/lifestyle
	Empower customers	Full control	High control	Some control	Little control	No control
	Source risk (health)	Low	Low-Medium	Medium	Medium-High	High

Pillars	Criteria	Rating Scale				
		4	3	2	1	0
Economic	Net economic cost ($/kL)	0-1	1-2	2-3.50	3.50-5	>5
	Complexity	Very low level of complexity	Low level of complexity	Medium level of complexity	High level of complexity	Very high level of complexity
	Reliability	Very high	High	Medium	Low	Very low
	Rainfall dependence	Not dependent (desalination, recycling)	Confined aquifer (groundwater)	Superficial aquifer (groundwater)	Rainfall dependent (surface storage)	Fully rainfall dependent
	Flexibility and adaptability	Very high (>5)	High (4 - 5)	Medium (2.5 - 3.5)	Low (1 - 2)	Very low (<1)

APPENDIX 5
DETAILED SCORINGS OF WATER SOURCE OPTIONS FOR DETAILED ASSESSMENT

Water Efficiency Initiatives

Options	Environmental						Social			Social			Economic						Total	Data Quality tag
	Physical footprint	Energy intensity	Enhance environment	Water efficiency	Water allocation	Sub total	Community preference	Indigenous sites	Social amenity	Empower customers	Source risk	Sub total	Economic cost	Complexity	Reliability	Rainfall dependence	Flexibility	Sub total		
Changing water use behaviour	4	4	2	4	4	18	4	4	2	4	4	18	4	1	0	4	4	13	49	3
Technological advancement	4	4	2	4	4	18	4	4	2	2	4	16	4	2	4	4	3	17	51	3
Increased urban density	4	4	2	4	4	18	4	4	1	0	4	13	4	1	4	4	4	17	48	3
Urban form	4	4	3	4	4	19	4	4	2	2	4	16	4	1	1	4	4	14	49	3
Mean	4	4	2	4	4	18	4	4	2	2	4	16	4	1	2	4	4	15	49	3

Alternative Water Supplies

Options	Environmental						Social			Social			Economic						Total	Data Quality tag
	Physical footprint	Energy intensity	Enhance environment	Water efficiency	Water allocation	Sub total	Community preference	Indigenous sites	Social amenity	Empower customers	Source risk	Sub total	Economic cost	Complexity	Reliability	Rainfall dependence	Flexibility	Sub total		
Greywater systems	4	2	2	2	4	14	4	4	2	4	2	16	0	1	2	4	1	8	38	2
Garden bores	4	2	2	3	4	15	0	4	3	4	2	13	4	3	2	2	1	12	40	3
Rainwater tanks	4	2	2	3	4	15	4	4	2	4	2	16	1	3	4	0	3	11	42	3
Community bore systems	0	2	2	2	1	7	1	3	3	2	2	11	3	4	2	2	1	12	30	2
Community greywater systems	0	2	2	2	4	10	3	3	3	2	2	13	2	2	2	4	1	11	34	3
Sewer mining systems	0	1	3	2	4	10	2	4	3	3	2	14	0	2	2	4	1	9	33	3
Mean	2	2	2	2	4	12	2	4	3	3	2	14	2	3	2	3	1	11	36	3

Major Water Recycling

Options	Environmental						Social			Social			Economic						Total	Data Quality tag
	Physical footprint	Energy intensity	Enhance environment	Water efficiency	Water allocation	Sub total	Community preference	Indigenous sites	Social amenity	Empower customers	Source risk	Sub total	Economic cost	Complexity	Reliability	Rainfall dependence	Flexibility	Sub total		
Industrial recycling	2	3	3	2	4	14	4	4	2	2	2	14	3	1	4	4	4	16	44	3
Groundwater replenishment	3	2	3	2	2	12	3	4	2	0	1	10	3	1	4	4	4	16	38	5
Direct potable recycling	2	3	3	2	4	14	0	4	2	0	0	6	3	0	4	4	4	15	35	2
Mean	2	3	3	2	3	13	2	4	2	1	1	10	3	1	4	4	4	16	39	3

Source Recovery

Options	Environmental						Social			Social			Economic						Total	Data Quality tag
	Physical footprint	Energy intensity	Enhance environment	Water efficiency	Water allocation	Sub total	Community preference	Indigenous sites	Social amenity	Empower customers	Source risk	Sub total	Economic cost	Complexity	Reliability	Rainfall dependence	Flexibility	Sub total		
Harvey water trading	4	4	2	1	3	14	1	4	2	0	3	10	4	2	4	1	3	14	38	3
Gnangara mound water trading	3	3	2	3	3	14	1	4	2	0	2	9	4	1	2	2	3	12	35	3
Reducing evaporation from dams	4	4	2	1	4	15	3	4	2	0	2	11	0	2	0	4	3	9	35	4
Catchment management	0	4	3	1	3	11	4	3	2	0	3	12	4	1	2	1	3	11	34	4
Cloud seeding	4	4	1	1	4	14	3	4	1	0	2	10	3	1	0	0	3	7	31	4
Mean	3	4	2	1	3	14	2	4	2	0	2	10	3	1	2	2	3	11	35	4

Desalination

Options	Environmental						Social			Social			Economic						Total	Data Quality tag
	Physical footprint	Energy intensity	Enhance environment	Water efficiency	Water allocation	Sub total	Community preference	Indigenous sites	Social amenity	Empower customers	Source risk	Sub total	Economic cost	Complexity	Reliability	Rainfall dependence	Flexibility	Sub total		
Southern Seawater Desalination Plant phase 2	0	1	1	0	4	6	2	3	2	0	3	10	2	2	3	4	2	13	29	5
Esperance to Kalgoorlie pipeline and seawater desalination	0	0	1	0	4	5	1	2	2	0	3	8	2	1	3	4	2	12	25	3
Seawater desalination - Other	0	1	1	0	4	6	2	3	2	0	3	10	3	1	3	4	2	13	29	5
Geothermal desalination	0	2	1	0	4	7	2	3	2	0	3	10	2	1	3	4	2	12	29	1
Wellington dam desalination	0	2	1	0	3	6	1	3	0	0	1	5	2	1	3	1	2	9	20	4
Mean	0	1	1	0	4	6	2	3	2	0	3	9	2	1	3	3	2	12	26	4

Groundwater

Options	Environmental						Social			Social			Economic						Total	Data Quality tag
	Physical footprint	Energy intensity	Enhance environment	Water efficiency	Water allocation	Sub total	Community preference	Indigenous sites	Social amenity	Empower customers	Source risk	Sub total	Economic cost	Complexity	Reliability	Rainfall dependence	Flexibility	Sub total		
North-west coastal groundwater	0	3	1	0	3	7	1	3	2	0	3	9	4	2	4	2	3	15	31	2
Karnup & Dandalup groundwater	1	2	1	0	2	6	0	3	2	0	3	8	3	2	2	2	3	12	26	2
Gingin & Jurien groundwater	0	2	1	0	3	6	0	3	2	0	3	8	2	2	2	3	3	12	26	2
Southwest Yarragadee	1	2	1	0	0	4	0	3	2	0	4	9	3	0	2	3	3	11	24	5
Collie coal basin groundwater	0	2	1	0	3	6	1	3	2	0	4	10	3	2	4	3	3	15	31	4
Jandakot groundwater expansion	1	3	1	0	4	9	0	3	1	0	3	7	4	2	2	2	3	13	29	4
Mining of confined aquifer in Gnangara	3	3	0	0	0	6	0	4	2	0	3	9	4	0	0	4	3	11	26	2
Mean	1	2	1	0	2	6	0	3	2	0	3	9	3	1	2	3	3	13	28	3

Surface Water

Options	Environmental						Social			Social			Economic						Total	Data Quality tag
	Physical footprint	Energy intensity	Enhance environment	Water efficiency	Water allocation	Sub total	Community preference	Indigenous sites	Social amenity	Empower customers	Source risk	Sub total	Economic cost	Complexity	Reliability	Rainfall dependence	Flexibility	Sub total		
Brunswick dam	0	3	0	0	1	4	0	1	0	0	1	2	2	1	4	1	2	10	16	4
Kimberley pipeline	0	0	0	0	0	0	2	0	2	0	1	5	0	0	3	2	1	6	11	5
Kimberley canal	0	0	0	0	0	0	2	0	2	0	0	4	0	0	3	2	1	6	10	5
Mean	0	1	0	0	0	1	1	0	1	0	1	4	1	0	3	2	1	7	12	5

Disclaimer

The Water Corporation is committed to quality service to customers, including the provision of reliable data in this document. The water source options assessed were identified further to consultation with the community and stakeholders. It does not represent the policy of the Water Corporation or the Government of Western Australia. Changes in circumstances after the publication may impact the quality of information.

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SUSTAINABILITY ASSESSMENT

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