Adoption of water recycling across Australia and lessons learned

ASERSA Webinar, 21 October 2020

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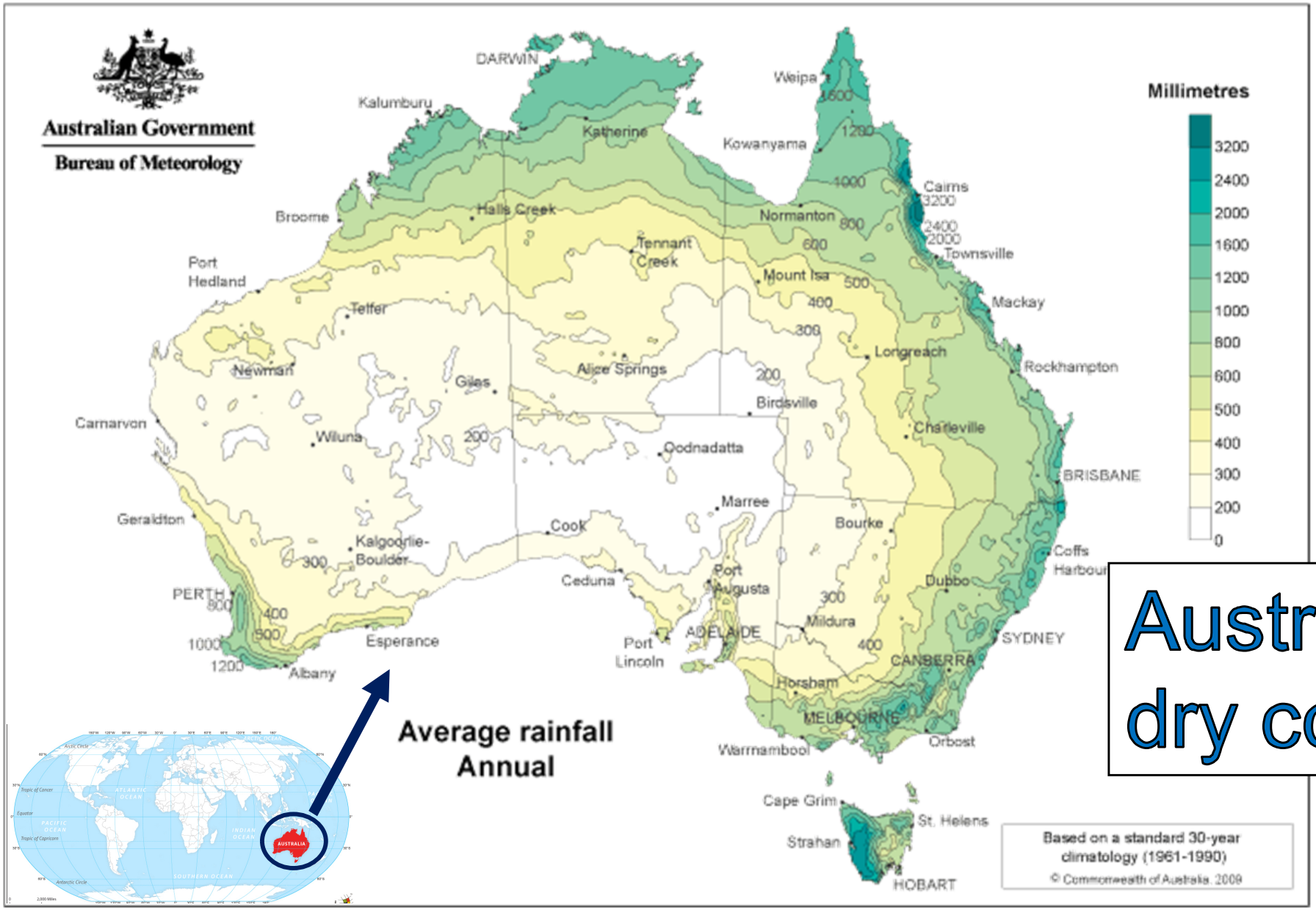
CSIRO Australia,

Australia's National Science Agency

Synopsis

- Governance of water in Australia
- Impact of Environmental Regulation
- The Millennium Drought
- Investment in Research and Development
- The return of the rain
- Recognising the true costs of water and its supply
- Complacency and the distraction of other policy issues
- When the next drought returns
- Learnings
- The debate on Direct Potable Recycling in the circular economy



Australia is a dry continent

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Australia is a federation of States, established in 1901

The States and Territories have constitutional responsibility for water

Australia has never used Combined Sewers

- Drinking water
- Stormwater
- Wastewater
- Recycled water

are managed in separate systems

Abbreviations

Australian common use			S.I. units
kL	(Kilolitres)	=	m^3
ML	(Megalitres)	=	$10^3\ m^3$
GL	(Gigalitres)	=	hm^3

The first suggestion of Water Recycling

1977 – Reports by GHD to Ministry of Water and Water Supply, Victoria on reclaimed water - suggested

- A national program of research, demonstration and education
- An integrated approach to water supply, sewerage and solid waste disposal as an integral part of one planning process
- In Victoria, water deficits would become a problem by 2000

There was no action!

1991 - *Ecologically Sustainable Development Report*

- **Australia states began establishing environment protection authorities.**
- **The damage from sewage effluent discharged to oceans, rivers and estuaries was recognised**
- **New Regulations set standards for discharges.**
- **States' Ministerial Councils endorsed the development of a *National Water Quality Management Strategy* (NWQMS).**

Each state developed guidelines for recycled water for specific purposes, incorporated into regulations

By 2001, recycled water was being produced in 500 WWTPs for:

- amenity horticulture,
- animal feeds,
- cemeteries,
- cotton growing
- dune stabilisation,
- environmental water,
- forestry,
- mineral processing,
- power generation/cooling,
- sports fields,
- steel processing.
- sugar cane
- vegetables, and vineyards.

The first domestic Dual Pipe system

1993, New South Wales developed the *NSW Guidelines for Urban and Residential Use of Reclaimed Water*

- Rouse Hill, new Sydney suburb, 32,000 homes
- WWTP treated 4.4 ML/day for reuse, by coagulation, flocculation, filtration and disinfection, ozonation, later UV and super-chlorination.
- Avoided damaging discharges to Second Pond Creek
- Learning for builders – 50 cross-connections found, corrected
- Recycled water for toilet flushing, clothes washing, gardens, car washing
- Owners used more water than houses with only drinking water

Dual (purple) pipe systems followed

In new suburbs

- **Brisbane – Pimpama-Coomera**
- **Melbourne – Aurora, Cranbourne**
- **Adelaide – Mawson Lakes, Seaford Meadows**
- **Sydney – high rise developments – Green Square**

and in numerous small suburban redevelopments.

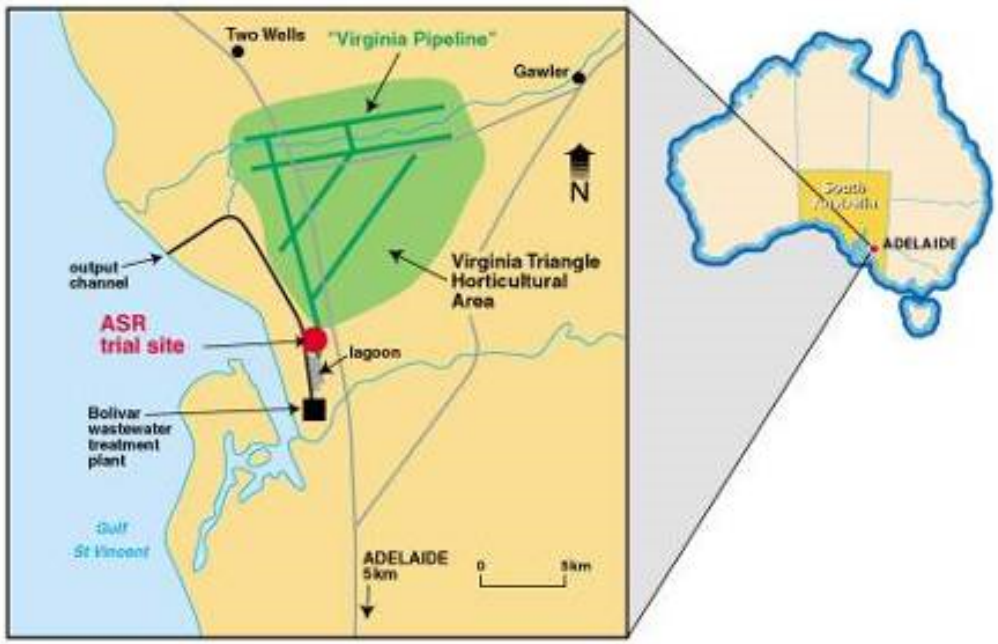
Retrofitting is more difficult in established suburbs

Dual pipe houses have two meters

Warning signs for amenity water features

Major horticultural development - recycled water

- Northern Adelaide Plains Vegetable growing - Groundwater overdrawn by 6-10 GL/year.
- Bolivar WWTP discharge damaging marine environment.
- Dissolved Air Floatation/Filtration (DAFF) plant installed with granular multi-media filtration and chlorine disinfection.
- From 1999 provided 15GL tertiary treated recycled water for unrestricted horticultural use.
- **Vegetables gained rapid market acceptance**
- Economic expansion 2020 with further 12GL



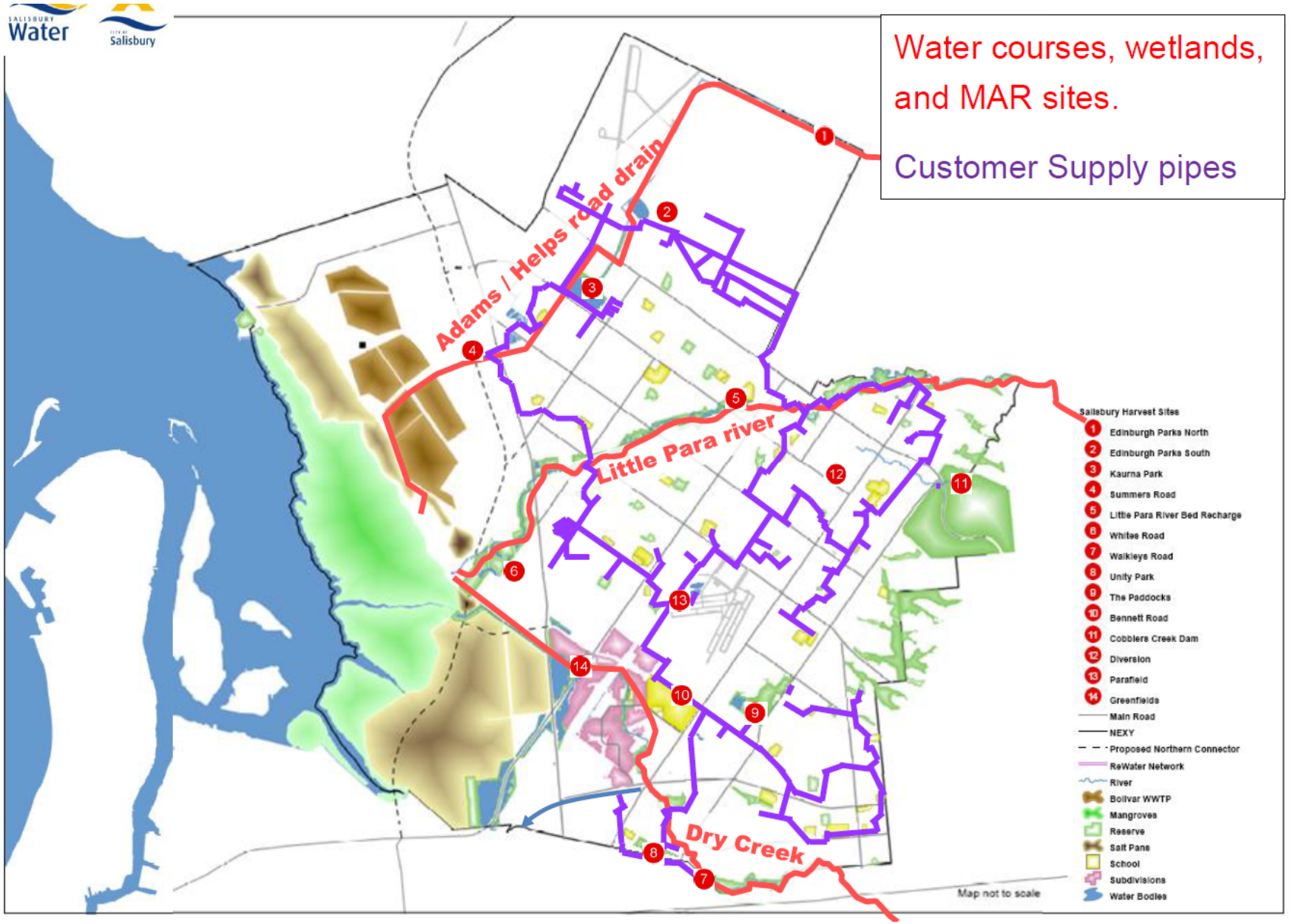
Recycled stormwater, wetland remediated Northern Adelaide suburb - City of Salisbury, South Australia

The Process train is located on Parafield Airport

- Water then stored with Aquifer Storage & Recovery (ASR)
- Integrated with other wetland systems built into new suburbs
- Supplied to Mawson Lakes dual pipe system
- Supplied to industrial and amenity customers and Council parks
- Linked by a ring main for supply throughout Council area
- Is a commercial business with 500 customers, including 31 schools

Wetland remediated recycled stormwater

Suburban wetland


Water courses, wetlands, and MAR sites.
Customer Supply pipes
Adams / Helps road drain
Little Para river
Dry Creek
Salisbury Harvest Sites
1 Edinburgh Parks North
2 Edinburgh Parks South
3 Kaurna Park
4 Summers Road
5 Little Para River Bed Recharge
6 Whites Road
7 Walkleys Road
8 Unity Park
9 The Paddocks
10 Bennett Road
11 Cobblers Creek Dam
12 Diversion
13 Parafield
14 Greenfields
Main Road
NEXY
Proposed Northern Connector
ReWater Network
River
Bolivar WWTP
Mangroves
Reserve
Salt Pans
School
Subdivisions
Water Bodies
Map not to scale

MAWSON LAKES

FEATURES

- 10,000 residents, 10,000 incoming workers, 5,000 university students
- Recycled water system **(purple pipe)** using stormwater (Parafield) + effluent (Bolivar WWTP) through a 2.6ML mixing tank
- Toilet flushing, gardens, car washing
- Reduced use of drinking water in Mawson Lakes by 50 per cent (compared to Adelaide average), saving 800 ML of drinking water per year.

Development of National Water Guidelines

- Subcommittees appointed by National and States' Ministers of Water, Environment and Health
- Included scientists, regulators and industry
- Drafts started by considering WHO & California standards
- Drafts were risk-based
- Drafts approved by Ministers to go to referees around the world
- Drafts modified as necessary
- Final versions approved by Ministers
- Each state then adopted the guidelines into its state regulations

Safety is defined using Disability Life Years (DALYs).

Microbial safety is <10^6 DALYs per person per year (identical to the WHO guidelines) which is equivalent to

- **1 day of diarrhoeal illness per 1000 people per year.**
- **DALYs measure impact in terms of severity and time.**

Required log reductions for recycled water, calculated from exposures associated with specific uses and treatment capability

Activity	Exposure Litres per year	Total log reduction required		
		Cryptosporidium	Virus	Campylobacter
Residential use – toilet flushing, gardens	0.67	5	6.5	5
Commercial crops – salad vegetables	0.49	5	6	5
Irrigation of parks – public access	0.05	4	5	4
Drinking water	300–750	8	9.5	8

Treatment	Total log reduction required		
	Bacterial	Viruses	Protozoa
Chlorination	2.0–6.0	1.0–3.0	0–1.5
UV light	2.0 - > 4.0	1.0 - > 3.0	>3.0
Filtration and disinfection	>5	5–6	3–4

Natural Resource Management Ministerial Council	MEETING NUMBER: 15
	LOCATION: HOBART
	DATE: 24 APRIL 2009
DRAFT AGENDA PAPER	ITEM: X.X

NATIONAL WATER QUALITY MANAGEMENT STRATEGY – AUSTRALIAN GUIDELINES FOR WATER RECYCLING PHASE 2

RECOMMENDATIONS

1. That Council:

   (a) **ENDORSES** the documents *National Water Quality Management Strategy (NWQMS) Australian Guidelines for Water Recycling: Managed Aquifer Recharge* (Annex A) and *National Water Quality Management Strategy (NWQMS) Australian Guidelines for Water Recycling: Stormwater Harvesting and Re-use* (Annex B)

Nationally agreed Recycling Guidelines

- **National Water Quality Management Strategy**

Australian Drinking Water Guidelines
(endorsed, published 2002-5, updated 2018)

Australian Guidelines for Water Recycling -
Phase 1 –– ***Managing Health and Environmental Risks*** -
Published 2006, being reviewed 2020

Phase 2 – ***Recycled Water for Drinking*** –
Ministers approved April 2008,

- ***Stormwater*** and
- ***Managed Aquifer Recharge***

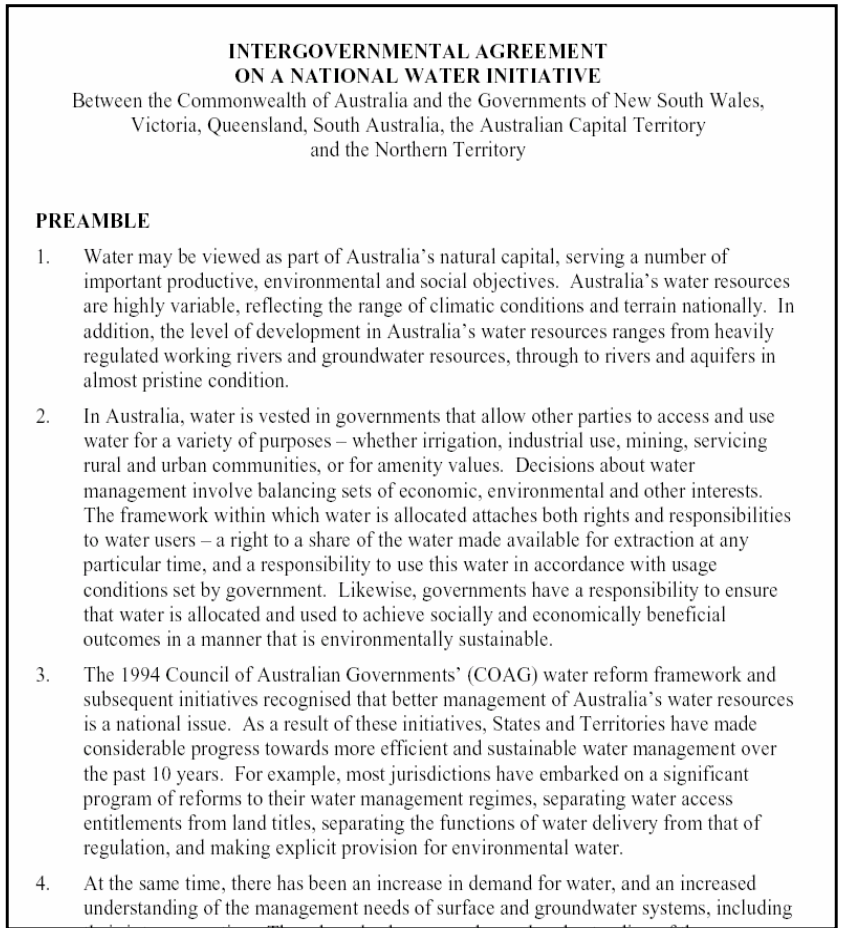
Ministers approved April 2009

https://www.waterquality.gov.au/guidelines/recycled-water

Nationally agreed water policies

Intergovernmental Agreement on a National Water Initiative

- **108 Clauses, signed by Commonwealth and all states**
- **National Water Commission established**



INTERGOVERNMENTAL AGREEMENT
ON A NATIONAL WATER INITIATIVE

Between the Commonwealth of Australia and the Governments of New South Wales, Victoria, Queensland, South Australia, the Australian Capital Territory and the Northern Territory

PREAMBLE

1. Water may be viewed as part of Australia's natural capital, serving a number of important productive, environmental and social objectives. Australia's water resources are highly variable, reflecting the range of climatic conditions and terrain nationally. In addition, the level of development in Australia's water resources ranges from heavily regulated working rivers and groundwater resources, through to rivers and aquifers in almost pristine condition.

2. In Australia, water is vested in governments that allow other parties to access and use water for a variety of purposes – whether irrigation, industrial use, mining, servicing rural and urban communities, or for amenity values. Decisions about water management involve balancing sets of economic, environmental and other interests. The framework within which water is allocated attaches both rights and responsibilities to water users – a right to a share of the water made available for extraction at any particular time, and a responsibility to use this water in accordance with usage conditions set by government. Likewise, governments have a responsibility to ensure that water is allocated and used to achieve socially and economically beneficial outcomes in a manner that is environmentally sustainable.

3. The 1994 Council of Australian Governments' (COAG) water reform framework and subsequent initiatives recognised that better management of Australia's water resources is a national issue. As a result of these initiatives, States and Territories have made considerable progress towards more efficient and sustainable water management over the past 10 years. For example, most jurisdictions have embarked on a significant program of reforms to their water management regimes, separating water access entitlements from land titles, separating the functions of water delivery from that of regulation, and making explicit provision for environmental water.

4. At the same time, there has been an increase in demand for water, and an increased understanding of the management needs of surface and groundwater systems, including

Urban Water Reform objectives

- **90(i) healthy, safe and reliable water supplies;**
- 90(ii) **increased water use efficiency**
- **90(iii) encouraging recycling of wastewater where cost effective;**
- 90(iv) **water trading in and to the urban and rural sectors;**
- **90(v) innovative water sourcing, treatment, storage and discharge; and**
- **90(vi) better pricing for metropolitan water.**

A new driver for water recycling

The millennium drought 2001-2011

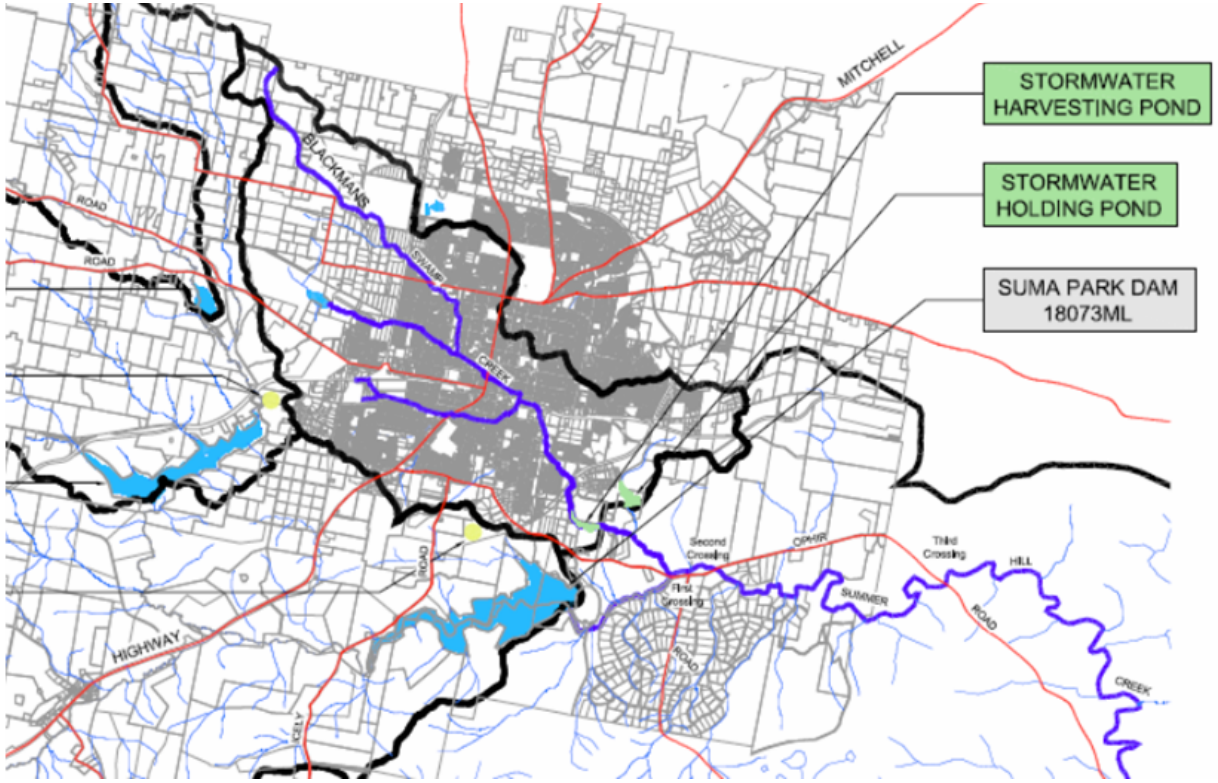
- **Water at any cost**
- **Diversity of supply**
- **Desalination and potable recycling**

Desalination Plants

Sydney	90GL/yr (2010)
Melbourne	160 GL/yr (2011)
SE Queensland (Tugun)	45 GL/yr (2009)
Adelaide	100 GL/yr (2011)
Perth – Kwinana	45 GL/yr (2006)
Binningup	100 GL/yr (2012)

Indirect potable recycled stormwater, Orange, NSW

3500 ha catchment (67% urban) adapted with suitable water treatment to meet health standards, used as a drinking water supply.



Annual yield

~ 1300ML

Toowoomba – The first potable recycling proposal

To cost $68 M. Commonwealth to fund $23 M of cost subject to referendum approval – Held July 29 2006

'Do you support the addition of purified recycled water into Toowoomba's water supply?"

	Yes votes	No votes
Total formal votes cast	**19,983**	**32,220**
	38.20%	61.55%

- Previous Mayor led "no" vote against current Mayor – personality clash
- Emotional opposition led by "Citizens Against Drinking Sewage" ("CADS")
- Political posturing and grandstanding
- Little understanding of underlying principles.
- Scheme conceived in short time frame with limited public consultation.
- **Later pipeline cost $187 M**

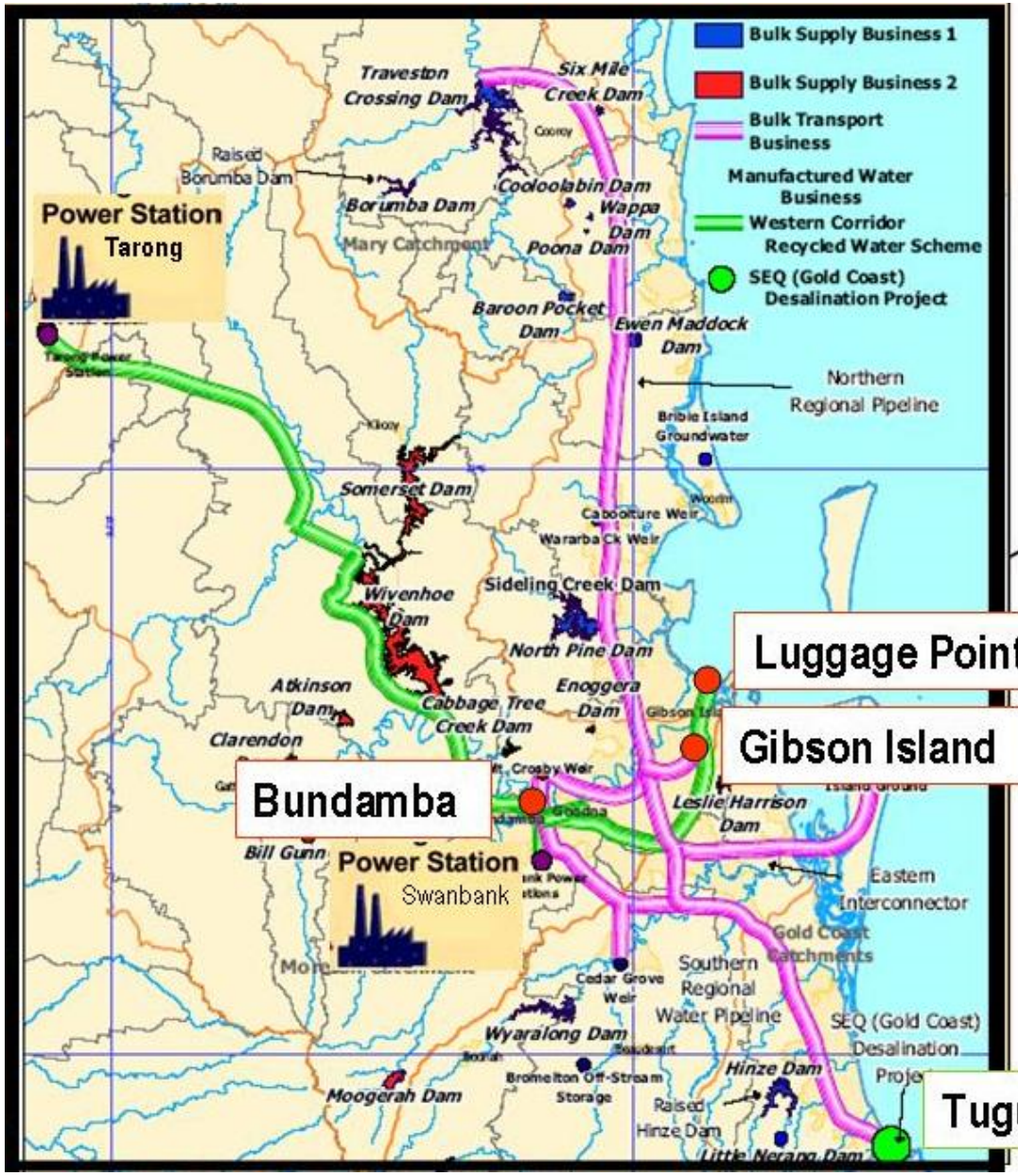
SE Queensland – "Western Corridor Scheme"

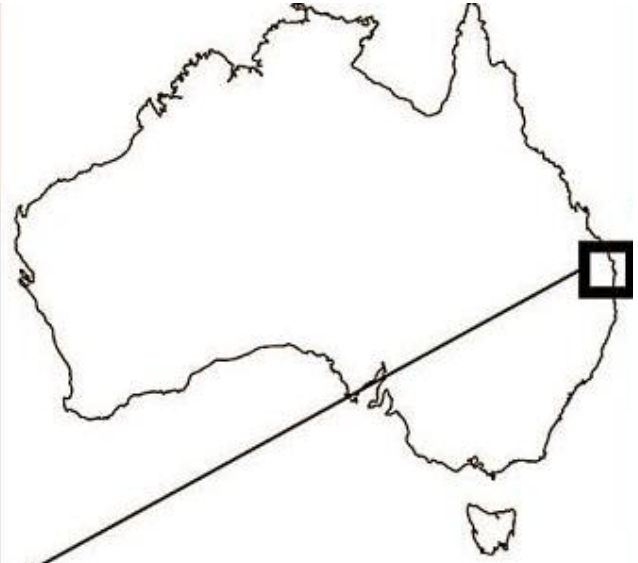
- In March 2007, South East Queensland was to vote in a $10M plebiscite on introducing recycled water into existing water supplies in Brisbane.

- Premier Beattie cancelled the Plebiscite in January 2007-
- SE Queenslanders were going to get indirect potable recycling anyway – "*No choice but to make Brisbane the first capital city to drink recycled wastewater*"

- Three MF-RO Advanced Water Treatment Plants were built with Indirect Potable Recycled water to be pumped to Wivenhoe Dam
- 84GL/annum, 30% of Brisbane supply

- Government claimed 78% supported the scheme



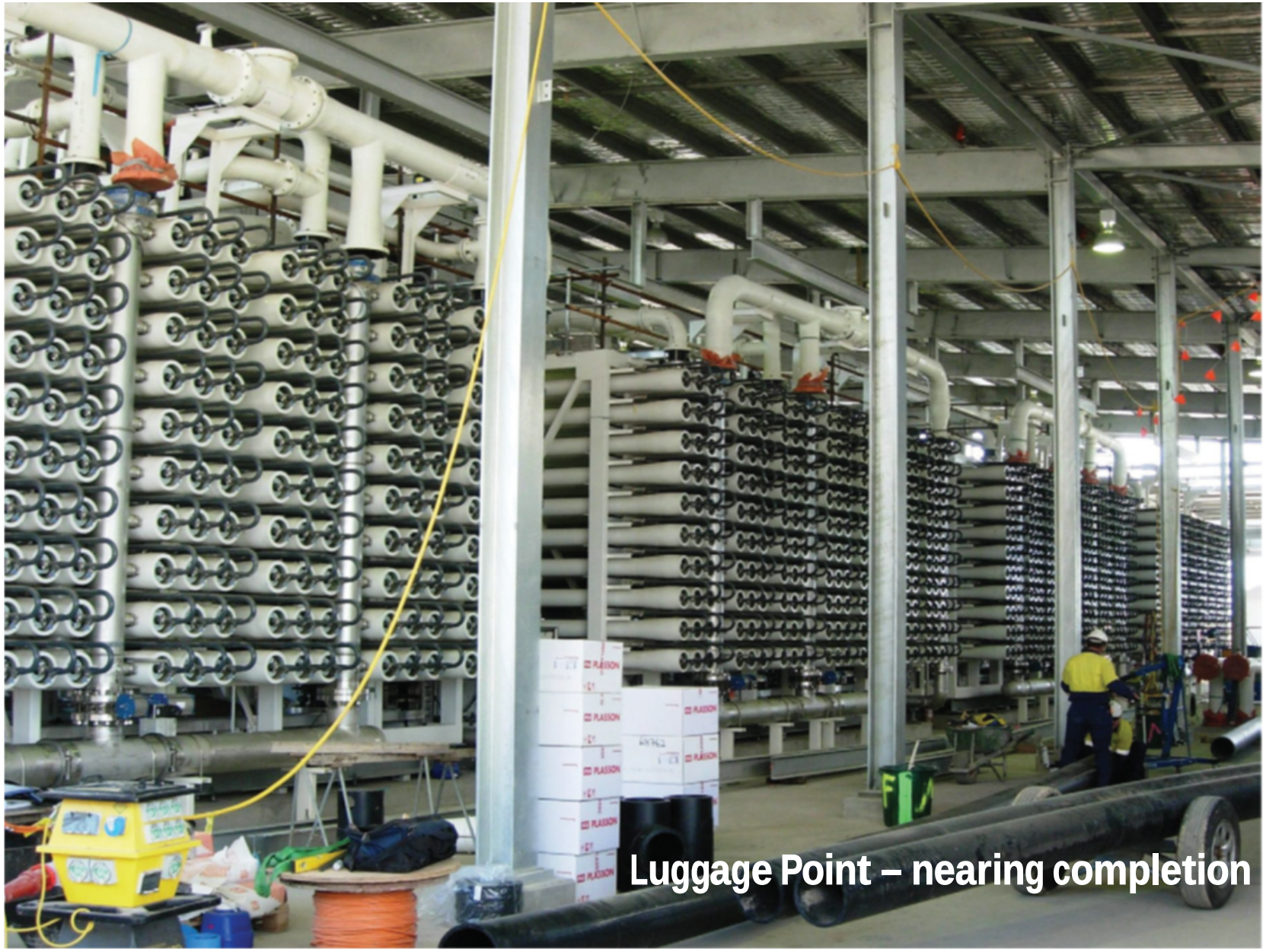


Recycling – Western Corridor Scheme

- Bundamba
- Gibson Island
- Luggage Point

Completed, tested, validated

To be used for drinking when Dams < 40%



Luggage Point – nearing completion

Federal funding for Research - 2010

Created:-

National Centre of Excellence in Desalination, Australia (NCEDA)

Australian Water Recycling Centre of Excellence (AWRCoE)

Each provided with $20 M over five years from the Commonwealth Government. With matching funds, each supported $50 M worth of research

Research Goals

Australian Water Recycling Centre of Excellence

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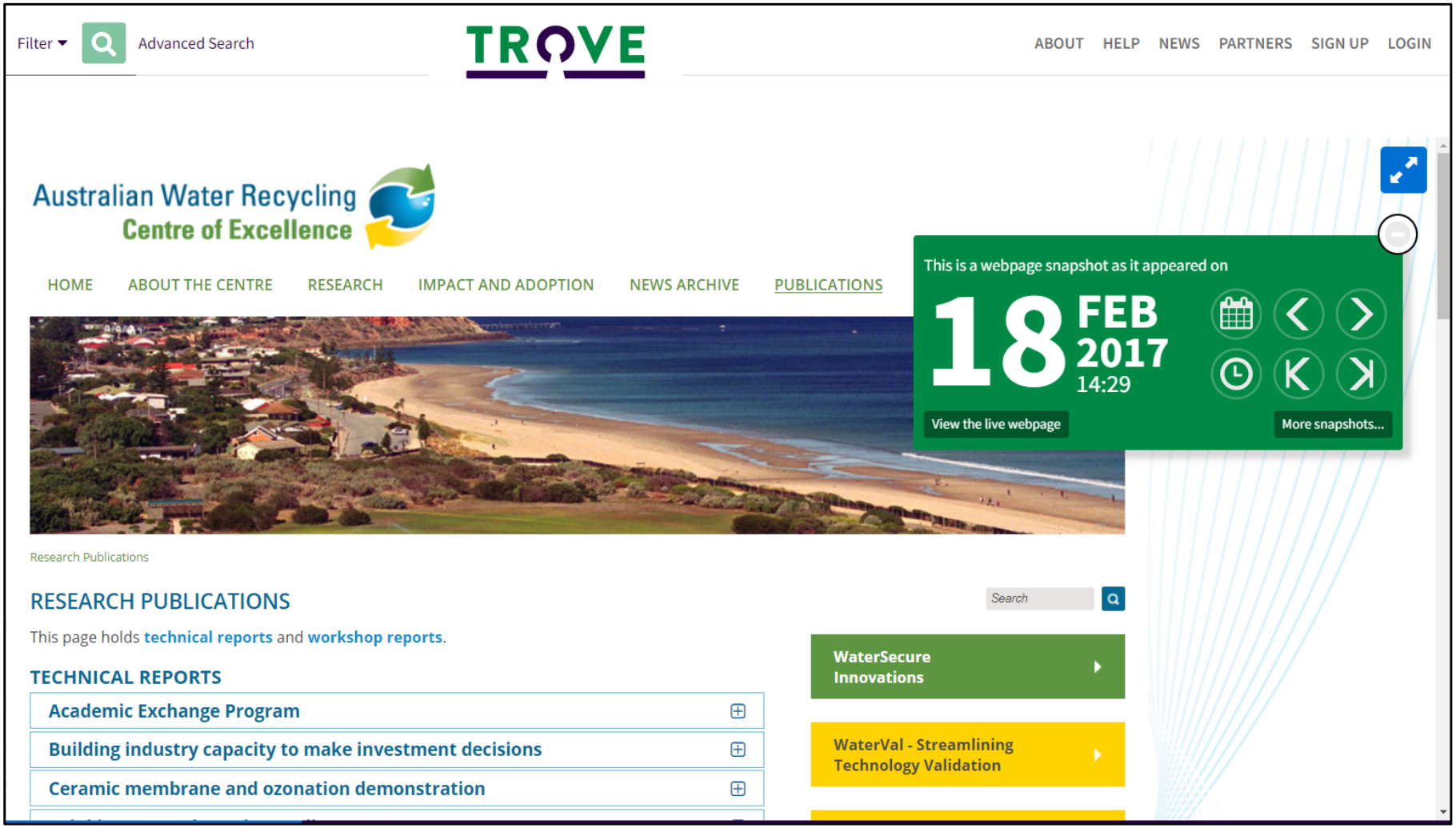
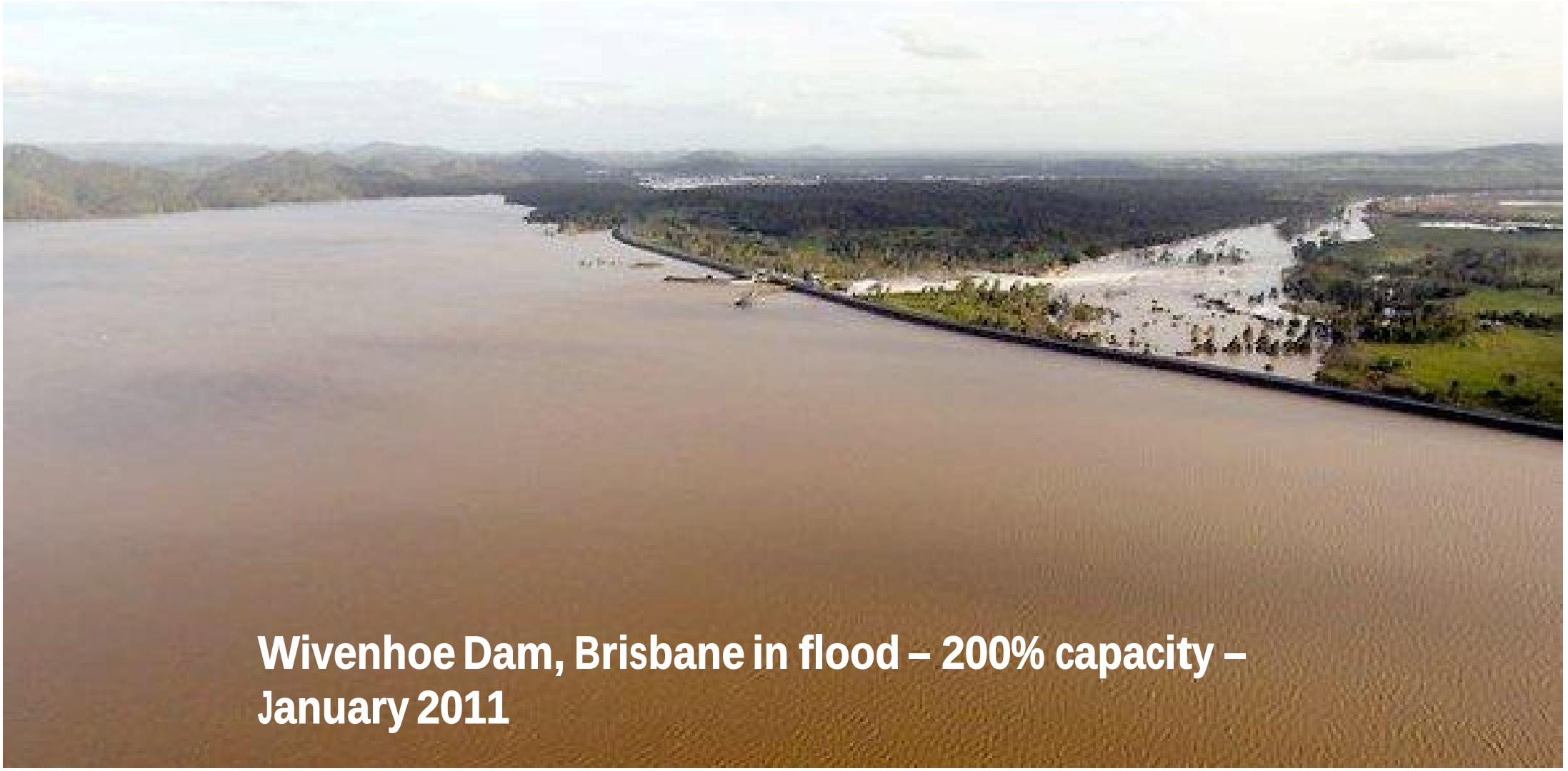


A legacy website gives access to 120 reports of research projects available at https://webarchive.nla.gov.au/awa/20170218032926/http://www.australianwaterrecycling.com.au/research-publications.html

Then it rained in Eastern Australia



Wivenhoe Dam, Brisbane in flood – 200% capacity – January 2011

Brisbane 2011

After the storm rains – negative media

THE AUSTRALIAN

WATER EVERYWHERE AND EFFLUENT TO DRINK

Flooding rains have removed the need for recycled water

THE 'Gabba roof is off, cars are floating under houses, ovals are turning into lakes, hillsides are sliding and creeks are breaking their banks. Southeast Queensland is awash its cent capacity. Yesterday, they stood at 45 per cent and were rising rapidly.

The drought has been a salutary lesson about water waste for millions of Australians. It is appropriate in a

THE AUSTRALIAN FRIDAY NOVEMBER 21 2008

6 THE NATION

Only full dams will halt water recycling

Greg Roberts

THE Queensland Water Commission has vowed to push ahead with plans to recycle sewage and industrial effluent for drinking water unless dams in southeast hoe, Somerset and North Pine dams rose to 45 per cent of capacity last night, a week earlier than predicted following the heavy rain in recent days, which is expected to continue falling over the next week.

nervous, writes
Greg Roberts

PETER Collignon is a worried man. "Nobody in the world has done what southeast Queensland is about to do," says the eminent microbiologist and Australian National University professor of clinical medicine. "What is about to happen is the reversal of 150 years of public health policy in Australia because sewage will be put into the drinking water of more than two million people. Everywhere else in the world, the emphasis is on keeping sewage out of drinking water. We should be concerned about what Queensland is doing, especially as it is being looked at by the rest of the country as a solution to water supply problems."

In February, southeast Queenslanders will become the first Australians to drink their own waste when 60 megalitres of recycled sewage a day is pumped into Wivenhoe Dam, Brisbane's main water source.

The total volume will rise to 230ML a day later in the year. Although much of it will be used by the Swanbank and Tarong North power stations — which began receiving recycled water last year — 10 per cent to 25 per cent of the drinking water in Australia's fastest growing population centre soon will be comprised of treated sewage.

The $2.5 billion Western Corridor Recycled Water Project, comprising 200km of underground pipes linking three advanced treatment centres and nine pumping stations, is the third biggest advanced water treatment project in the world.

Collignon insists that contrary to claims by the Queensland Government, the project is unprecedented. "Nowhere in the world is the proportion of drinking water that is recycled sewage anything like 10 or 25 per cent. There's never been a population of this size that has been subjected to this." He says Singapore, one of the examples cited by Queensland, had a "very different" system. And waste water — pumped through a pipeline separate from the reticulated system — accounted for less than 1 per cent of Singapore's dam capacity.

Collignon rejects government claims that a seven-stage treatment process will ensure the water is safe. He raises three key health concerns. The technology is not available to detect minute quantities of viruses, some potentially fatal, which may enter the water supply. "The quantity of virus must effectively be reduced 10 billion-fold to make it safe. If you have a 1 per cent leakage through a tear in the reverse osmosis membranes, then the water is not safe."

Second, Collignon cites the delay of one or more days before the results of tests for E. coli and other dangerous bacteria can become available. "By that time, you will have substantial quantities of contaminated water in the dam and, although you can do things to reduce the damage, there is potential for infections to get through.

"There will be no real-time testing being done to get results immediately."

Collignon also says it is inevitable some antibiotics and other natural and man-made chemicals will not be filtered out.

"It is of concern if various estrogens and [other] hormones are being recycled, and it is not good if antibiotics and other drugs are being recycled," he says.

Collignon concedes Queensland's treatment system is the best in the world. "If you're

Make mine a double: Residents of southeast Queensland will become the first Australians to drink their own recycled sewage in February as part of a $2.5 billion project

Flush then drink

Worried man: Microbiology and infectious diseases expert Peter Collignon

Vocal opponent: Businessman Clive Berghofer donated $20,000 to the no campaign

CSIRO

After the rains, a new driver for water recycling

Economic reality

Use of the Desalination Plants

Most plants completed after the drought ended

Sydney (2010) -	$1.9 B	Not used until 2019 low use 2020
Melbourne (2012) -	$3.5 B	Not used until 2017
SE Queensland (2009)	$1.2 B	Occasional use, Mostly standby
Adelaide (2011)	$1.8 B	Used at 10%, Full use 8 mo. 2020
Perth – Kwinana (2006)	$ 387 M	Full use
Binningup (2012)	$1.4 B	Full use

There was criticism of over-investment when it started raining from 2008-9

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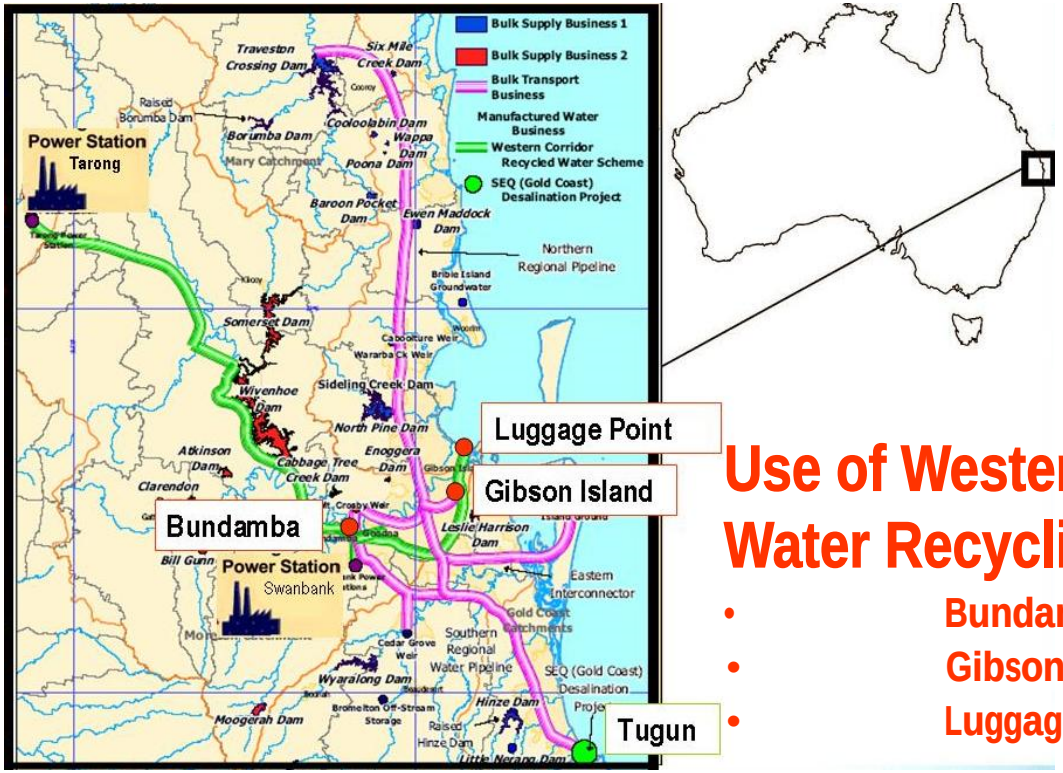


Use of Western Corridor Advanced Water Recycling Scheme

- Bundamba
- Gibson Island
- Luggage Point

- **Cost $2.6 billion**
- **Only sent recycled water to two power stations for 12 months**
- **No water ever added to Wivenhoe Dam**
- **New government dismantled, removed the membranes**
- **Described project as a “white elephant” of previous government**

Cost of Water, South East Queensland

Desalination, Tugun	$959/ML
Western Corridor Advanced Recycled Water	$834/ML
Catchment water to Wivenhoe Dam	$ 67/ML

S. Warner, Maintenance of Water Infrastructure Assets, SEQ Catchments. Submission to the State Development, 2015. Infrastructure and Industry Committee Inquiry into Queensland Audit Office Report 14 to Parliament 2013

"Sub-divisional **dual reticulation's future** is uncertain – it's generally proven to be very expensive and imposes an ongoing management risk of cross-connection."

Chris Davis, National Water Commission

Pimpama-Coomera Purple Pipe system closed

Gold Coast City Council resolved in 2013 to stop supplying recycled water to 6,700 houses provided with dual reticulation systems in Pimpama-Coomera by 2017.

- **Costs outweighed community benefits**
- **Dual pipes increased costs for houses yet to be built**
- **Unclear about recycled water demand over drinking water**

Some Victorian dual pipe systems completed but not operated

Sydney Water determined not to build new subdivision purple pipe systems

High rise building systems continuing

Water sector debt

State of Victoria:

- **Interest-bearing liabilities increased 2009 - 2013 by 248%**
- **Interest represents 21% of total operating costs**
- **Servicing the debt and repaying it are major challenges for water industry**

Victorian Auditor-General December 2013

Some states

- **Lengthen borrowing term to reduce annual consumer charges**

National Water Commision National Performance Report 2012-13

CSIRO

Summary - after the end of the Millenium drought

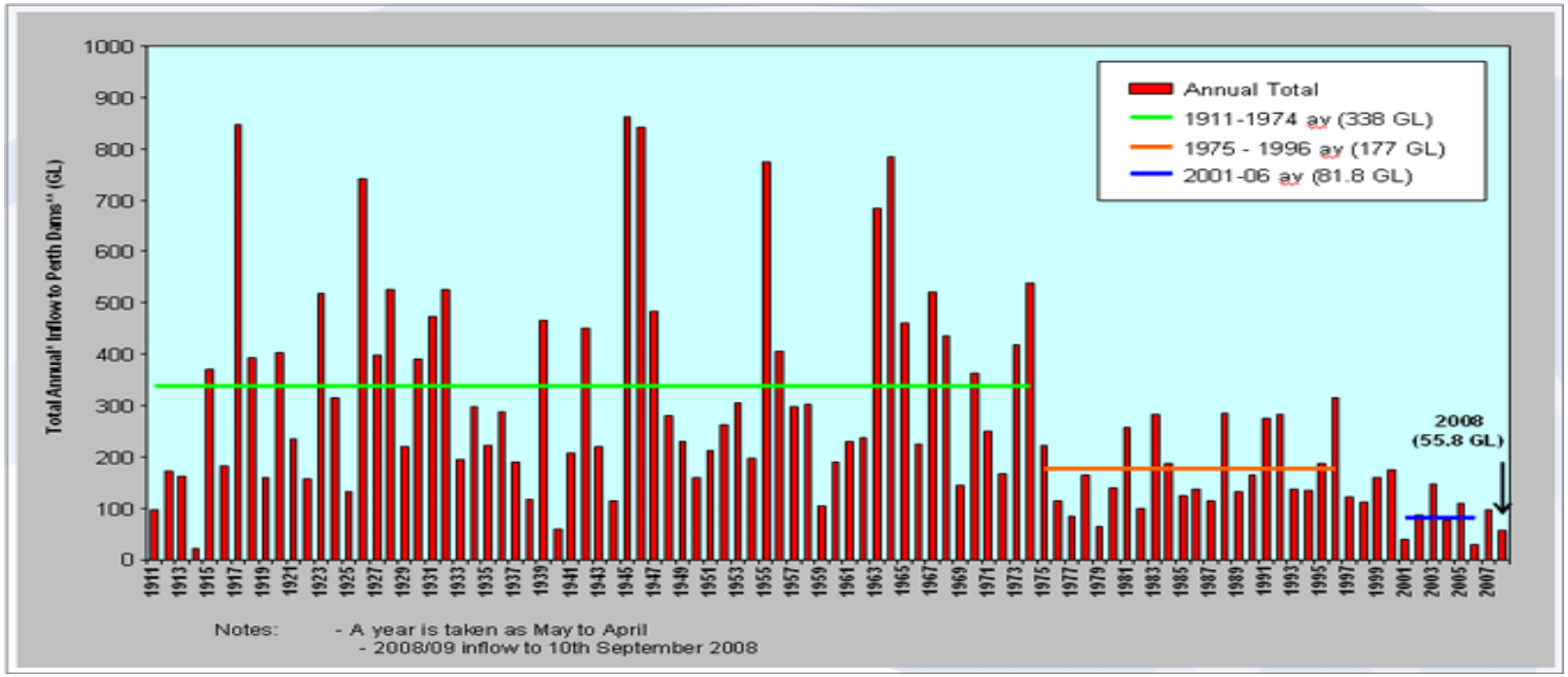
- The reservoirs filled
- The Eastern states desalination plants were out of use, Brisbane's Western Corridor indirect potable system closed
- Government policy interest moved from water to elsewhere
- Research funding was drying up
- The National Water Commission was closed
- The Ministerial Council for Environment and Water abolished
- A period of Water Policy complacency?

"Now it's rained, why worry?!"

Recycled water supplied, 2017-18

Adelaide	25,564 ML
Canberra	30,396 ML
Darwin	451 ML
Melbourne	42,085 ML
Perth	12,100 ML
SE Queensland	13,056 ML
Sydney	42,833 ML

But Western Australia is different



Recognising Climate Change - Perth catchment declined 1911-2008

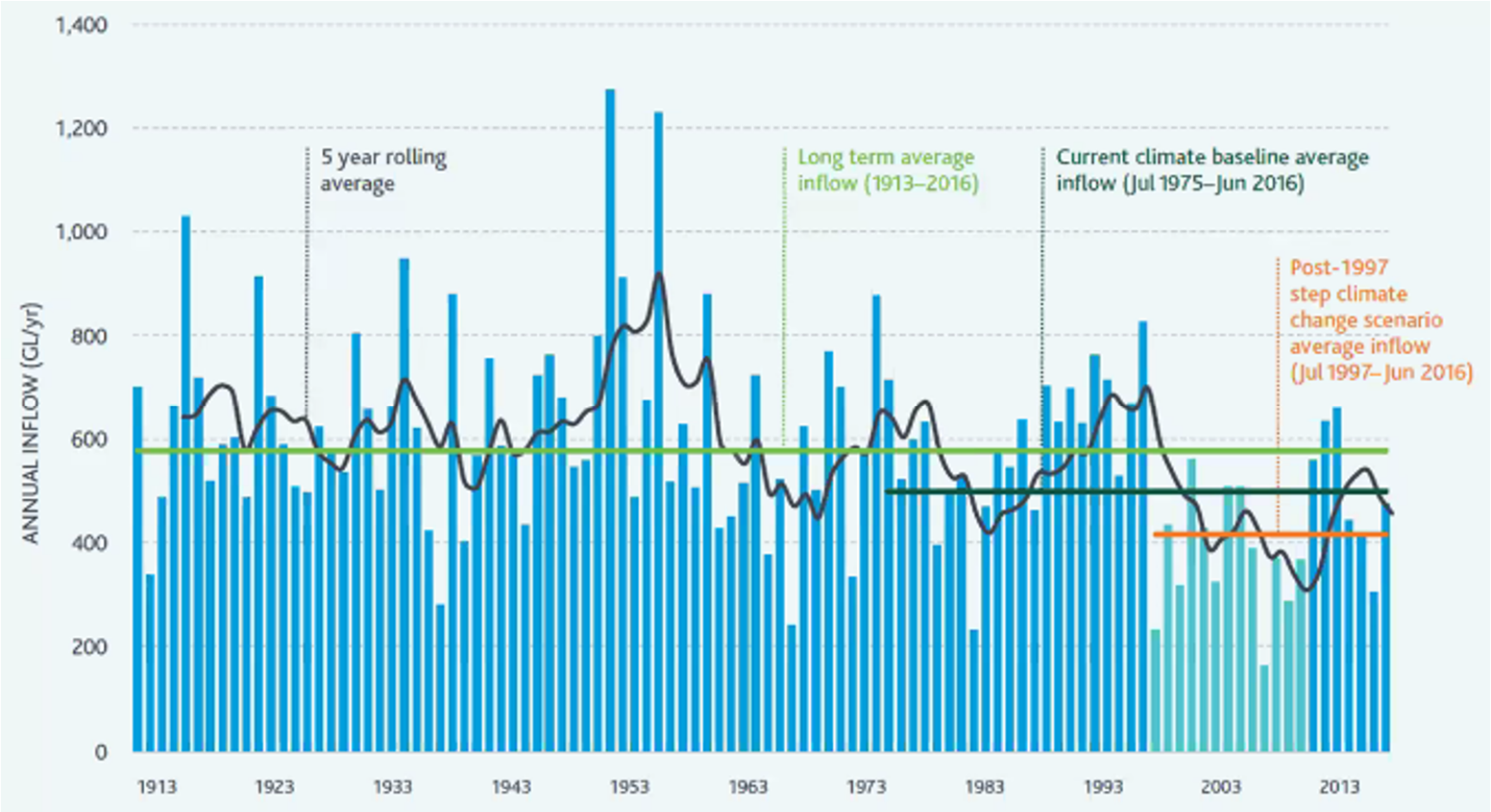
Population (2 million) growing rapidly

Perth already got 60% of its water from Groundwater, but it was overdrawn

It also has 200,000 unmetered back yard wells

CSIRO

(Climate Change is evident in Melbourne too)



Perth response: Groundwater replenishment

After long community discussion, a pilot plant was established in 2008 at Beenyup WWTP with MF/RO to produce 5ML recycled water daily for reinjection into Perth's Leederville Aquifer

The Premier's Collaborative Research Program project "Characterising Treated Wastewater for Drinking Purposes Following Reverse Osmosis Treatment" was conducted for 3 years

The Departments of Health, Water, Environment and Conservation, the WA Water Corporation, the University of WA, Curtin University, the National Measurement Institute, CSIRO and the Chemistry Centre of WA were project partners.

Department Regulators. overseeing project, found the outcomes compliant with water recycling guidelines.

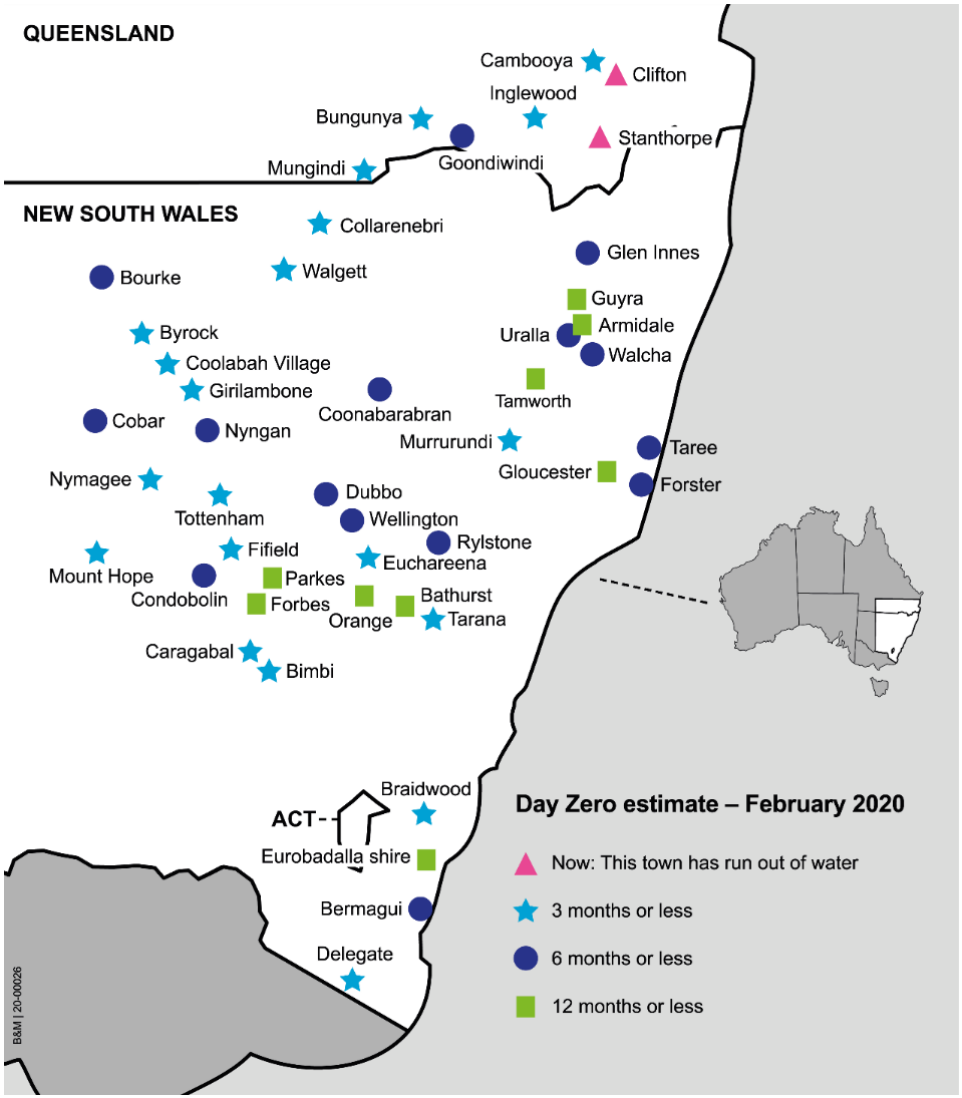
CSIRO

The pilot plant was used as a demonstration for community visits including by school children. Communication/consultation program gained 76% community acceptance 2013

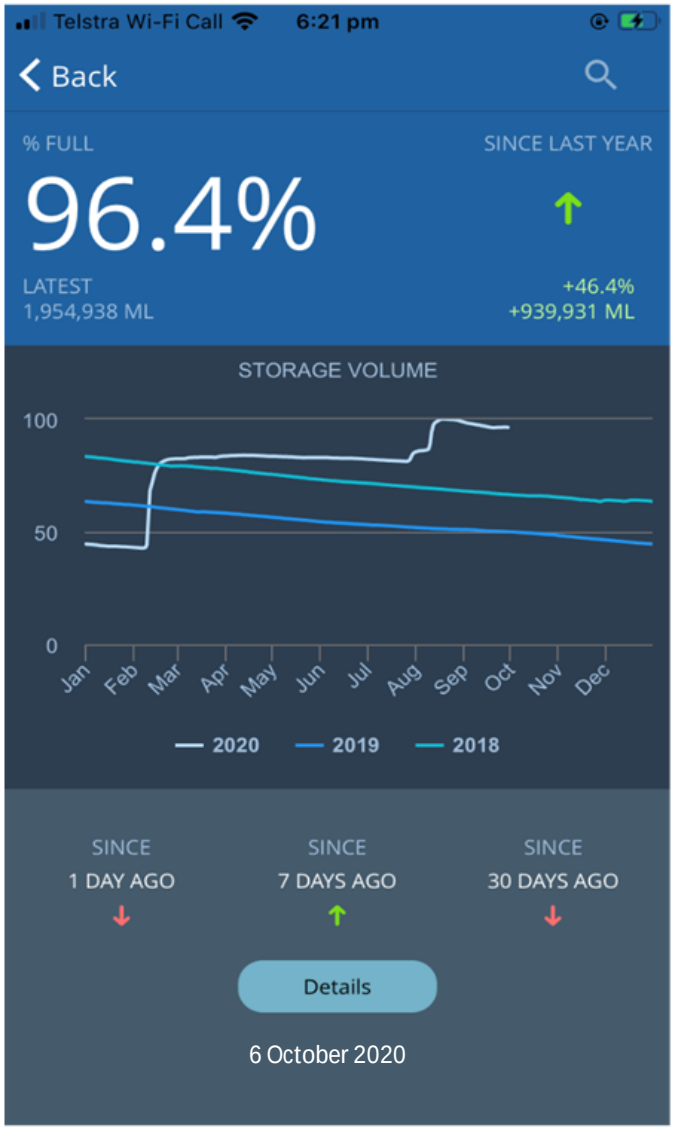
Recycled water (MF-RO) for groundwater replenishment for drinking adopted by Western Australian Government

First component – 14GL/yr completed 2016
Second component – 14GL/yr completed 2020

Meanwhile, 2019, Eastern Australia back in drought



- Regional towns running out of water
- Starting to think about local recycling



Bureau of Meteorology Water Storage App

Then it rained again

Warragamba Dam – Sydney's main reservoir

January 2020 – below 50% - start desalination

Mid February 2020 – Rainstorm, overnight, increases to 82% - slow down desalination

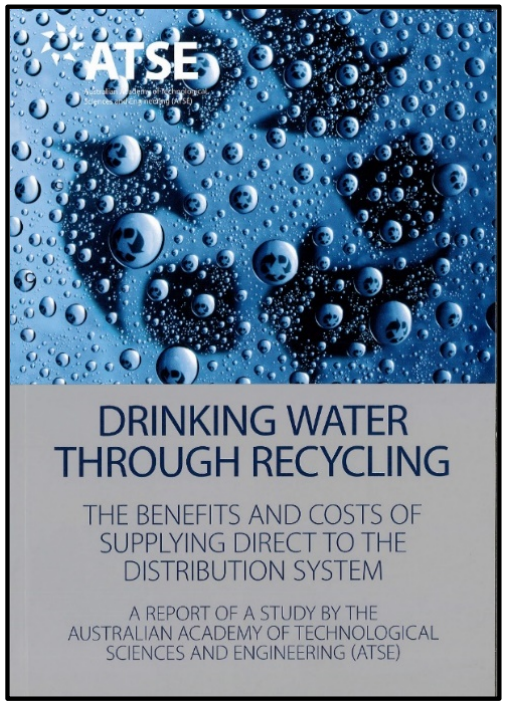
August – Winter rains – full – 100% - first time in years

Learnings for the future

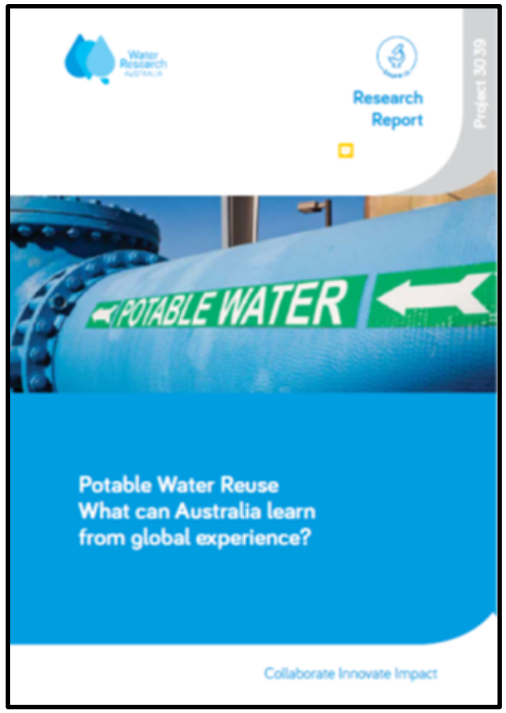
- Leadership must come from and be committed from the top
- Water planning is a long term issue, shortage can focus the mind
- Climate change impacts will vary, but must be recognised
- Manage variation in water availability through diversity
- The true value of water and its supply costs must be recognised and paid
- One cost of supply is the investment in research and new technologies
- Water supply planning must be integrated with energy, environment, food supply and urban planning policies
- Consumers must participate and their role be recognised in decision-making
- New technology should be demonstrated and accepted, e.g. in pilot plants
- The demand for recycled water can initially be over-estimated
- Consideration of the circular economy will lead to potable water recycling

Developing a long term interest in Direct Potable Recycling

Three recent Australian reports



Academy of Technology & Engineering



Water Research Australia

Water Services Association of Australia

It is a debate we still need to have.

Thank you

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