

Integrated water cycle management – inclusion of decentralised strategies to balance uncertainty

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Philosophy

- Key motivations include integrated water cycle management, sustainability, minimising carbon footprints, innovation and forensic analysis of systems
- We need to understand operation of systems, synergies and the detail
- Need to approach sustainability as a integrated systems concept
- Sustainability is NOT a cost + add on to an otherwise traditional project.

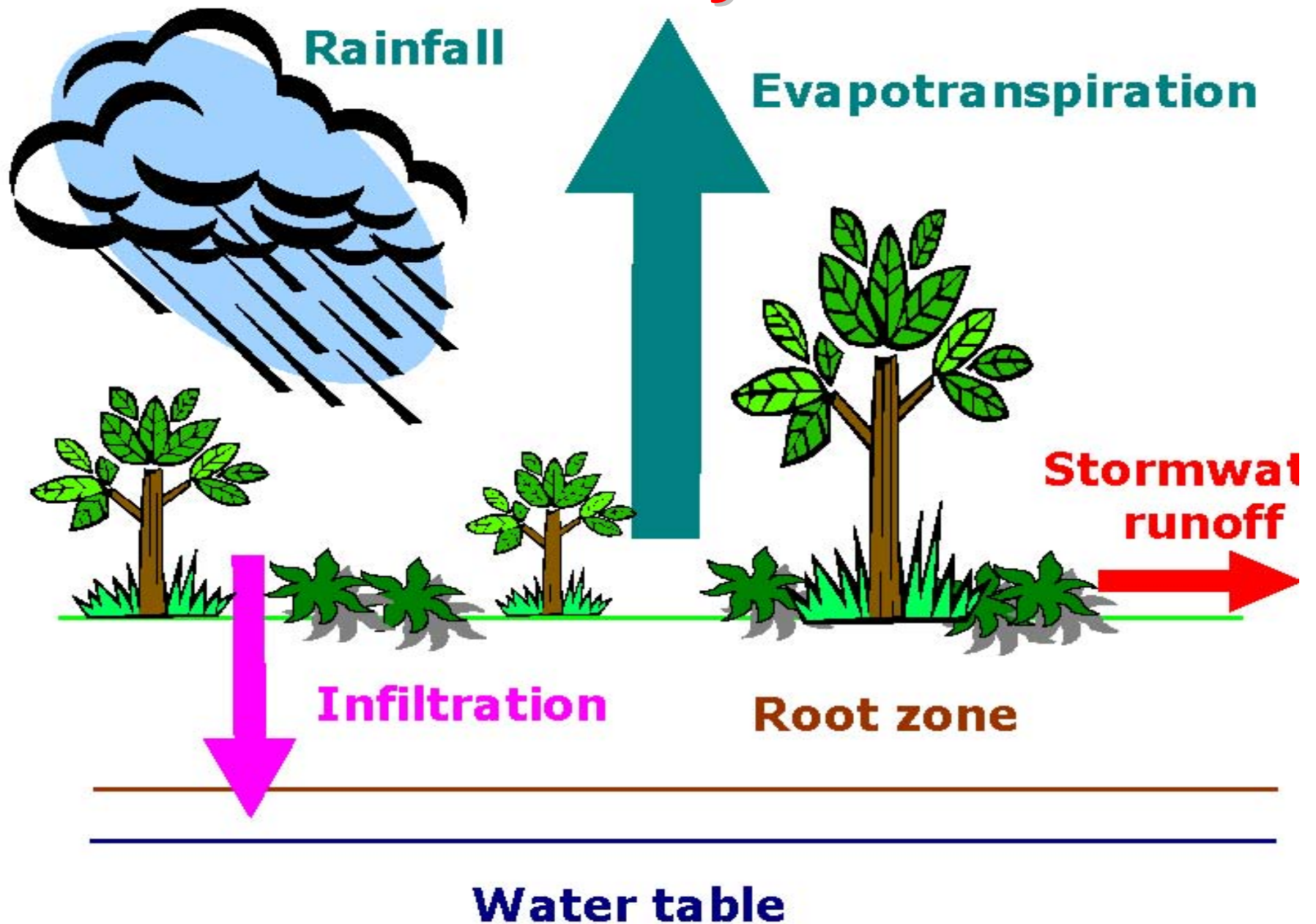
Observations

- A diverse portfolio of water sources and strategies is required to secure Australia's water futures
- **The synergistic benefits of the decentralised water cycle management are often overlooked**
 - Reductions in stormwater, water and wastewater infrastructure
 - Impacts on environment and water security
 - Urban food bowls
- **The decentralised water management approach provides**
 - A buffer against the impacts of climate change
 - Availability of local water sources increases with population

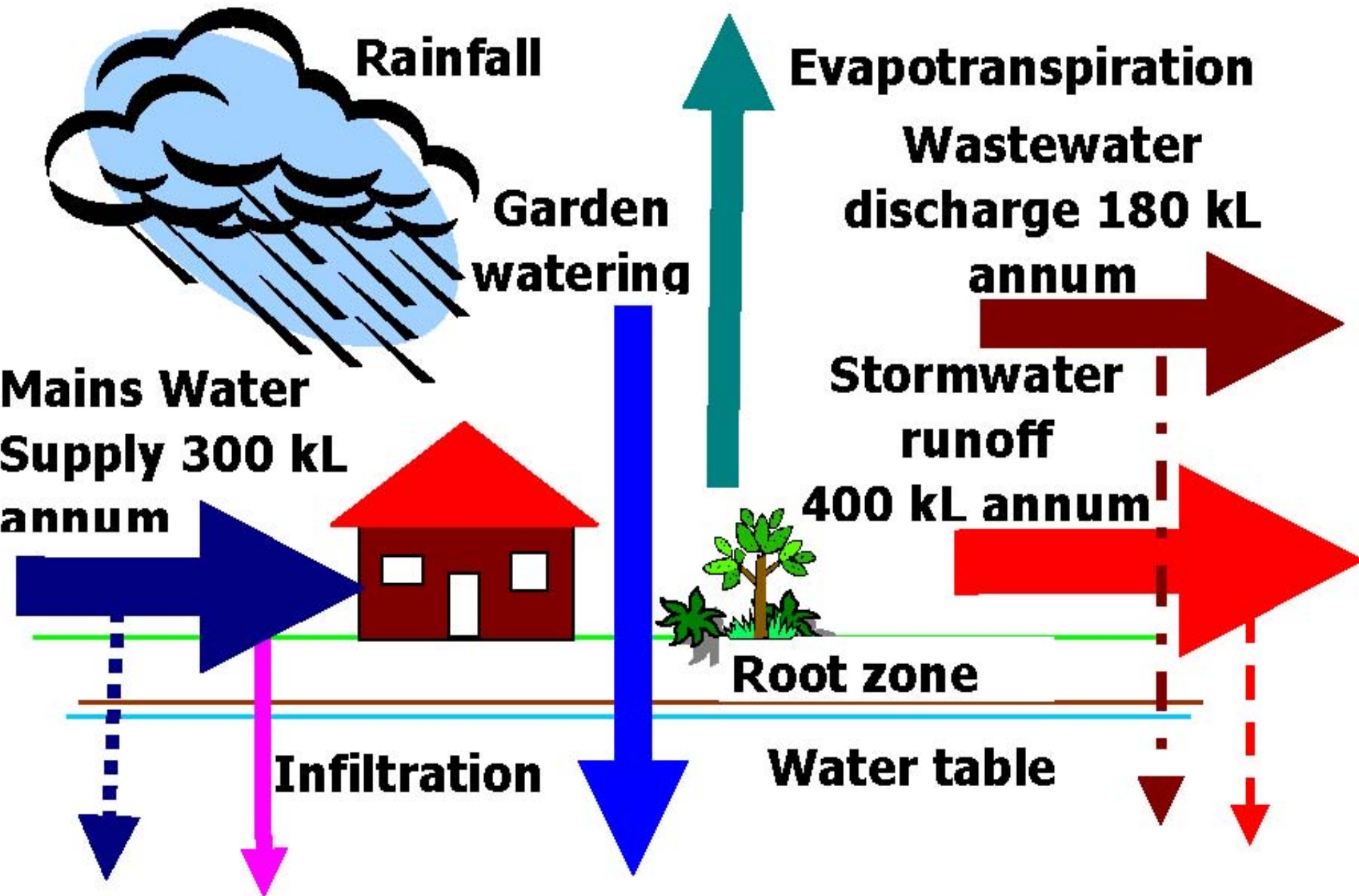
Observations

- Sustainable developments create water security – this value must be counted
- Traditional design standards and methods cannot be used to design integrated strategies
- Application of unrealistic objectives and constraints to sustainable projects – not applied to BAU
- Selection of boundary conditions of analysis changes economic results
- Need systems analysis that includes feedback with the planning process
- Every project moves society towards the next augmentation and further environmental impact
- Need to supplement to capacity of existing infrastructure and facilitate restoration of catchments

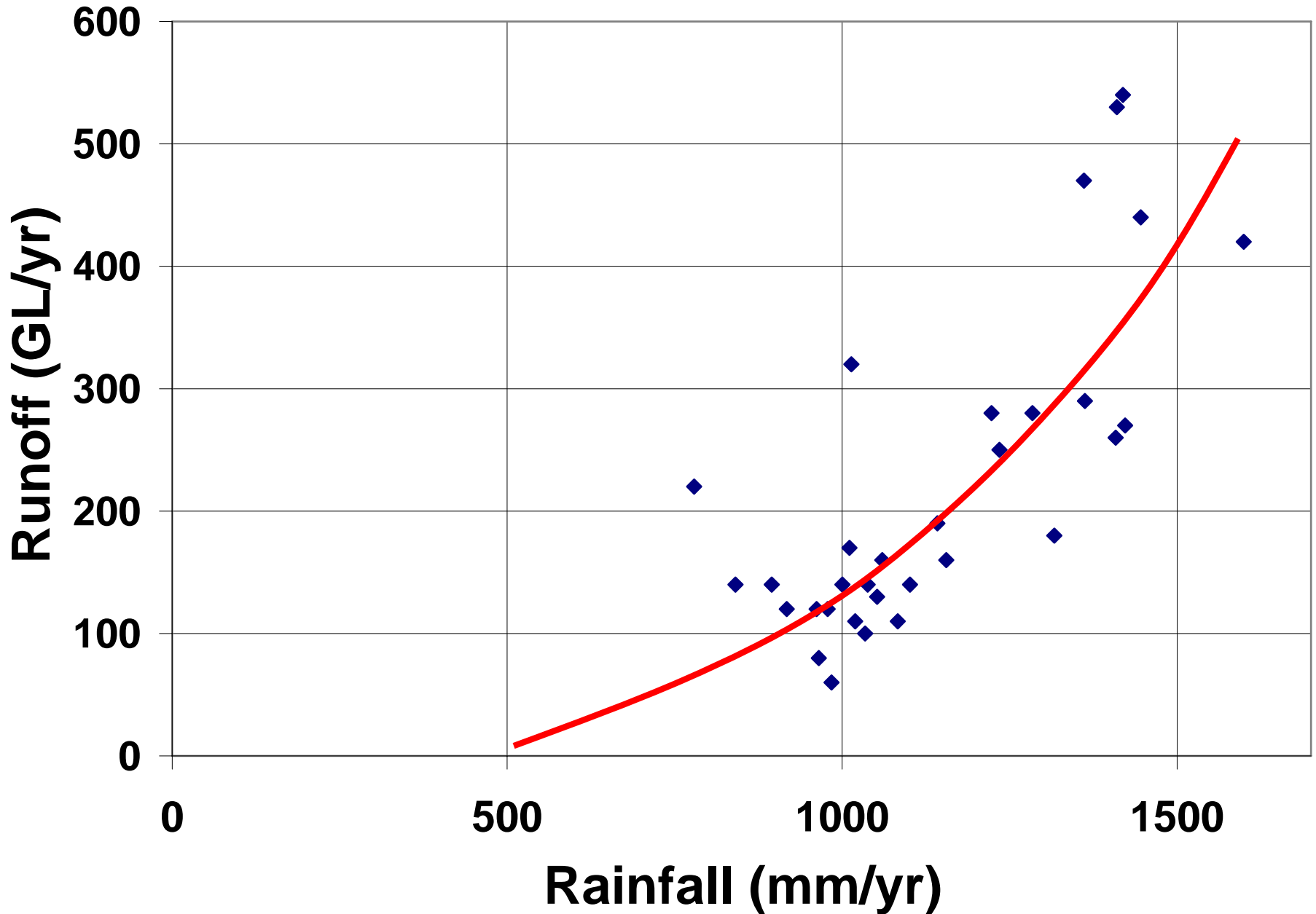
Natural System



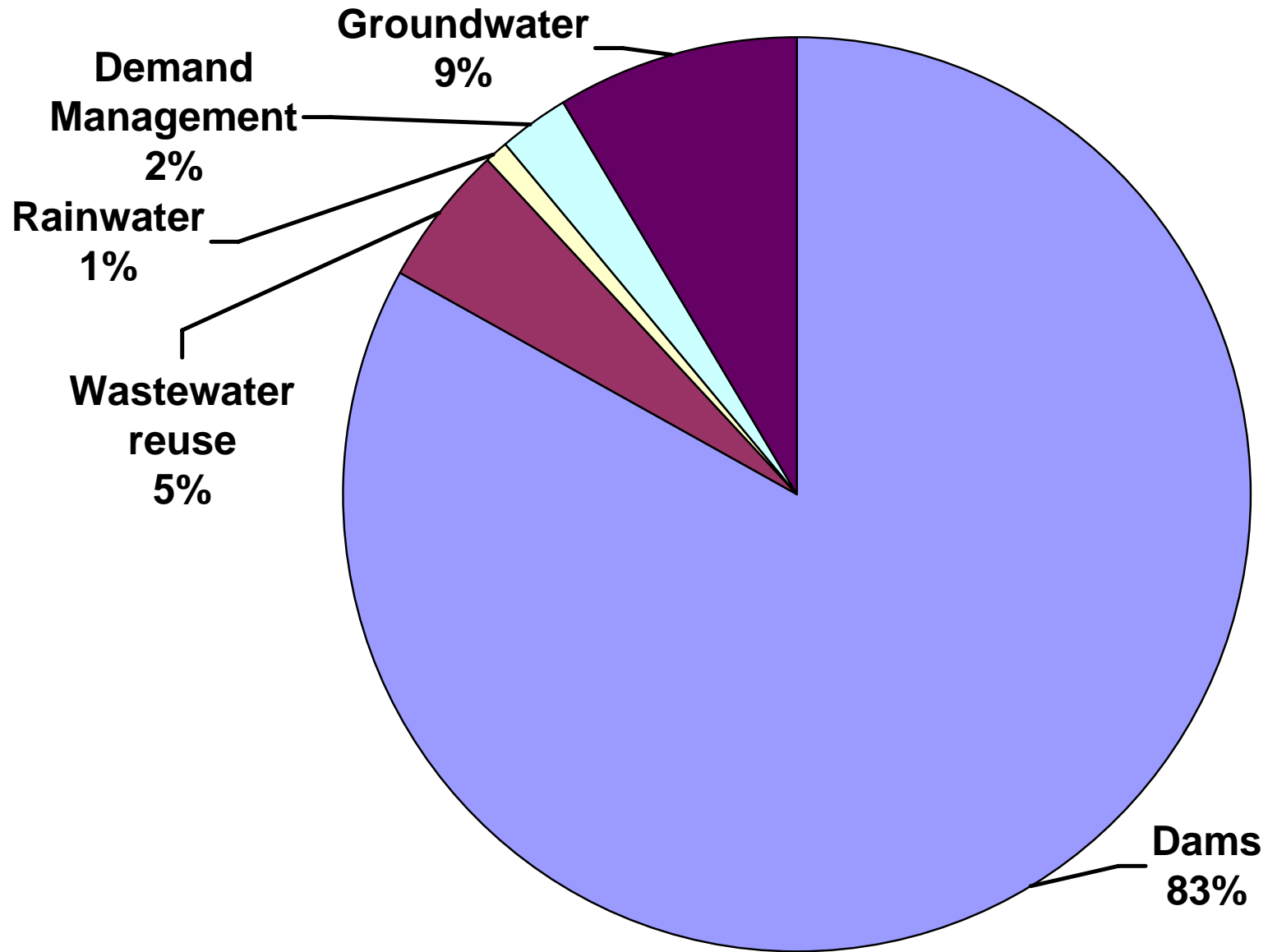
Urban Water Cycle



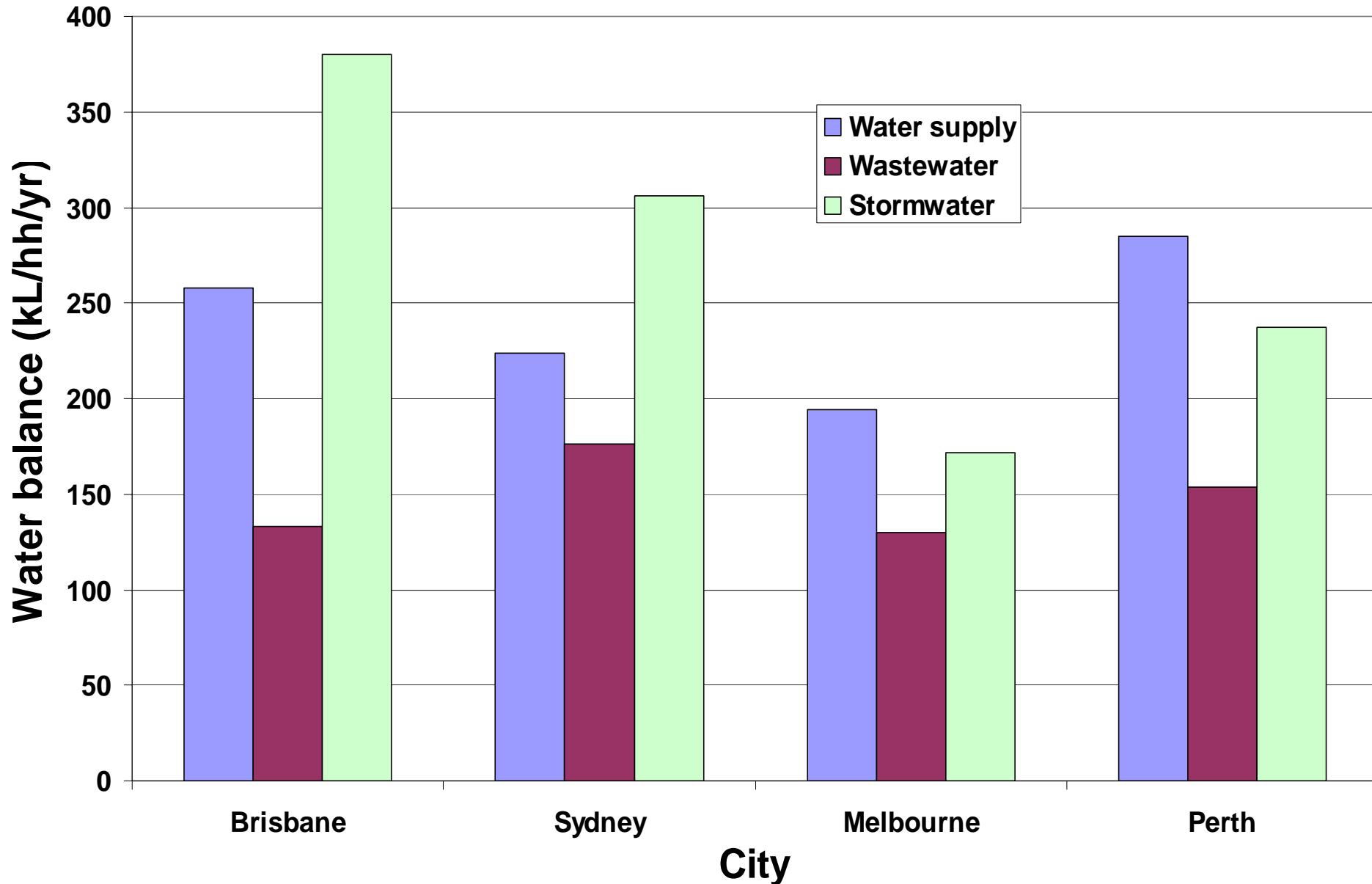
Runoff into dams supplying Perth



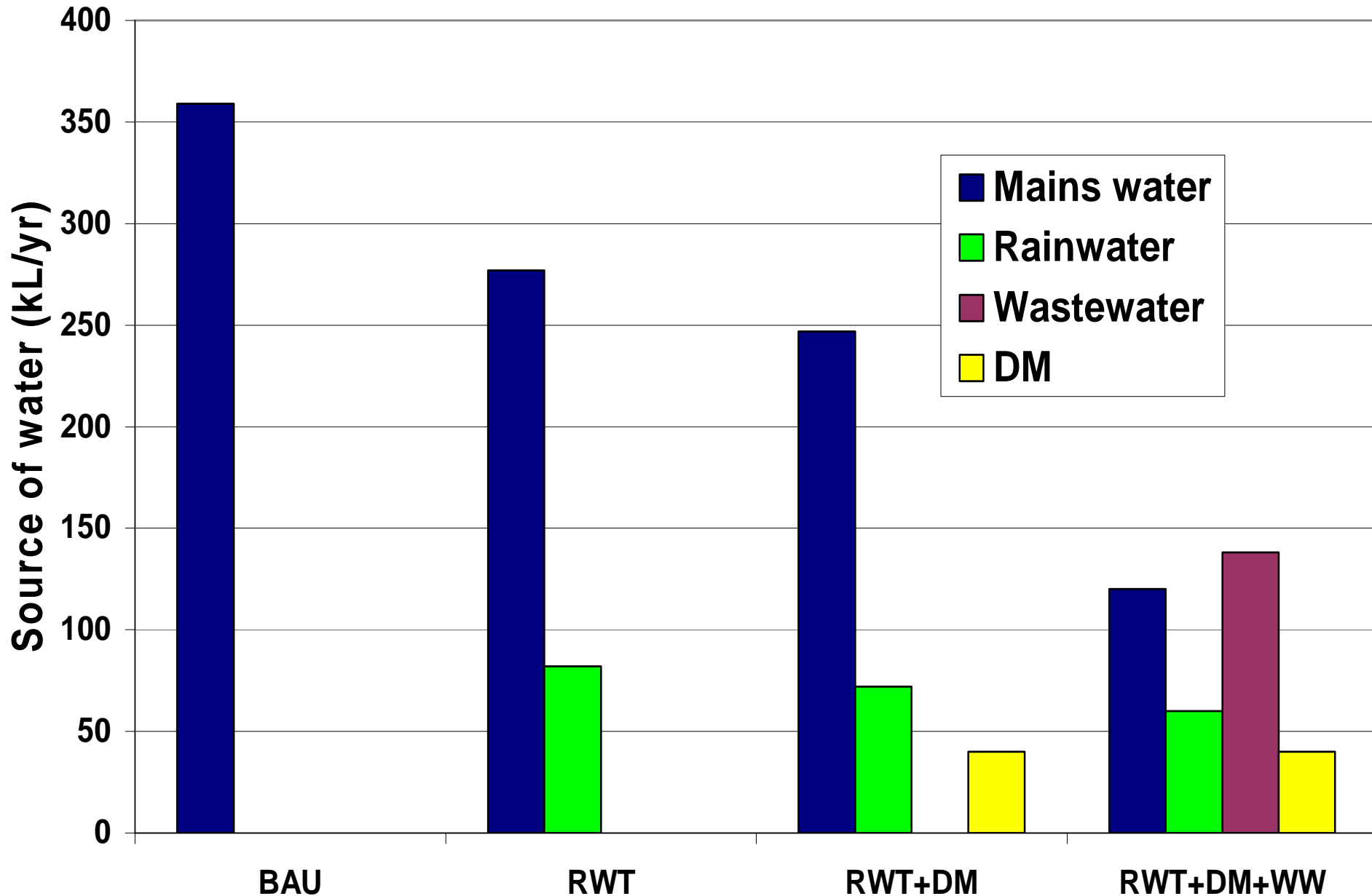
Current sources of urban water



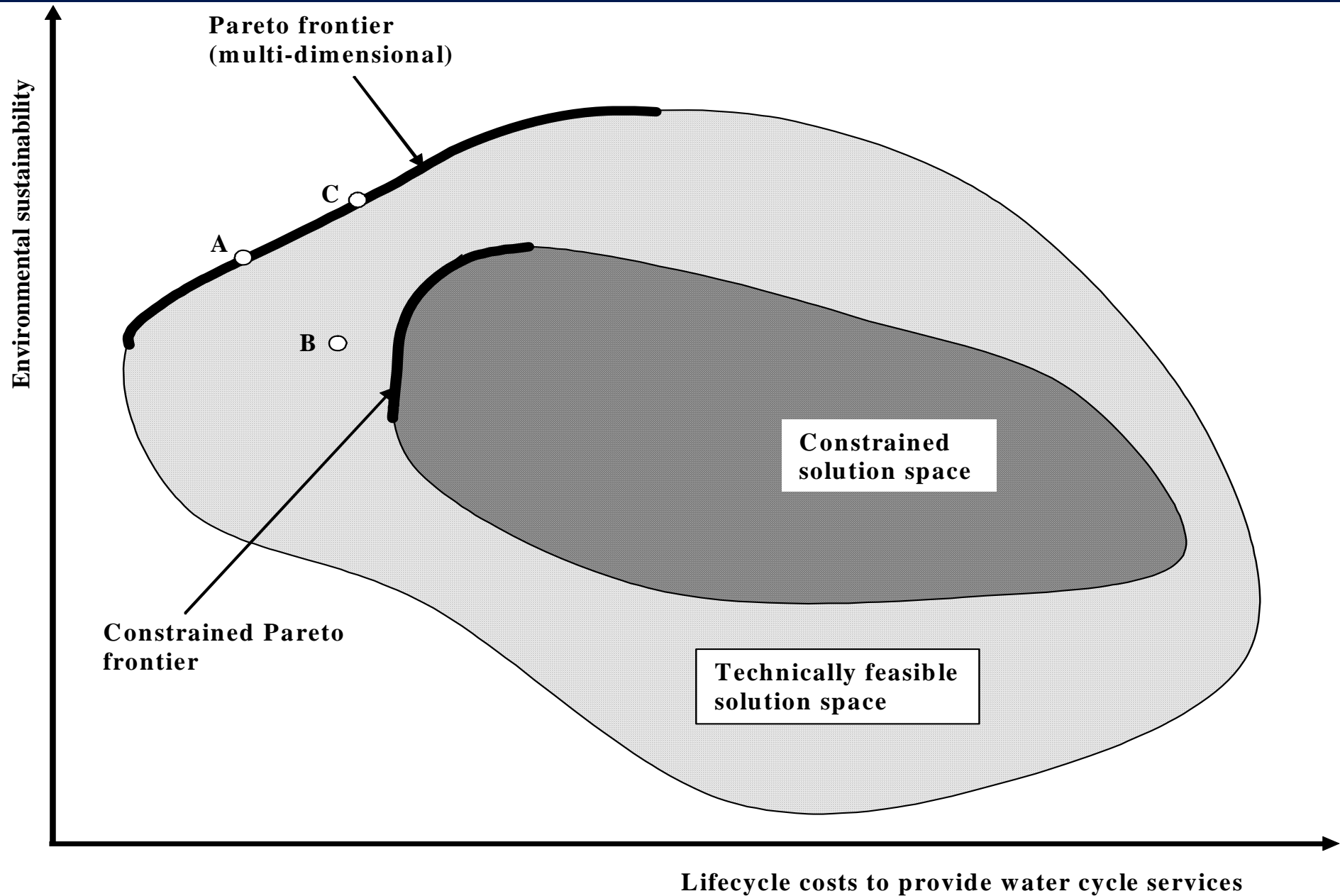
Available water in cities



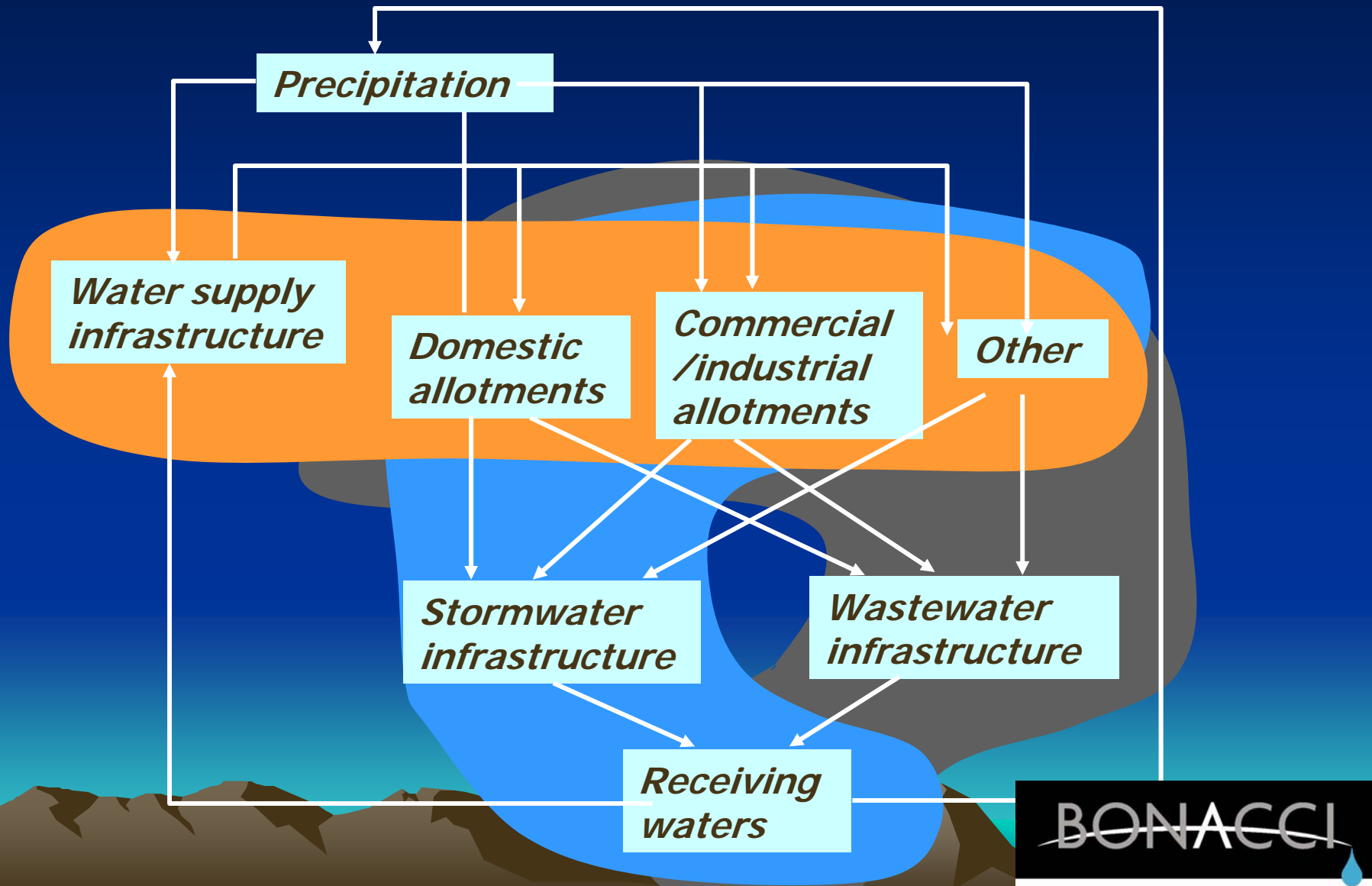
Decentralised water sources



A constrained solution set



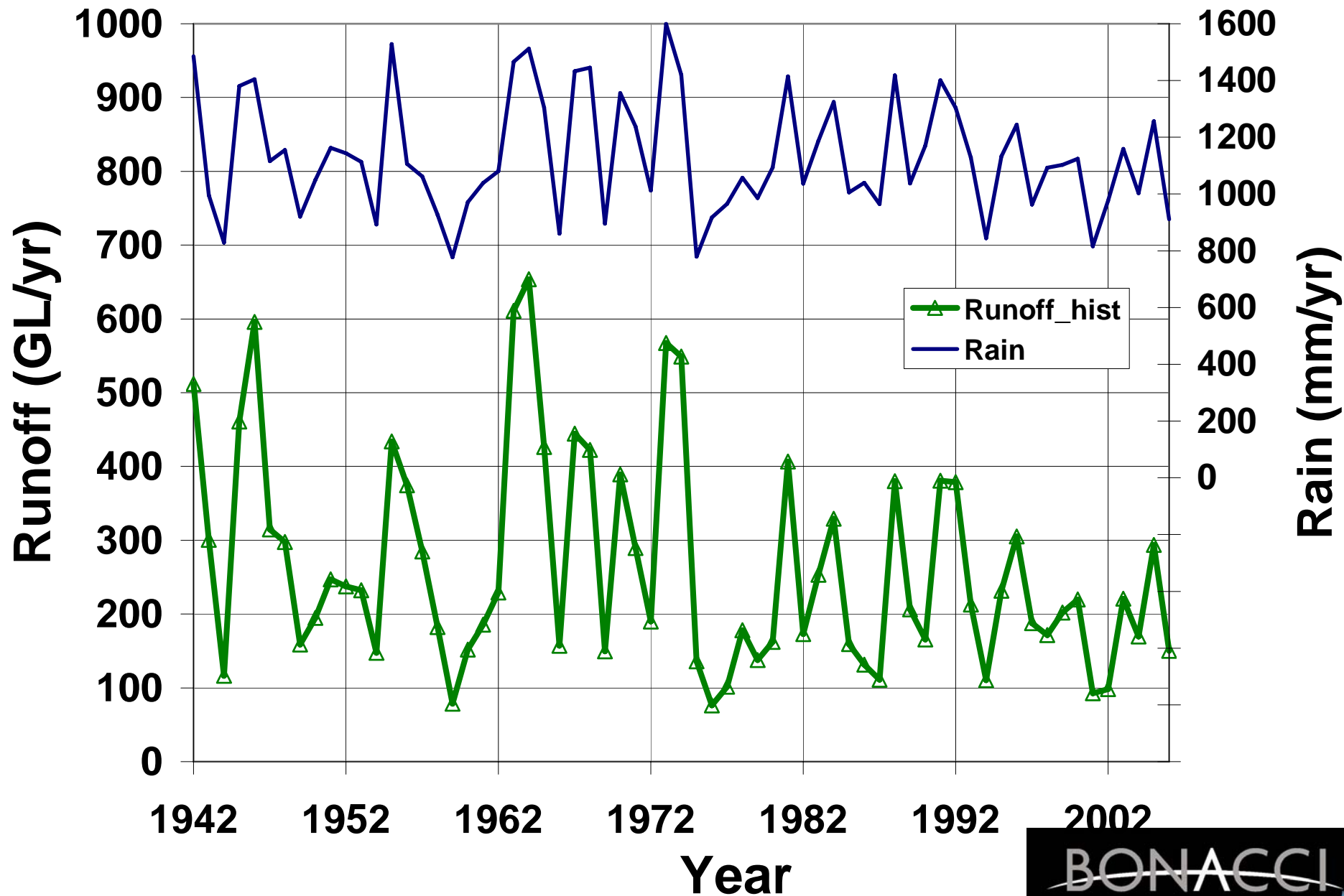
The integrated urban water cycle



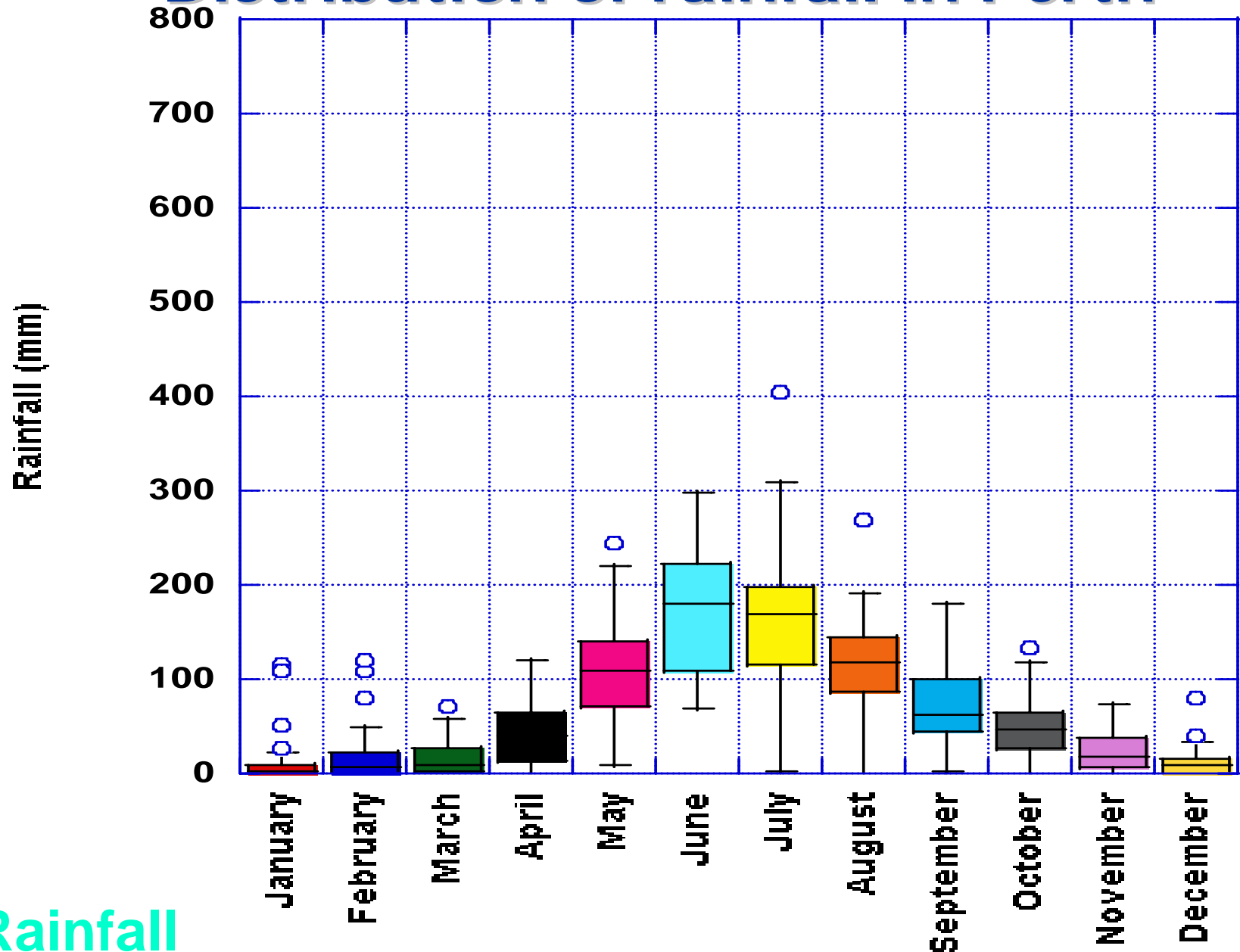
The Opportunity

- Population growth ~ 1% per annum
 - Include new dwellings and buildings in water planning
 - 30% of dwellings by 2050
- Urban renewal ~ 1.5% per annum
 - Include renovated or replacement dwellings and buildings in water planning
 - 44% of dwellings and buildings by 2050
 - Decentralised strategies can add capacity to aging stormwater, sewerage and water supply infrastructure systems
- Total impact > 74% of dwellings and buildings could include decentralised strategies by 2050
 - Reduce demand for water and requirement for centralised infrastructure

South East Dams: rainfall & Runoff

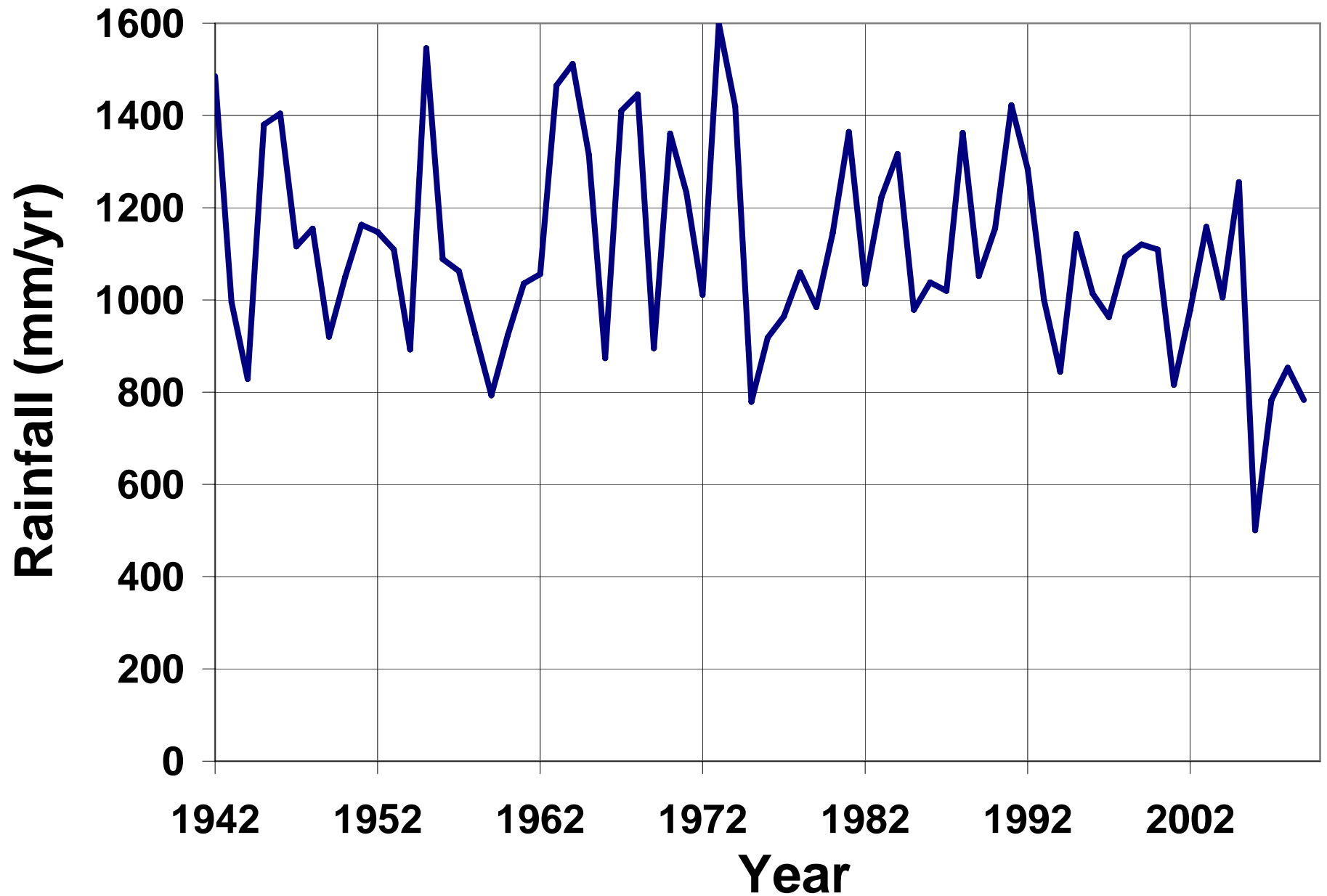


Distribution of rainfall in Perth

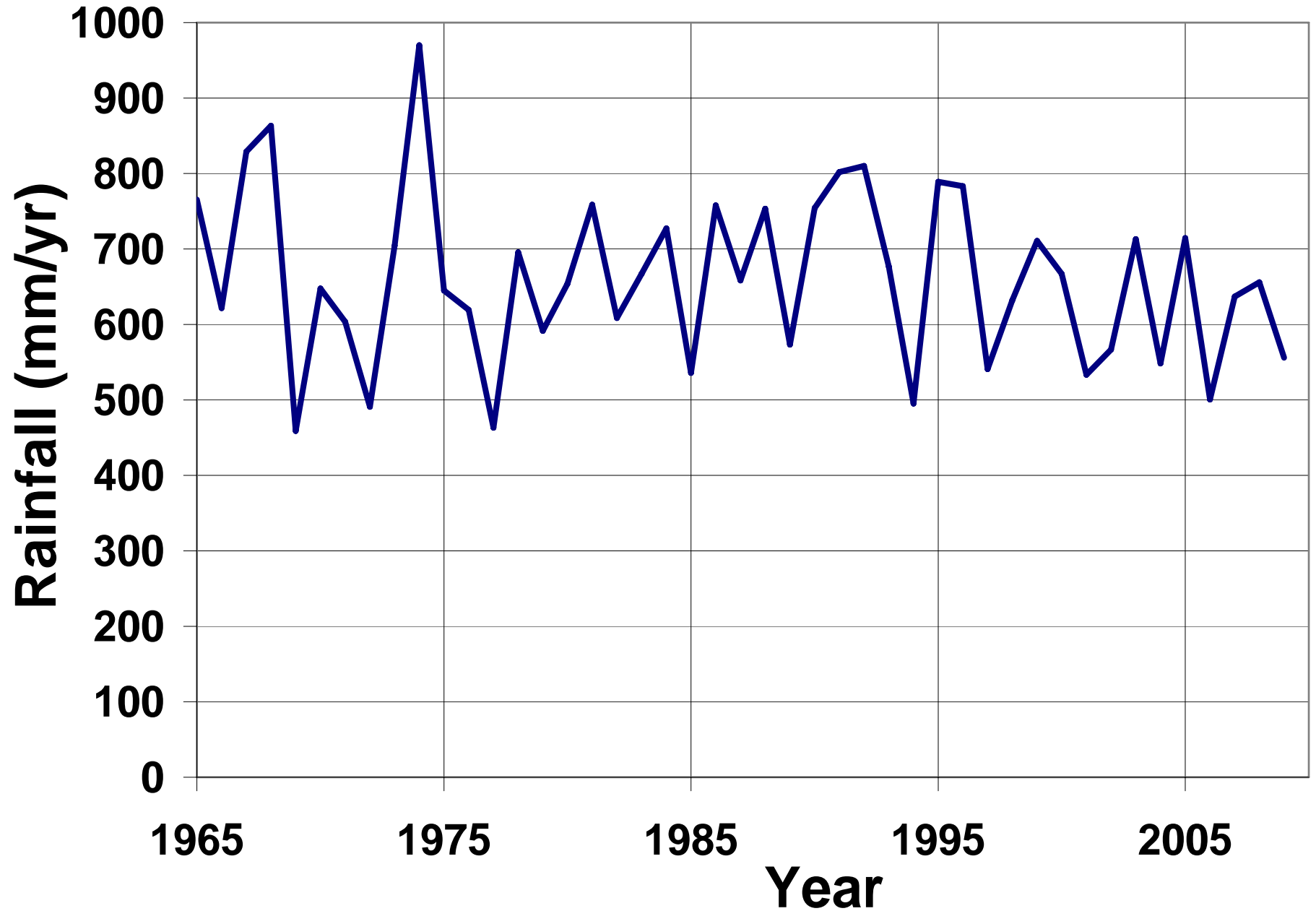


Rainfall

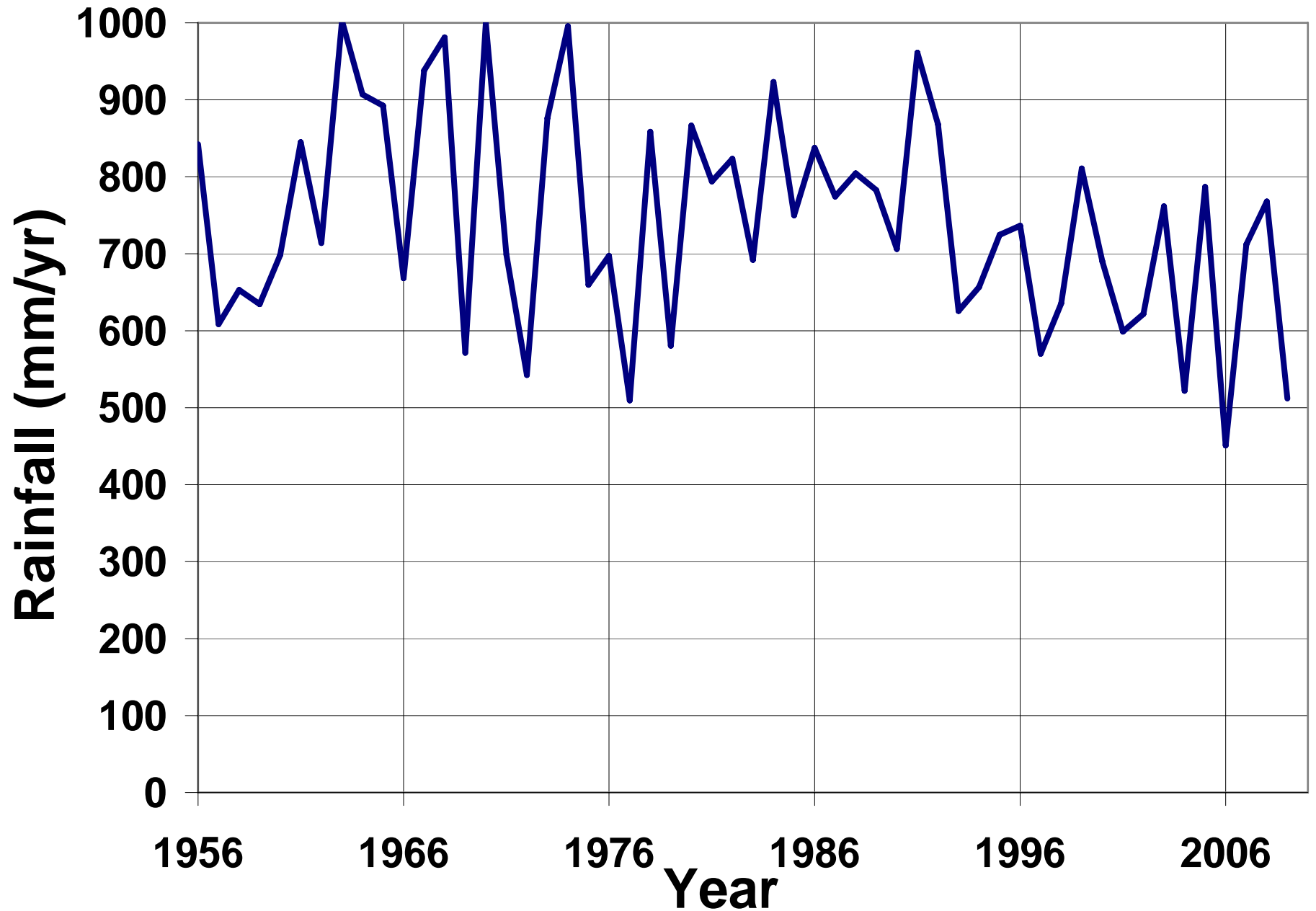
Serpentine rainfall



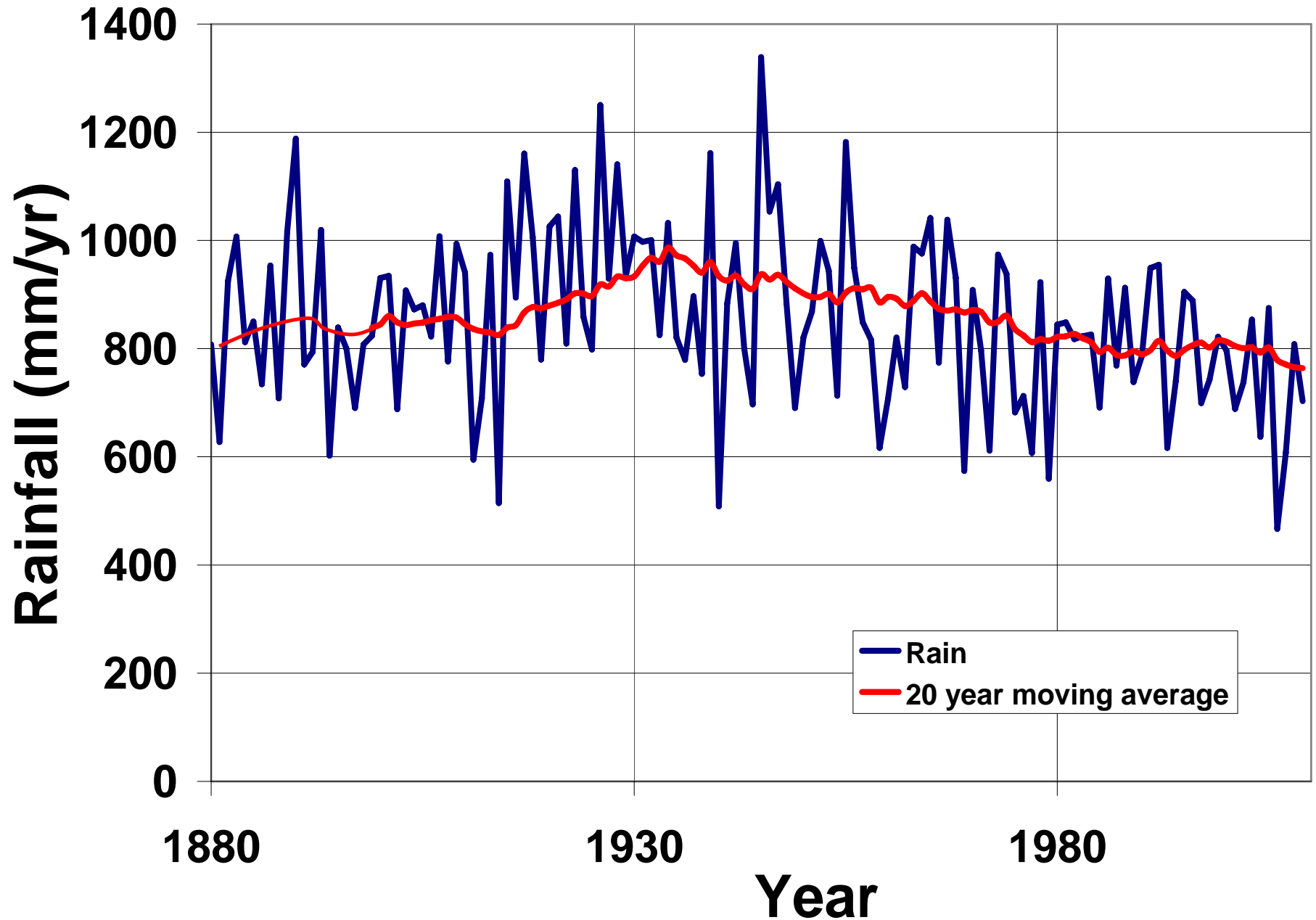
Pearce Rainfall



Kwinana rainfall

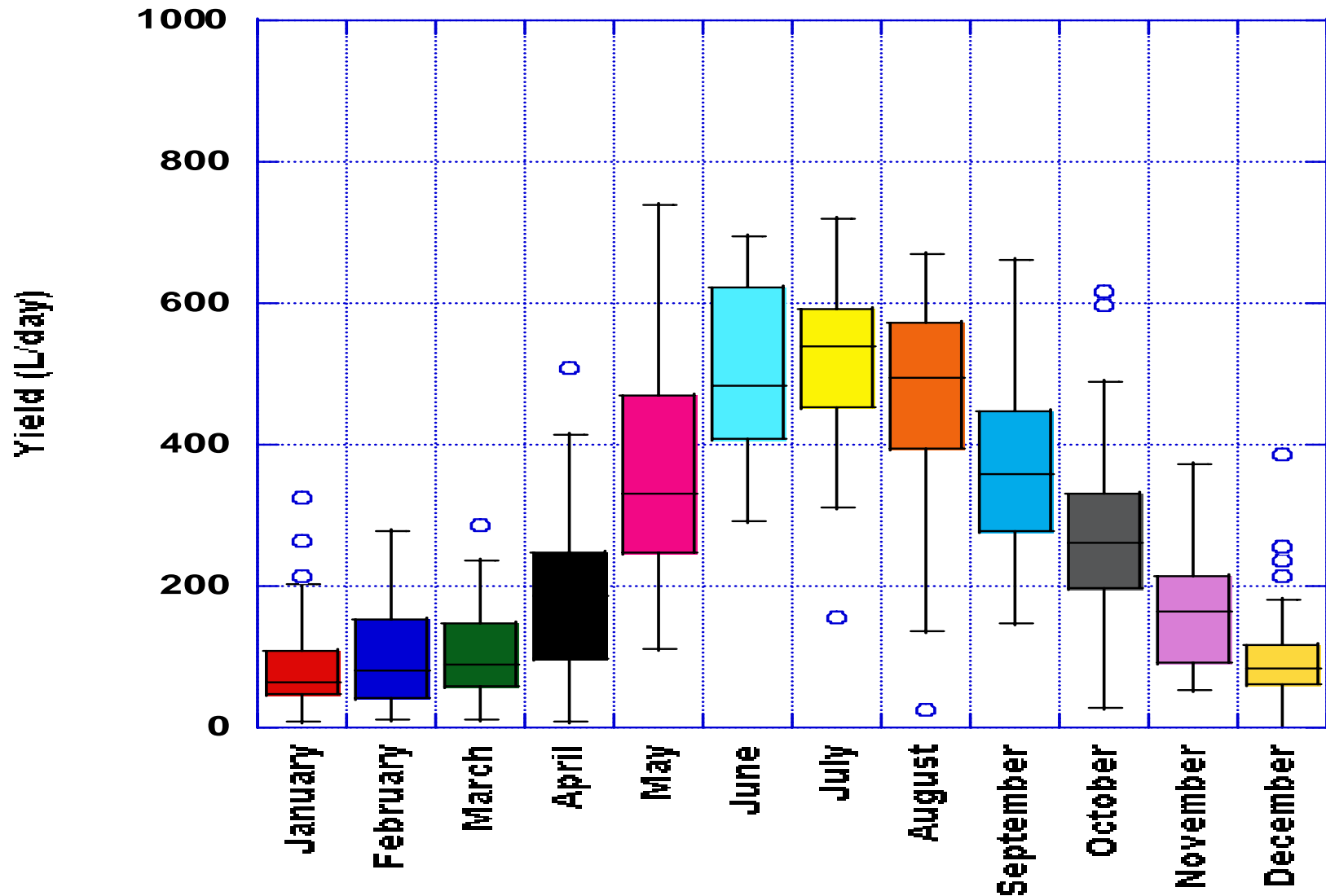


Perth rainfall

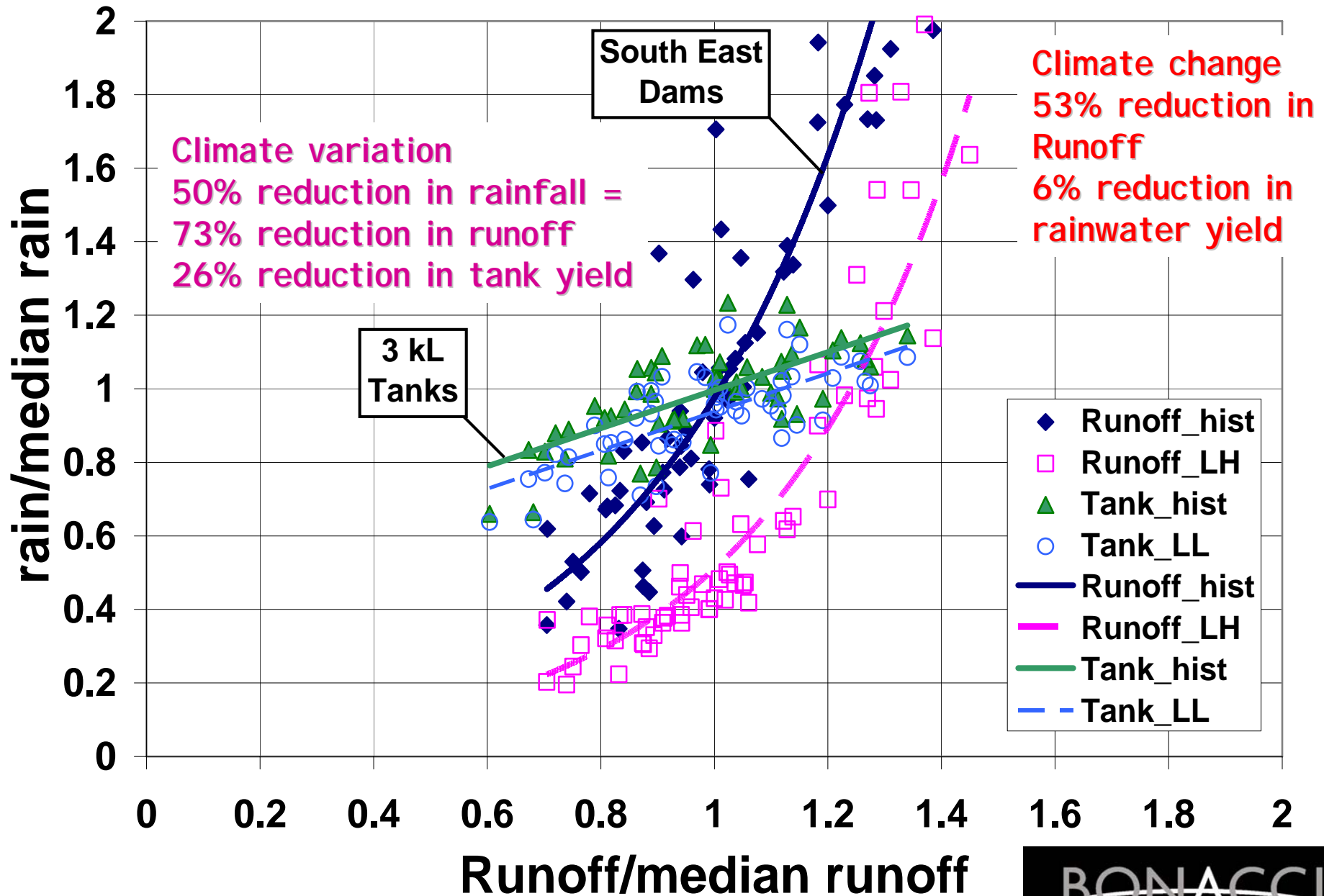


Performance of rainwater tanks in Perth

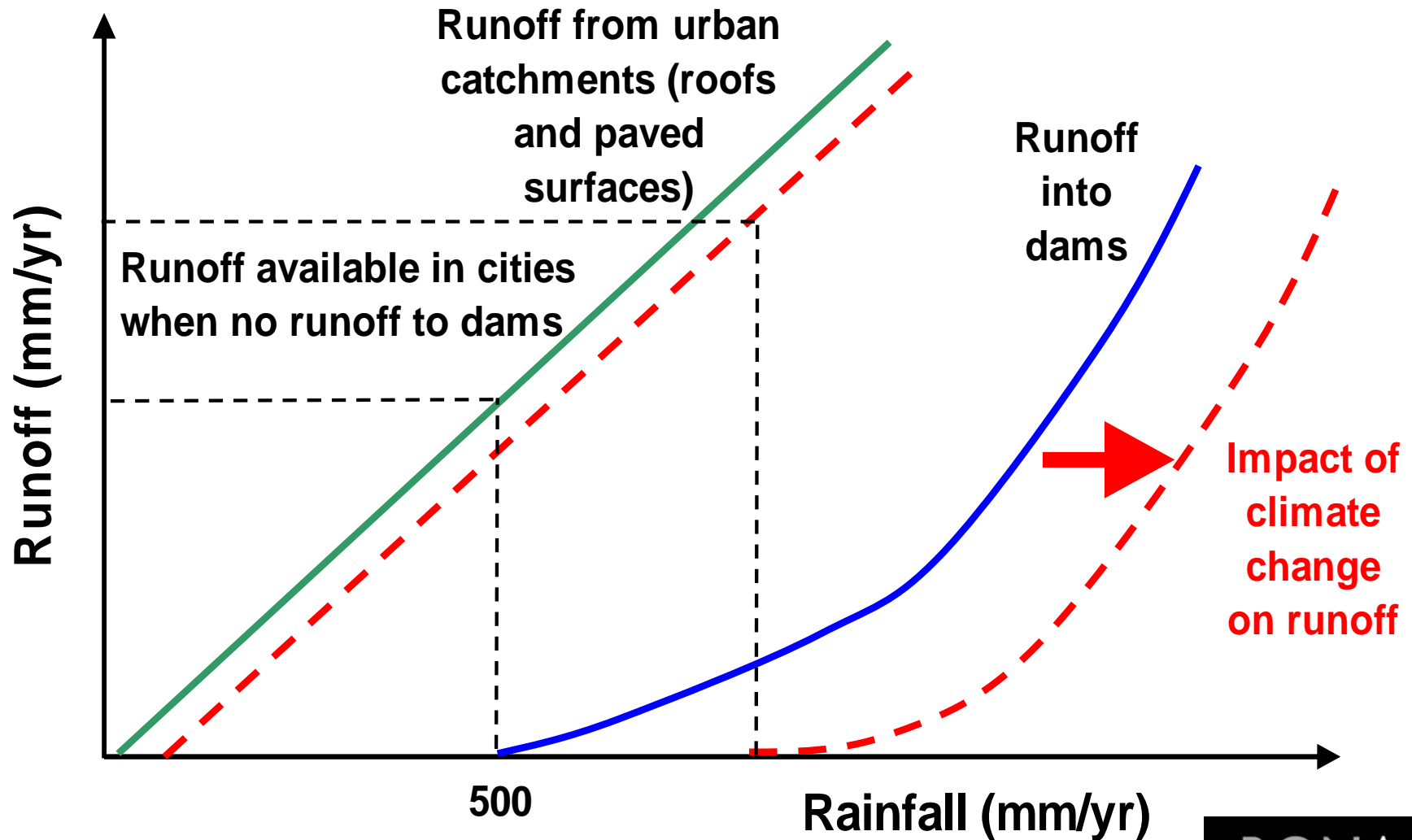
Perth



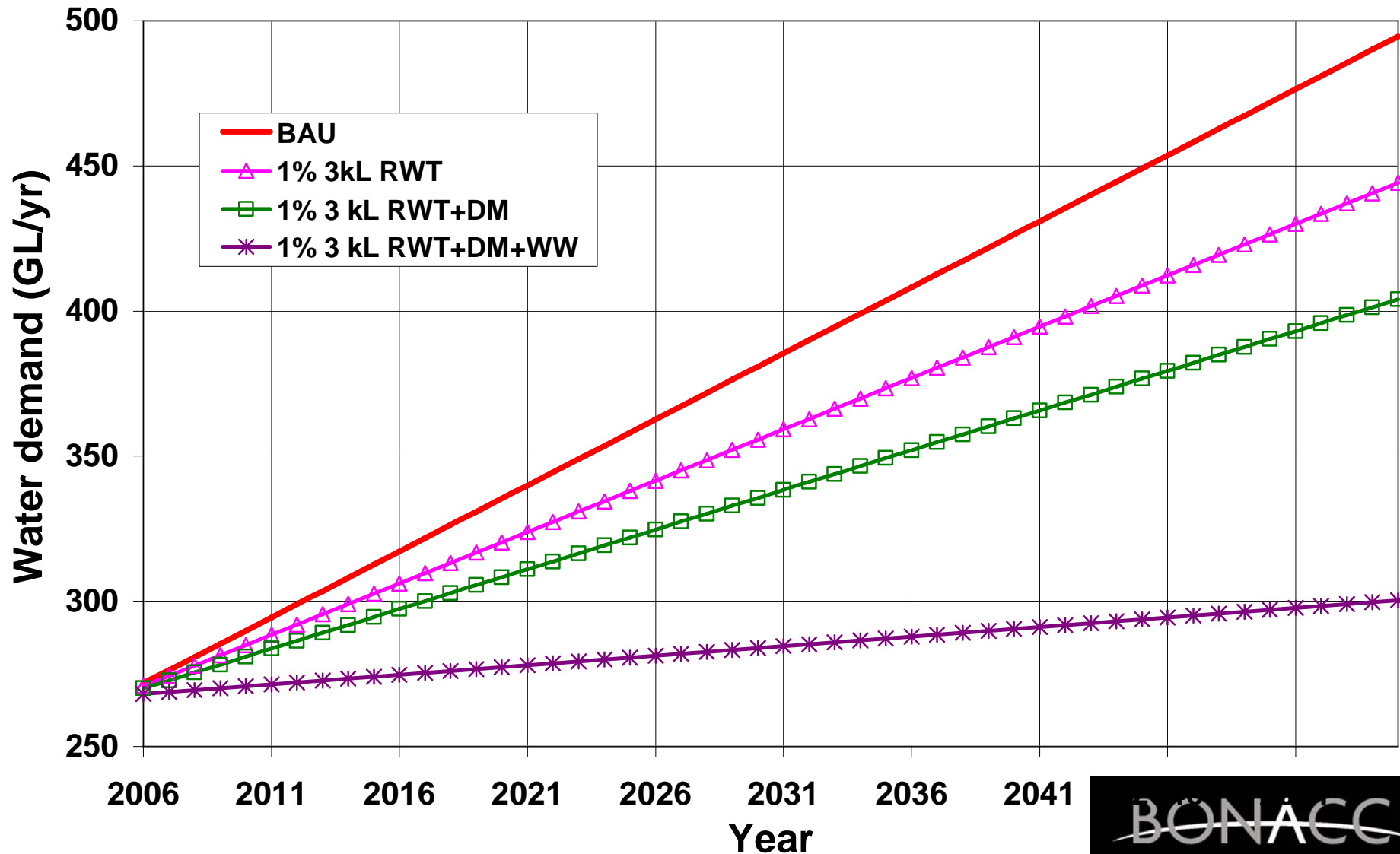
Natural variation & climate change



Conceptual relative catchment efficiency



Perth's water futures: including decentralised strategies



Perth's water futures: including decentralised strategies - improved water security

Scenario	Augmentation timing (year)			
	BAU	RWT	RWT+DM	RWT+DM+WW
BAU	2041, 2052			
New houses		2047	2053	>2055
New+ 1% houses		2052	>2055	>2055
New+ 2% houses		>2055	>2055	>2055



Results: economics and CO₂ emissions

Economic benefits derived from reduced regional operating costs

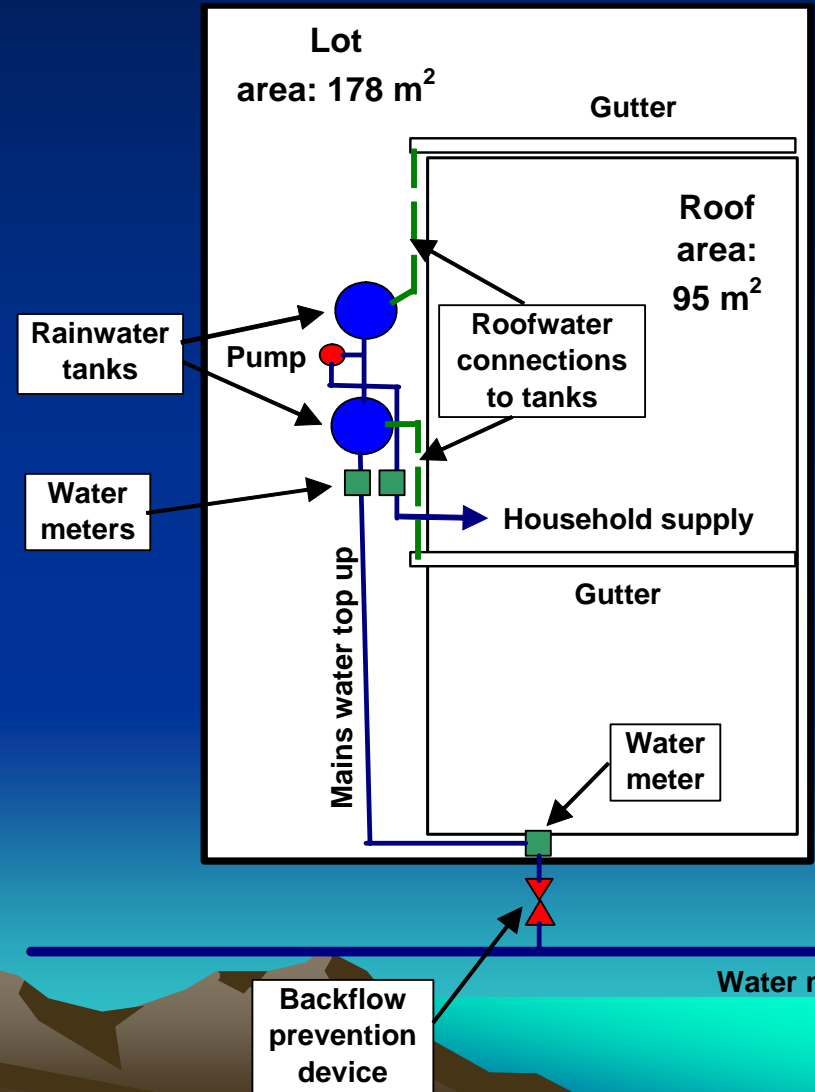
Scenario	Benefit (\$/house)		
	RWT	RWT+DM	RWT+DM+WW
New houses	1,098	1,732	3,403
New + 1% houses	984	1,716	3,109
New + 2% houses	113	171	322

Change in CO₂ emissions

Scenario	Change in greenhouse gas emissions (%)		
	RWT	RWT+DM	RWT+DM+WW
New houses	-7	-15	-35
New + 1% houses	-12	-24	-56
New + 2% houses	+24	+7	-24

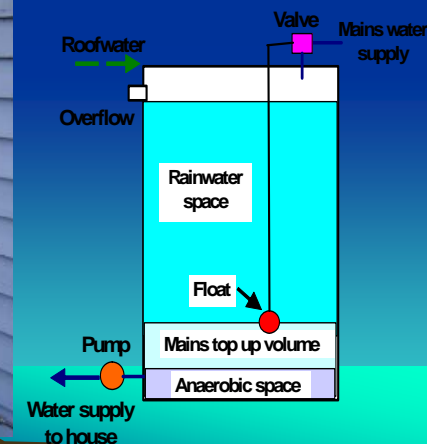
Systems and Synergies: a lot scale example

- 84% (95 m²) roof area connected to tanks
- Two 2,200 L tanks supply all household water uses
- Trickle top up with mains water
- 4A rated washing machine
- Existing water use is 183 kL/annum
- Two residents



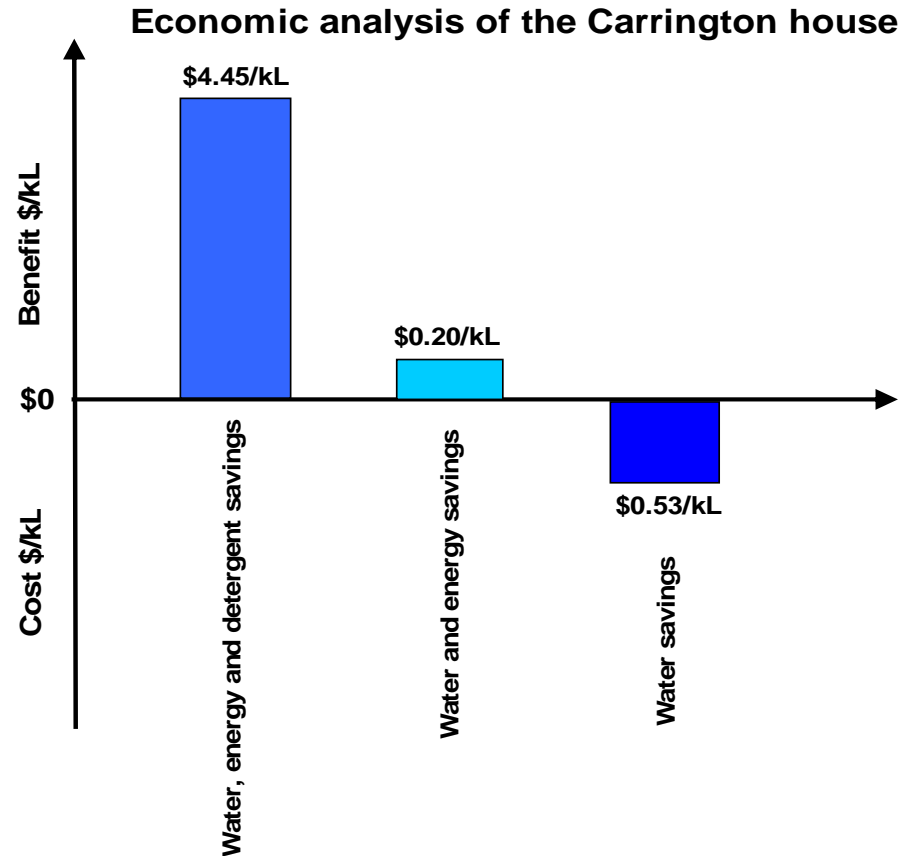
Monitoring results

- Installation costs:
 - Tanks: \$2,350
 - Washing machine: \$940
- 6 years monitoring
- Reduced impacts
 - Water: 131 kL/yr (71%)
 - Electricity: 19% reduction
 - CO2: 1,126 kg/yr
 - Detergent use
- Savings:
 - Water: \$167/yr
 - Electricity: \$146
 - Detergent: \$1029

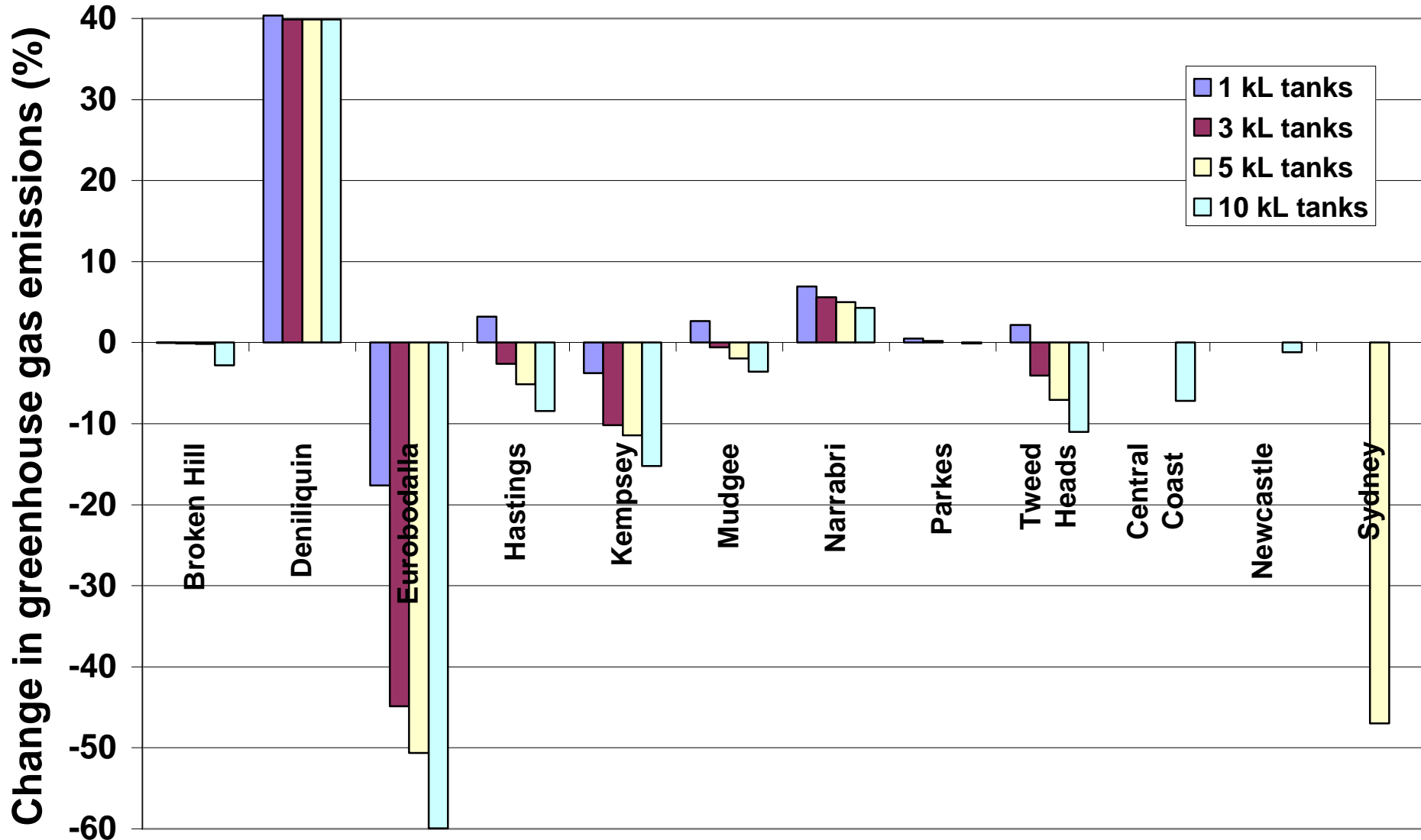


A systems response

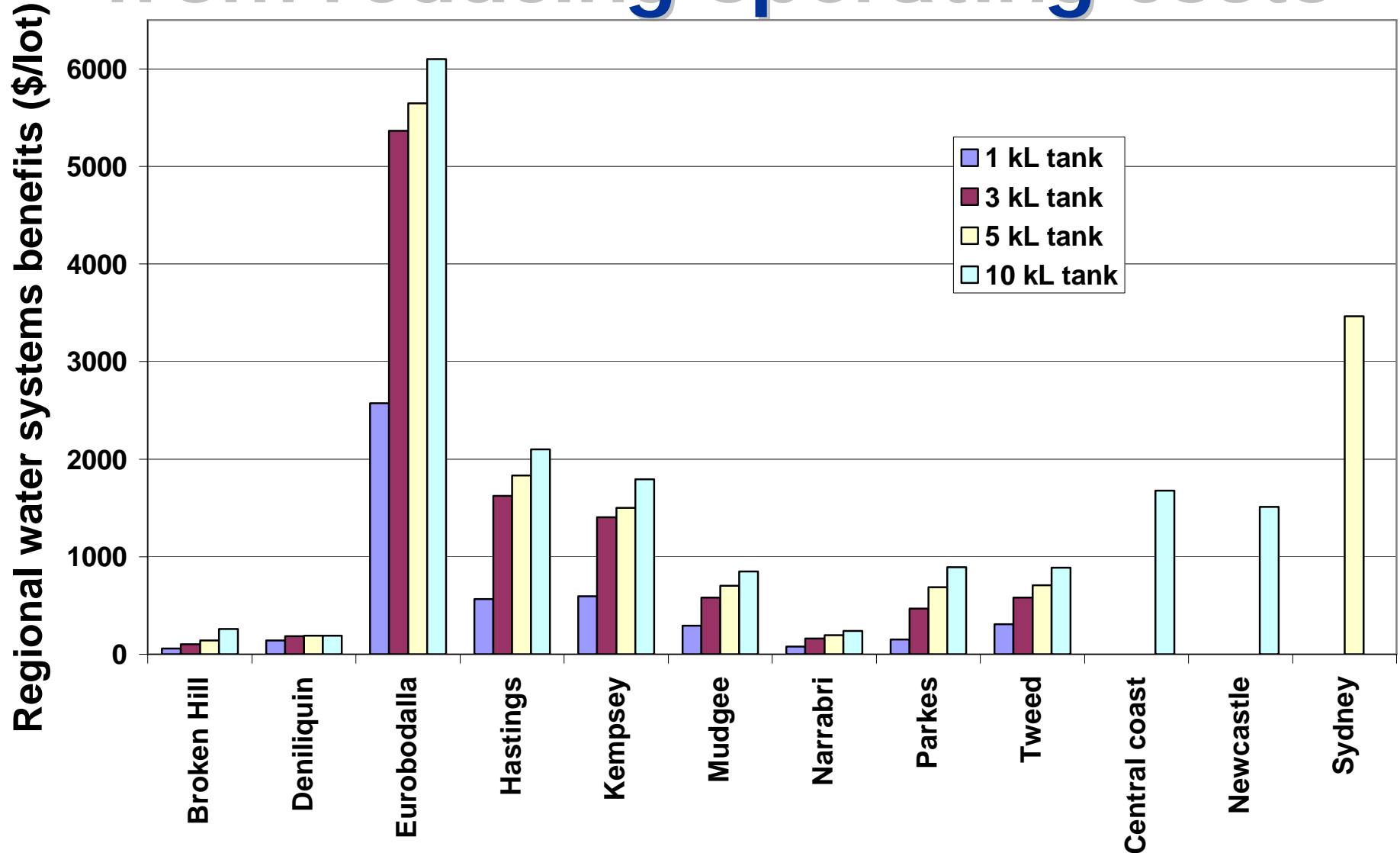
- Reduced water use
 - Washing machine 14%
 - Lower water pressures: 8%
 - Behavior change: 5%
- Reduced energy use
 - Washing machine
 - Lower water pressures and flow rates



Impact on CO₂ emissions from decentralised water strategies



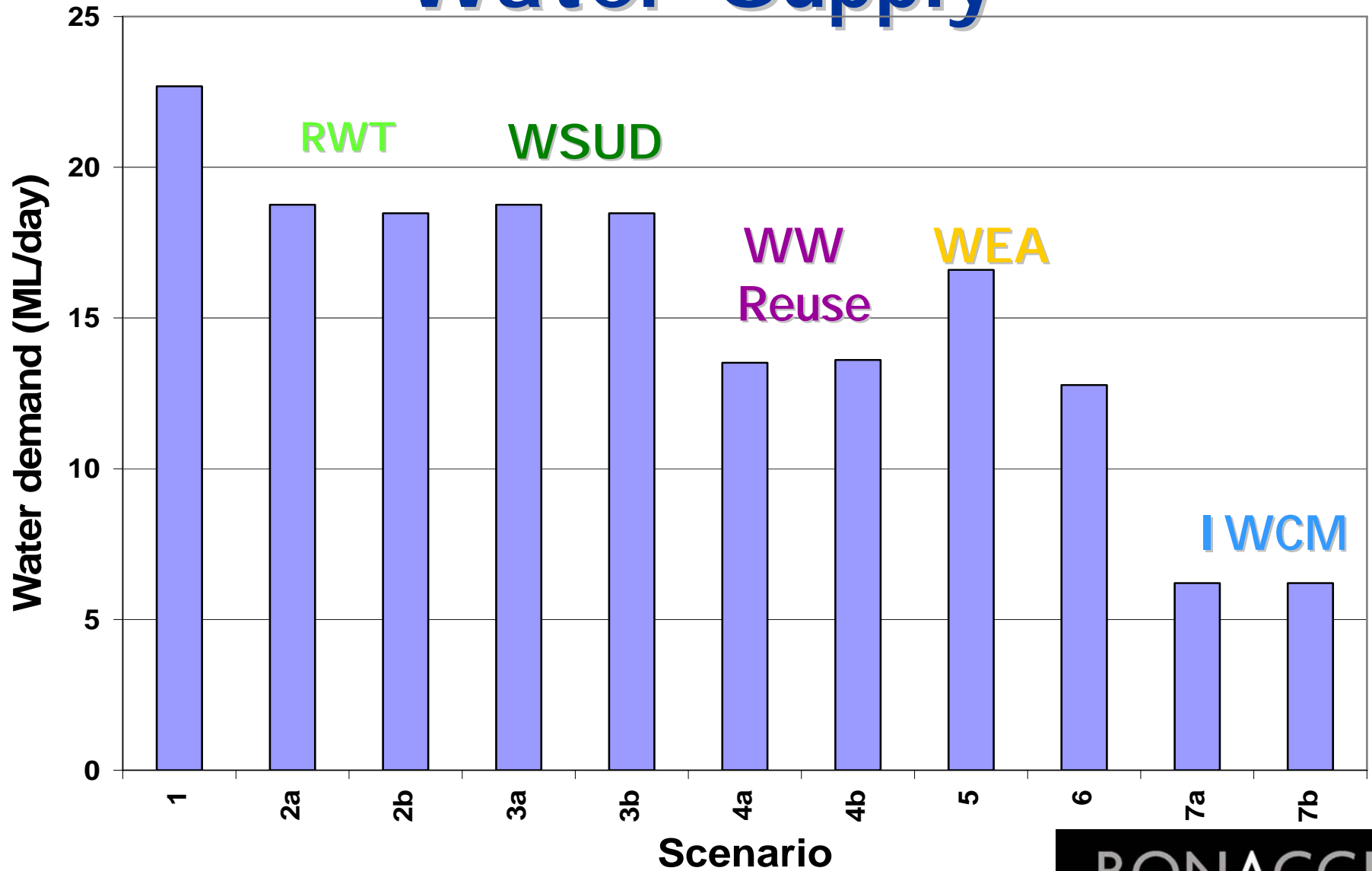
Economic benefits derived from reducing operating costs



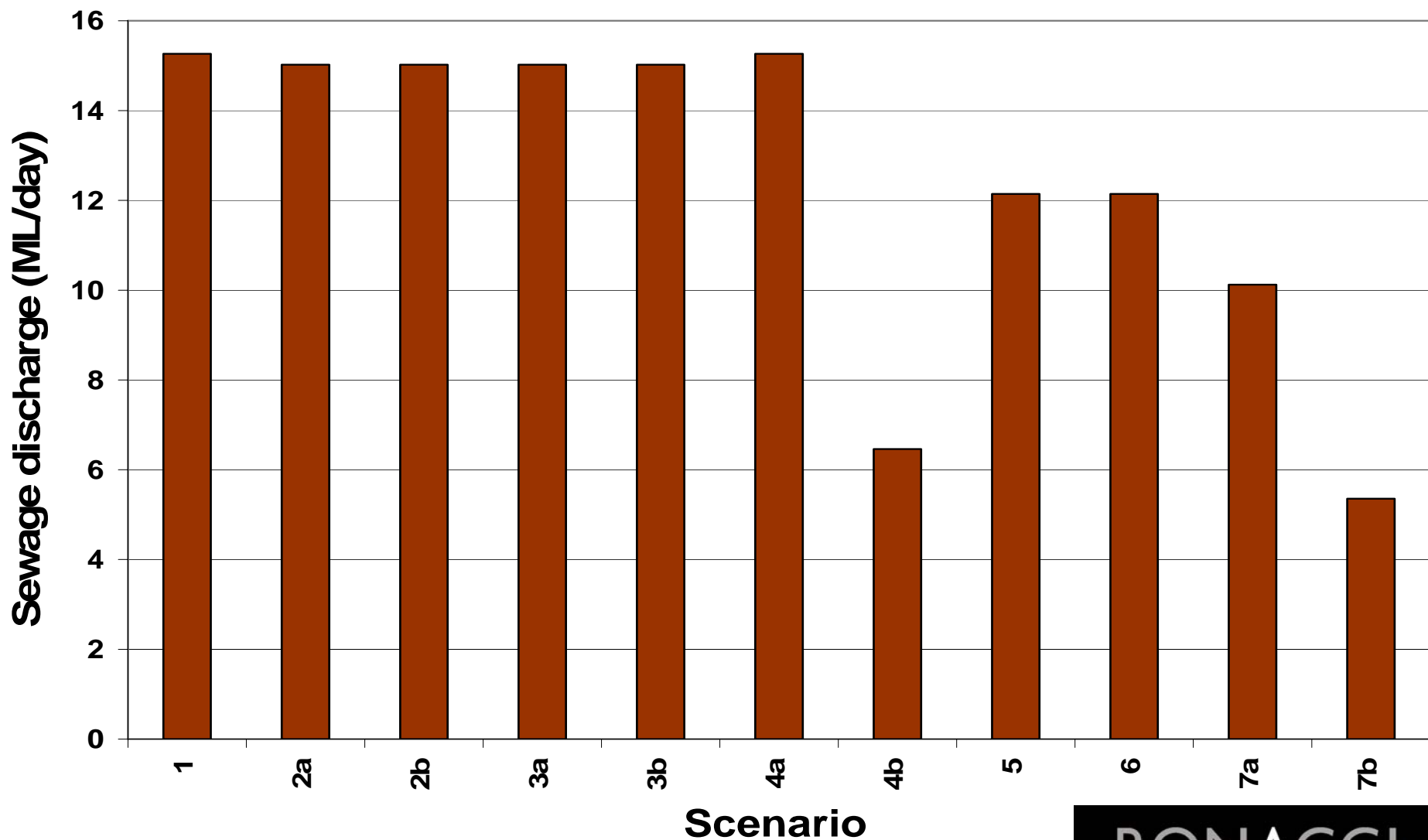
Armstrong Creek I WCM Strategy



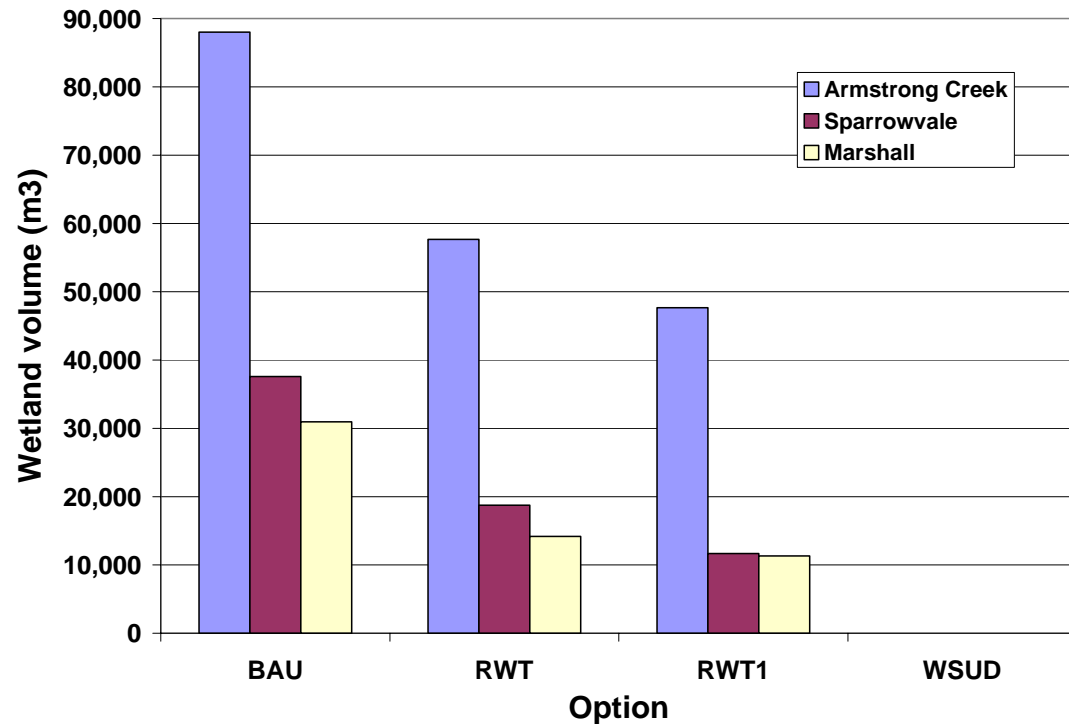
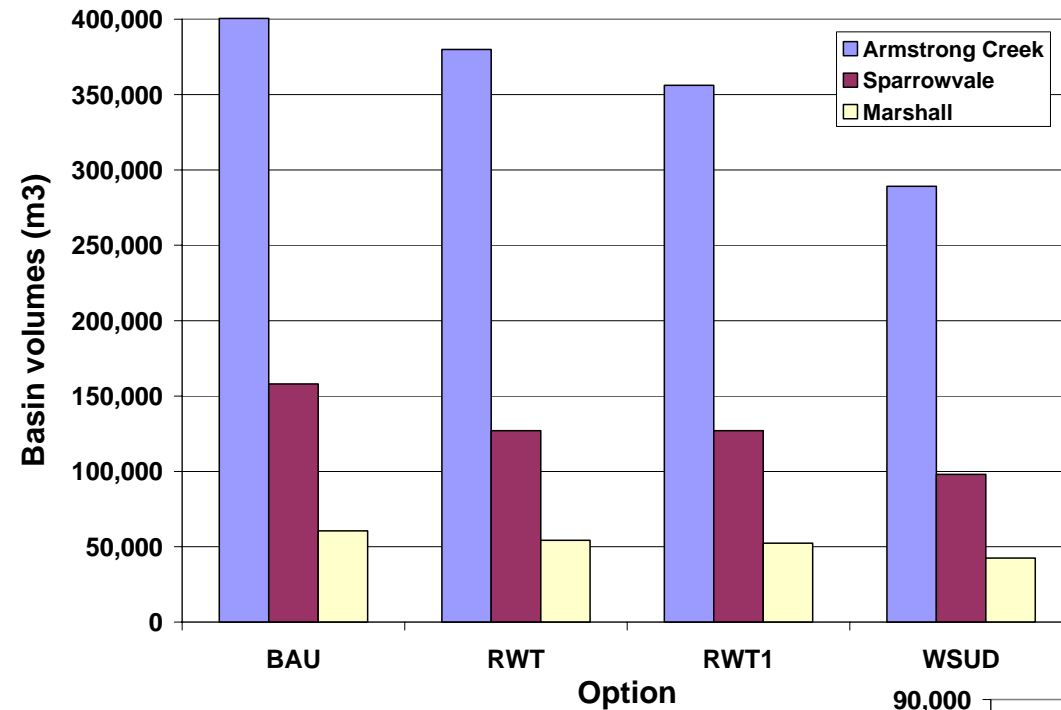
Water Supply



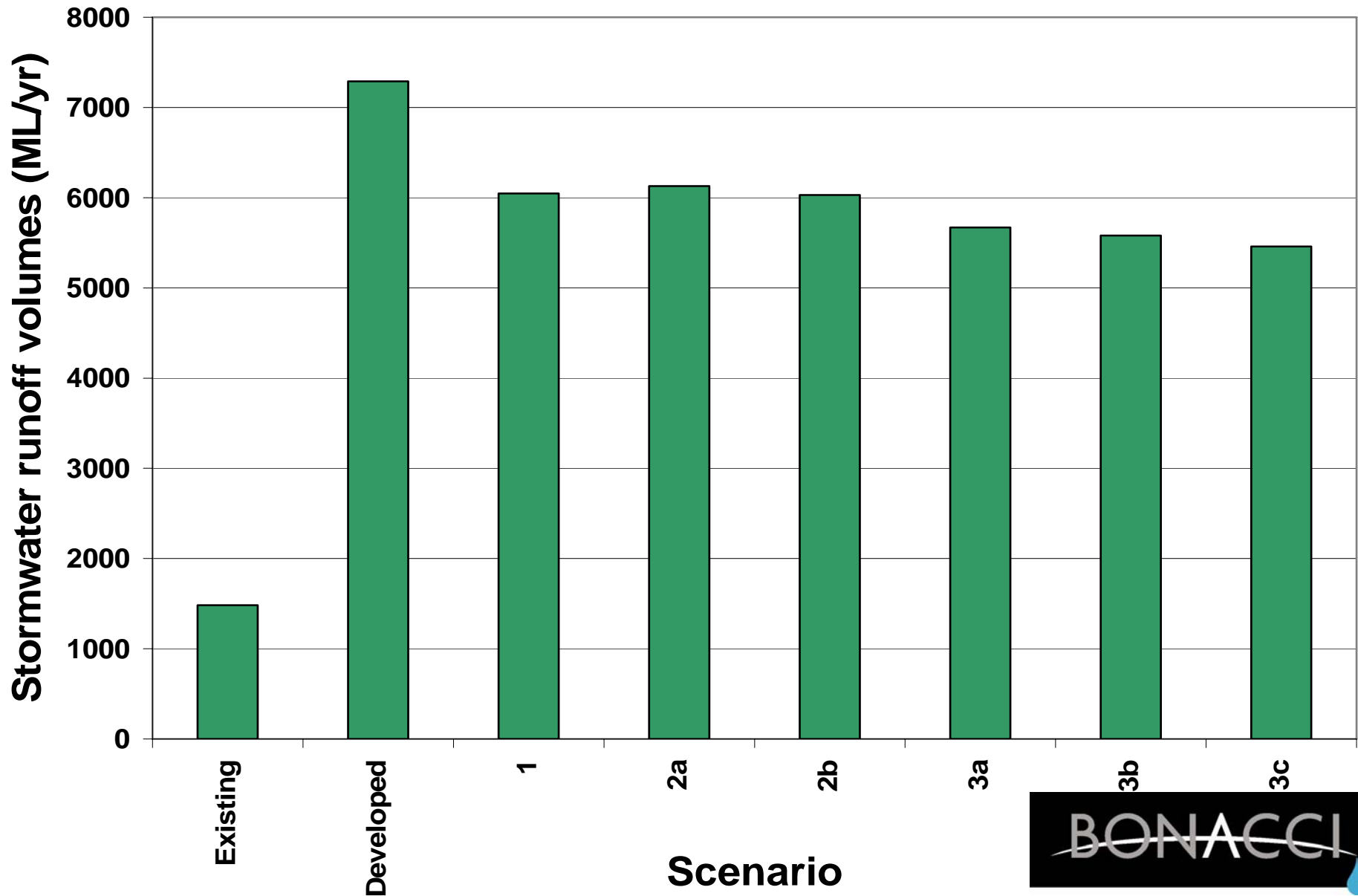
Wastewater discharges



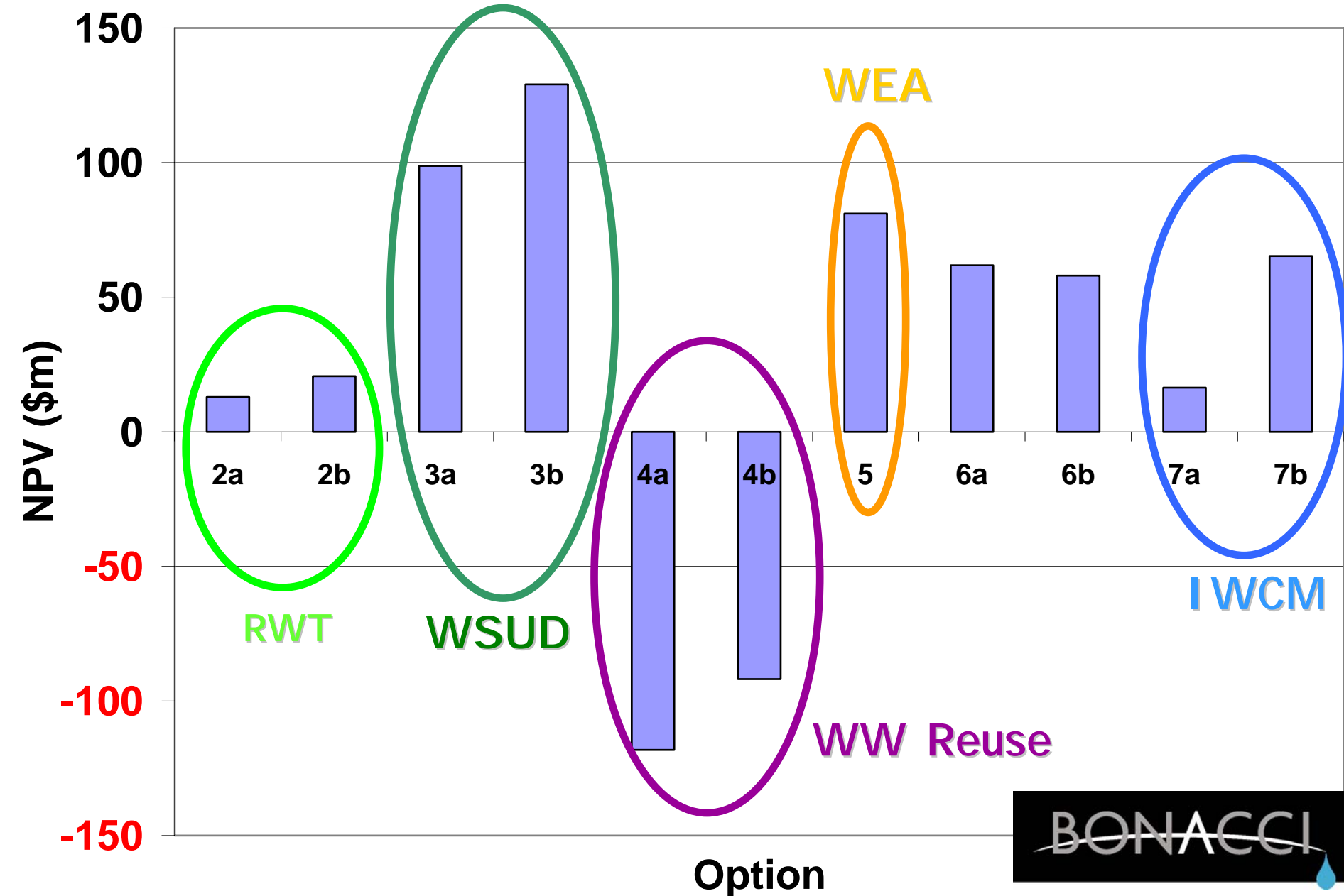
Requirement for Stormwater Infrastructure



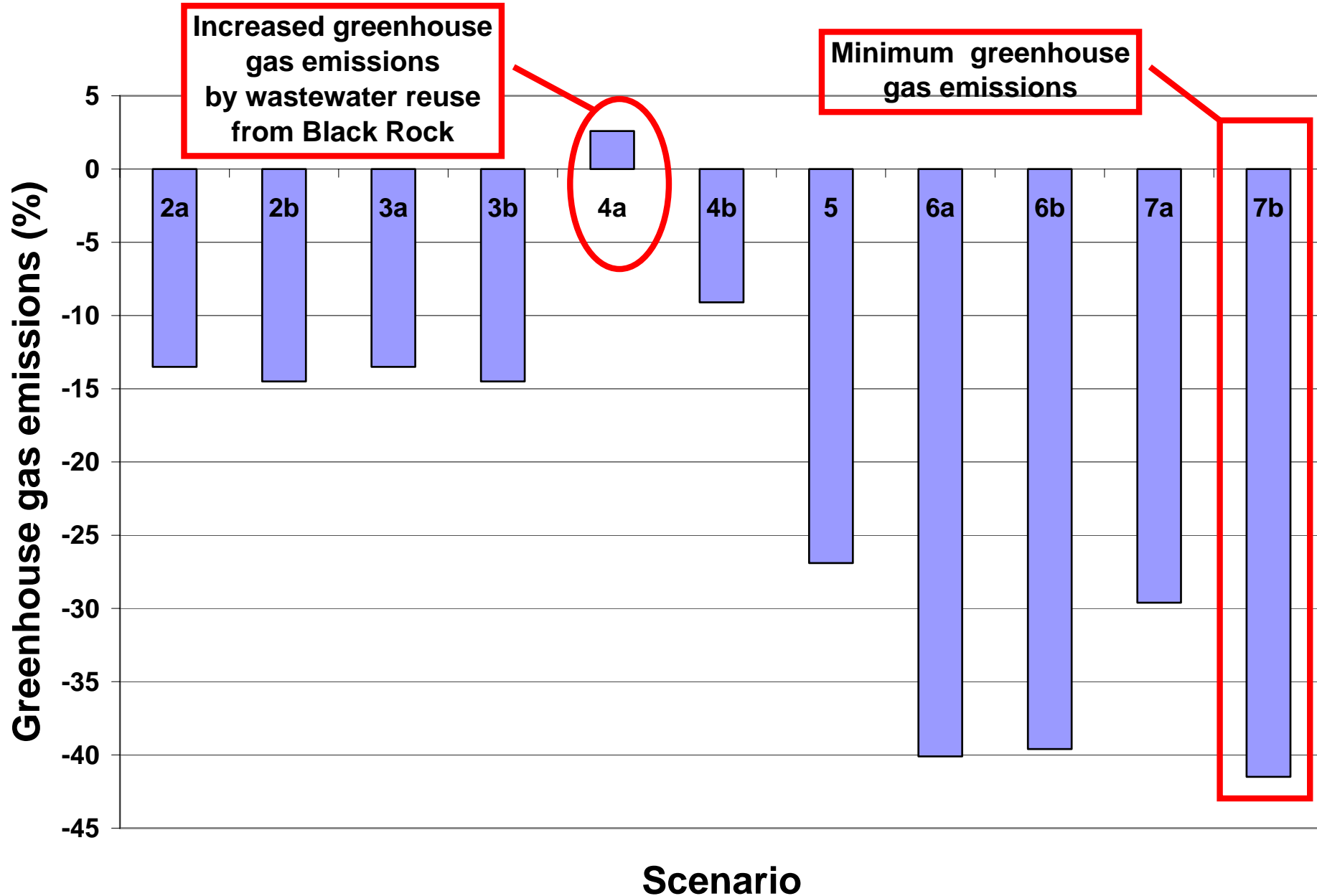
Stormwater runoff



Economic Evaluation

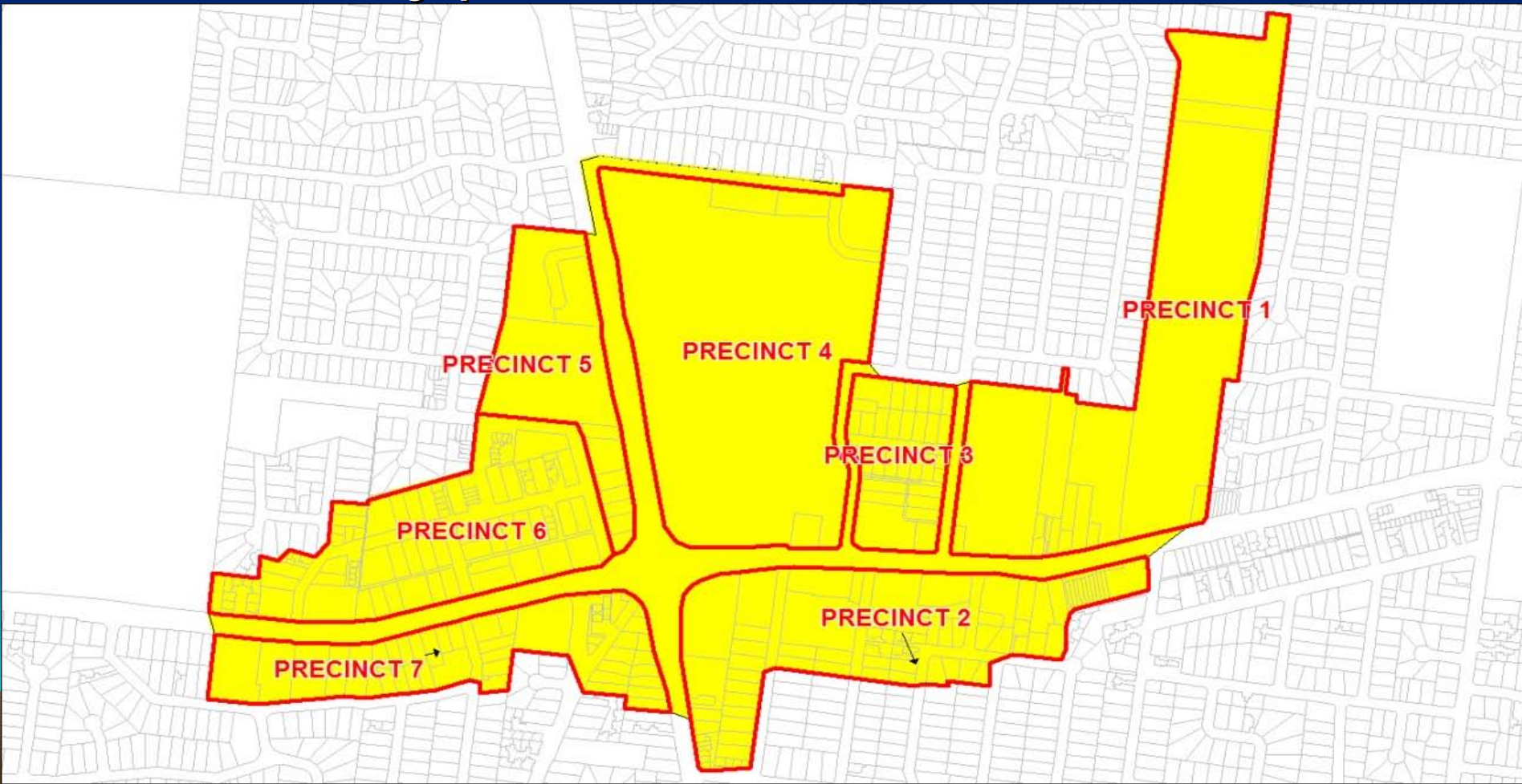


Greenhouse Gas Emissions

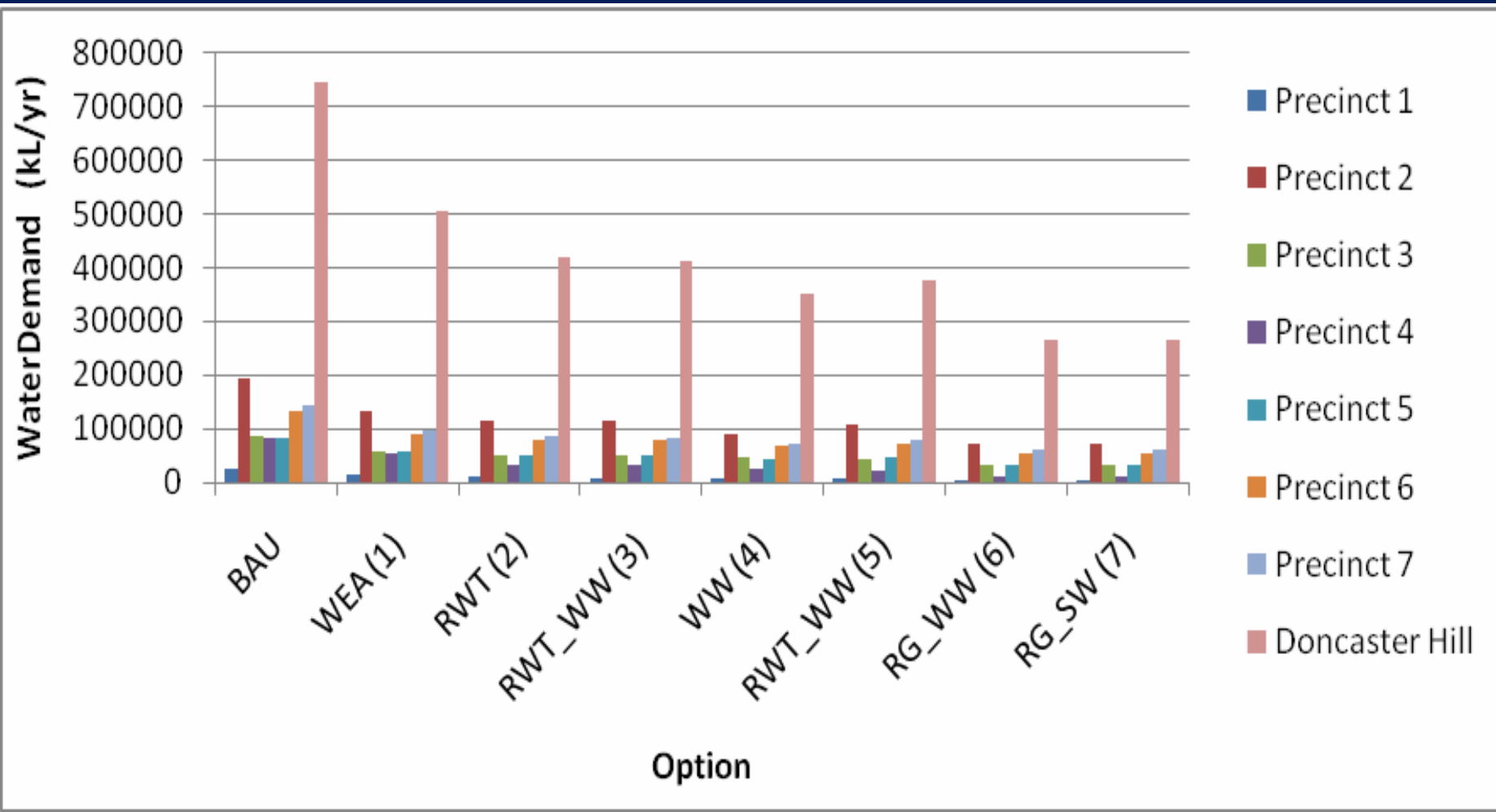


Doncaster Hill – brownfield site

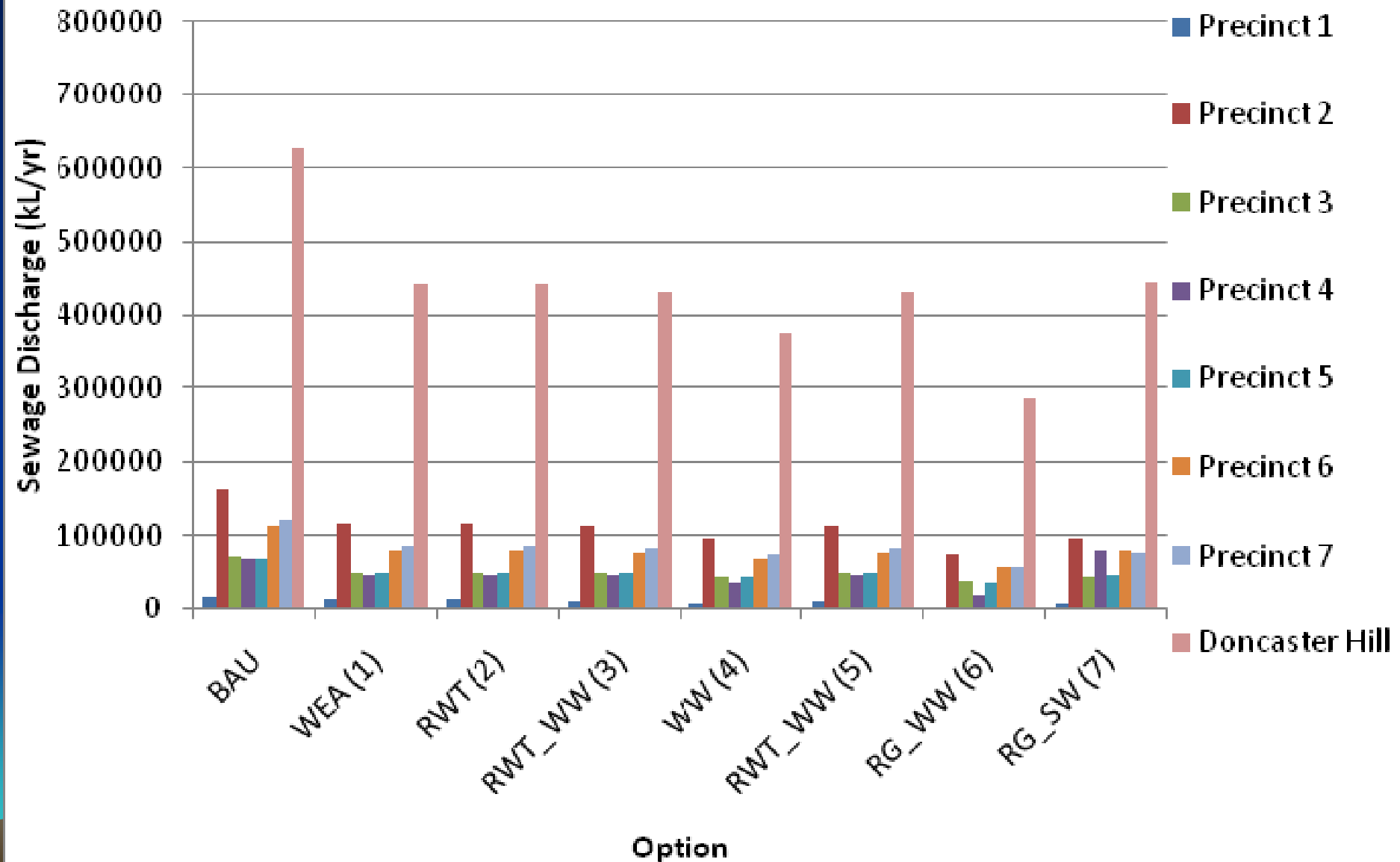
- Urban renewal of a Principal Activity Centre
- Increase density to accommodate 15,000 people
- Key motivation includes development of an exemplar sustainability precinct



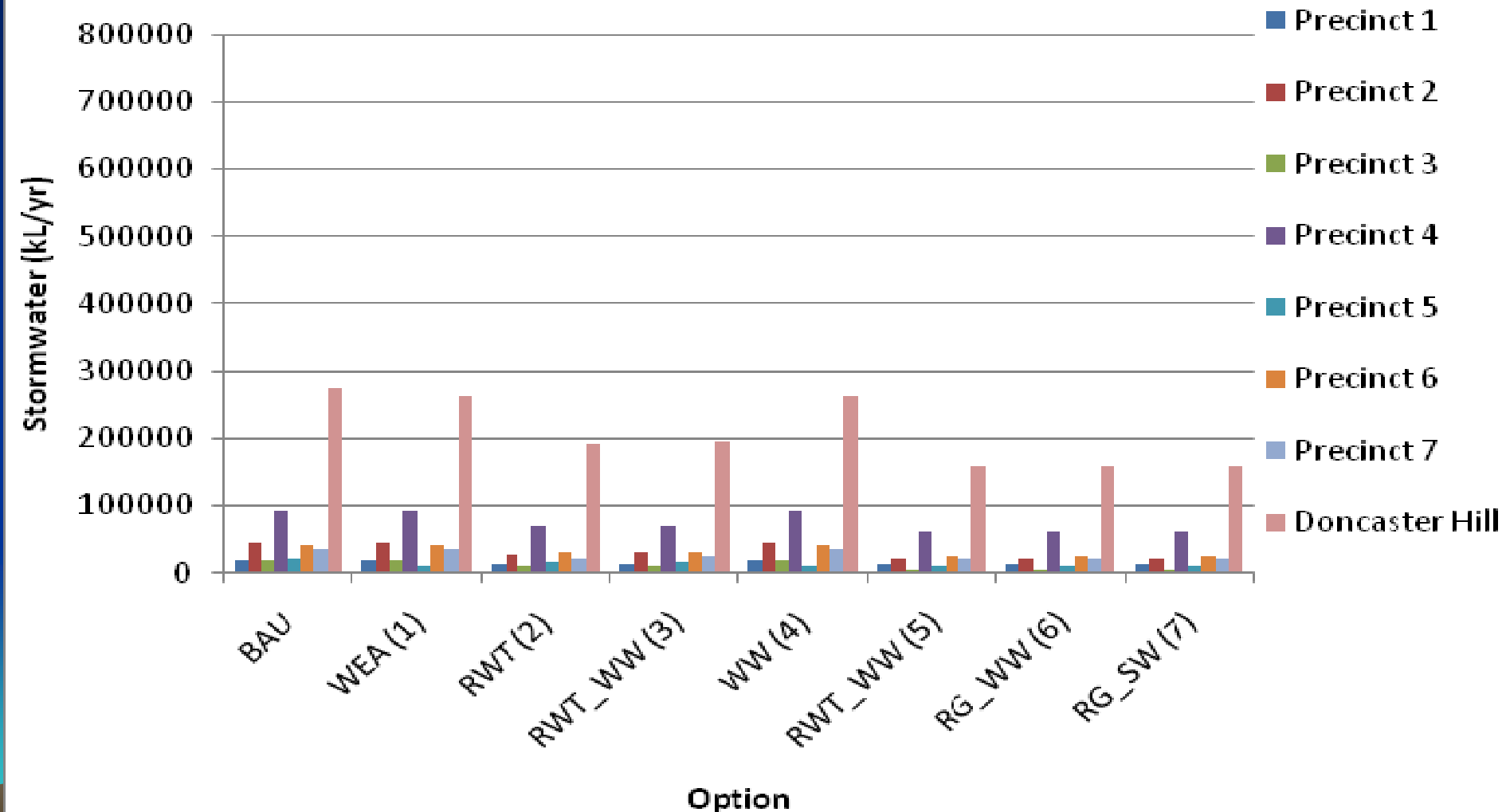
Water demands



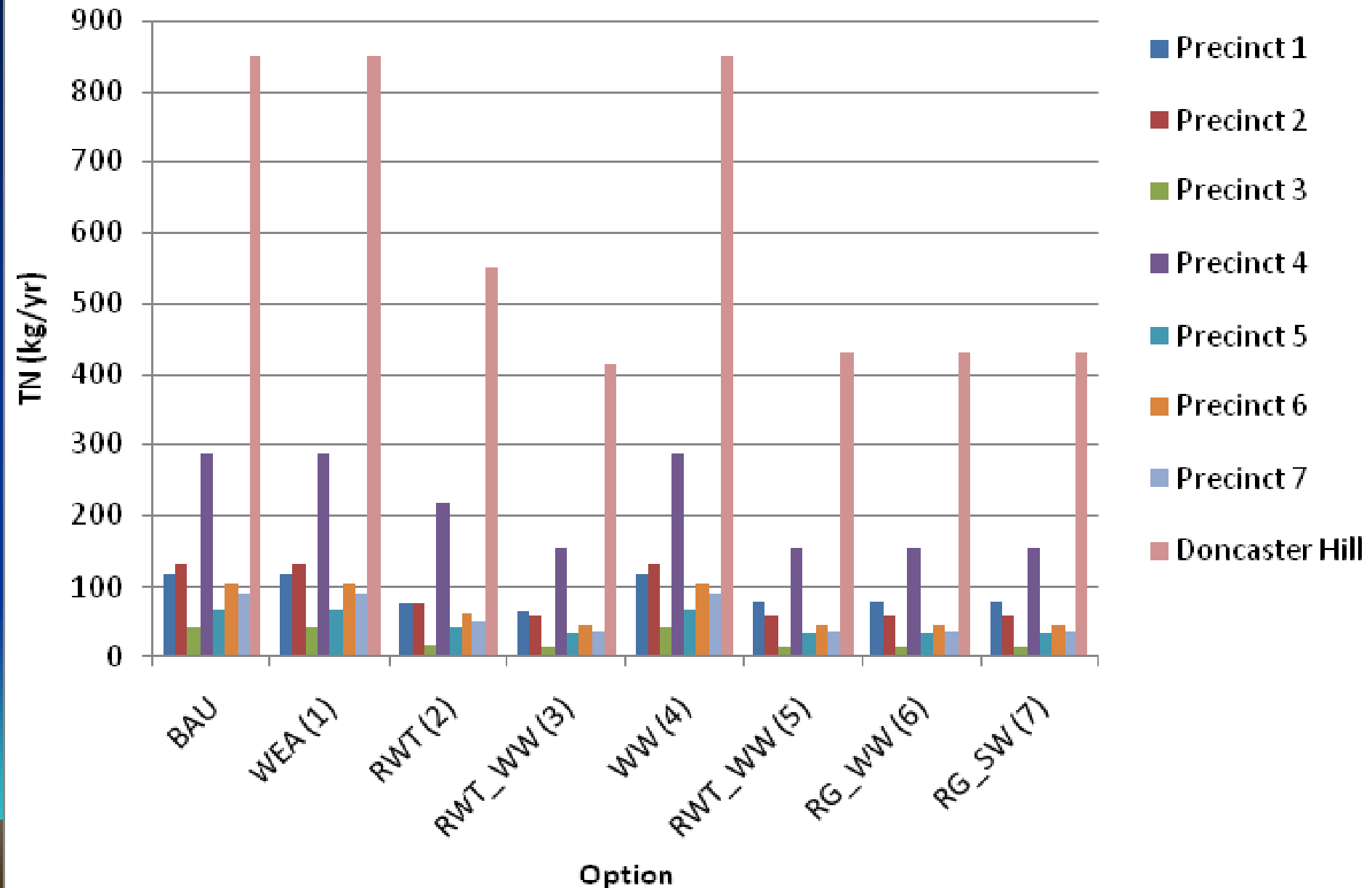
Wastewater discharges



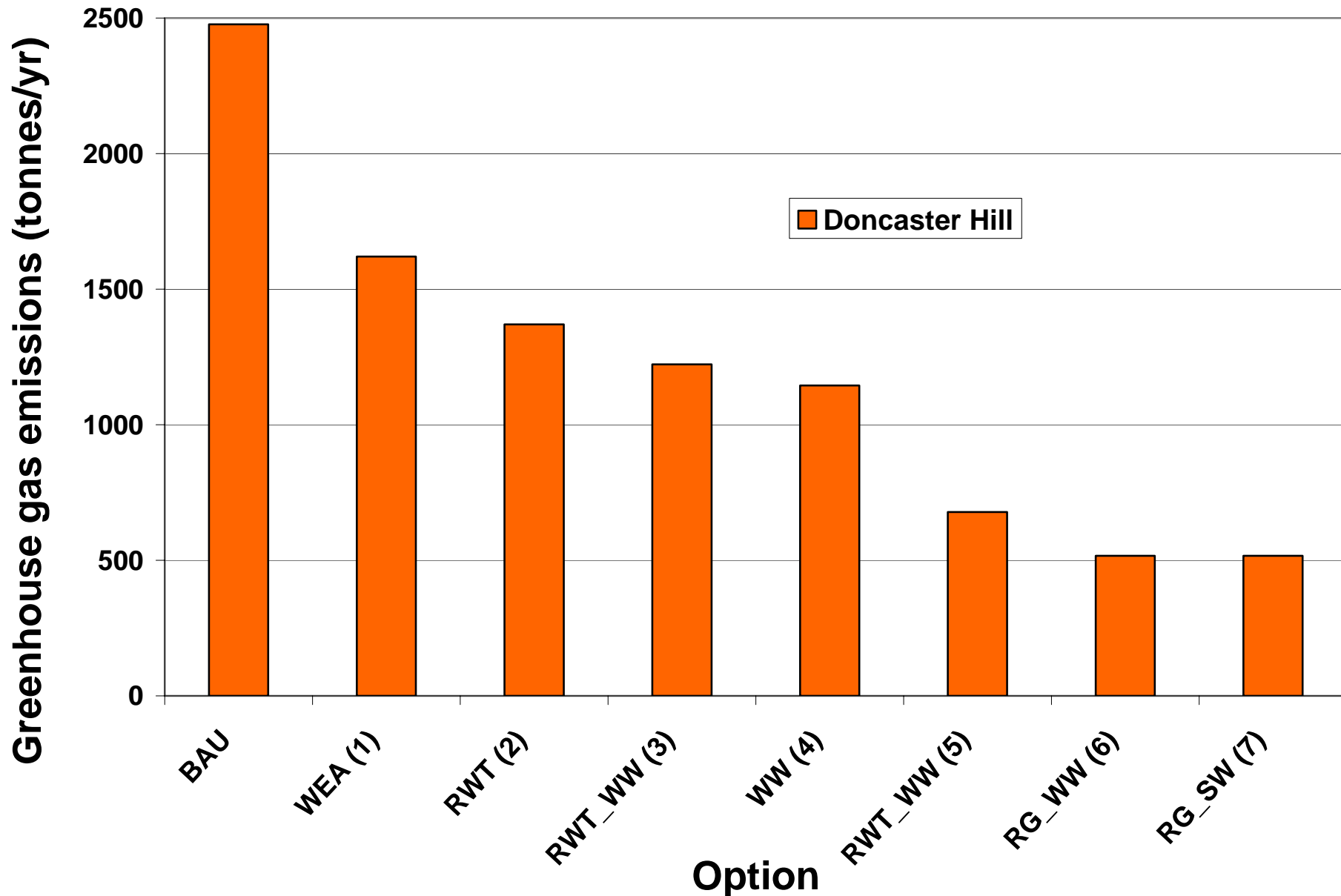
Stormwater runoff



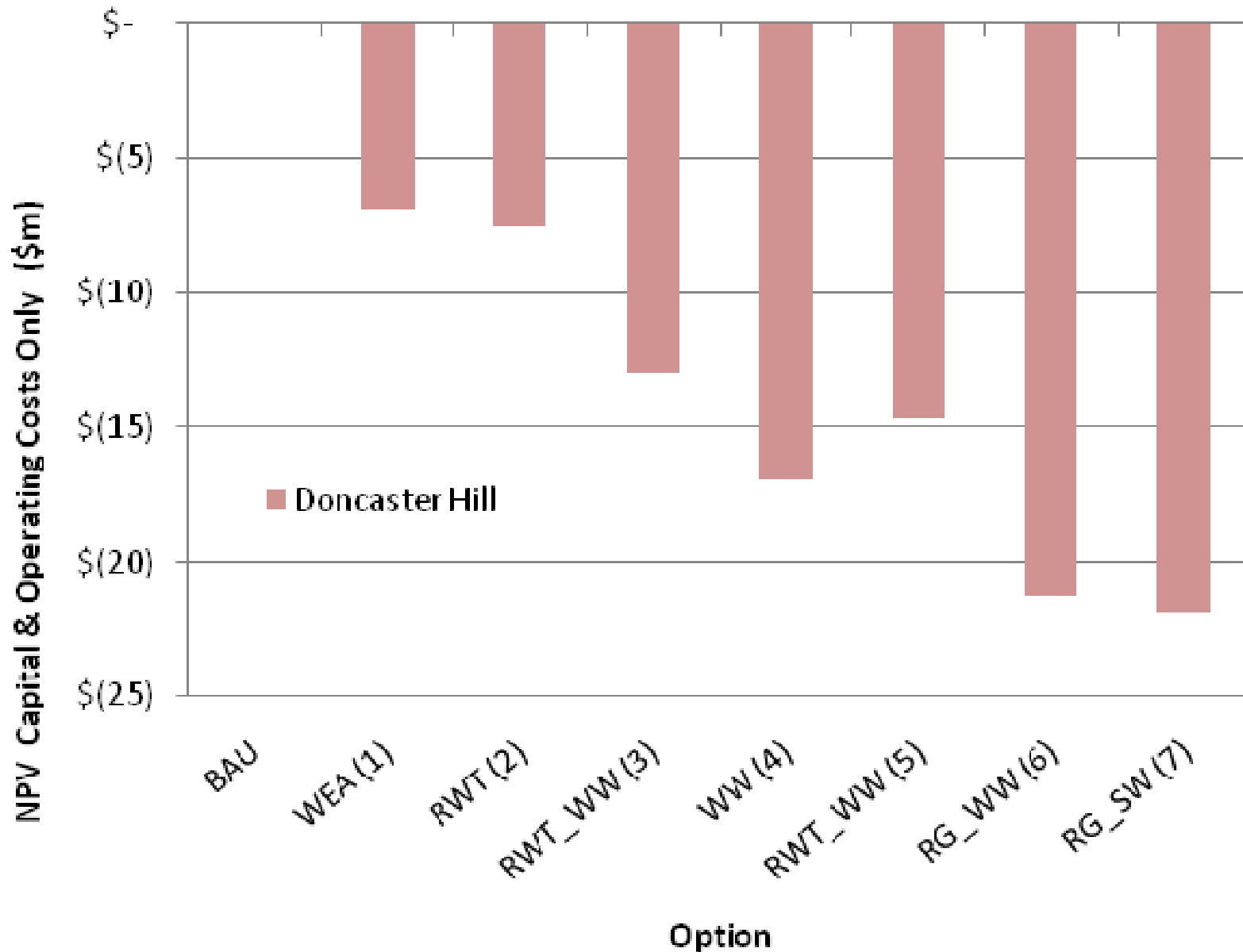
Nitrogen Loads



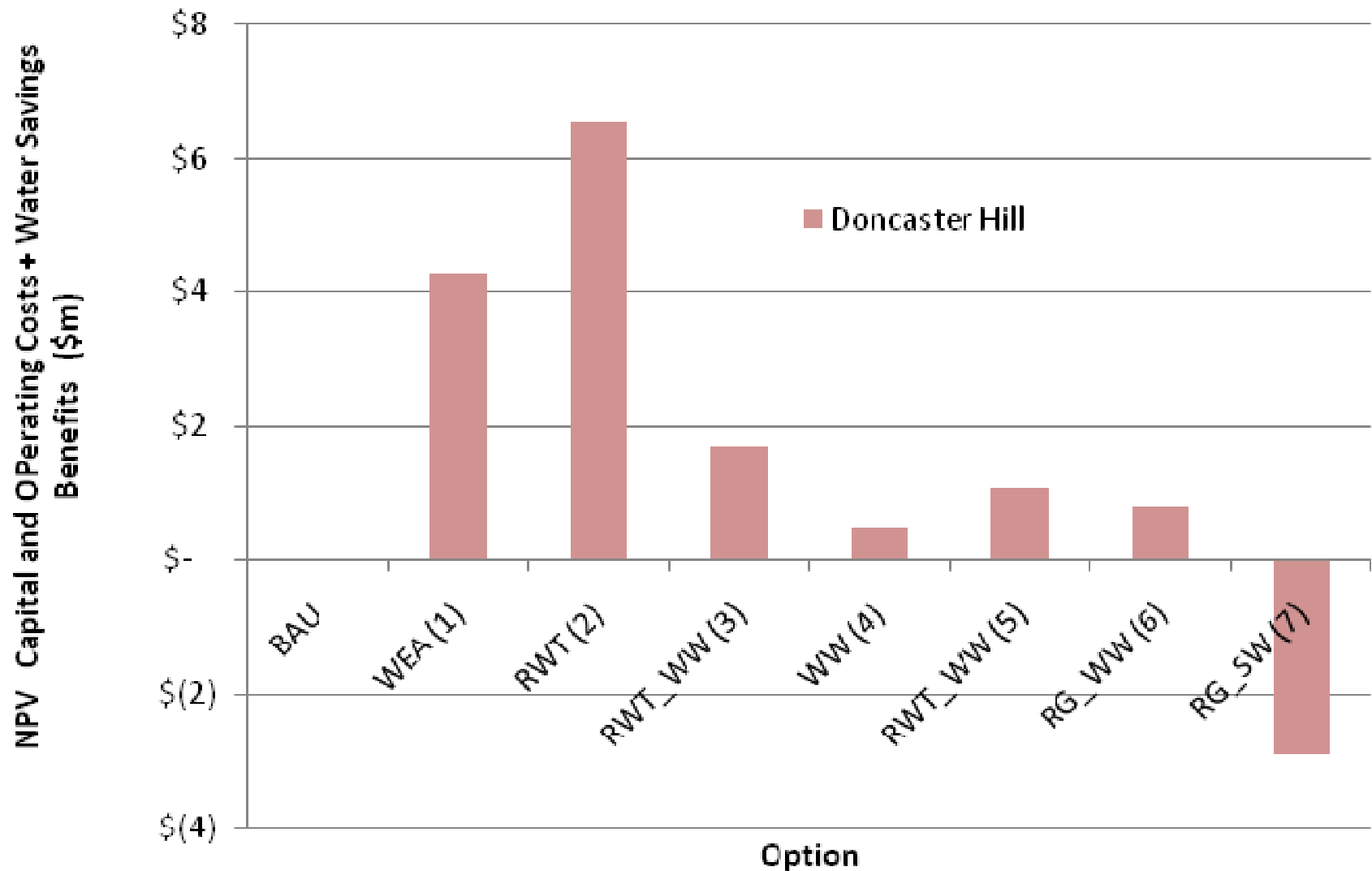
Greenhouse gas emissions



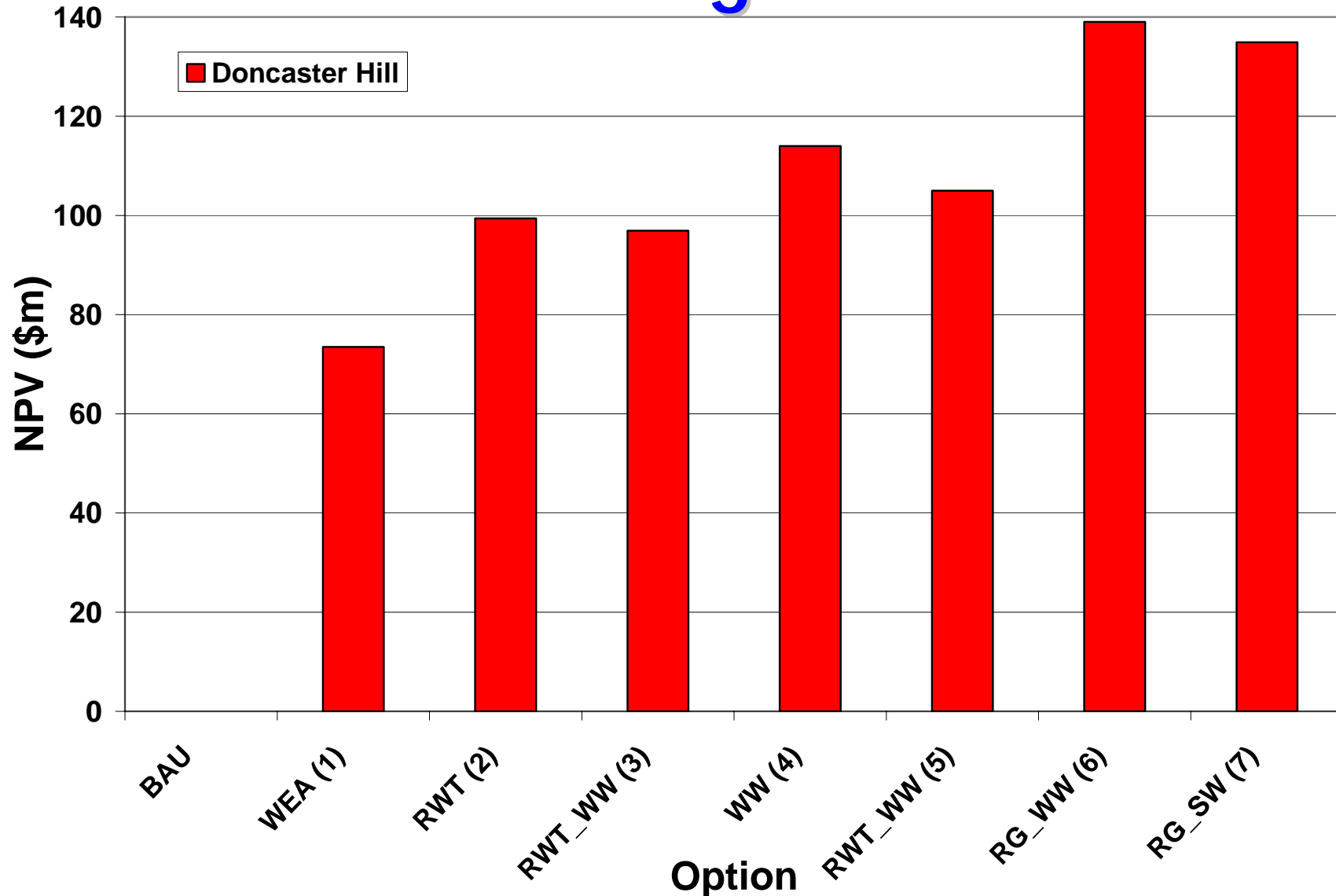
Water industry economics



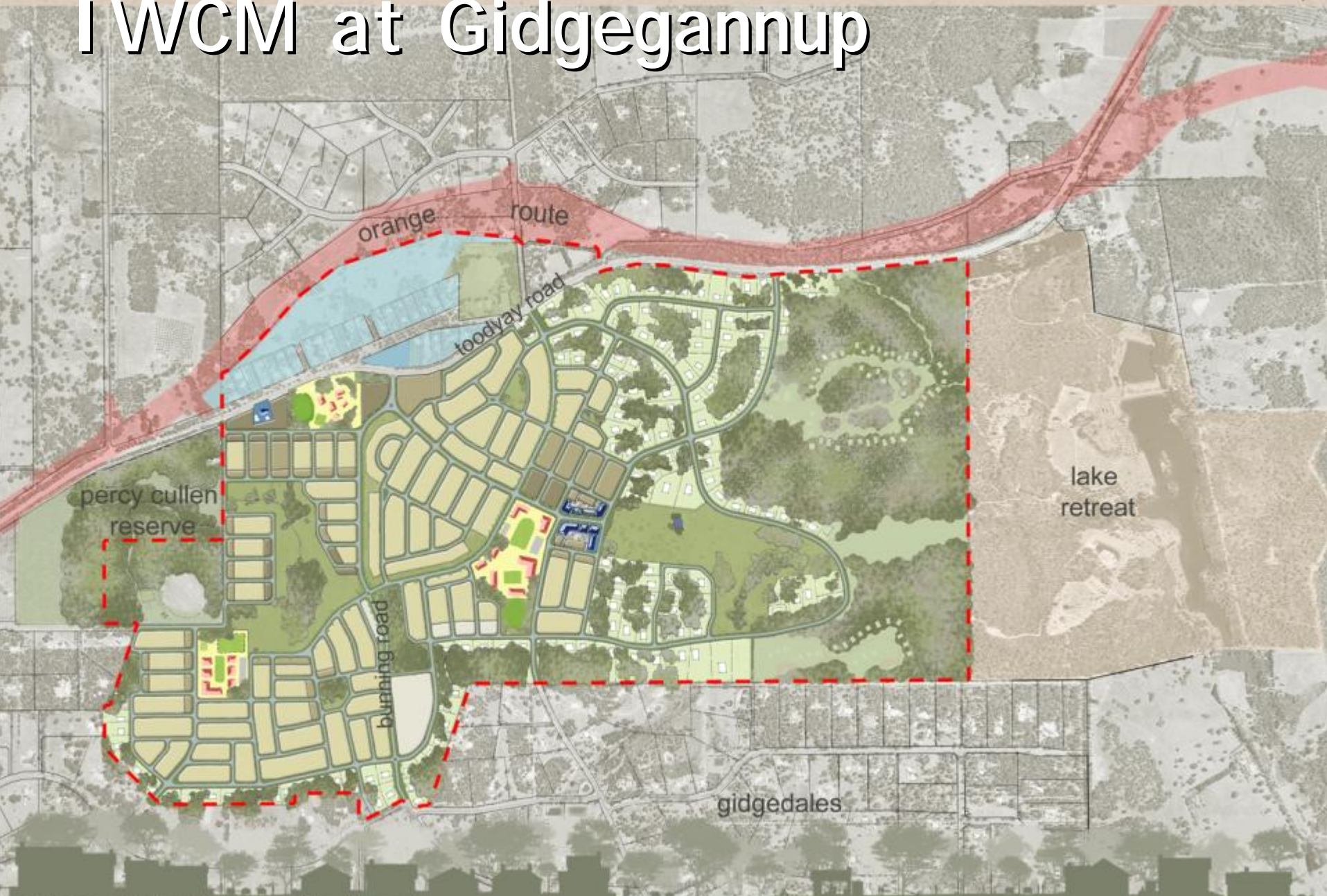
Economics – include benefits of saving water



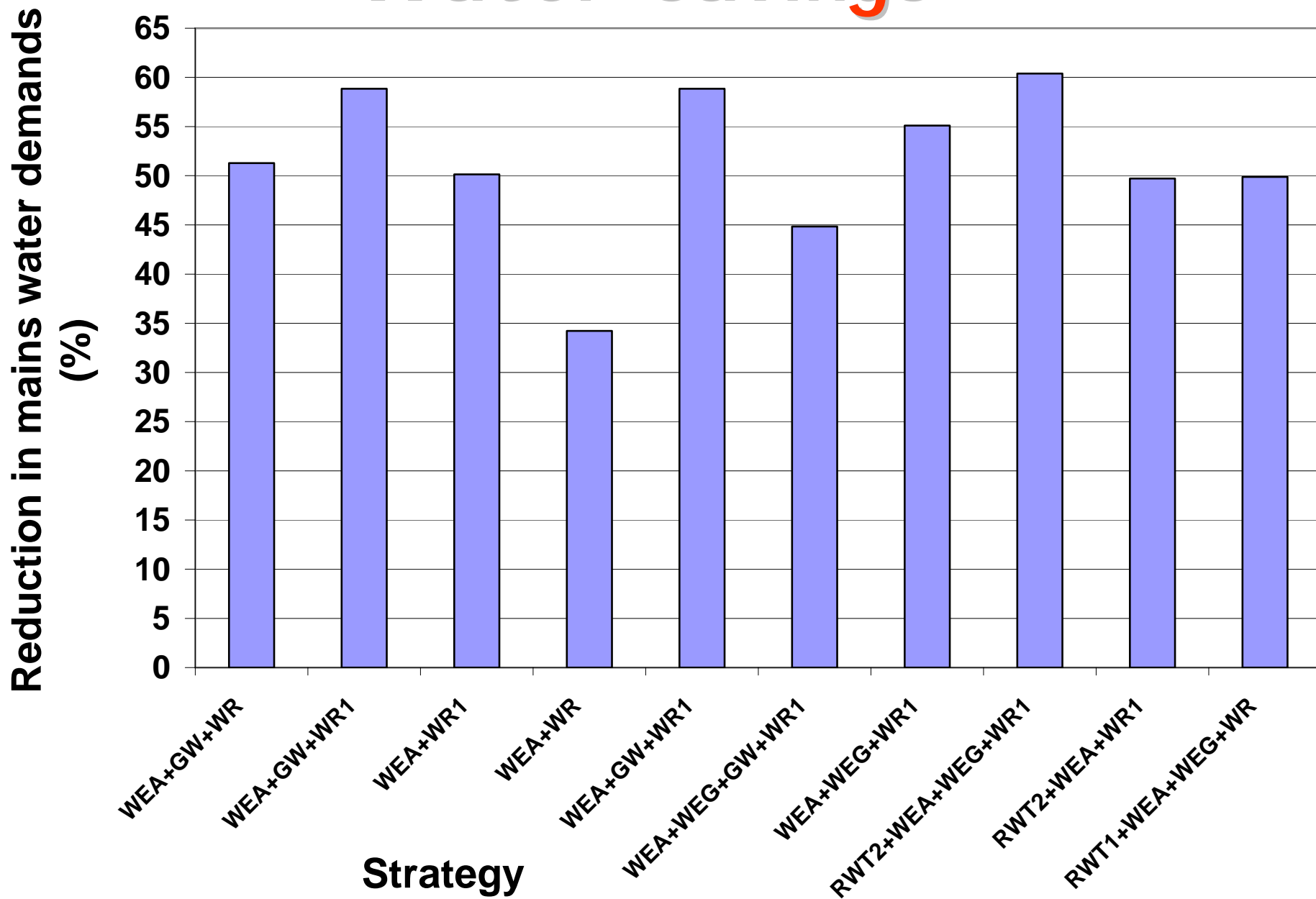
Economics – include deferral or avoidance of augmentation



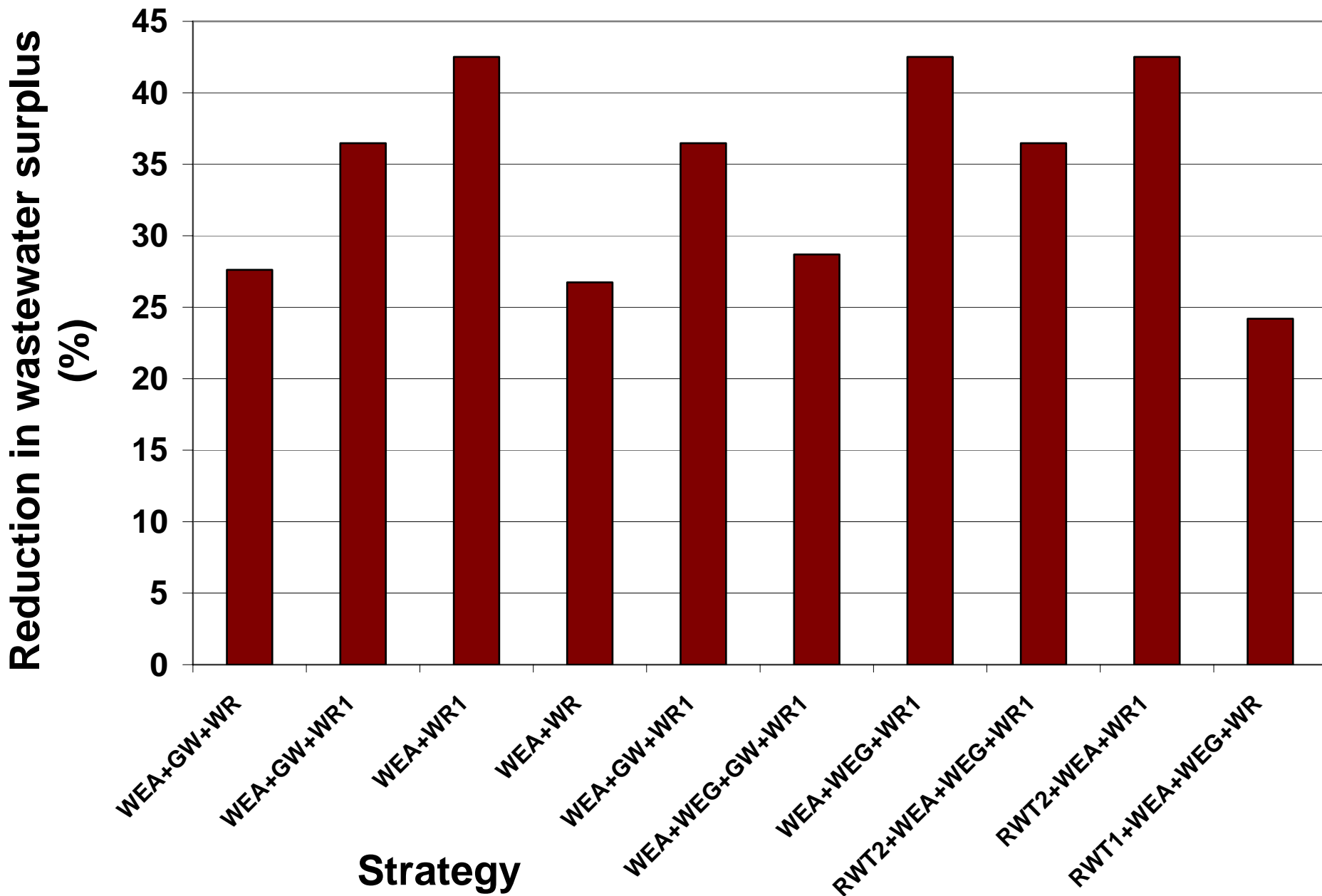
I WCM at Gidgegannup



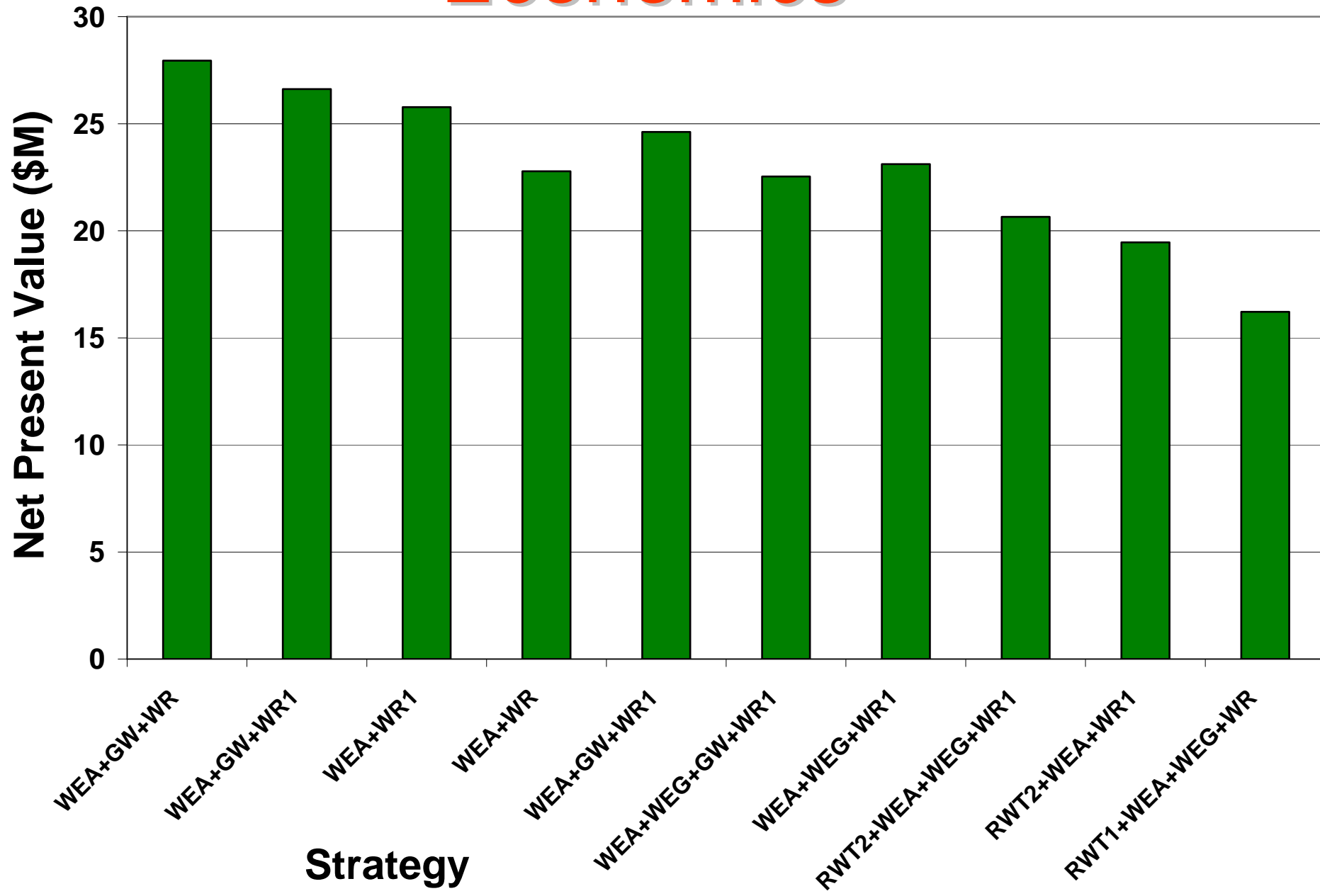
Water savings



Wastewater



Economics



Conclusions

- Rainwater, stormwater and wastewater within cities is an untapped resource
 - 60% to 90% reductions in mains water demand is possible
 - We cannot generalise about the impacts of climate change
 - The synergistic benefits of the decentralised water cycle management are often overlooked
 - Reductions in stormwater, water and wastewater infrastructure
 - Impacts on environment and water security
 - The decentralised water management approach provides
 - A buffer against the impacts of climate change
 - Availability of local water sources increases with population
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