Reuse Project Workshop

Introduction

Riyadh 28/04/2008

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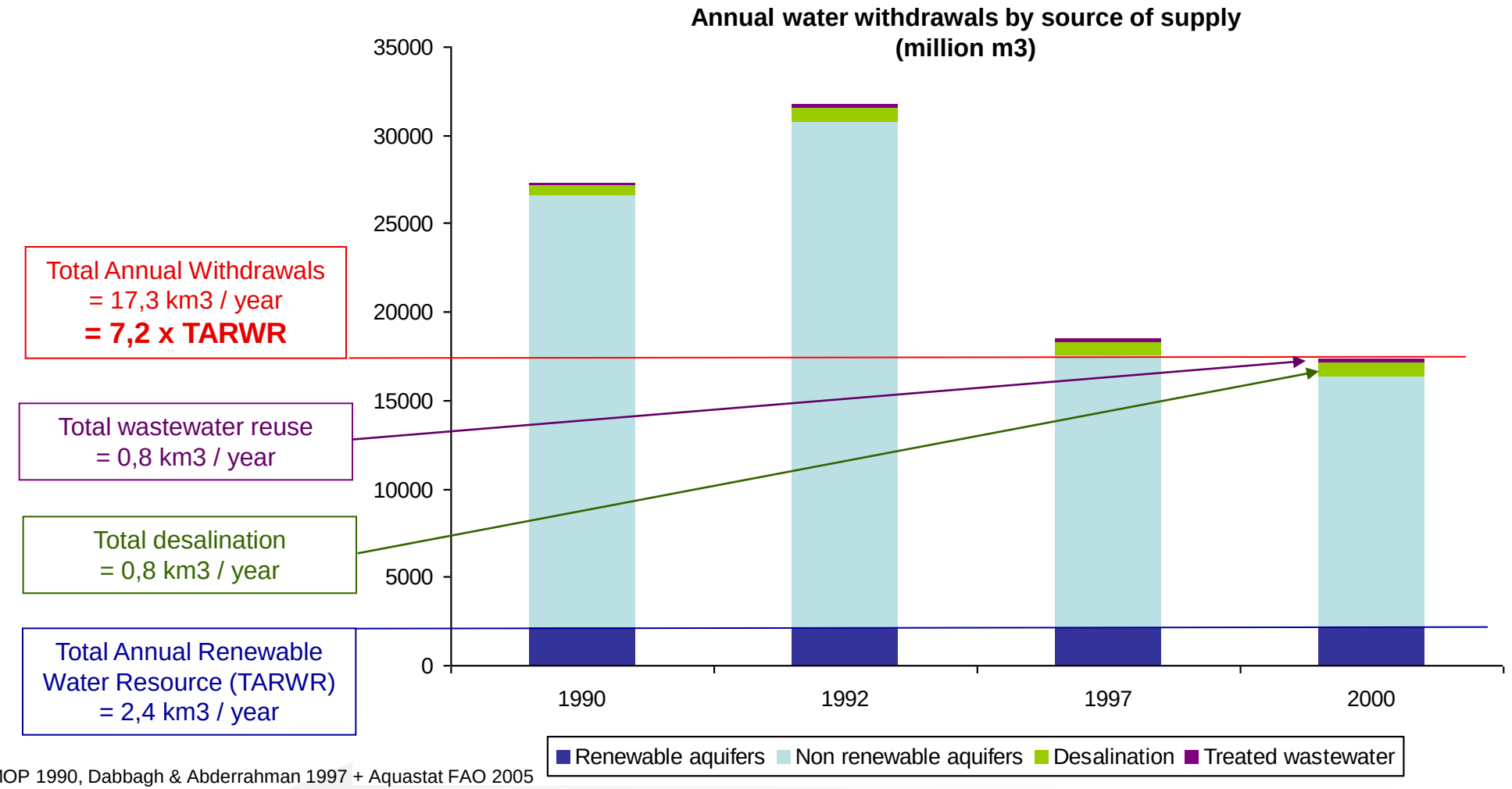
Background *Water availability in Saudi Arabia*

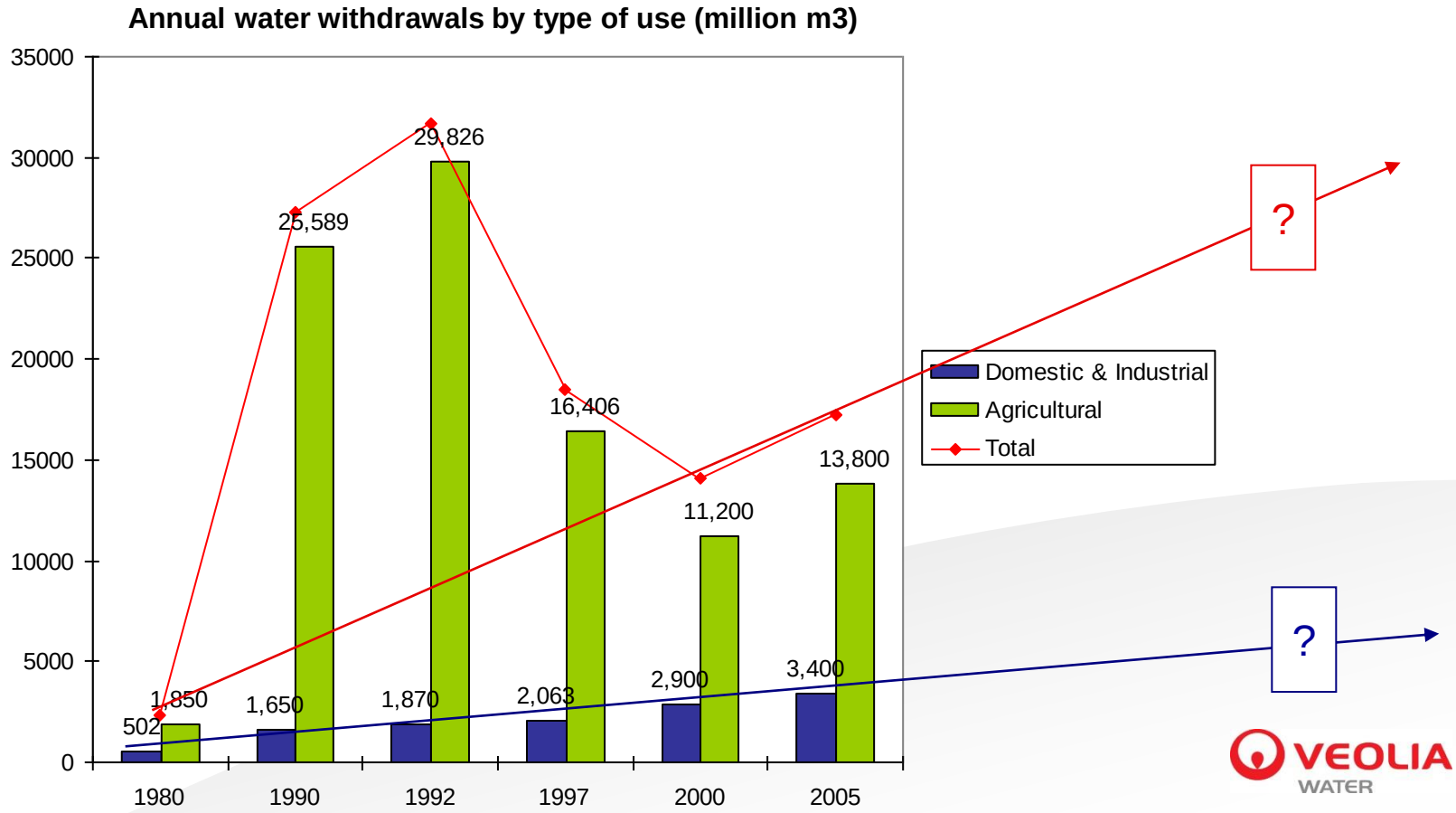
Current water demand is seven times higher than natural renewable water resources.



Source: MOP 1990, Dabbagh & Abderrahman 1997 + Aquastat FAO 2005

Background *Changes in water demand*

Current annual water demand is 17.3 km3. Estimated groundwater reserves (to 300m below ground surface) are 2,185 km3. Depletion of groundwater reserves will depend on future growth.



Source: Dabbagh & Abderrahman 1997 + Aquastat FAO 2005

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Background *Early demand management measures*

Since the early 90ies, a number of measures have been introduced to control water demand in Saudi Arabia.

> Domestic water demand management
- 1994: Introduction of water tariffs
- Leakage control measures to reduce water losses from supply networks
- Some treated wastewater reuse (e.g. Ablution water) and use of highly saline water instead of desal water

> Irrigation water management
- 1980: Royal decree regulating well drilling
- 1993: Reduction of area eligible for wheat price support to 25% of previous size

→ Drop from 28,6 km3 to 15,4 km3 in water pumped from non-renewable aquifers

Background *Reuse for irrigation*

Existing reuse schemes have been mostly designed for irrigation applications.

> Authorized since1978

> 1997: 9,000 ha of date palms and forage crops near Riyadh reused 146 Mm3 treated wastewater + landscaping use in several cities including Riyadh

> 2000: Treated Wastewater and Re-use of Wastewater Law

> 2006: Implementing Regulations

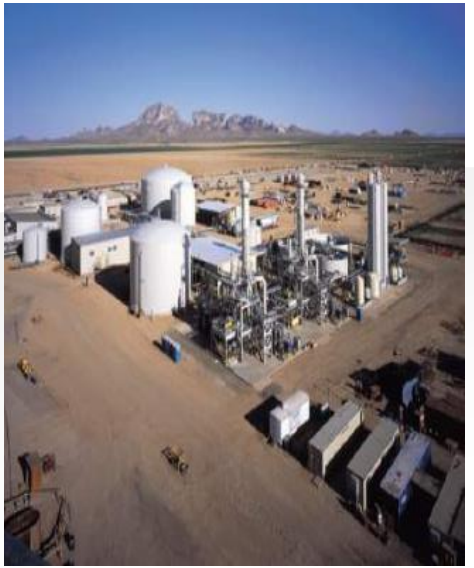
> Selected project implemented by VWS Metito
- Al Salam Park (output used as lake make up)
- Al Hassa tertiary (output to irrigation canal)
- Industrial Nada IWTP (output to irrigation)

> In 2007, Saudi Aramco reused approximately 50% of its industrial and sanitary effluent, over 80% of which in irrigation applications.

Background *Reuse in industry*

Significant reuse projects with industrial applications are being developed.

- Reuse of Riyadh City treated wastewater at Saudi Aramco's Riyadh refinery into cooling and boiler feed applications (Aramco conducting all tertiary treatments required)
- Saudi Aramco projects to increase industrial wastewater recycling through :
  - Combining sanitary and oily wastewater
  - API and walnut shell filtration
  - MBR + RO treatment to provide boiler feed water
- SABIC is developing on-site reuse of various wastewater flows at one of its affiliate sites in the Jubail area
  - Various treatment files apply to various flows (wastewater from plastics production, olefins production, demin regeneration...)
  - Total wastewater produced is 10,000 m3/d
  - Based on potable cost savings, pay-back assessed around 5 years
- A number of ZLD schemes have been developed at large industrial plants



Background *Current plans*

Faced with growing water needs, NWC has to combine demand-side and supply-side measures, in order to provide the water needed while protecting water resources. Re-use becomes a cornerstone of the supply-side strategy.

> MOP's 8th development plan
- Raise sewerage collection coverage from 33.5% in 2004 to 40% in 2009
- Raise treated effluent reuse from 37% in 2004 to 40% in 2009

> MOWE's initiatives in wastewater re-use
- Feasibility studies conducted over 200 residential areas, covering 80% of the Kingdom's population
- 100% sanitation objective in 4 major cities
- Large BOO / BOOT WWTP projects in Riyadh City

> Factors supporting the plans
+ Tertiary treatment technologies and costs well established
+ Recent Royal decrees on treated wastewater recycling for various applications and on water consumption control amongst large consumers
+ Sanitation and network efficiency ambitions

> Key challenges facing urban effluent re-use initiatives:
- Water tariffs among the lowest in the world → threatens treated wastewater sales and overall economics of the projects
- Urban effluent re-use schemes require thorough, multi-stakeholders, financial and contractual engineering

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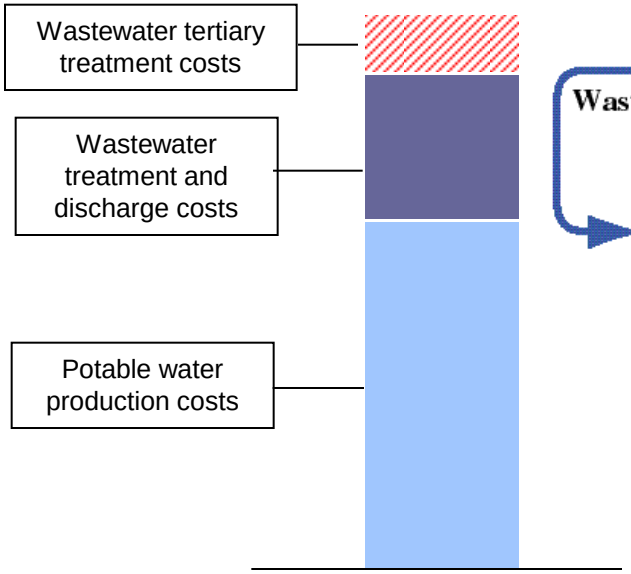
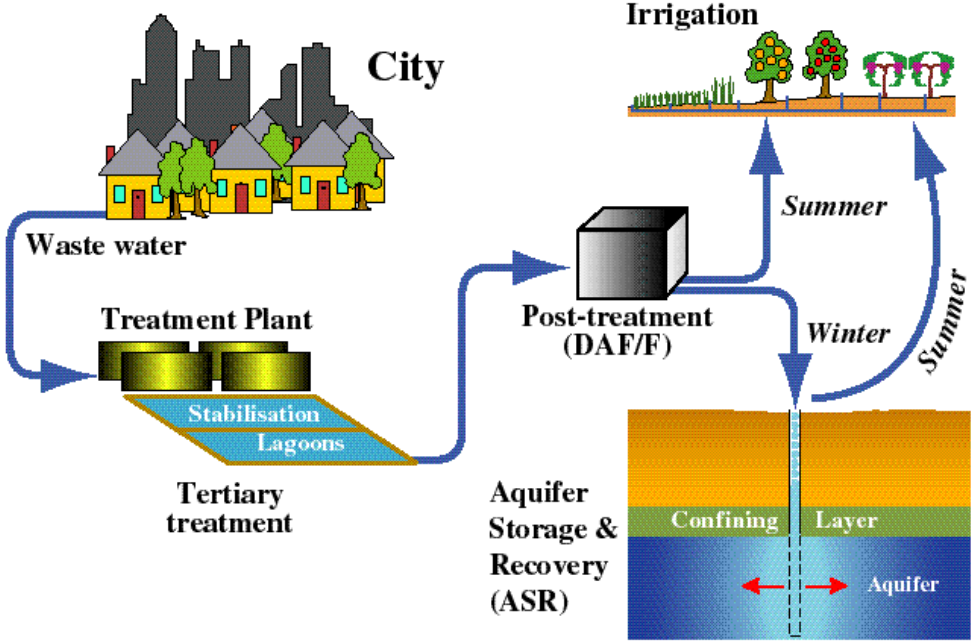
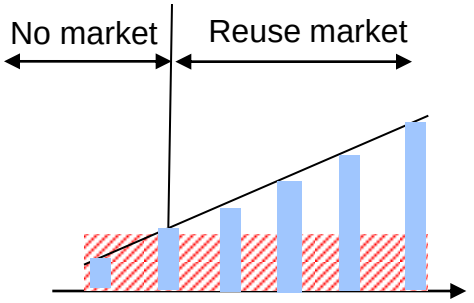
Background *Potential revenues from treated wastewater sales*

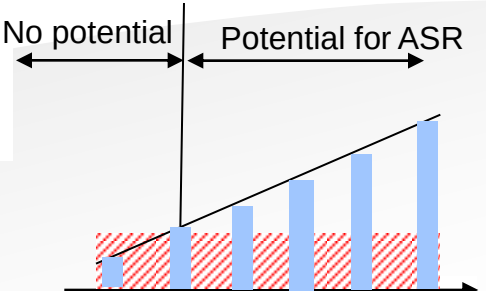
Revenues from treated wastewater sales may be assessed at any time based on potential users' base water supply costs.







Increase in irrigation water production costs



Increase in groundwater opportunity costs

Objectives and approach

This workshop is intended to feed NWC's investigation of possible procurement, contracting and management avenues for its wastewater reuse projects. Our proposed approach is as follows:

> Present an overview of current reuse technologies and associated costs.

> Investigate, through case studies, possible business models associated with various geographical regions, reuse drivers and types of application for treated effluents.

> Drill further into the approach taken by the state of Queensland (Australia) in the Western Corridor project.

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Technologies and costs

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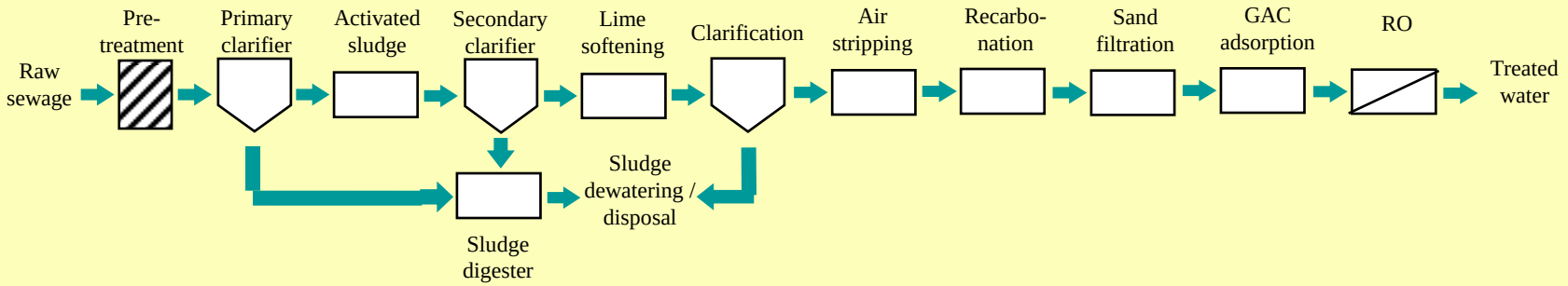
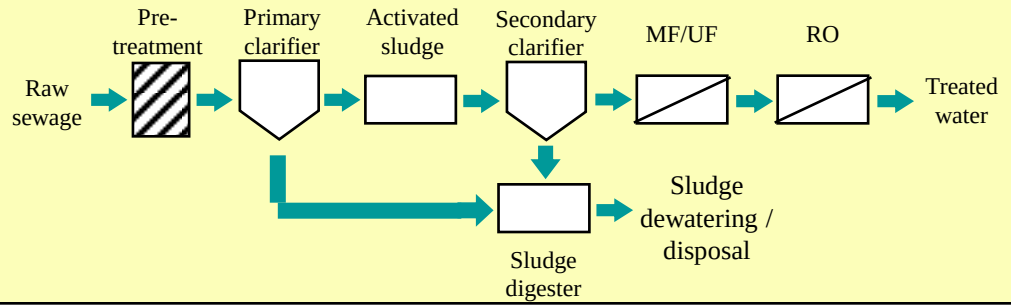
Water Reclamation Process Trains

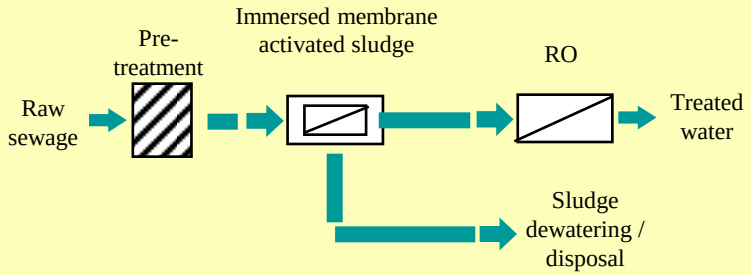
Conventional



Conventional activated sludge with MF/UF pretreatment to RO



Immersed membrane activated sludge and RO



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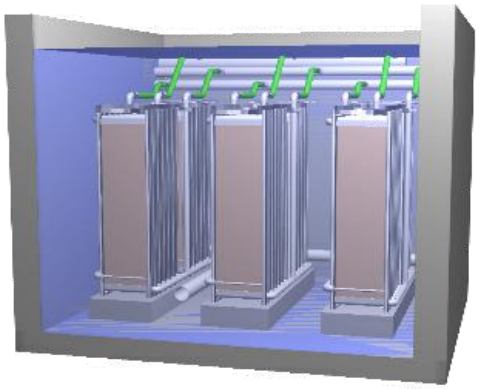
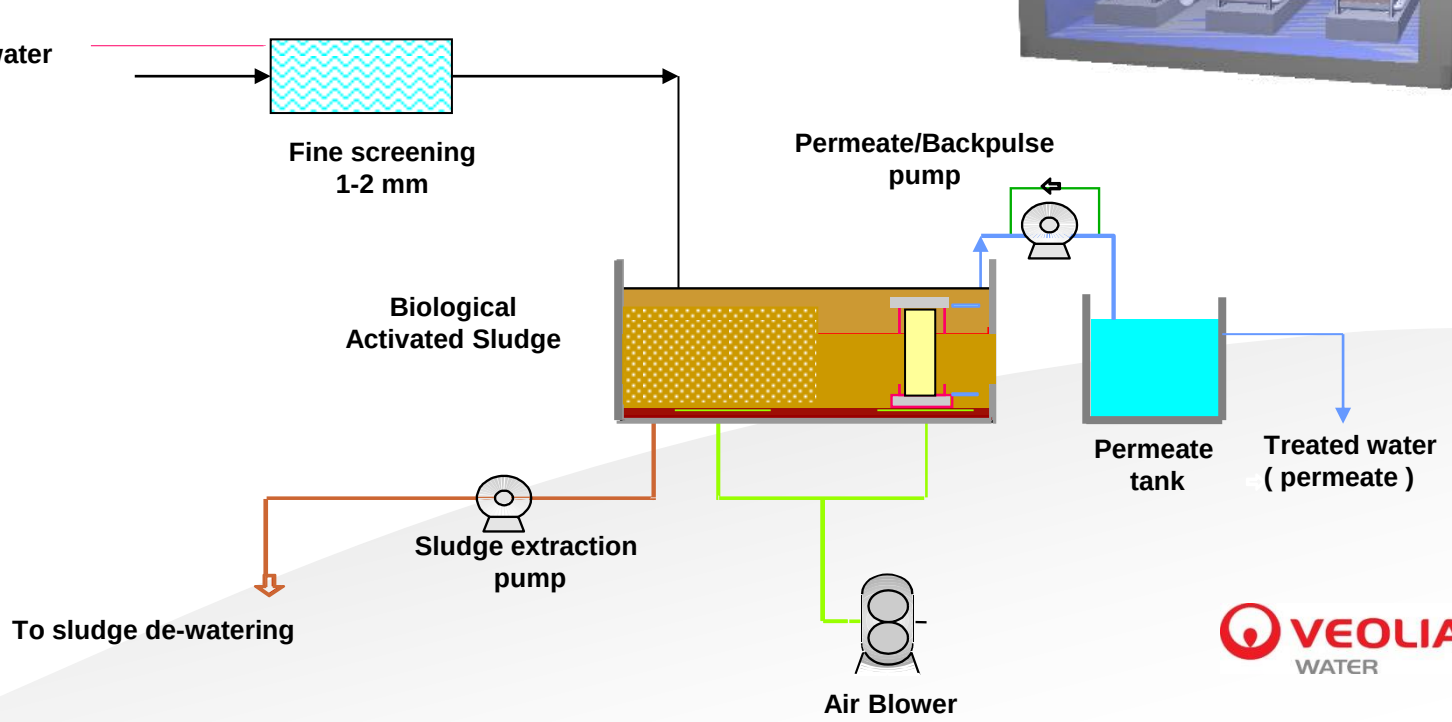
Secondary treatment - Membrane bioreactors

Secondary treatment options impact requirements for reuse treatments. MBRs are often preferred as secondary stage when reuse is planned downstream.

- Activated sludge process where the clarification step is replaced by a submerged membrane separation technique
- Achieves stringent discharge requirements Adaptability to load variations
- Compact design





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Membrane-based tertiary treatments

While irrigation applications usually require only micro filtration, other applications requires a combination of MF and RO.

Biological Treatment

Micro filtration

Reverse Osmosis

- Turbidity: < 0.2 NTU
- SDI: < 3
- Total Coli: < 10 u/100 ml
- Faecal Coli: < 10 u/100 ml
- Parasites: LRV 4

Agricultural demand

Industrial demand
Groundwater recharge
Drinking water

Drinking water quality

Quality standards for irrigation reuse

Treated Wastewater and Reuse Bylaw N°42 (from 2000) provides a framework for the development of both restricted and unrestricted irrigation applications.

> Key reclaimed water standards for restricted irrigation in Saudi Arabia:
  - SS < 40 ppm
  - BOD < 40 ppm
  - Ph: 6 - 8.4
  - Fecal coliforms < 1000 MBN / 100 Ml

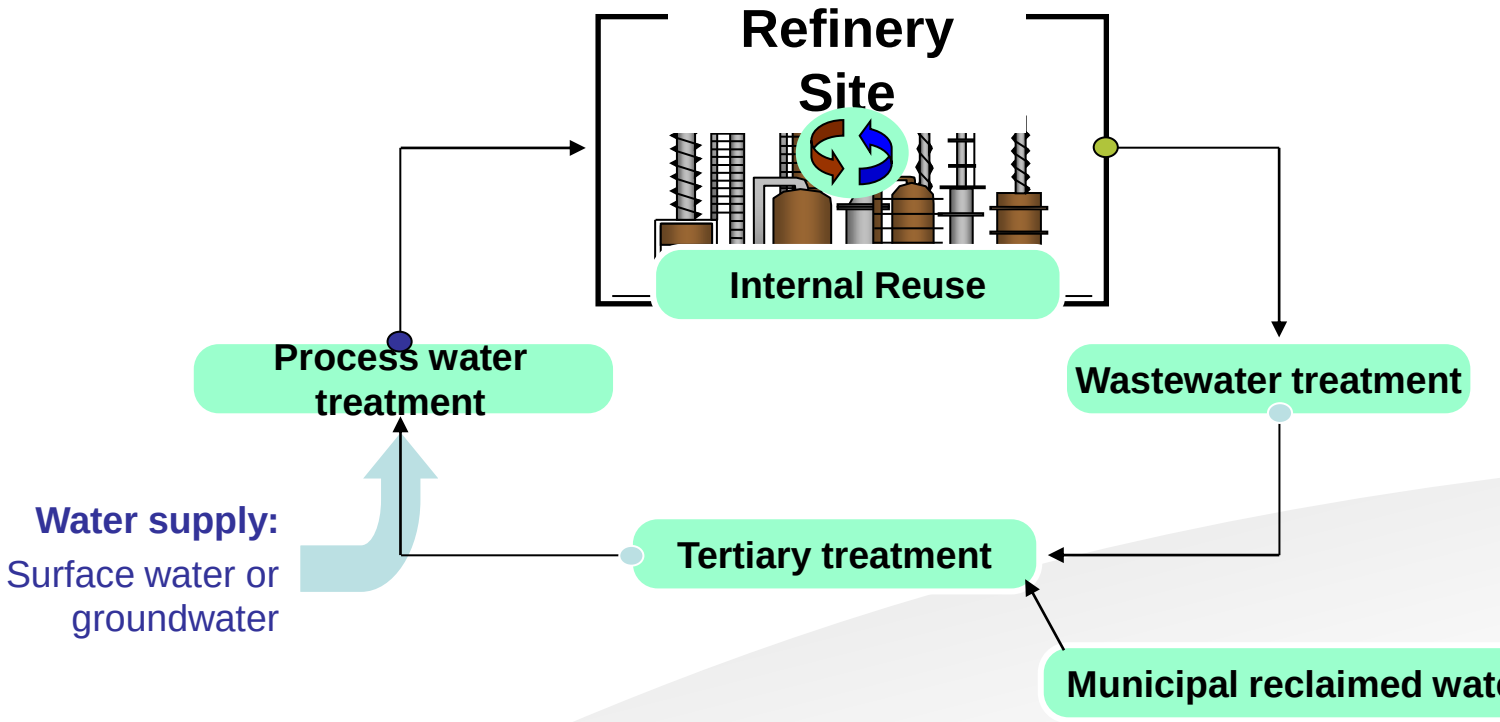
→ Usage on road green islands and non public places

> Key reclaimed water standards for unrestricted irrigation in KSA:
  - SS < 10 ppm
  - BOD < 10 ppm
  - NH3-N < 5
  - pH: 6 - 8.4
  - Fecal coliforms < 2.2 MBN / 100 Ml
  - Helminthes eggs < 1 oval / 1

→ Usage in parks, gardens and public spaces

Quality standards for industrial reuse

Industry may be an important off-taker of treated municipal wastewater. However, the volumes required depend on the importance of internal (on-site) reuse.



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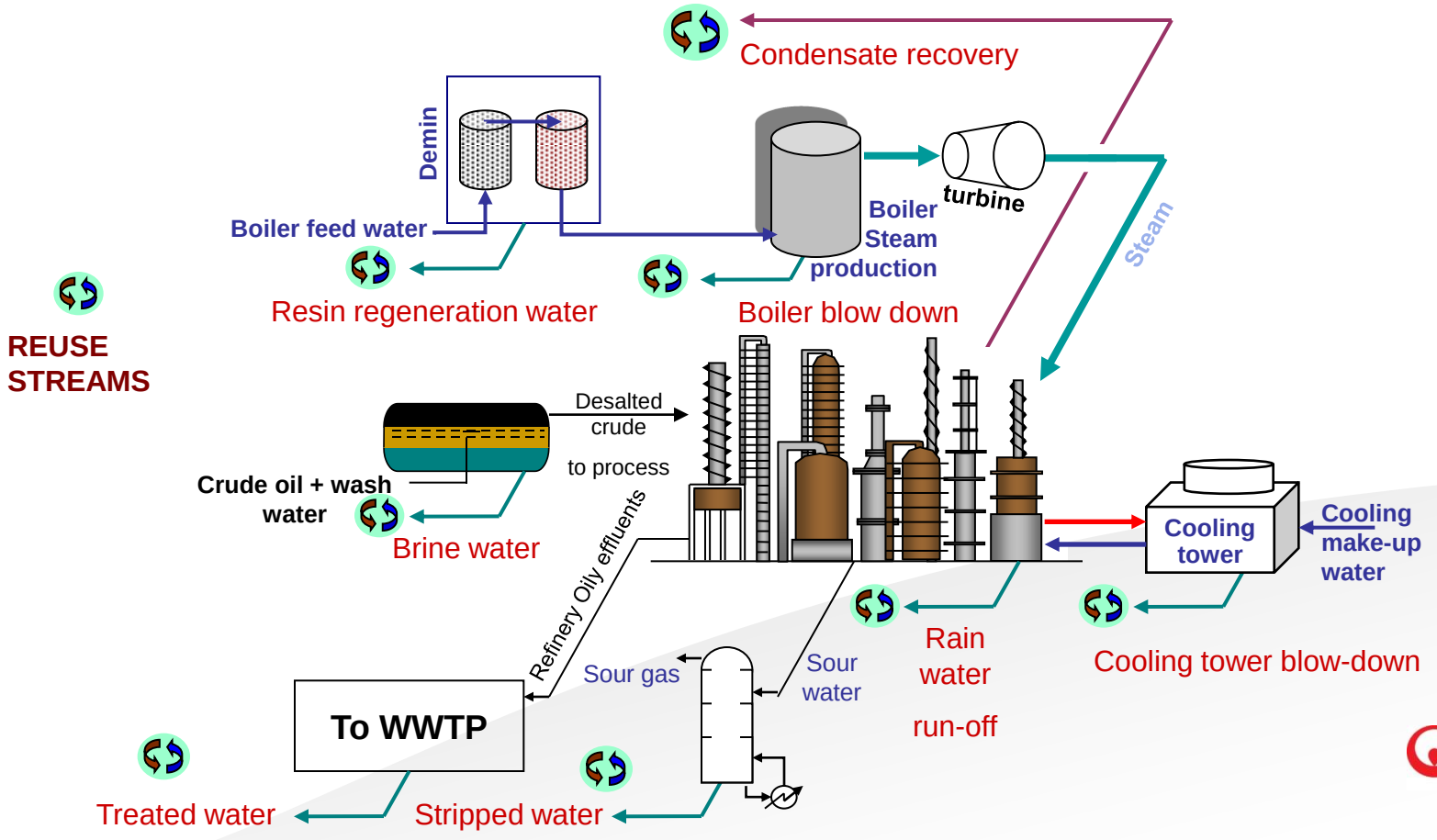
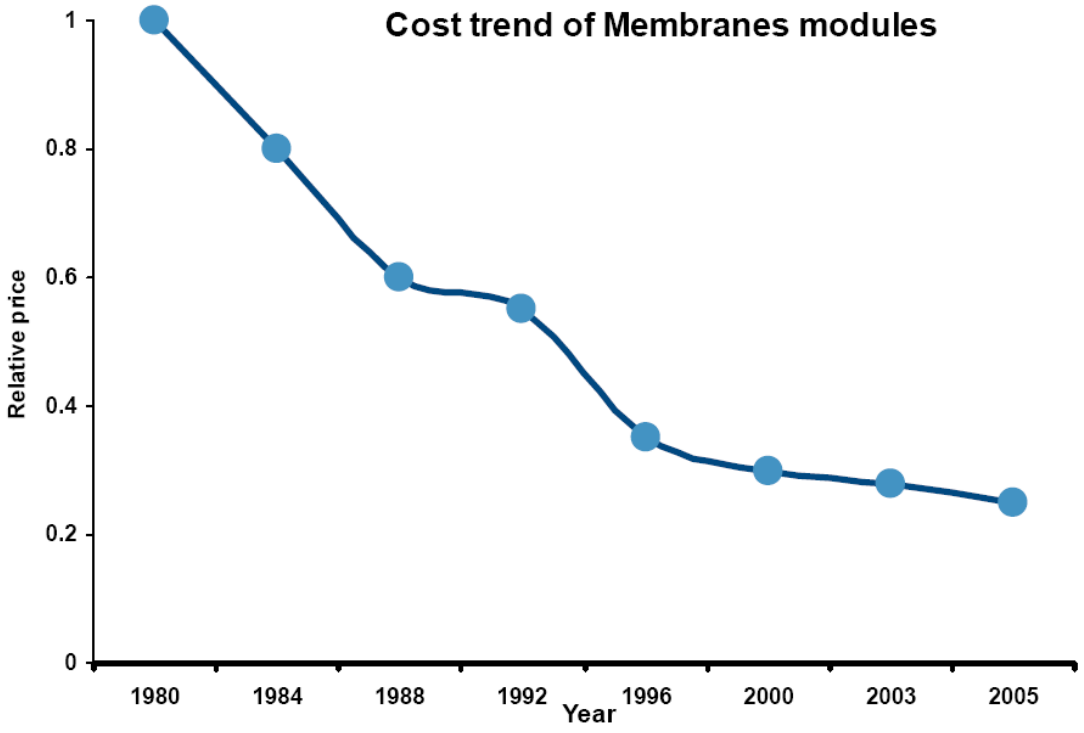
Quality standards for industrial reuse

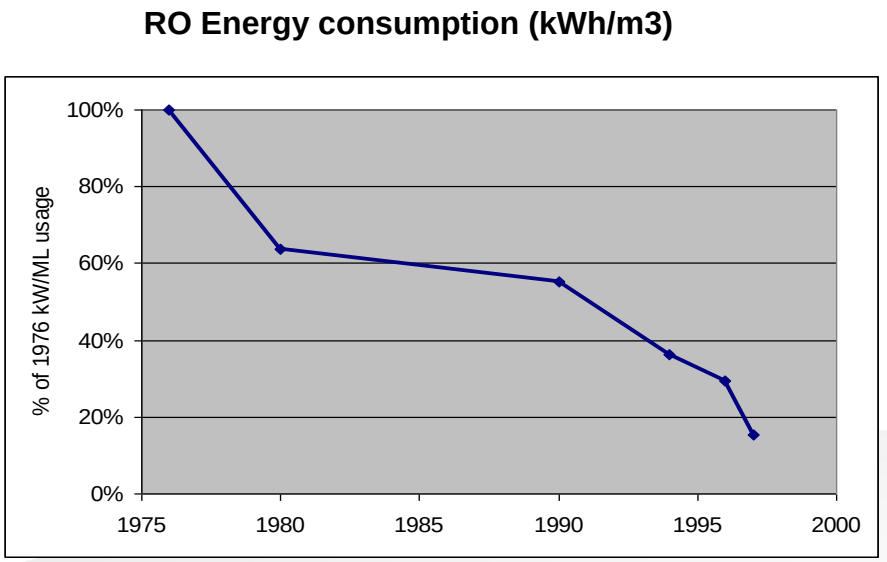
Key on-site reuse loops concern the process condensates, boiler blow-downs, cooling blow downs and process wastewater flows. Each application requires specific water quality and reuse reclamation treatment level.



Historic costs

The cost of RO membranes modules has gone down by 80% in the last 20 years. The same applies to RO energy consumption.





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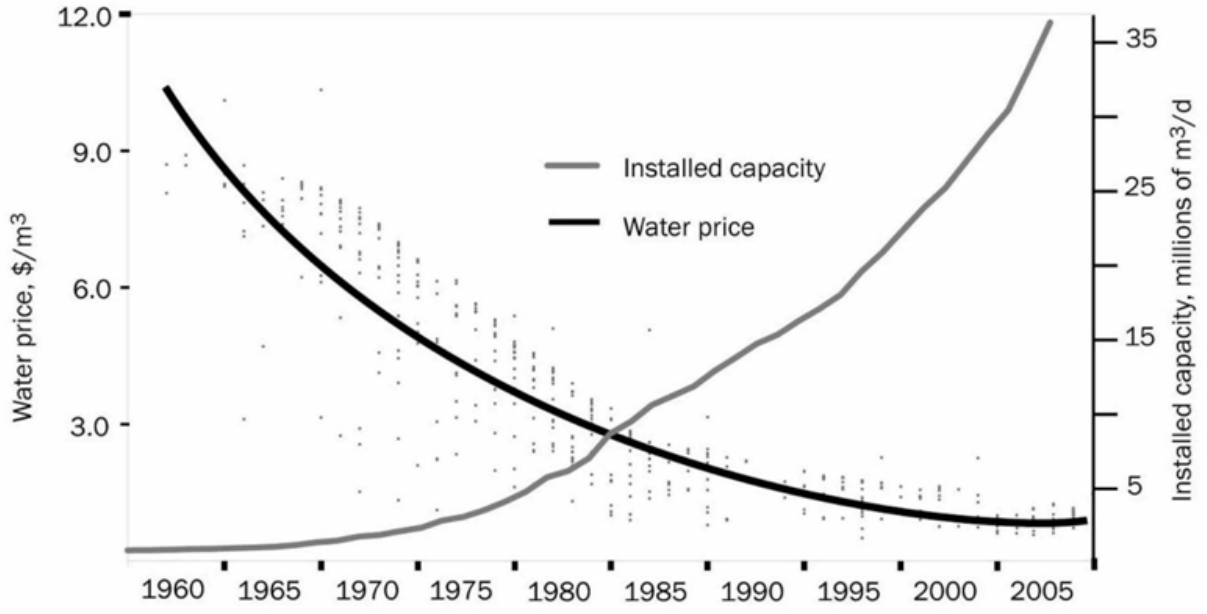
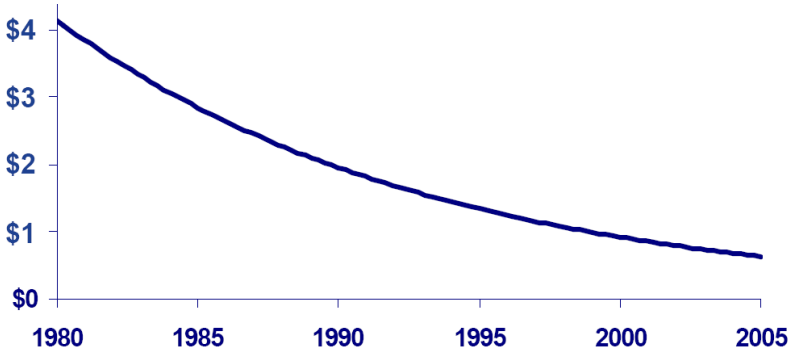
Historic costs

As a result, project Capex and life-cyle costs have plunged.





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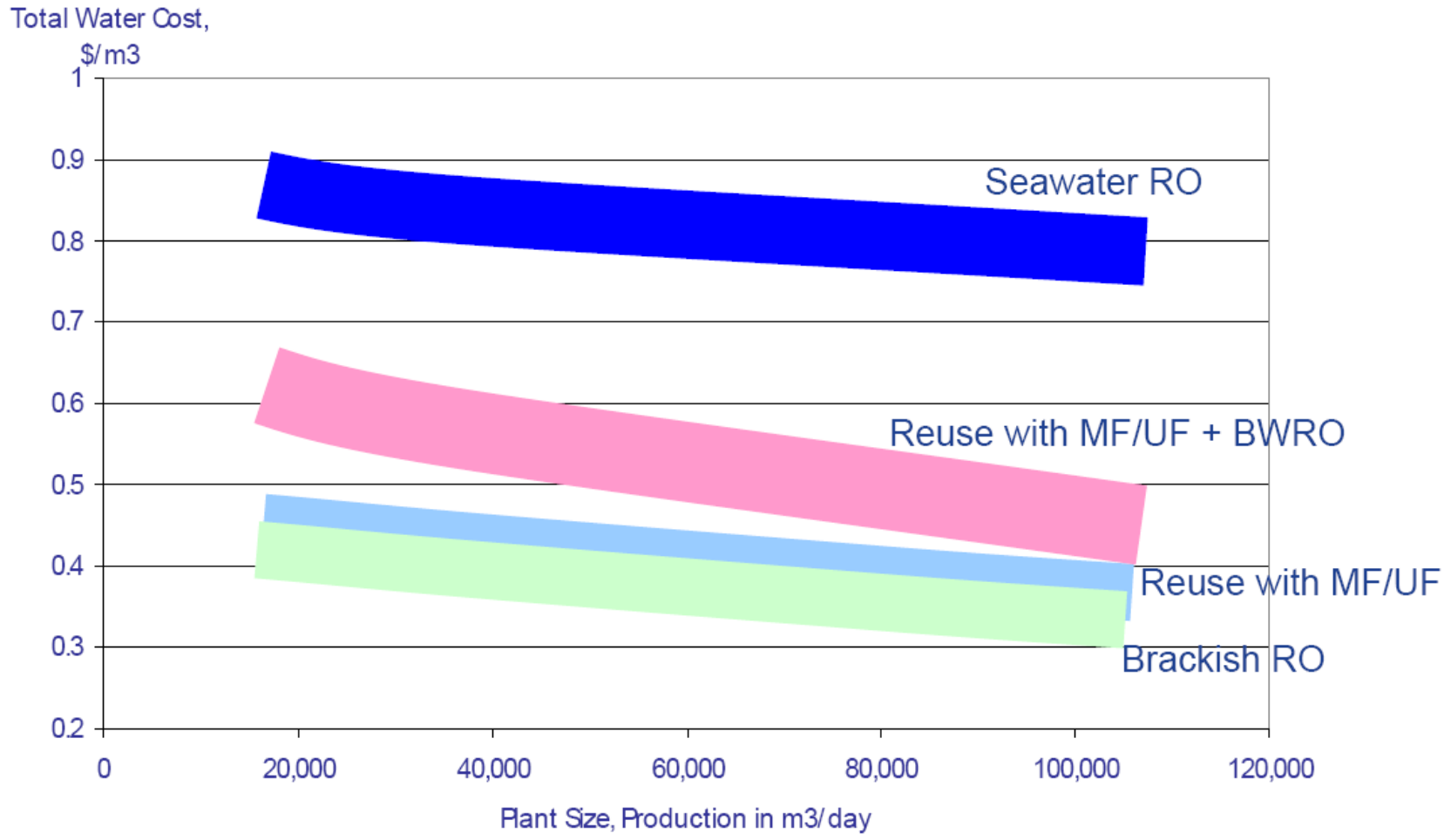
Historic costs

The same trends apply to reuse membranes, with life cycle unit costs for reused water being approximately one half of those for desalinated water.



Veolia’s reuse capability

Veolia Water's reuse expertise is based on the technological expertise of its subsidiaries and on a large number of references.

> 88 references worldwide for all reuse applications (Zero Liquid Discharge, aquifer recharge, irrigation, drinking water production systems, etc.)

> 38 projects specifically for industry in all industrial sectors (Energy, Chemicals, Refinery, Micro-electronics, Pulp and Paper, Automotive, Food and Beverage, Primary metals)

> Five projects for wastewater reuse on-board ships

> Dedicated reuse technologies and expertise

> Solutions based on model markets of which Australia (over 20 years of experience)

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Veolia's reuse capability

Veolia Water has references in all reuse applications throughout the entire world.

Application \ Customer	Major cities	Coastal areas	Small towns
Aquifer recharge	Berlin (Germany)	Adelaide, Bolivar (Australia)	State College (USA)
Indirect drinking water production		Kranji (Singapore)	
Industry	La Rosita (Mexico) Maubeuge (France)	Durban (South Africa) Honouliuli (USA) Kranji (Singapore)	Kwinana (Australia)
Irrigation	Cuernavaca (Mexico)	Almeria (Spain) Limassol (Cyprus) Gerringong (Australia)	Yautepec (Mexico)
Urban uses	WRAMS Olympics 2000 (Australia)	Mawson Lakes (Australia)	Nex Haven Village (Australia)
Direct drinking water production	Windhoek (Namibia)		

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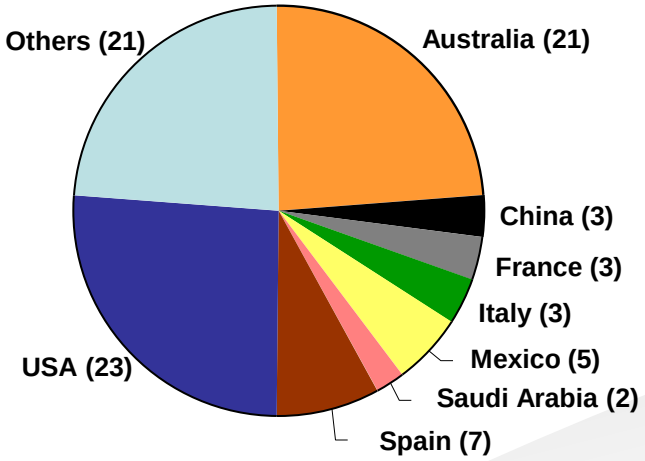
Veolia's reuse capability

Veolia Water has references in all reuse applications throughout the entire world.

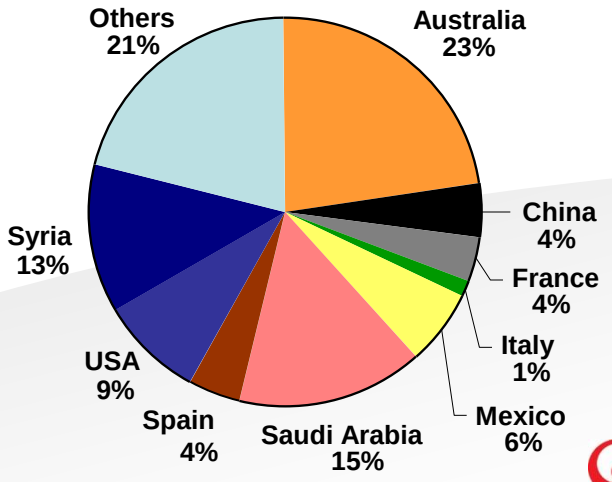
Customer	Industrial	Municipal			
Applications	Process or other industrial applications	Process or other industrial applications	Irrigation	Aquifer recharge	Urban uses
Number of references	38	7	42	3	10

N.B.: a reuse project may have various applications

Reuse references by country (number of projects)



Reuse references by country (flow rates)



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Case Studies

South Africa
Singapore
Australia

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Water Reuse in South Africa

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Durban Water Recycling *Project drivers* *2001*

Durban Metro needed to find new sources of supply to face a dramatic increase in population and to meet industrial needs.

> Situation
  - Abolition of apartheid
  - Metropolitan population: 1 million → 3 million
  - Annual rainfall 200 mm/y + soaring population → water scarcity + overload of long sea outfall
> Needs
  - Provide basic services to growing population, 26% living in townships
  - Increase volumes of higher quality water to industrial customers

Durban Water Recycling *Off-takers* *2001*

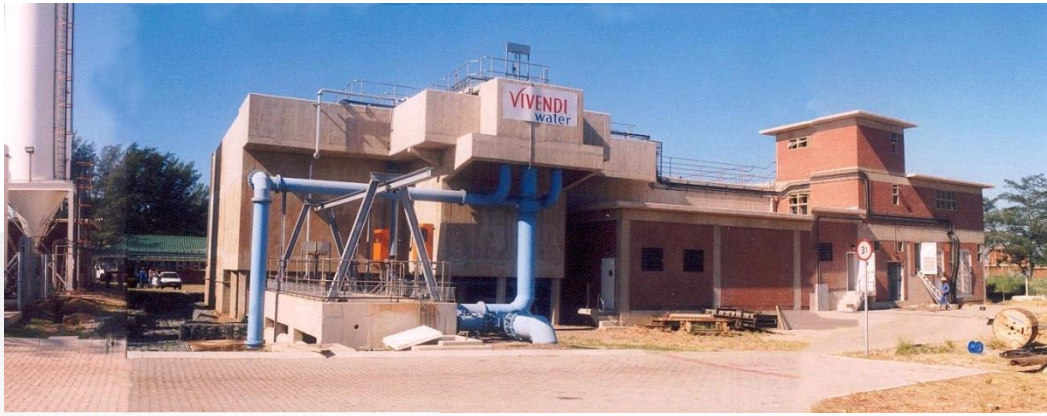
Industrial off-takers were identified at project inception. Not only did they initiate the project by expressing their interest, they became key project stakeholders.

> Off-takers

- 1993: Mondi approached Durban for the provision of additional recycled water.
- 1994: Durban implemented a technical feasibility study.
- 1995: Pilot plant process investigation indicated the technical viability of the project.
- Sapref was the second key off-taker

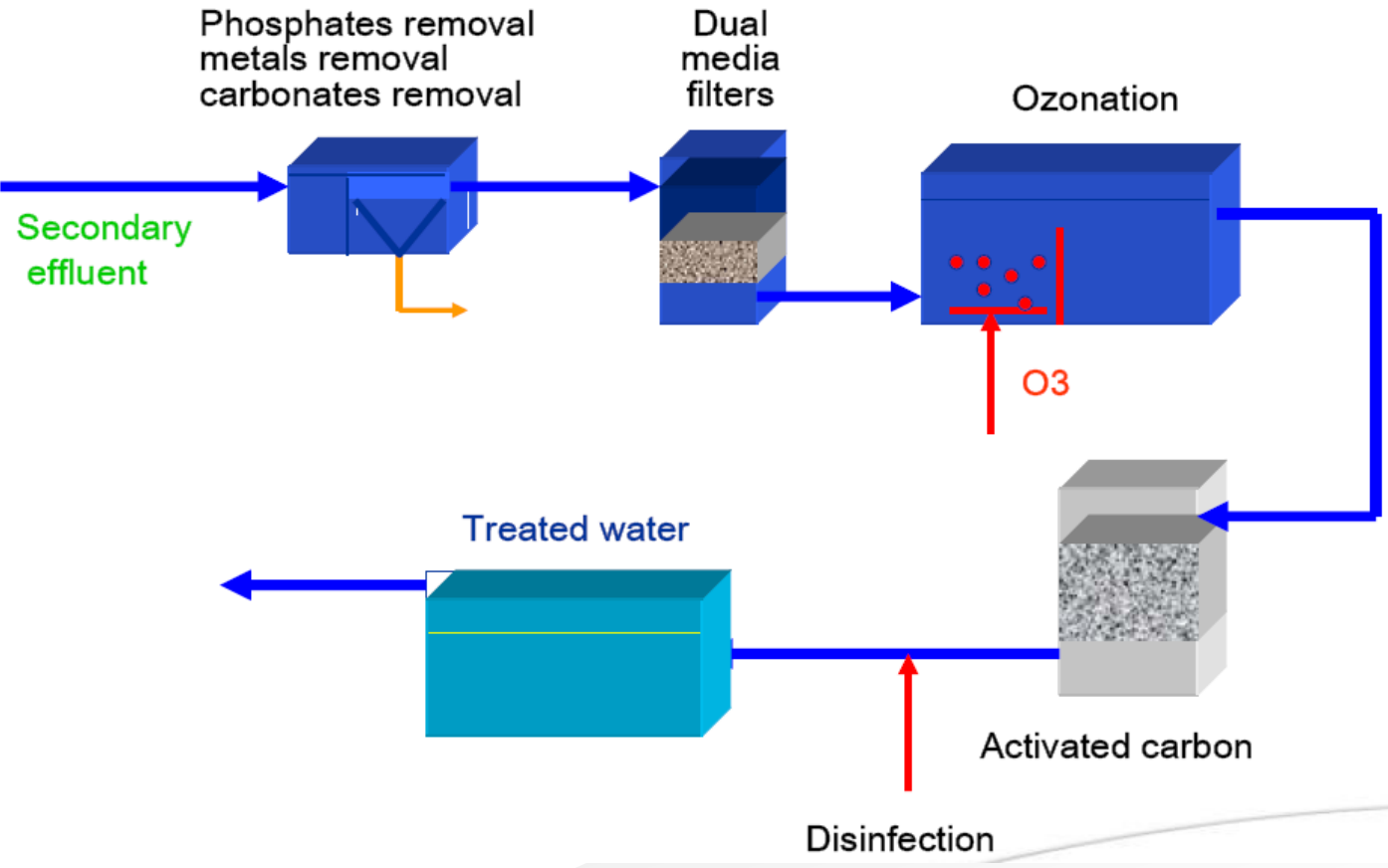
> Project size and specifications

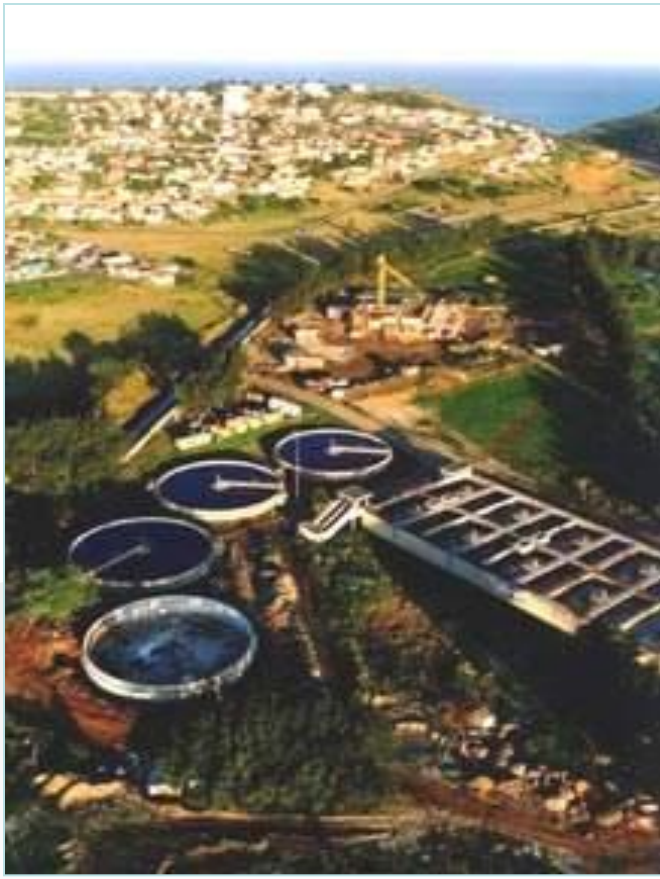
- 47.5 Ml/day of secondary muncipal wastewater to be treated to near potable quality
- Reclaimed water to feed directly industrial paper process (Mondi) and indirectly refining process (Sapref)



Durban Water Recycling *Technologies* *2001*

The plant uses a novel combination of wastewater and potable water treatment technologies to produce near potable quality water.

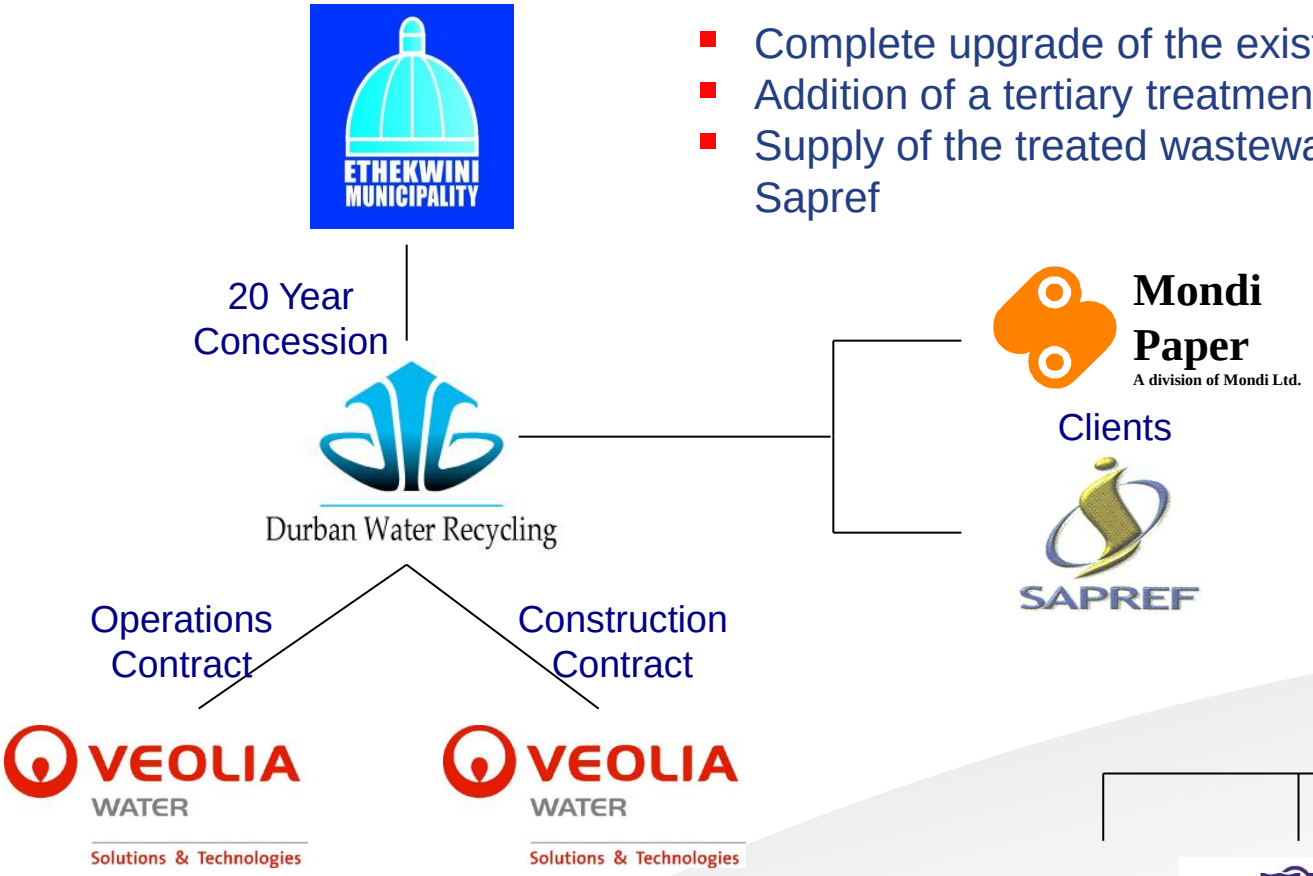


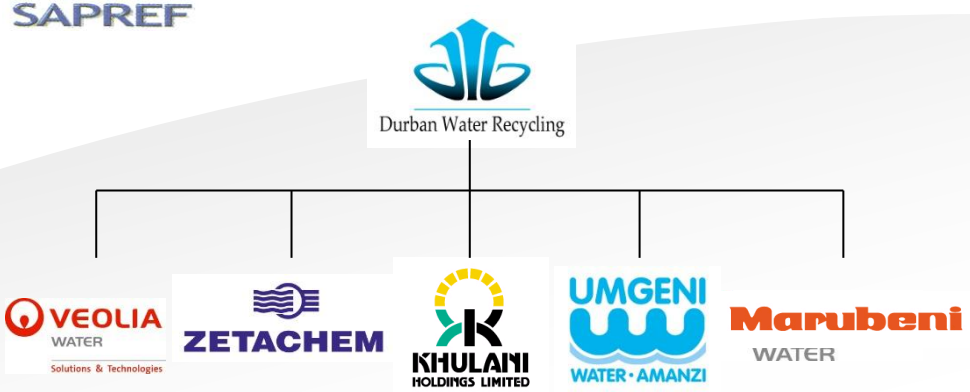


Durban Water Recycling *Contract arrangements* 2001

DWR was awarded a 20-year concession contract for the design, construction and operation of a wastewater treatment and recycling unit including:

- Complete upgrade of the existing plant (47 500 m3/j)
- Addition of a tertiary treatment unit
- Supply of the treated wastewater to Mondi Business Paper and Sapref





Durban Water Recycling *Risks and rewards* *2001*

DWR project has provided Durban Metro with enough water to meet 7% of total demand, without the need for expensive infrastructure investments.

> Project risks
  - Technical risks managed by concession contractor
  - Revenue risk neutralized from project inception by off-takers

> Project rewards
  - Cost savings on water purchases for the businesses concerned: 40%
  - Alternate supply meeting 7% of city's water demand
    → extension of supply to 220,000 households in Greater Durban area
    → avoidance of expensive inter-catchment transfer schemes
  - Reduction in treated wastewater output by 10%
  - Extension of the lifetime of the deep water outfall

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Water Reuse in Singapore

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The Singapore PUB needed to increase its water supply to meet increasing demand from new developments, while increasing self-sufficiency.

> Situation

- In 2000, the Public Utility Board provided 1.3 Mm3/d of water to 4 million people
- Limited water resources: no river or lake, only source of supply is rain water collected in reservoirs
- Land scarce country → no new reservoirs could be built
- Fast industrial, economic and social developments → sharp increase in water demand

> Needs

- Secure sustainable water supply for future developments
- Reduce dependence on imported water from Malaysia

Kranji HGWRP *Reclaimed water uses* *2002 - 2007*

The PUB's secondary wastewater treatment and reclamation strategy was aiming at producing NEWater fit for Indirect Potable Reuse.

> Water reclamation study

- Initiated in 1998 by the Public Utilities Board (PUB) and the Ministry of Environment
- Objective: determine the suitability of using NEWater as a source of raw water to supplement Singapore's water supply
- NEWater is treated used water that has undergone stringent purification and treatment process using advanced dual-membrane (microfiltration and reverse osmosis) and ultraviolet technologies
- Initial 10,000 m3/J Newater plant

→ Product water met WHO Drinking Water guidelines

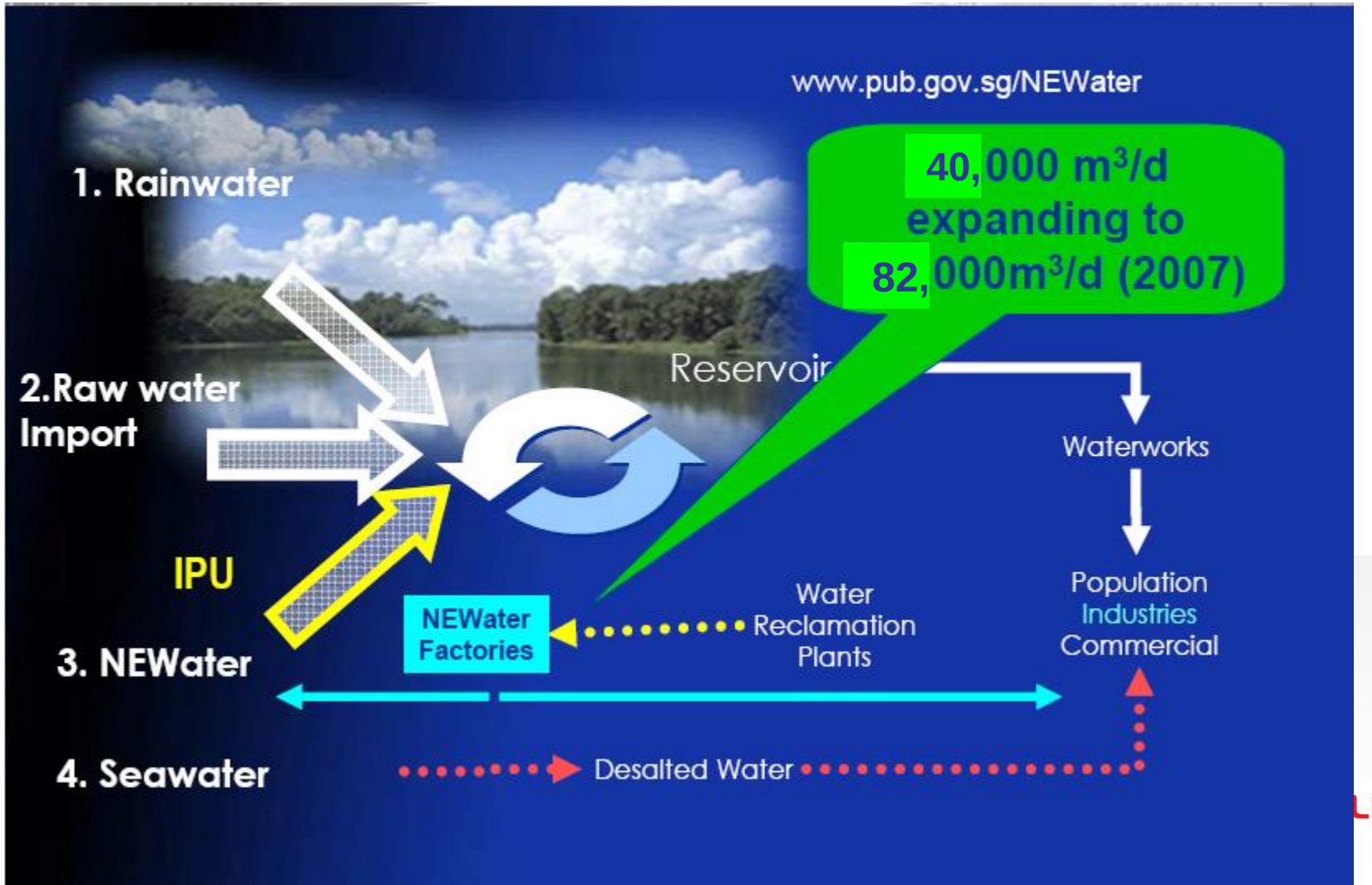
→ PUB could adopt Indirect Potable Reuse approach

> High Grade Water Reclaimation Plant

- New project to supply Newater to wafer fabrication plants and other industries for non-potable use
- Phase I: 40,000 m3/d built in 2002
- Extensions up to 82,000 m3/d in 2008

Kranji HGWRP *Reclaimed water uses* *2002 - 2007*

In the final scheme, reclaimed water is used as Indirect Potable and industrial water.



Kranji HGWRP *Project risks and rewards* *2002 - 2007*

> Project risks

- Delivery of the NEWater plant:
  - 3 phases: 40,000 m3 / 16,000 m3 / 26,000 m3, delivered as DB / EPC contracts
  - Initial investment: S$ 21M, funded by the PUB
  - Power usage and chemical consumption part of the guarantees with LDs applying.
  - Actual power for the plant < 1 KWh/ m3 of water produced; Chemical costs < S$0.10 / m3.
- NEWater sales:
  - NEWater is directly marketed by the PUB
  - Individual contracts in place with each off-taker
  - No take-or-pay; consumers billed based on actual consumption
  - Sale price is approximately S$ 1/ m3

> Project benefits

- Using Veolia Water's innovative technologies, the PUB provides cost-effective, high quality water to its industrial customers.
- The plant reduces the impact of changes in rainfall/drought, it also reduces the need for importation of water and the amount of seawater desalination needed.
- It also provides new water resources for Indirect Potable Use (the water quality meets with the WHO drinking guidelines).

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Water Reuse in Australia

- Western Australia
- New South Wales
- South Australia
- Queensland

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Kwinana Water Reclamation Plant *Project drivers* *2004*

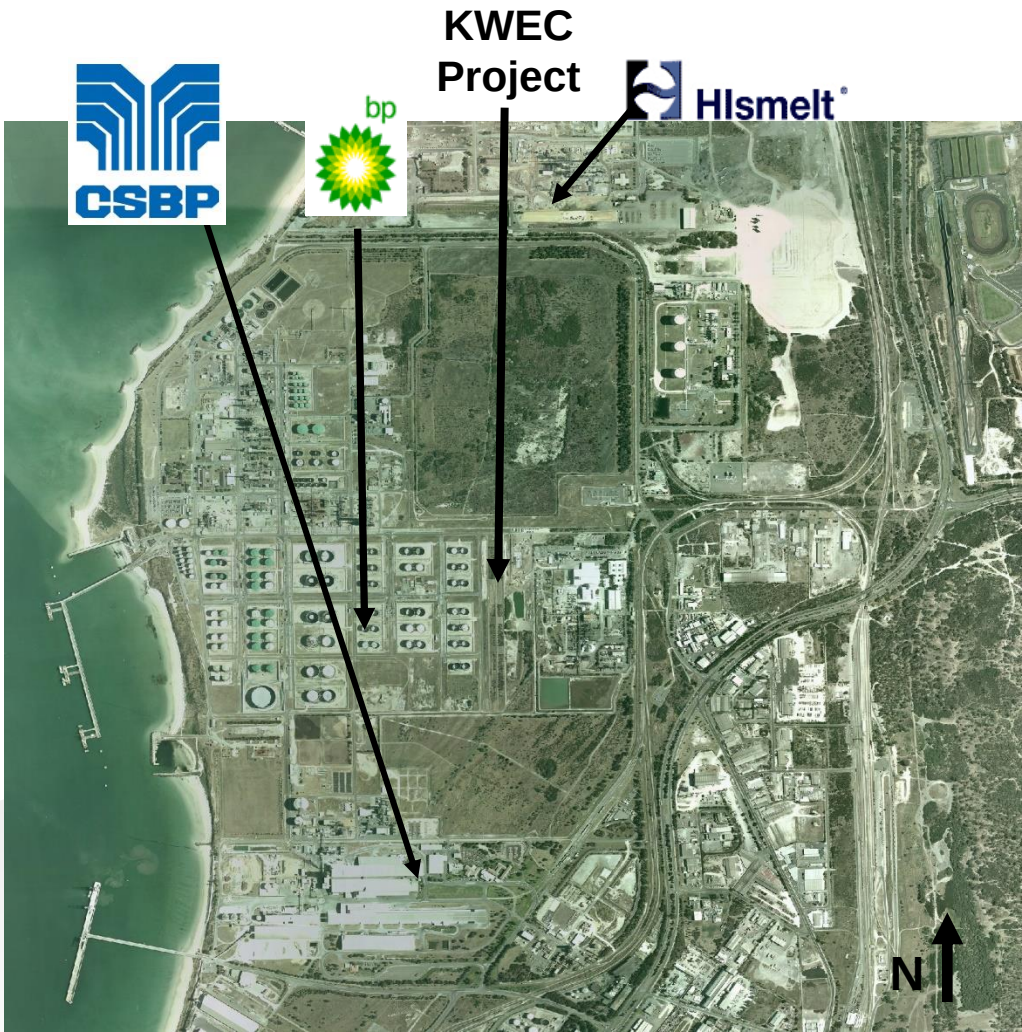
The Water Corporation needed to provide the Kwinana Industrial Area with additional water resources in a context of increasing groundwater supply scarcity.

> Situation

- The Water Corporation provides water and wastewater services to the Perth Metropolitan area.
- The Kwinana Industrial Area, 40 km to the south of Perth, is the primary heavy industrial centre for Western Australia and contributes more than 10% of the state's industrial output.
- 60% of total industrial water demand was supplied through local groundwater.
- Groundwater supplies in the Perth region were under pressure, with an approximate 25% reduction in rainfall and 40% reduction in runoff over past 25 years.
- Proposed industrial expansion in the area would outstrip available supply.

> Needs

- Provide alternative water source to industrial customers
- Improve the quality of Woodman Point WWTP discharge to respond to public pressure



Kwinana Water Reclamation Plant *Off-takers* *2004*

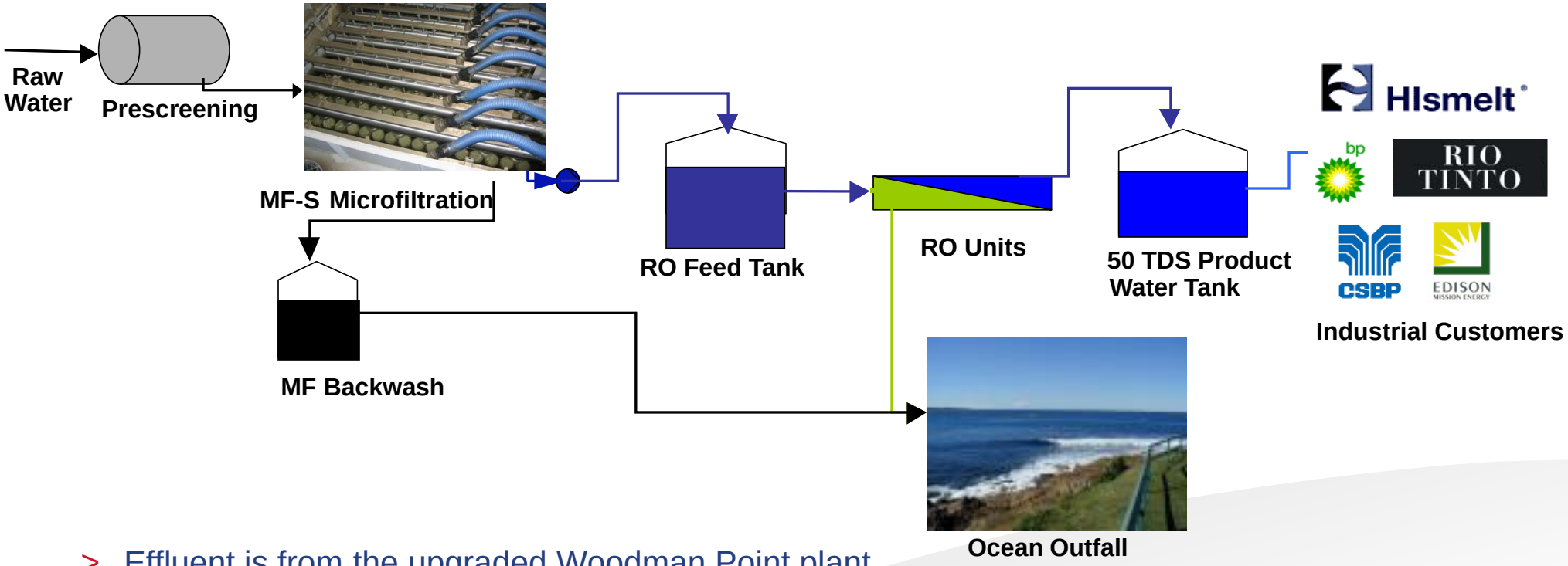
Four industrial off-takers committed to receiving the reclaimed water.

> Off-takers:
- Rio Tinto: HIsmelt pig iron plant which was under construction at the time
- Edison Mission: power generation company
- CSBP: chemical fertiliser manufacturer
- BP: refinery

> Project size and specifications
- Capacity of WRP: 16,700 m3/day, upgradable to 26,700 m3/day
- High quality (< 50 mg/l) product water to be used as process, cooling and demin water

Kwinana Water Reclamation Plant *Technologies* *2004*

The plant uses a dual membrane system of micro/filtration and RO that is well known and established in municipal wastewater recycling.



- Effluent is from the upgraded Woodman Point plant
- Effluent is screened and chloraminated for biological control
- Water is microfiltered prior to reverse osmosis for salinity reduction
- Feed water is dosed with antiscalant and acid to avoid scaling from calcium phosphate among other scaling compounds

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Kwinana Water Reclamation Plant *Risks and rewards* *2004*

> Project risks
  - KWRP was procured by the Western Australian Water Corporation as a Design Build project ($25 million AWTP)
  - Revenue risks were neutralized at project inception through off-takers' commitment to receive reclaimed water and subsidize

> Project rewards
  - This contract was the first step in the State's Water Strategy launched in February 2003 to achieve 20% re-use of treated wastewater by the year 2012.
  - KWRP has doubled Water Corporation's water reuse capacity from 3% to 6%
  - It has provided the industrial off-takers with the quality water they needed, et reduced operating costs (mostly savings on chemicals)

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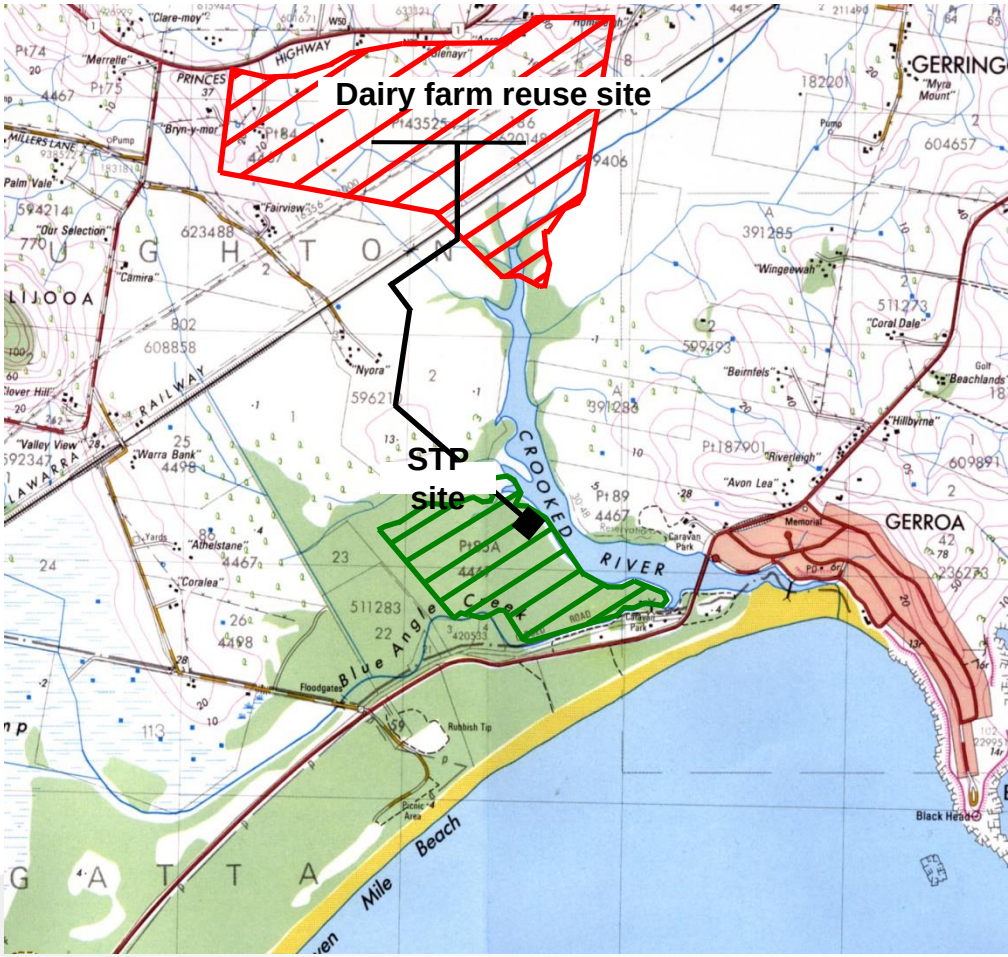
Gerringong Gerroa Reclamation Scheme *Project key features* *2004*

- Capacity 2.2 ML/d
- Advanced tertiary treatment producing effluent of almost drinking water quality:
  - BNR and sand filtration
  - Advanced Tertiary – ozone/BAC, microfiltration and UV disinfection
- Construction of an advanced wastewater treatment plant, a collection system and a reuse system
- Scheme is a full scale pilot plant with an associated R&D project
- Operation under a DBO contract 20 year
- Rates decided by NSW government body (IPART)- $0.3-$1 per m3
- Scheme subsidized by Sydney Water



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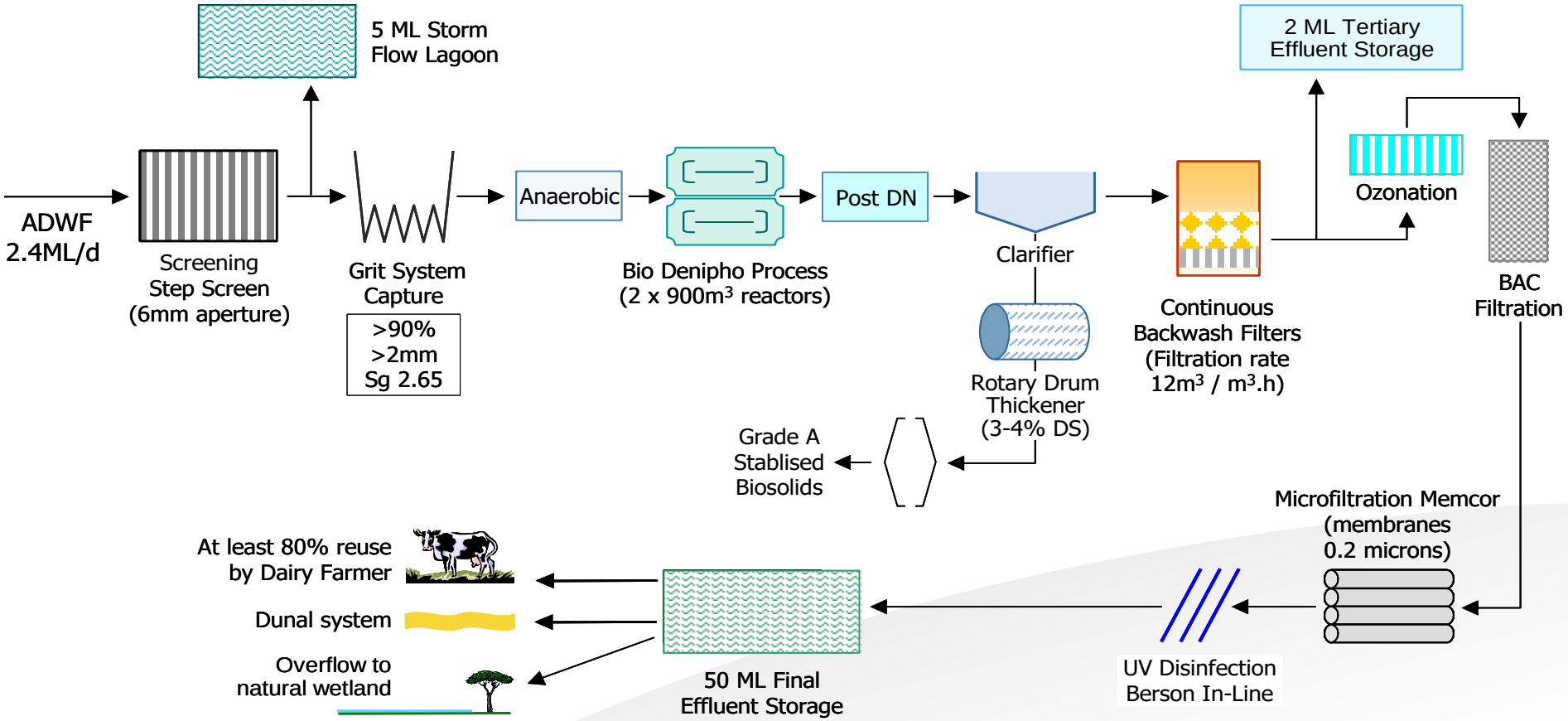
Gerringong Gerroa Reclamation Scheme
Process Schematic



Illawara Water Reclamation Plant *Project off-takers* *2005*

BlueScope Steel at Port Kembla is the sole off-taker of treated effluent. The advanced wastewater treatment unit is designed to meet the steel works water demand for cooling, process, dust suppression, steam generation and other uses.

Illawara Water Reclamation Plant *Project drivers* *2005*

- Situation
  - Water restrictions on the Port Kembla site since 1992
  - Sydney Water Corporation wished to improve beaches and bathing water quality, and protect the marine ecosystem over a wide area.
  - The Wollongong WWTP, which is SWC's main plant, is located in the industrial zone of Port Kembla, close to the BHP steelworks.
  - BlueScope Steel was looking for ways to reduce water demand

- Needs
  - Advanced wastewater treatment plant to treat wastewater from 300,000 residents
  - Supply high-quality recycled water for industrial reuse

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Illawara Water Reclamation Plant *Project technologies* *2005*

Port Kembla 51 000 m3/day + **Bellambi & Wolongong 126 000 m3/day***

* transported to Wolongong

Storm water 143 000 m3/day

Screening – Grit removal
Activated sludge clarifier

Sand filtration

20 000 m3/d

UV

1km diffused ocean discharge pipe.

Actiflo
UV

1km diffused ocean discharge pipe.

BLUESCOPE STEEL

Camellia RWP *Project background* *2008*

- AquaNet Sydney Pty Ltd (AquaNet)
  - A joint venture between Singapore Power International Pte Ltd / Babcock & Brown and Veolia Water Australia
  - AquaNet have been developing a large-scale recycled water scheme for Sydney
  - The scheme involves using disused gas mains to transport recycled water
- Camellia Project
  - Originally developed by Veolia as an unsolicited proposal; however State insisted it should be developed through competitive tendering
  - The Camellia RWP is intended to supply high quality water to industrial customers in Camellia and surrounding western suburbs of Sydney.
- 6 ‘foundation’ customers identified – predominately industrial demand (10 ML/d).
- Current proposal is for 20 ML/d plant MF/RO with ion exchange up front for ammonia removal (at Camellia)
- AquaNet see the Camellia RWP as the first stage in the development of their large-scale scheme.

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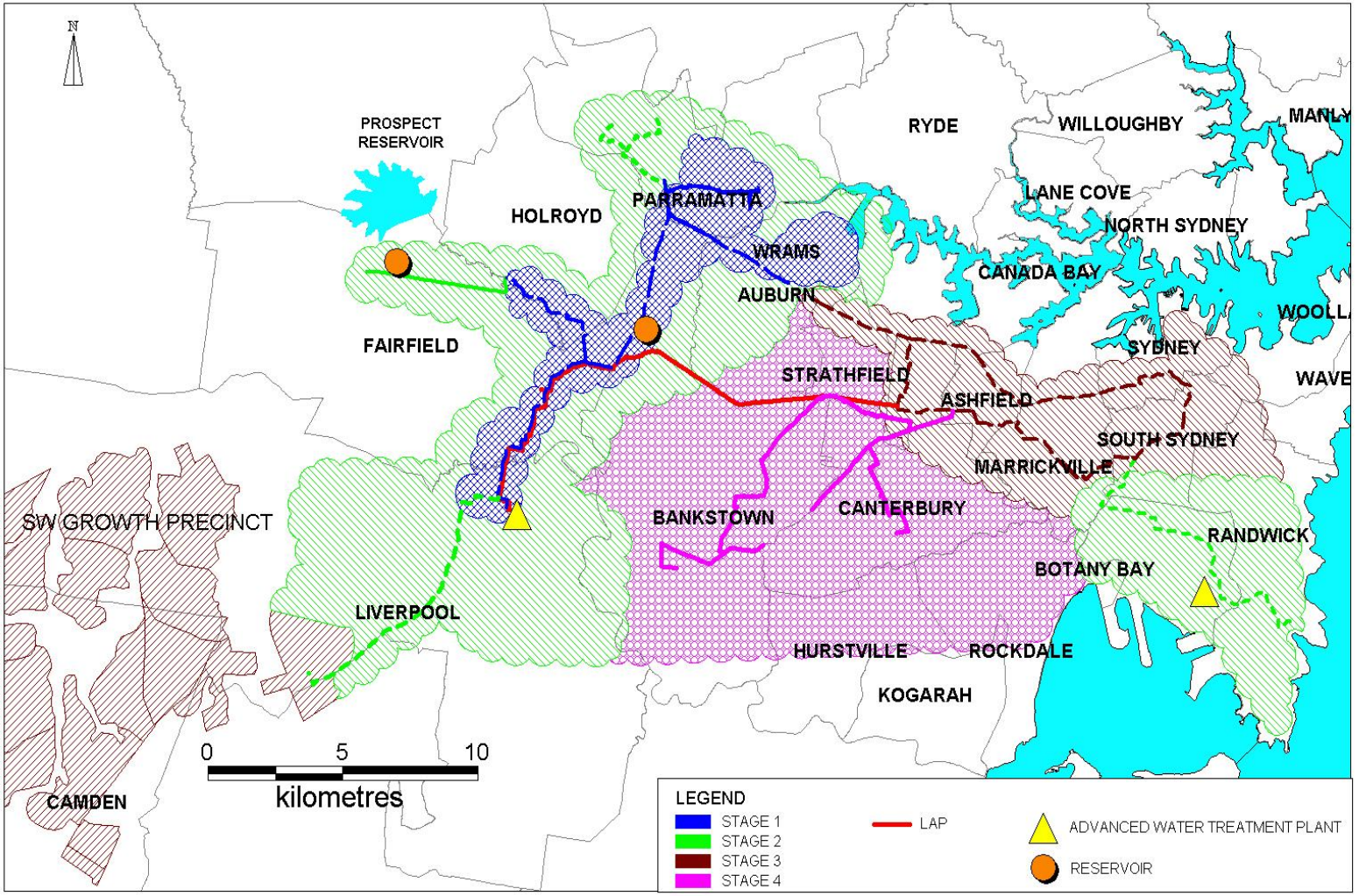
Camellia RWP *Project concept* *2008*



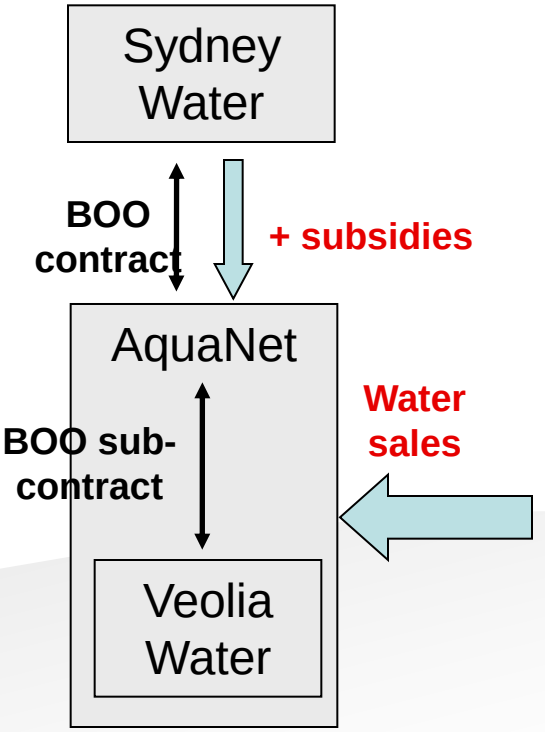
Camellia RWP *Project delivery and operations* 2008

> Delivery of Camellia RWP

- Approximate value: $100M
- The Camellia RWP is being procured through a Build Own Operate (BOO) contract.
- AquaNet selected last November as preferred bidder out of 3 short listed companies, based on detailed submission
- Veolia Water will build the advanced water Treatment Plant as an “inside the fence” BOO.

> Sale of purified water

- AquaNet will enter into a Take or Pay agreement with Veolia
- Reclaimed water will be sold to customers 10 cents below drinking water rates. AquaNet will be subsidized by Sydney Water for the difference between its costs (financing and operating) and the sale of recycled water.
- It is envisaged that overtime the subsidies will decrease as the water rates will increase.
- AquaNet will market new customers in order to optimize Return on Equity.



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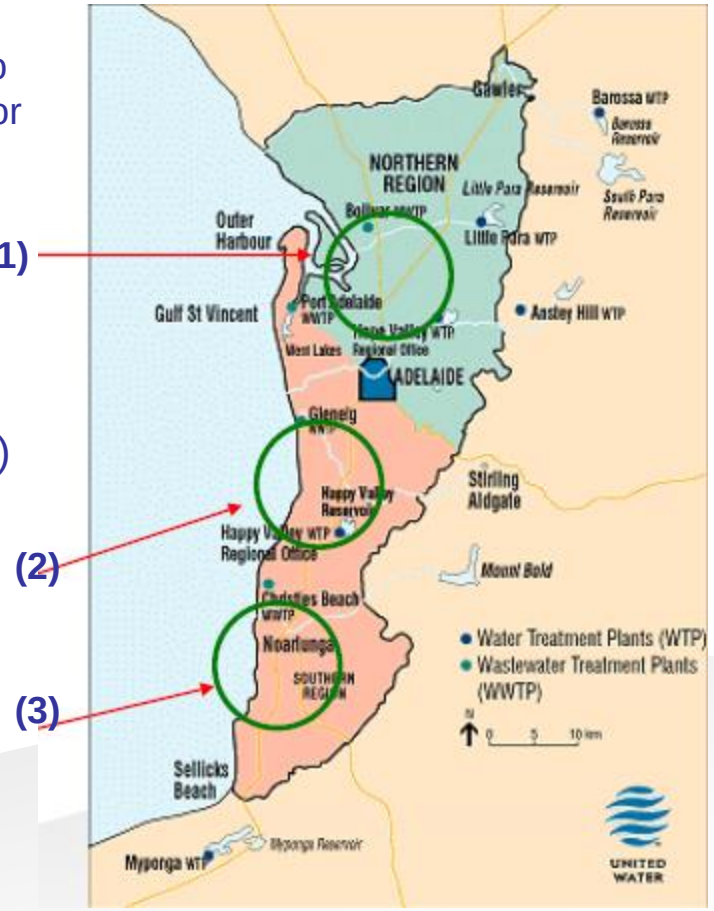
Adelaide projects *Background* 2000

The Bolivar reuse projects are key components of SA Water's strategy to conserve water resources.

> SA Water added 120 MLD dissolved air flotation filtration (DAFF) to the Bolivar plant, resulting in high-quality treated effluent suitable for agricultural irrigation.
> The DAFF unit was procured as a DBO project from Veolia Water.

1. **Bolivar WWTP**
   - Virginia pipeline scheme
   - Mawson lakes
   - Aquifer storage and recovery (1SR)
2. **Glenelg WWTP**
3. **Christies Beach WWTP**



> The plant was the first in Australia to apply a traditional water treatment process to wastewater on a large scale.
> Owned by the State Government and SA Water
> Operated by United Water (100 % Veolia Water)

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Bolivar VPS *Project key features* 2005

The VPS project was intended to provide water to the agricultural industry. Growth in this industry was limited by water scarcity associated to depleted aquifers.

- Virginia Pipeline Scheme (VPS)
  - A network of 100 km water supply pipelines to distribute Class A reclaimed water for irrigation applications
  - VPS is a partnership between SA Water, the Water Reticulation Services Virginia (WRSV) and the Virginia Irrigation Association (VIA), which represents the growers (250).
  - The VPS was procured as a DBO project, at the same time as the DAFF project
  - WRSV, who was responsible for project implementation, now markets reclaimed water from the Bolivar plant (signs up irrigators).
- Project funding (total project value: $56M)
  - SA Water: $30 M (DAFF and plant upgrade)
  - Commonwealth Government: $10.8M
  - SA Government: $7M
  - Private investors: $8M
  - Horticulture Australia Ltd: $0.7M
- Price paid by growers:
  - $80-180 / 1000 m3 for “foundation growers”
  - $300 / 1,000 m3 for “new comers”

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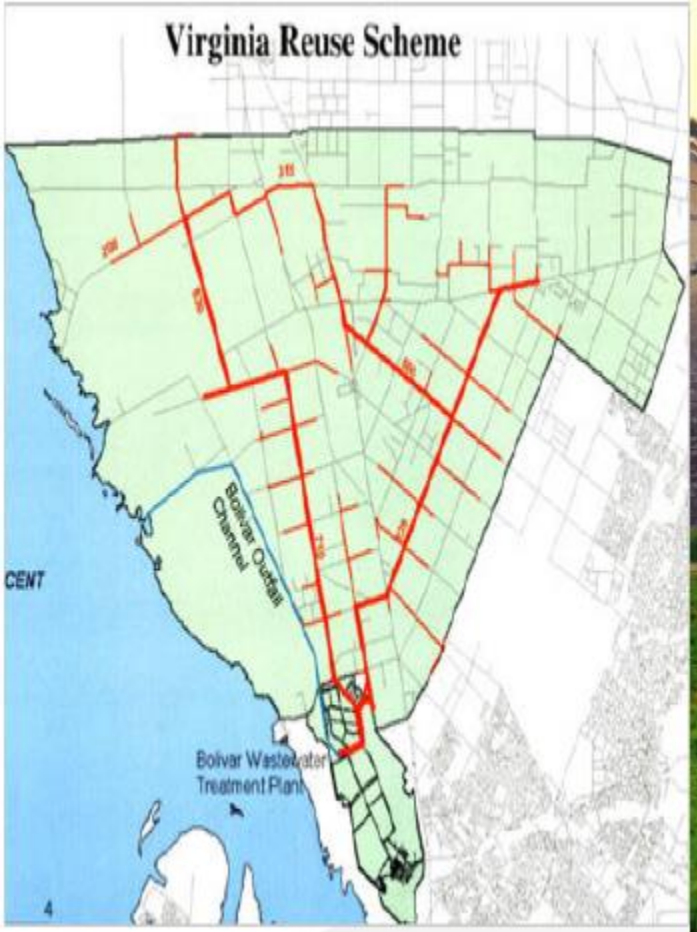
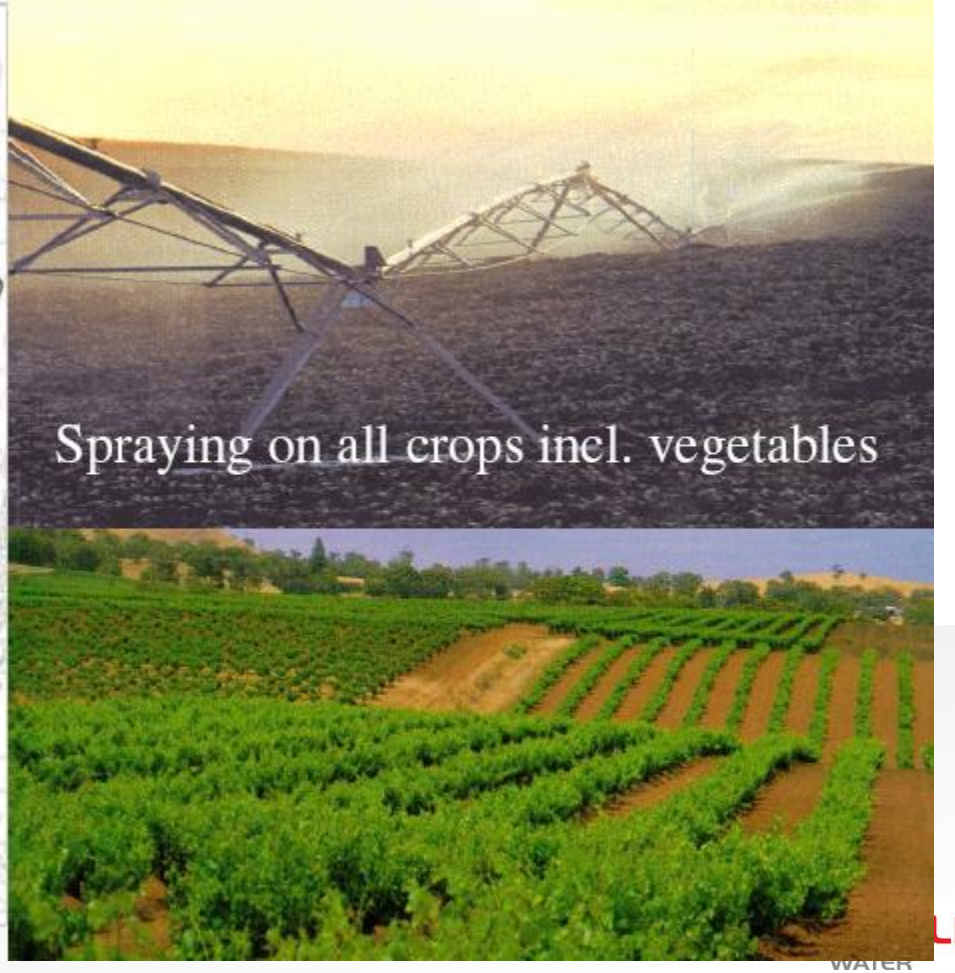
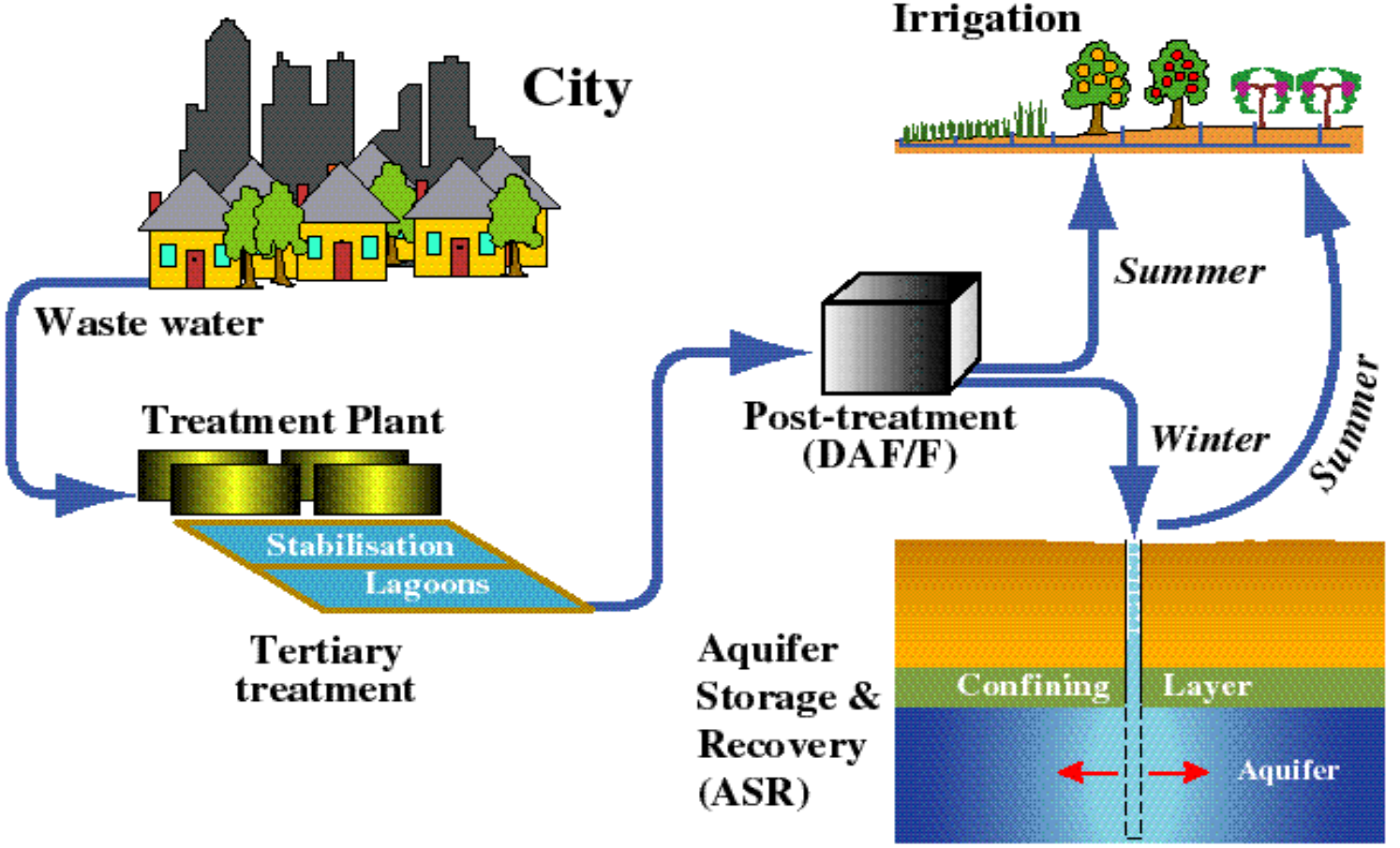
Bolivar VPS *Project key features* *2005*

The Bolivar VPS project is the first large-scale agricultural reuse scheme in Australia and one of the largest in the world.





Bolivar Aquifer Storage and Recovery



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Bolivar Mawson Lake *Project key features* *2005*

Mawson Lakes is the first large scale dual reticulation scheme in Australia.

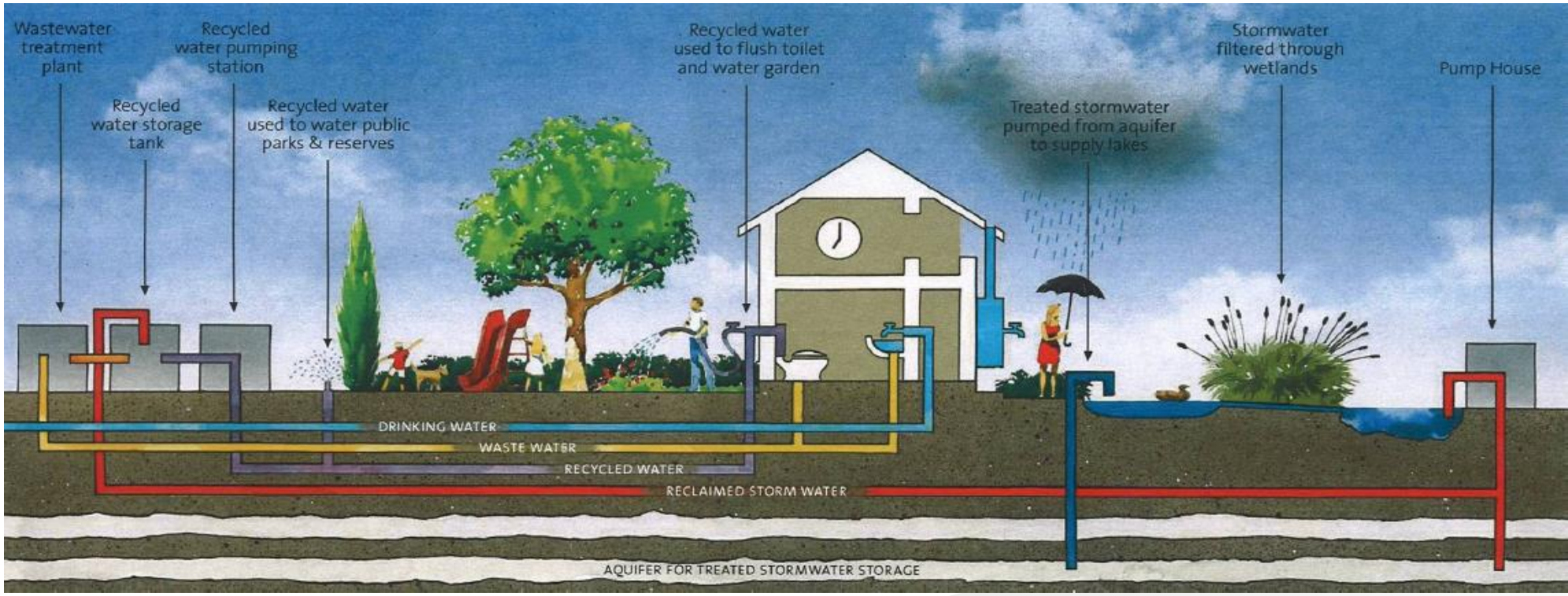
> The Mawson Lakes development
  - Show case residential, commercial, educational and technical development, 12 km north of Adelaïde.
  - 4,300 allotments; 11,000 residents (by 2010)
  - 620 hectares, 1/3rd open space

> Project objective
  - Demonstrate the economic feasibility of serving 50% of total water demand with reclaimed water
  - Reclaimed water to be used for: irrigation, car washing, toilet flushing
  - Reclaimed water prohibited for: drinking, pools / spas, clothes, personal washing, indoor cleaning, recreational activities, fire fighting
  - Reclaimed water price is 75% of drinking water price
  - Recycled water use will help reduce the impact of urban development
  - A significant reduction in the amount of stormwater containing harmful nutrients and pollutants entering the environment
  - Reduction in nutrients entering Gulf St Vincent

> United Water designed the treatment facilities and is operating the 3 pipe system.

Bolivar Mawson Lake *Project benefits* *2005*

The Mawson Lakes scheme will help reduce the impact of urban development.



- Use of reclaimed water saves 111 m3 of potable water / household / year, i.e. savings in the use of water from the Murray River is 800,000 m3 a year
- Reduction in nutrients entering Gulf Saint Vincent

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Western Corridor Recycled Water Project
Queensland Australia

April 2008

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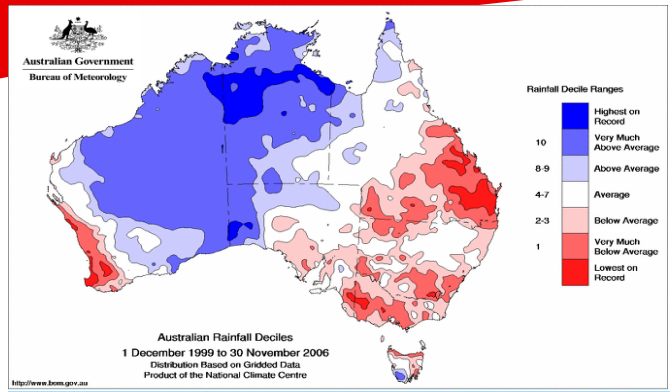
Project Need



Lake Wivenhoe May 2007

- **Unprecedented demand** has been placed on South East Queensland's water supplies due to a growing population and a dynamic economy
- **Worst drought** in recorded history
- **Water levels** in the dams, which supply the region with drinking water, fell to historically low levels. (July 2007 - 17% of the total capacity, less than 18 months of supply)
- **Water restrictions** imposed to the public by Queensland Government (level 6 – Residential water use - no outdoor watering - electricity production reduction…)
- **Implementation of long term water supply strategies:**
  - Creation of a water grid
  - Desalination facility
  - Construction of new dams
  - Treated wastewater recycling
  - Demand management
  - The operating costs involved for implementing the strategy are not known yet.

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Project Objectives

- The Western Corridor Recycled Water Project is an important part of the Queensland Government's A$9 billion South East Queensland Water Grid the largest urban drought response in Australia.
- The objective of this project is to enhance the security of water supply in South East Queensland through:
  - Increasing available water supplies that are less dependent on climate trends
  - Providing a system to supply purified recycled water to power stations, industry and agriculture and to replenish drinking water reserves
  - Delivering in accordance with the community's expected best practice mainly in terms of environmental impact.

WESTERN CORRIDOR
RECYCLED WATER PROJECT

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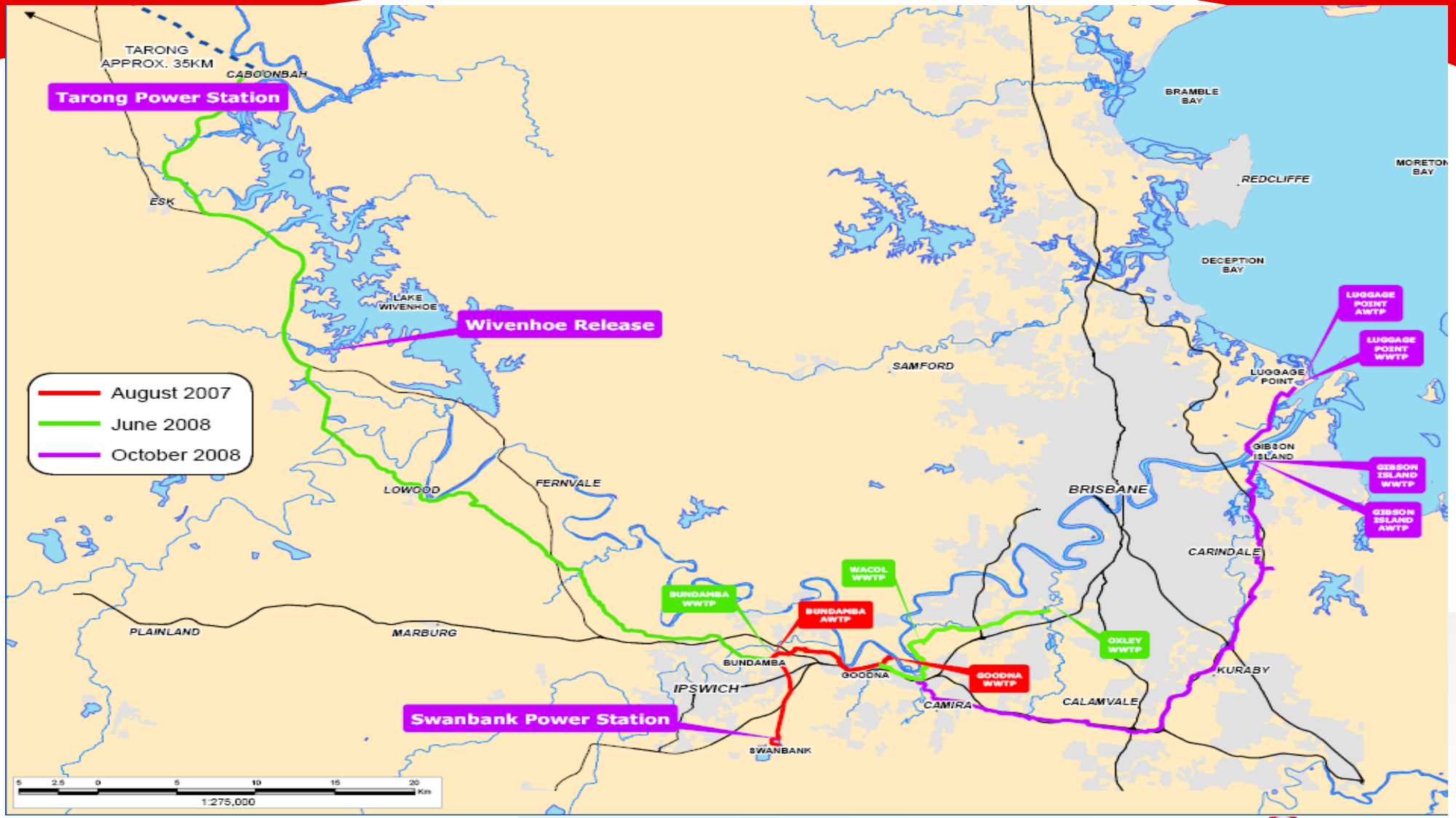
Project Schematic



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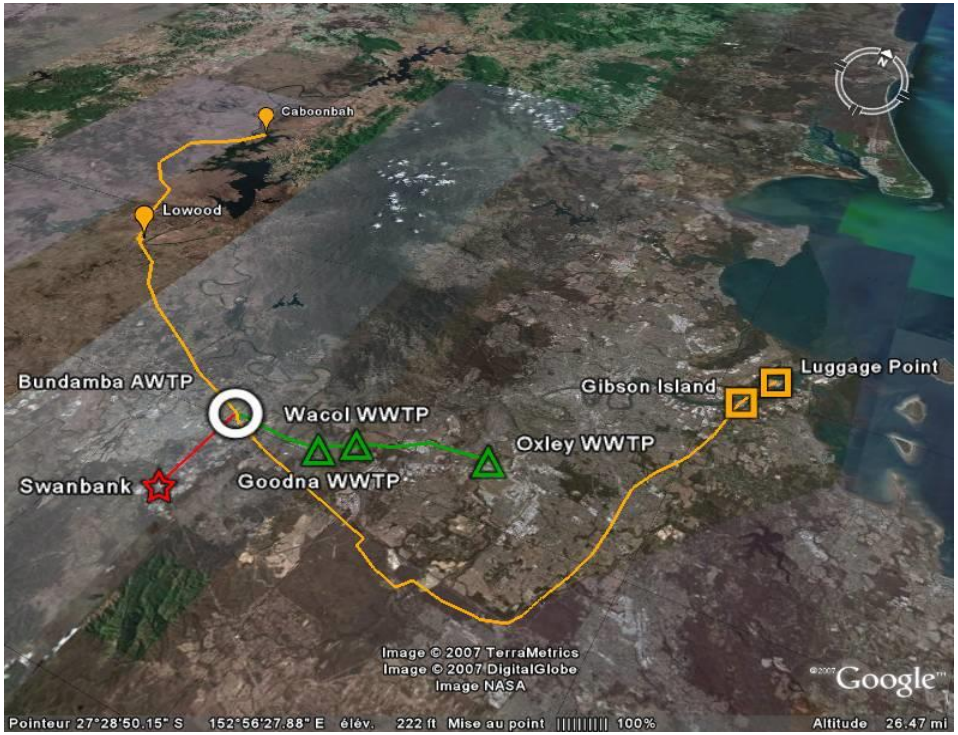
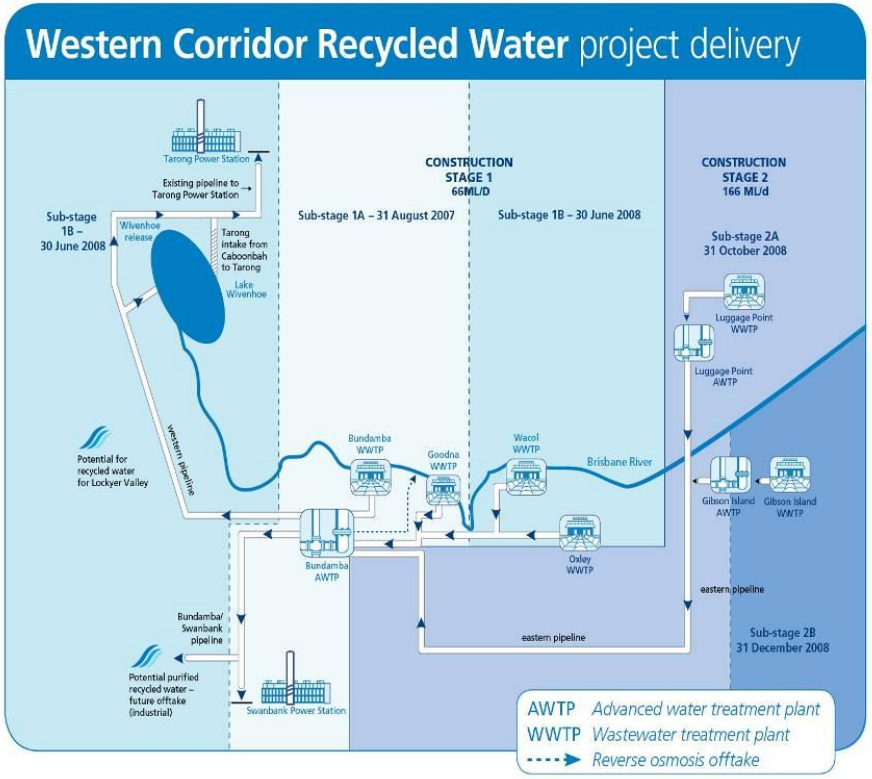
Aerial View & Project Schematic





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Key Project Figures

- Most important recycled water project in the Southern Hemisphere, world's third largest
- Project cost : € 1.5 billion
- Construction time : 2.5 years
- 200 km of pipeline
- Eight storage reservoirs
- Nine pumping stations
- Three water treatment plants

Water Treatment Plant	Capacity m3 per day	Delivery date
Bundamba 1A Phases 1A & 1B combined	20,000 m3 66,000 m3	August 2007 June 2008
Luggage Point 2A	66,000 m3	October 2008
Gibson Island 2A	50,000 m3	October 2008
Gibson Island 2B	50,000 m3	December 2008

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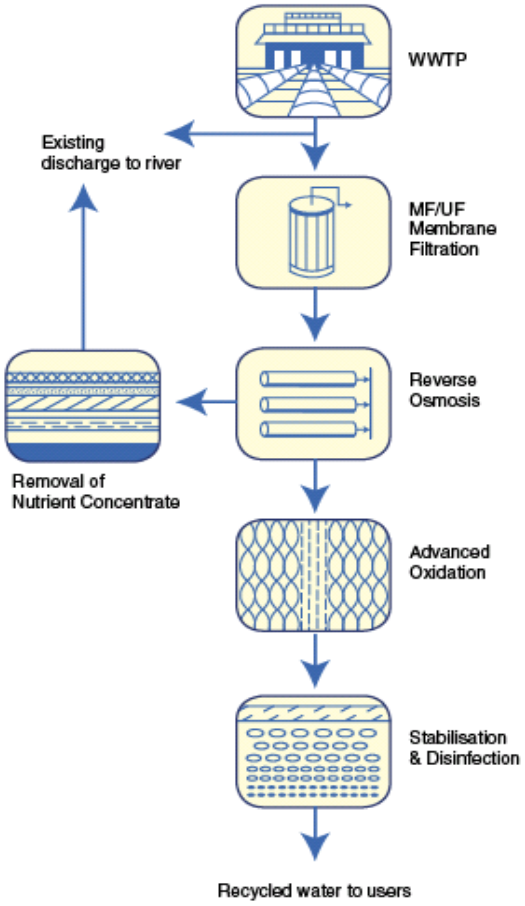
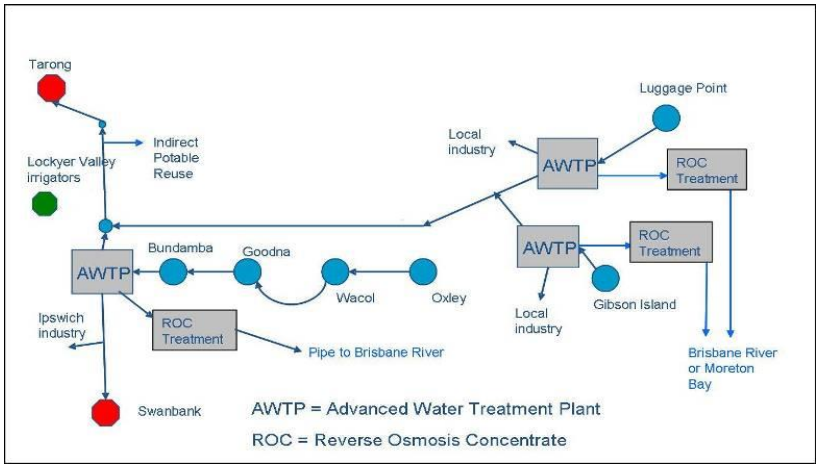
The Advanced Water Treatment Process

WCRW project will further process the treated water produced by six Wastewater Treatment Plants (Brisbane and Ipswich).





The main treatment steps are

- Wastewater transfer
- Microfiltration
- Reverse osmosis
- Nutrient removal
- Advanced oxidation
- Stabilisation and disinfection

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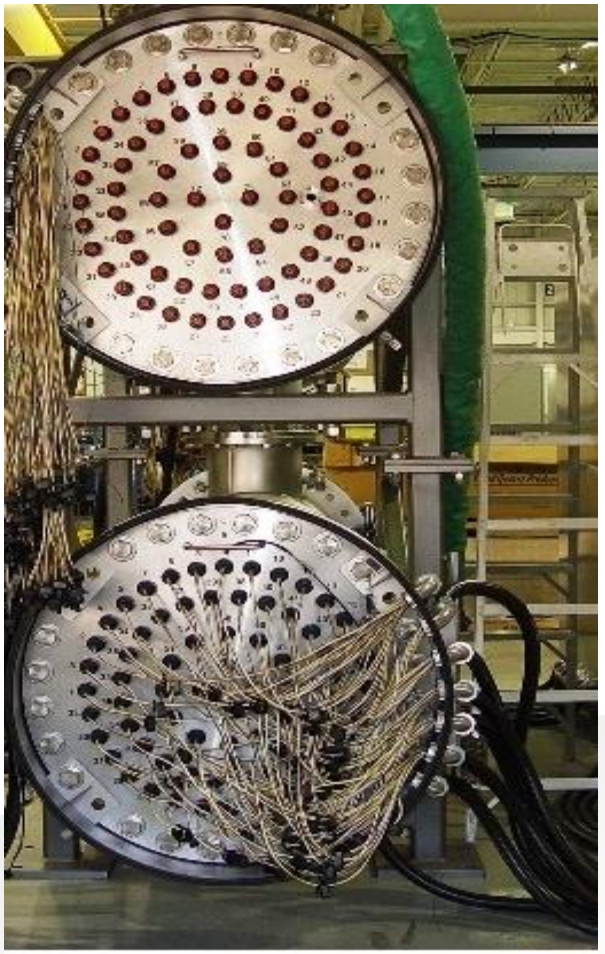
Technology

Membranes de Micro Filtration

Membranes d'osmose inverse



Oxydation avancée- UV

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Alliance Contracting as a Delivery Method

- Multi-million dollar Alliance contracts fast tracked and awarded to:

Bundamba AWT Plant	Thiess and Black & Veatch
Luggage Point AWT Plant	CH2M Hill and Laing O'Rourke
Gibson Island AWT Plant	Montgomery Watson Harza, Worley Parsons, Baulderstone Hornibrook and United Group Infrastructure
Western Pipeline Alliance	McConnell Dowell, Abigroup and GHD
Eastern Pipeline Alliance	AJ Lucas, Transfield Services, GHD, Sunwater

- The government is part of the Alliances.
- Separate Operations and Maintenance contract to start at the same time as Alliance contracts. Scheme Operator not a part of Alliance but cooperates with Alliances and advises the asset owners.

Scheme Operator	Veolia Water Australia

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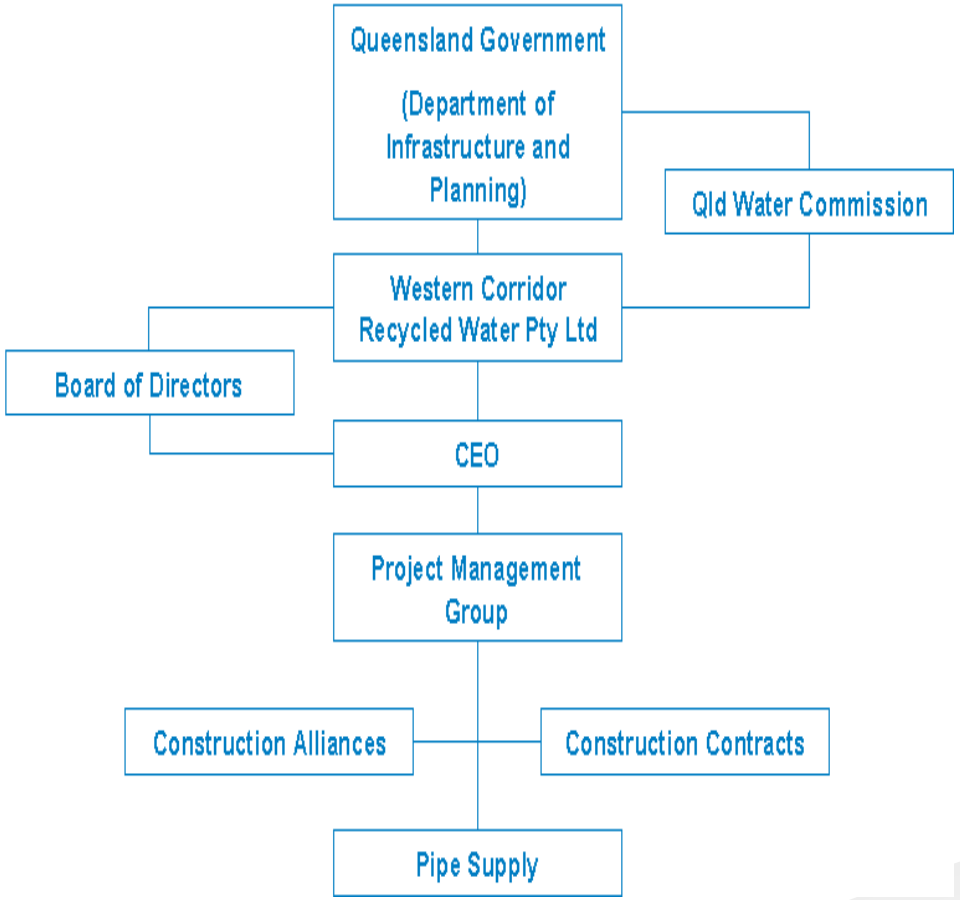
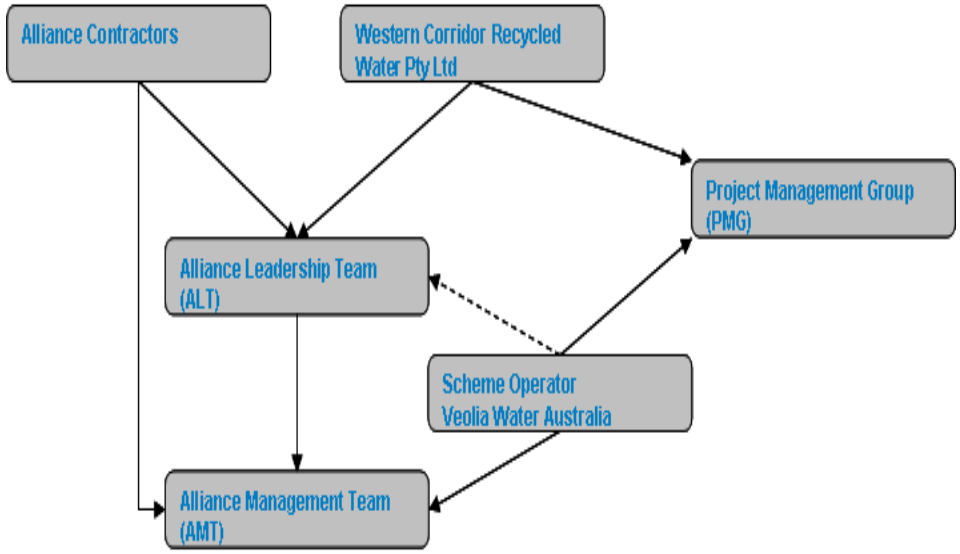
Delivery Structure and Governance





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Alliance Scope of Works

- **Bundamba Alliance**
  - Stage 1A capacity – 30ML/day AWTP(4MF, 3+1RO trains)
  - Stage 1B capacity – 36ML/day AWTP(5MF, 4+1RO trains)
- **Gibson Island Alliance**
  - Initial capacity: 50ML/day AWTP (6MF, 3+1RO trains
  - Final capacity: 100ML/day AWTP (12MF 6+1RO trains)
- **Luggage Point Alliance**
  - Capacity – 66ML/day AWTP (11MF, 3+1RO trains)
- **East pipe Alliance**
  - 58.56 km DN 1086mm MSCL treated water pipeline
  - 27.13 km DN 1086mm MSCL raw water pipeline
  - 7.50 km DN 900mm HDPE treated water pipeline
  - 9.71 km DN 800mm MSCL ROC pipeline
- **West pipe Alliance**
  - 32.00 km DN 1451km MSCL treated water pipeline
  - 16.26 km DN 1200 GRP treated water pipeline
  - 48.50 km DN 1000mm GRP treated water pipeline

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Alliance Principles

- **The five alliances all embrace the fundamental alliance principals**:
  - Objectives of all participants are aligned and all decisions are made on a “best for-Project” basis;
  - Collective responsibility for performance and outcomes; all participants win or all participants lose together;
  - A “no-blame” culture;
  - All transactions are fully open-book; and
  - All issues must be resolved within the Alliance.
- **Each Alliance** will develop its own set of project objectives (Time, Cost, Performance, Quality, Environmental etc) consistent with, the overall Western Corridor Project Objectives.
- **Each Alliance** is independent and will naturally be focussed on its own ‘Best for Project’ objectives.
- **To ensure** that the individual Alliances make decisions that are best for the overall scheme, the ‘Owner Representatives’ on the Alliance Leadership Team (ALT) form the link between the Alliance and the Owners Project Management Team (PMG).
- **The Owner Representative** advises the respective Alliance of any overall project requirements as they arise.

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Alliancing Project Management Group

- The role of the Alliance Project Management Group (PMG) will be to provide overall asset delivery governance by the Owner including:
- Ensuring that the whole of project objectives are met, particularly meeting the regulated dates that have been set by Government regulators.
- Optimisation of delivery across all of the Alliances.
- Direction-setting in response to any significant variances from Alliance Target Cost Estimate's (TCE's) and completion dates.
- Prioritisation and whole-of-project high level decision-making in relation to PMG team responsibilities (land, approvals, Government supplied pipe, etc).
- High level decision-making in response to any coordination issues that may arise during construction.
- Make decisions in relation to any retained PMG responsibilities that impact on the Alliances, particularly in relation to target costs and completion times.

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Alliance Leadership Teams

The Alliance Leadership team (ALT) is similar to a company Board, responsible for the governance (not the management) of the respective Alliance. The responsibilities include the following:-

1. Governance
   - Strategy, policy and objective setting – driving Alliance principles;
   - Appoint an Alliance Manager (AM);
   - Financial performance (including setting the Target Cost Estimate in the Alliance Agreement);
   - Compliance, ethics and principles; and
   - Risk management;
2. Make decisions referred by the Alliance Manager;
3. Implement directions from Owners project Management Team, including assessment and decisions on Material Scope Changes;
4. Ensure the Alliance Manager has necessary resources to achieve objectives;
5. Resolve any Alliance Disagreements.

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Alliance Management Team

- The **Alliance Leadership Team (ALT)** for each Alliance is responsible for the governance of the Alliance and is ultimately responsible for the success of the Alliance.
- The work under each Alliance will be delivered by an **Integrated Project Team (IPT)**. The IPT will be drawn from the resources of all Alliance participants and external sources if appropriate, based on the “best-for-project” principle. The intention is that the structure will reflect a single “virtual organisation” without any person making a duplication of responsibilities.
- All members of the IPT are accountable to the Alliance and not to their Employer organisations.
- The ALT’s oversee the establishment and operation of an **Alliance Management Team (AMT)** for each project, made up of senior Project personnel, including at least one representative from each participant in the Alliance and the Scheme Operator.
- The AMT is headed by an Alliance Manager appointed strictly on a “Best-for-Project” basis. The Alliance Manager is responsible for the day-to-day leadership and management of the AMT and the IPT, and is accountable to the ALT for the overall performance of the Alliance in meeting - and intentionally exceeding - the project objectives.

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Veolia Water Australia's roles

- Veolia was appointed as Scheme Operator in November 2006 with two main missions :
  - Adviser to the Government for the delivery of the project
    - Active Member of the **PMG, ALT** (non voting) and **AMT**
    - Review consistency across the project
    - Review design and specifications
    - Bring technical specifications when needed
    - Assist the Alliances in the commissioning
    - Assist the Government in stakeholder negotiations.
  - Scheme operator
    - Long term contract (18 years) for the operations and maintenance of the project
    - Progressive risk transfer
    - Assist the WCRW Pty Ltd company to market the PRW
    - Research and development on Recycled Water

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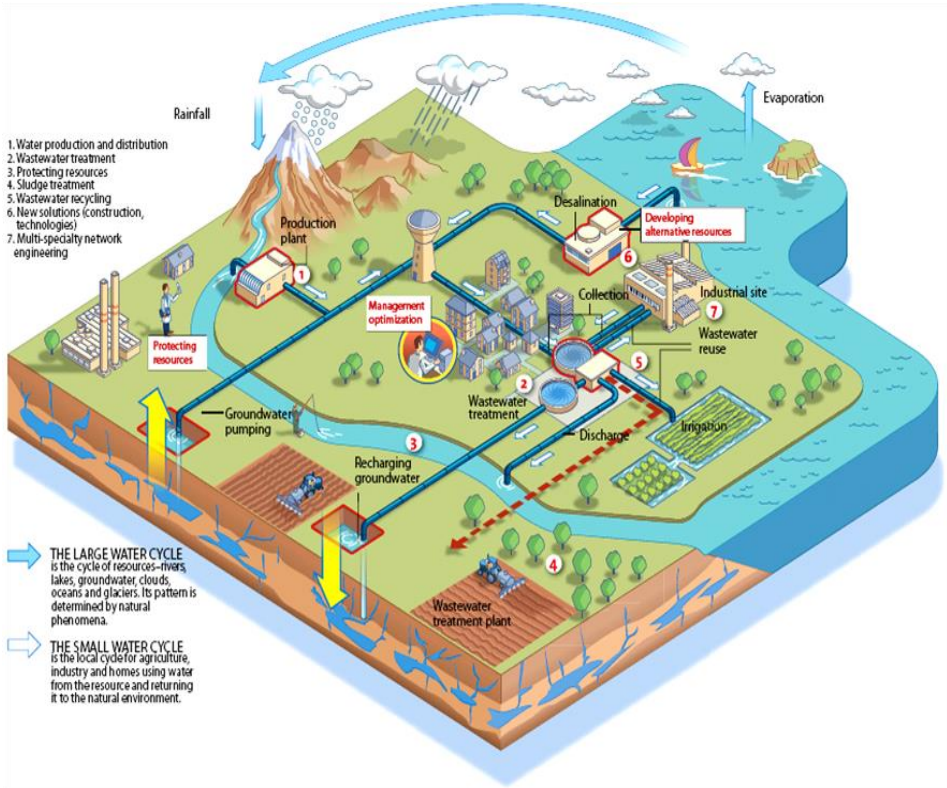
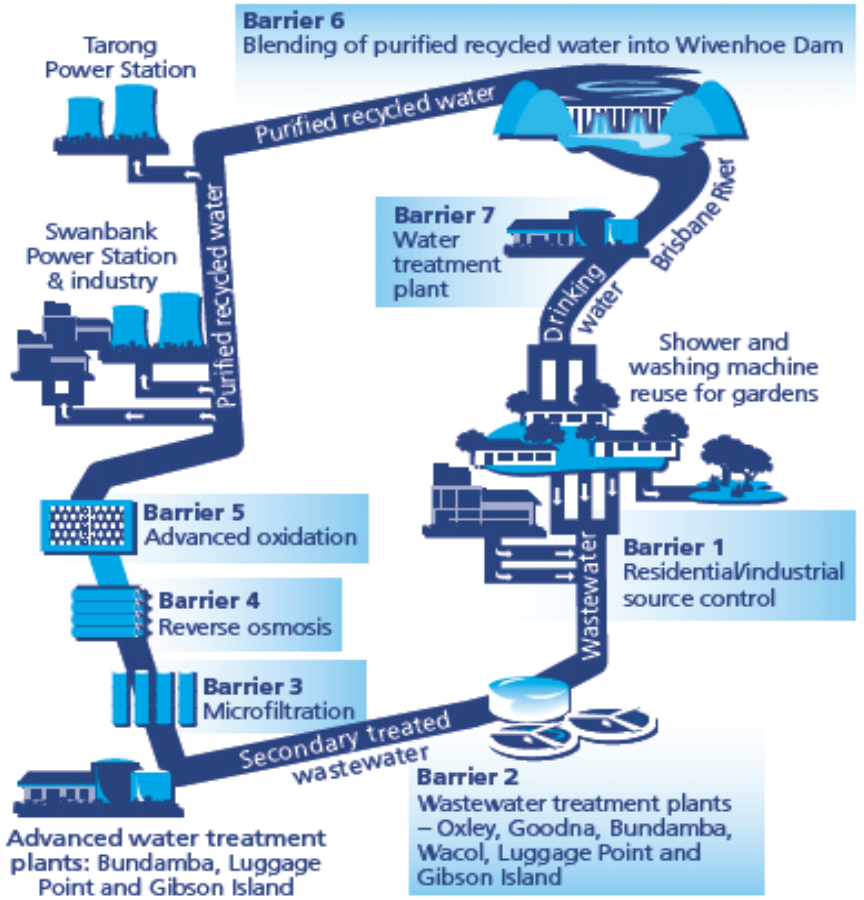
Water Cycle & Purified Recycled Water Cycle





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Recycled Water & Regulations

- **Guidelines have been published and Regulations are at the drafting stage.**
- **Draft Regulatory Framework outlines responsibilities for risk management in various components of the PRW cycle**
- **Proponents must prepare a Recycled Water Management Plan (RWMP)**
- **Methodology is based upon Hazard Analysis and Critical Control Points (HACCP)**
- **A panel of world leaders in eco-toxicology, environmental science, microbiology and advanced water treatment will provide independent advice on the regulatory framework and the Western Corridor Water Recycling Scheme.**

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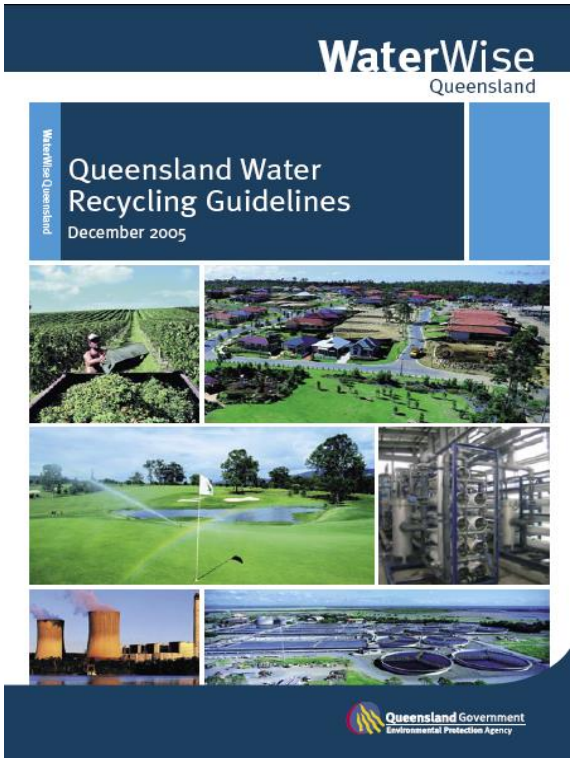
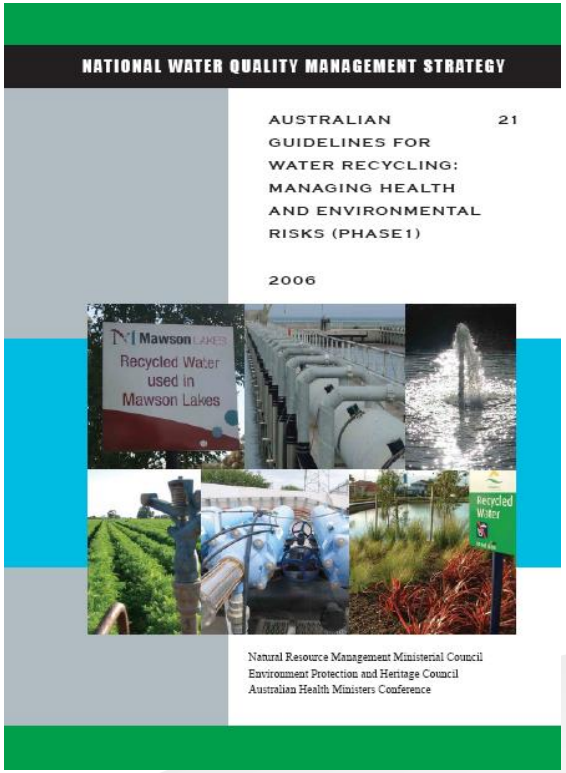
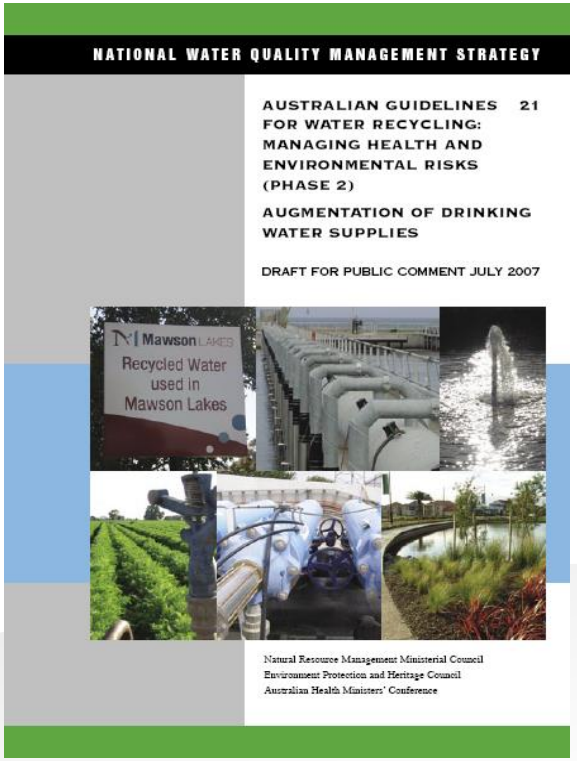
Recycled Water & Regulations







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Expert Advisory Panel

- An expert advisory panel has been established to provide advice on technical issues associated with purified recycled water.
- The panel members are:
  - Chair Professor Paul Greenfield AO (Senior Deputy Vice Chancellor, University of Queensland)
  - Professor Brian Priestly (ecotoxicologist, Australian Centre for Human Health Risk Assessment)
  - Professor Richard Bull (ecotoxicologist, Washington State University)
  - Professor David Hamilton (environmental scientist, University of Waikato)
  - Dr Joan Rose (microbiologist, Michigan State University)
  - Harry Seah (advanced water treatment expert, Singapore Public Utility Board)
  - Professor Mike McLaughlin (environmental chemist, CSIRO)
  - Professor Ian Frazer (Director, Diamantina Institute for Cancer Immunology and Metabolic Medicine, University of Queensland, Australian of the Year)
  - Dr Zelle Hodge (President of the Australian Medical Association Queensland)

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Treated Water Characterisation

- Implementation of a monitoring program for drinking water parameters on the treated water from the Bundamba 1A AWTP developed in consultation with Queensland Health (QH). Based on what is currently known from the source water monitoring
- The main observations from the first sets of data (first month of monitoring) are as follows:
  - No parameter in the purified water exceeded any guideline limits and no pharmaceuticals, herbicides, phenols, EDTA or halo acetic acids were detected above their limit of reporting (LOR).
  - Very low levels of trihalomethanes were detected in the purified water (around 5 times lower than the guideline limit for drinking water) and low levels of gross alpha and gross beta activity were detected (around one third of the guideline limit).
  - The only EDC compound detected in the purified water was Bisphenol A at a concentration of 5 ng/L. The guideline drinking water level for this compound is 200 000 ng/L.
  - NDMA removal through Reverse Osmosis was not very consistent but more data would be required to verify this observation. NDMA removal through advanced oxidation is very effective and approaches 2-log removal efficiency.
- In general, the concentrations of compounds of concern detected in the RO Feed water already meet the guideline limits defined in the Australian Drinking Water Guidelines and Australian Guidelines for Water Recycling.

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Conclusion

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Case studies *Lessons learnt*

Our worldwide and diverse reuse experience allows us to identify, design, implement and promote viable projects.

- Viable projects « MUST HAVE »:
  - Scarce natural water resources due to population or economic growth and / or drought
  - Water tariffs reflecting the complete costs of providing drinking water, including the costs of replacing natural resources and of treating wastewater to appropriate discharge standards
  - Advanced wastewater treatment systems
  - Government strategy and “champions” promoting reuse
  - Legal framework supporting the strategy
  - Off-takers in need of alternative sources of supply and prepared to commit

- Project « **NO NOs**» **include:**
  - Inadequate water pricing (water is almost free and of little perceived value)
  - Remote customers (logistics problems make project uneconomic due to cost of recycled water infrastructure)
  - Lack of regulations for wastewater reuse (technical standards for reuse, ownership of recycled water etc.)
  - Inadequate or competing regulators or administrations
  - Competition from potable water utilities who would loose revenue from water reuse
  - Very low flow rates (<50m3/hour reduces opportunity for savings); lack of feed water specification and/or time to run pilot studies (especially on industrial waste feed)