CRCWSC Research Synthesis

**Discussion Paper** | CRC for Water Sensitive Cities

# IDEAS FOR FISHERMANS BEND

CRC for Water Sensitive Cities

Australian Government
Department of Industry and Science

Business Cooperative Research Centres Programme

LOW CARBON LIVING CRC

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# How to use this report

This report applies ideas from emerging research and international best practice to the development of Fishermans Bend, focusing on water services and urban design.

The ideas demonstrate how a water sensitive and low carbon approach can effectively deliver the stakeholders' vision for the development, including the aspiration for leading edge innovation in water services and creating liveable precincts.

The Fishermans Bend brownfield redevelopment in inner Melbourne, Victoria, will occur over the next 40 years. The ideas have therefore been designed to be implementable in 2015, as well as remaining relevant in 2055 when new options are likely to become available through developments in policy, science and community attitudes. This is a key strategy in building a city of the future and this report provides a case study that we hope will inspire similar responses in other urban scenarios.

This synthesis report reflects the input of the CRC for Water Sensitive Cities and CRC for Low Carbon Living. This collaboration provides an opportunity to address the water-energy nexus challenge. The ideas presented are primarily focused on water management but highlight the importance of integrated performance metrics.

The proposed design itself is conceptual (Figure 1). It is intended to provoke further analysis alongside other potential options but suggests a direction for the next stages of design evaluation and consultation at Fishermans Bend.

*Figure 1. A water sensitive and low carbon approach will transform the liveability, sustainability and productivity of Fishermans Bend (image credit: Realm Studios)*

# Introduction

Regeneration of brownfield areas on the scale envisaged at Fishermans Bend provides unique opportunities for pursuing multiple urban development objectives aligned to the Council of Australian Government's vision for the performance of Australian cities (Department of Infrastructure and Transport, 2011): competitive and productive, liveable, environmentally sustainable and socially inclusive.

The precinct scale of these developments is small enough to warrant innovation in the design of the built environment, yet significant enough to materially reduce demands and reliance on currently stressed centralised energy, water and sewerage infrastructure systems.

Achieving these outcomes requires an urban design response for buildings that aspires to be:

- Water sensitive – minimising the import of potable water into; and export of wastewater, mitigating flood hazards and avoiding stormwater pollution of urban waterways;
- Carbon negative – generating electricity from renewable energy that is surplus to the requirements of building; and
- Biophylic – optimising the exposure of the community to natural elements e.g. vegetation, water features, natural ventilation and light.

This approach must also be mirrored in the public realm, where the design of precinct-scale infrastructure and open space can harness the performance of individual buildings as elements of an overall system for the precinct. Providing options to integrate in-building and in-precinct water and energy management therefore becomes an essential urban design consideration from the earliest phases in the precinct planning process[1]. The public realm will also need to respond to the soil contamination of the site attributed to past land uses and the historical vulnerability of the site to flooding.

Aspirational public-private partnerships and leadership will be required to ensure that integrated precinct design provides a pathway for innovative built environment development over the expected 40 year development cycle of the precinct and its neighbouring interface areas (e.g. Melbourne's existing CBD).

This discussion paper, presented by the CRC for Water Sensitive Cities in collaboration with the CRC for Low Carbon Living, outlines a range of technical, design and governance ideas to inspire these discussions. These ideas are summarised in Figure 2.

*[1] For the purpose of the Ideas report, the scenario of a single model across the whole site was explored. Further work in the following stages of analysis could explore other scenarios in which locally specific approaches are provided across the four different precincts of the development*

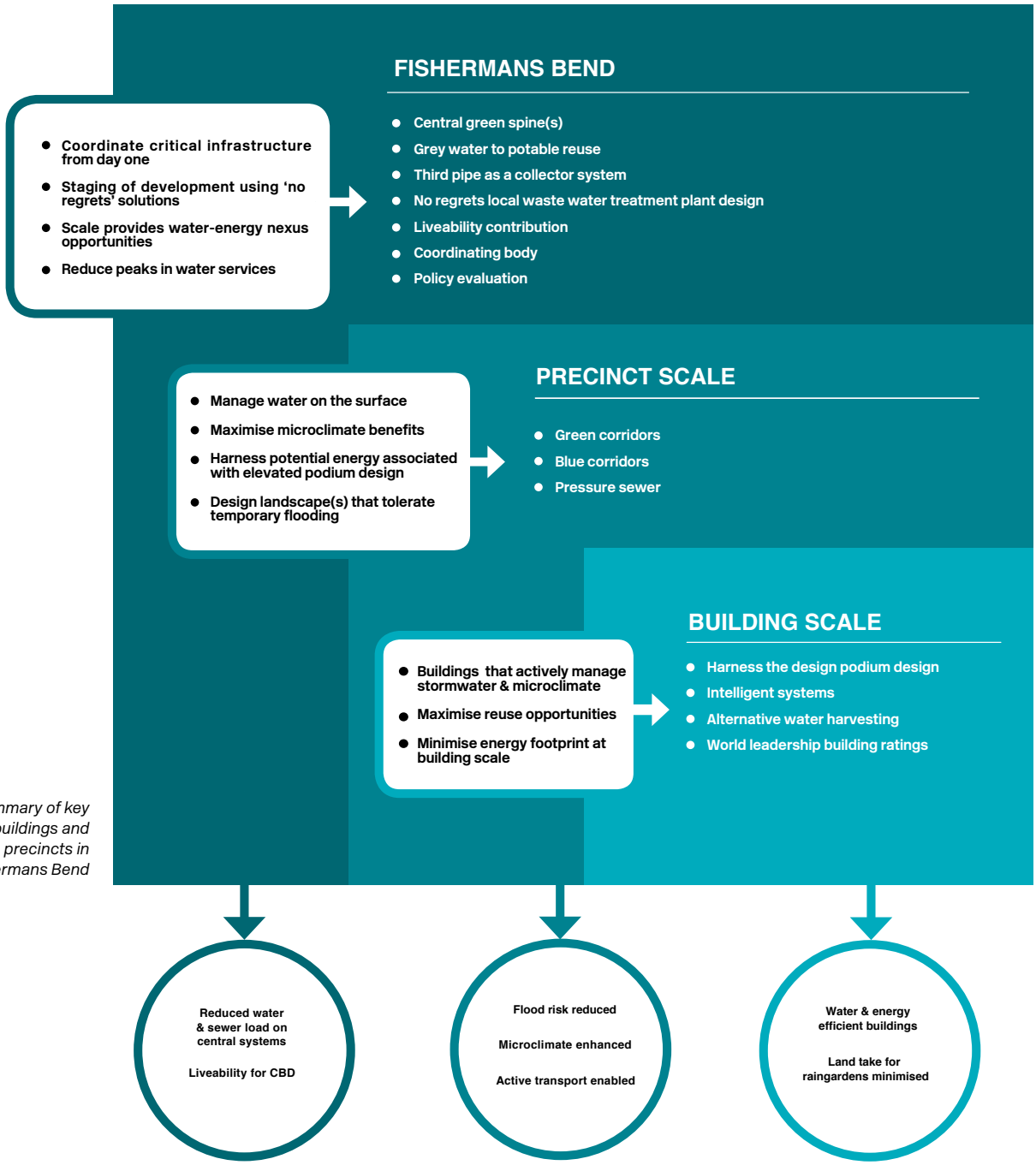



*Figure 2. Summary of key ideas for buildings and precincts in Fishermans Bend*

## The CRC for Water Sensitive Cities

The CRC for Water Sensitive Cities (CRCWSC) was established in July 2012 to facilitate research and industry partnerships to meet three critical drivers affecting Australian cities and towns:

- population growth and the subsequent changes in lifestyle and values;
- climate change and variability; and
- changing economic conditions.

These drivers can act in unison to reduce water security, increase flood vulnerability, and degrade natural systems across our cities.

The CRCWSC sees integrated urban water cycle management as an opportunity to address these issues and deliver the socio-technical urban water management solutions, capacity-building programs, and industry engagement required to help cities to become more water sensitive.

## The CRC for Low Carbon Living

The CRC for Low Carbon Living (CRCLCL) was also established in July 2012 and seeks to enable a globally competitive low carbon built environment sector, informed by evidence-based research undertaken in three intersecting arenas:

- integrated building technologies;
- low carbon precincts; and
- engaged communities.

The CRCLCL brings together property, planning, engineering and policy organisations with researchers to develop social, technological and policy tools to facilitate the development of low carbon products and services that will reduce greenhouse gas emissions in the built environment.

# Research synthesis

The CRCWSC and CRCLCL are undertaking numerous research projects that address the key knowledge gaps preventing the implementation of water sensitive and low carbon practices. These projects span disciplines from the physical sciences, engineering, planning and climatology to the social sciences including economics, political science and behavioural sciences.

Synthesis projects provide a mechanism to integrate these diverse areas into site based solutions (Figure 3). They are based on case studies nominated by our industry partners and generate specific ideas for the implementation of the research outputs. The discussion papers produced outline contemporary ideas for development practices and are intended to increase the capacity of our industry partners to adapt our varied research findings to their needs.

Three research synthesis workshops were held between October 2014 and February 2015 to scope the ideas for Fishermans Bend. These workshops were attended by a large number of researchers from the two CRCs as well as representatives of CRCWSC participant organisations: Department of Environment, Land, Water and Planning (DELWP), Melbourne Water, South East Water, City of Melbourne, City of Port Phillip, City West Water, Yarra Valley Water, Department of Health, Environment Protection Authority Victoria, and GHD. Representatives from the Metropolitan Planning Authority of Victoria also took part in the workshops.

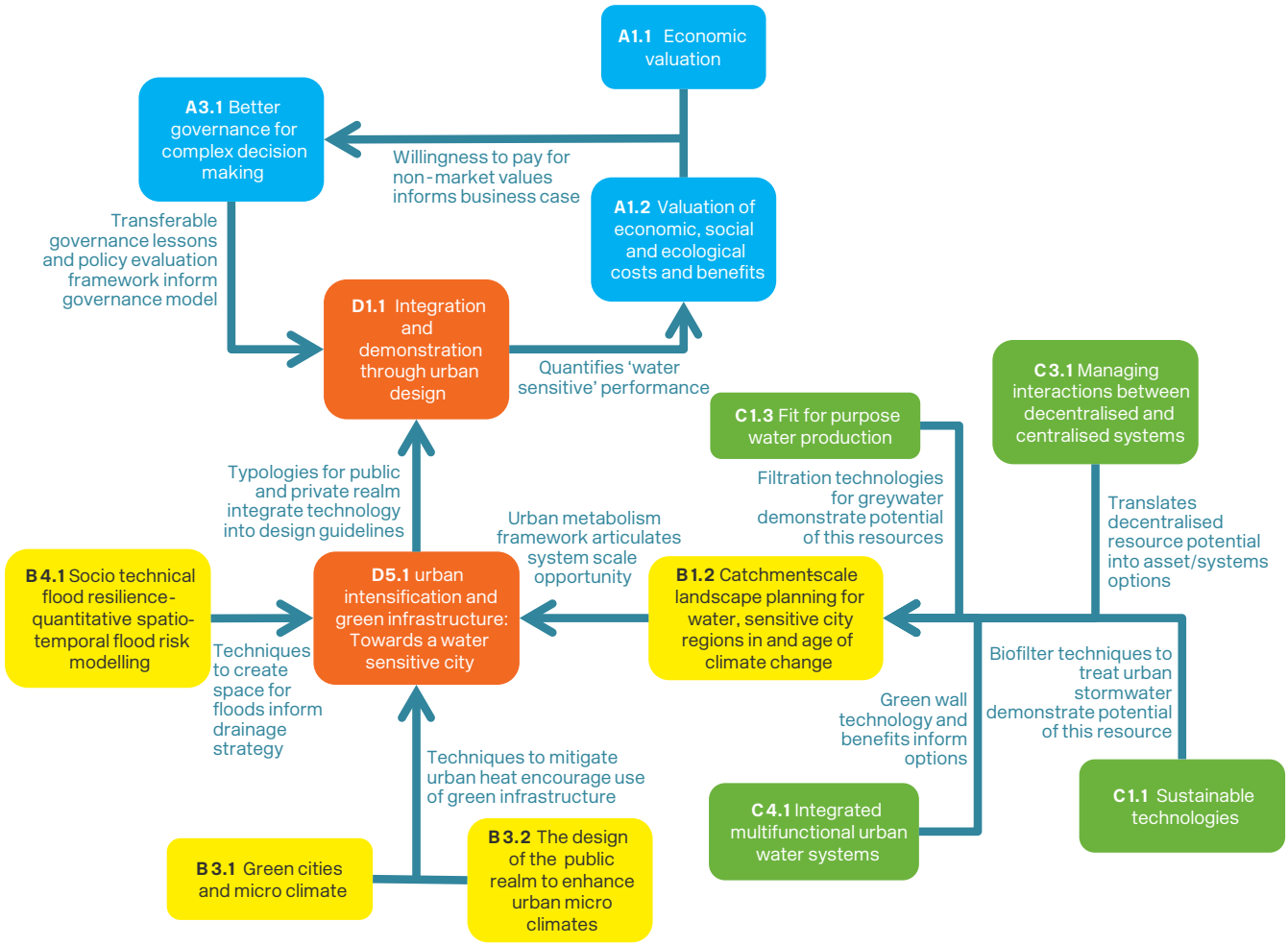



*Figure 3. Ideas for Fishermans Bend integrates the knowledge and outputs of 13 CRCWSC research projects*

# Context

Fishermans Bend is a 258 hectare urban redevelopment project in inner Melbourne (Figure 4). The current industrial uses at the site will be replaced over the next 40 years with a mix of high density residential, retail and commercial developments that will extend Melbourne's CBD towards Port Phillip Bay.

The population of Fishermans Bend is anticipated to increase to at least 80,000 people by 2055. This is a conservative population estimate, with some alternative scenarios predicting an increase to 120,000 or even 240,000 (GHD, 2015).

Most of the land at Fishermans Bend is privately owned. While local government is overseeing the strategic plan for the site (via the Metropolitan Planning Authority, City of Melbourne and City of Port Phillip), the private sector will have a significant influence over the design of the development.

The site will be developed as four precincts (Lorimer, Montague, Sandridge and Wirraway) with connectors (such as Buckland Street in the Montague precinct) linking community nodes including shopping strips and local open space within each precinct (Places Victoria, 2013). Existing thoroughfares such as Plummer Street will link and connect these precincts to the CBD, Port Phillip Bay and surrounding suburbs.

*Figure 4. Fishermans Bend location*

A Strategic Master Plan Framework (Metropolitan Planning Authority, 2014) outlines a range of initiatives, including conditions for water servicing (Figure 5). Of specific relevance are the requirements for developers to provide:

- Connection of buildings to a third pipe network to supply Class A[2] non-potable water sources
- Rainwater tanks on buildings to provide on-site detention. GHD (2015) adopted a size of 192 KL for these tanks in its assessment of water servicing options for the site[3].

Several physical constraints exist that will directly affect the way that Fishermans Bend is developed:

- A combination of shallow groundwater, contamination issues and highly compactable Coode Island silts dictate special construction techniques
- The site is flat, impervious and close to sea level. It also sits at the end of the floodplain of the lower Yarra River. As such it is affected by flooding resulting from heavy rainfall in the local catchment, flooding in the Yarra River and storm surge in Port Phillip Bay.

*Figure 5. The Strategic Framework Plan proposes a transformation of this inner city industrial area into a modern and vibrant extension of Melbourne's CBD (image credit: Metropolitan Planning Authority(MPA))*

*[2] Class A is the highest quality of recycled water and is treated to a standard that is specified for non-drinking use (http://www.yvw.com.au/Home/Waterandsewerage/recycledwater/index.htm)*

*[3] GHD is a partner of CRCWSC and this GHD project was undertaken in parallel with the research synthesis workshop. GHD is participating in the synthesis workshops to provide a link between these two processes*

As a result of these site conditions there is a preference to minimise buried services or assets and to utilise raised podium developments (Figure 6).

*Figure 6. Podium development will be the norm at Fishermans Bend and can become an enabler of green infrastructure solutions (image credit: Realm Studios)*

**Water Balance**

A water balance analysis based on the estimated 120,000 resident population (as adopted by GHD 2015) shows the following water flows through the site:

*Table 1. Indicative water balance for Fishermans Bend based on its ultimate population*

| | |
|---|---|
| Water imported | approximately 10,800 ML/year |
| Sewage discharged | approximately 9,200 ML/year |
| Rainfall volume across the site | approximately 1,700 ML/year |

GHD (2015) estimates that the water demands include 4928 ML/year for non-potable uses which can be substituted with alternative water sources (thus reducing water imported to ~5.9 GL/year). Of the anticipated water demand, the majority (> 3500ML/year) is residential demand, with less than 200ML/year expected to be used for the irrigation of open space.

Assuming a fully built set of one hundred and twenty 30-storey high rise apartments and up to fifty 15-storey commercial buildings at Fishermans Bend, an additional 2.03 million GJ of electricity per year is required from the east coast grid in a current practice scenario. This equates to 625,000t$CO_2e$[4] per year.

[4] *Tonnes of carbon dioxide equivalent*

# Ideas for Fishermans Bend

The water sensitive and low carbon strategy for Fishermans Bend is based on the application of four key principles:

1. Adopting a definition of water security that includes flood resilience, environmental performance and liveability as essential elements of security for a city[5]

2. Consideration of the 'water-energy nexus'[6] to maintain a balanced approach to sustainability

3. Using water services or assets to enhance liveability by maintaining community health and wellbeing, creating a sense of place and ultimately drawing people into Fishermans Bend as a destination in its own right

4. Harnessing urban design as a platform to integrate these ideas.

**14 Ideas for Fishermans Bend**

**a. Fishermans Bend scale**

1. Central green spine(s)
2. Grey water to potable reuse
3. Third pipe as a collector system
4. No-regrets local wastewater treatment plant design

**b. Precinct scale**

5. Green corridors
6. Blue corridors
7. Pressure sewer

**c. Building scale**

8. Harness the podium design
9. Intelligent systems
10. Alternative water harvesting
11. Adopt world leadership building ratings

**d. Implementation**

12. Liveability contribution
13. Coordinating body
14. Policy evaluation

*[5] Water security is used in this context as defined by UN Water, 2013*

*[6] The water-energy nexus takes into account the relationship between water use and energy consumption*

# a. Ideas for all of Fishermans Bend

**1. Central green spine(s)**

Central green spines such as Plummer Street can be used to frame the Fishermans Bend development and link the subsequent ideas into a cohesive urban design.

Driving this is a drainage strategy based on a three-tiered approach to flood resilience. In situations such as Fishermans Bend, where risks arise primarily from pluvial[7] flooding, these tiers may be interpreted as:

**Retreat** – making room for flood waters in the landscape by determining appropriate land uses and establishing areas designated for flood detention and conveyance

**Adapt** – creating source control for stormwater by incorporating natural filtration processes into the urban landscape

**Defend** – creating barriers and flood conveyance to divert flood waters to locations designated for flood inundation (i.e. "retreat") and protect critical assets of the development.

A key urban design strategy lies in utilising the central Plummer Street spine to frame the development. This establishes a network of multi-function corridors throughout the development, linked via the spine and connected to landscape detention nodes which comprise parks and water plazas (Figure 7 & 8).

*Figure 7. Open space strategy as outlined in the Strategic Framework Plan, showing the Plummer Street 'connector' (shaded pink) and parks/open spaces shaded green (image credit: MPA)*

[7] *Pluvial flooding is caused when local rainfall exceeds the capacity of drainage systems*

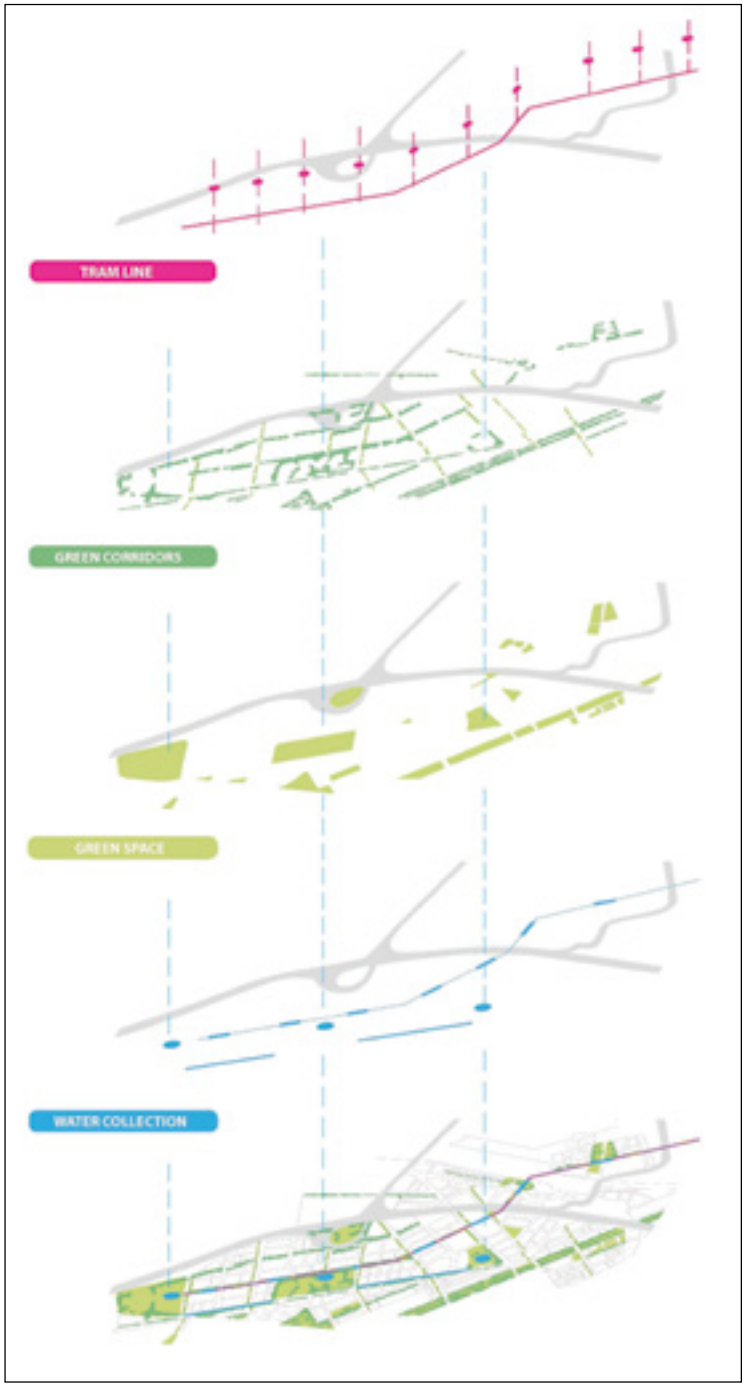
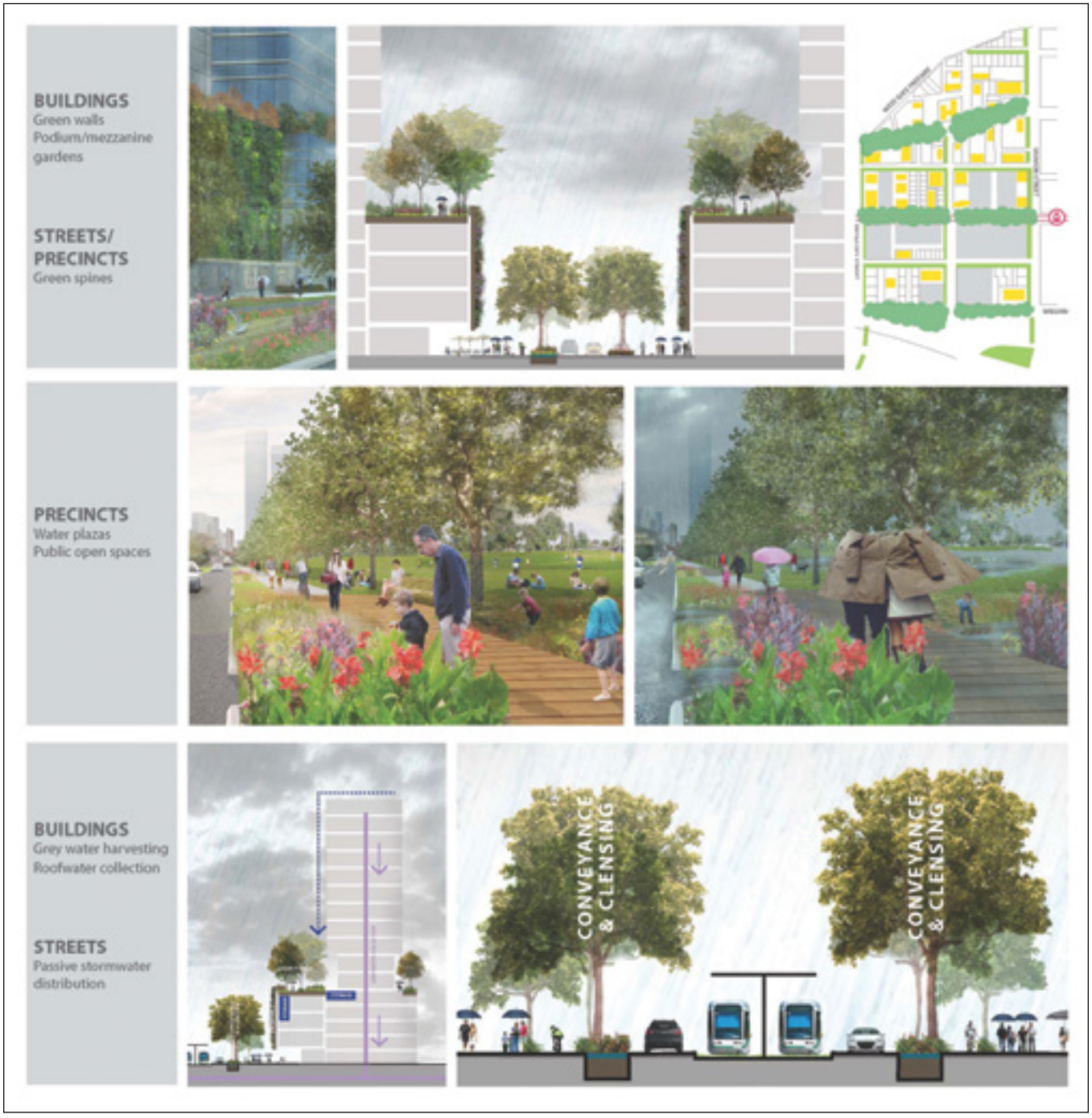



*Figure 8. The Plummer Street connector becomes a central blue-green corridor that frames the Fishermans Bend precincts and ties the drainage and green infrastructure into a unified design (image credit: Realm Studios)*


BUILDINGS
Green walls
Podium/mezzanine gardens
STREETS/ PRECINCTS
Green spines
PRECINCTS
Water plazas
Public open spaces
BUILDINGS
Grey water harvesting
Roofwater collection
STREETS
Passive stormwater distribution
CONVEYANCE & CLENSING
CONVEYANCE & CLENSING

These connections include streets that act as both source controls and conveyance, and building scale green roofs and green walls that provide additional source control.

At a catchment level, the Fishermans Bend site can also be re-shaped:

- Retreat: Make room for temporary flooding in designated open spaces and green corridors (Figure 9)
- Adapt: Drain directly to the Bay to remove the tailwater influence of the Yarra River on local drainage
- Defence: Reconfigure the elevations of the relatively flat topography to create protected spaces that provide areas that offer protection from stormwater and flood water.

In this way the catchment can be layered to provide a lower, stormwater/flood zone where water is conveyed on the surface; and a network of raised corridors (inspired by New York's Highline[8]) that create a new, liveable landscape above the flood inundation zone.

*Figure 9. The network of green infrastructure throughout Fishermans Bend provides temporary rainwater and stormwater detention (image credit: Realm Studios)*

[8] See http://www.nycgovparks.org/parks/the-high-line

**2. Greywater to potable recycling**

To minimise the reliance on central potable water supplies, greywater will be harvested, treated and used as a potable source.

Greywater is chosen as the preferred source to minimise the policy, risk management and perception implications often associated with the potable reuse of sewage

This idea (Figure 10) lifts the volume of potable water that can be substituted from 3.5 GL/year (86 L/p/day or 45% of total water demand) in a Class A recycling scenario[9] to 5.2 GL/year (151 L/p/day or 78% of total water demand). The full comparison of water use scenarios is outlined in Appendix 1.

This idea has the additional benefit of concentrating the sewerage waste stream discharged to Western Treatment Plant (WTP) or a dedicated local resource recovery plant. This decreases the load on the sewerage system whilst also aiding resource recovery opportunities.

This idea is not without risks. Appendix 2 outlines a range of risks that require further analysis and management.

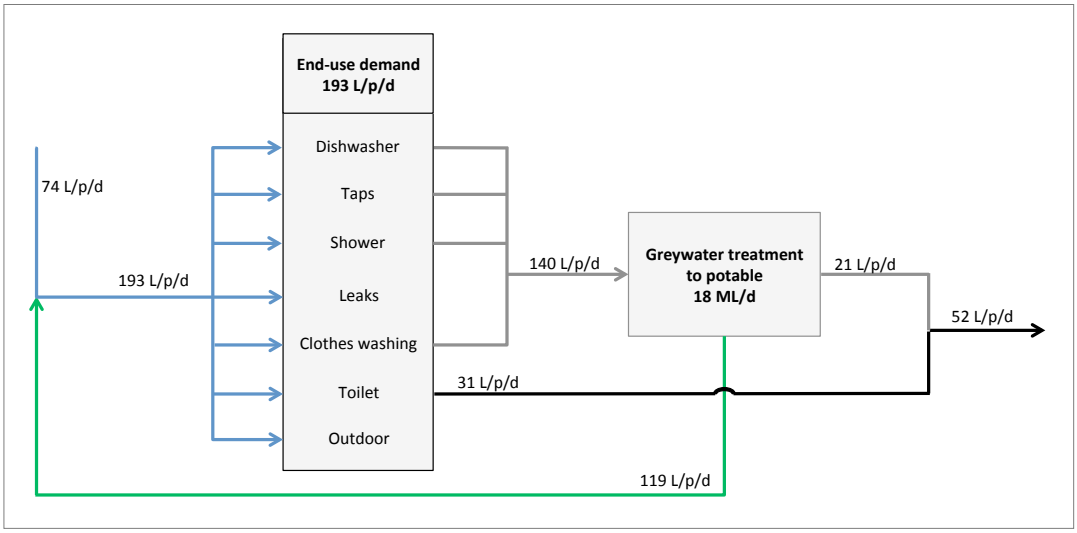



*Figure 10. Potable reuse scenario. Here dual collection pipes separate grey and blackwater; greywater is recycled to potable standard and distributed via potable network*

[9] *Assuming a resident population projection of 120,000*

**3. Third pipe as a collector system**

All buildings are required by the Strategic Framework to provide a third pipe connection to a reticulated system. Transforming the third pipe network from a supply system into a collection system will facilitate the potable reuse scheme. To operate the greywater recycling it is proposed that this network be configured within buildings as a collection system for greywater. The district system will be connected as an input rather than as an output to the proposed local wastewater treatment plant.

**4. Local Waste Water Treatment Plant – a 'no regrets' approach**

The proposed local waste water treatment plant affords an opportunity for decentralised resource recovery. This decentralised resource recovery could either be for wastewater (including sewer mining) or greywater treatment to a potable water source. With this in mind, the treatment process needs to be future proof: while the policy environment precludes some options, new processes are rapidly emerging on the technology horizon that should be considered. There is a risk in applying current paradigms if this locks out future resource recovery opportunities.

Assuming that the science, policy and community conversation surrounding potable reuse will evolve over the life of the development, a 'no regrets' approach is proposed. This involves including a local treatment plant in the servicing strategy but deferring its design until 30% of the development has been built. In the interim, the stakeholders can encourage further consideration of policy and treatment plant designs to ensure an informed decision is ultimately reached.

If potable reuse for recycled greywater is the adopted treatment scenario the best design option may be a membrane bioreactor and/or granular sludge. This process could also incorporate energy recovery or side stream anammox[10] process for treatment of high nitrogen waste streams. These technologies are still 'novel' in Australia but are likely to be mainstream within a decade.

With a wastewater treatment plant options also exist for sewer heat mining to partially offset local industry energy demands and provide concessions to the water-related energy demand of the plant. Internationally this has been demonstrated to be cost-effective and can be further evaluated by investigating the local temperature differential and heat demand at Fishermans Bend

*[10] ANaerobic AMMonium OXidation (ANAMMOX)*

# b. Ideas for Precinct Scale

**5. Green corridors**

Existing streets, laneways and open space will extend green infrastructure throughout the precinct and be linked together to form a precinct scale network of green corridors. These green corridors will play a strong role in shaping the identities of each precinct by improving local connectivity, increasing amenity and enhancing microclimate. These green areas will be irrigated by stormwater and rainwater. A more detailed supply-demand balance could be established to identify shortfalls and thus any residual water demand that can be met by other sources.

For example the east-west configured streets in the Wirraway precinct can be transformed into green corridors by establishing tree lined boulevards and linking local open space to the Plummer Street spine. Similarly the Montague precinct is well suited to distributed water sensitive urban design (WSUD) features. New public spaces along Montague Street that act as flood detention areas can also frame these features.

*Figure 11. Wirraway and Montague precincts showing the potential for green corridors at the precinct scale (image credit: Realm Studios and MADA)*

**6. Blue corridors**

Precinct scale drainage is designed to manage minor flood flows[11] and reduce stormwater peaks without the use of underground drains. This can be achieved by managing stormwater on the surface using a 'short runs' approach that reduces the size of drainage catchments. This avoids deep, large drains or eliminates the need for underground stormwater pipes altogether.

The width of the green corridors and the corresponding size of underground stormwater pipes can be minimised by a combination of:

- detention of flood water in the public realm landscape; and
- managing water in the private realm by harnessing the roofs and walls of buildings as additional stormwater storage (see Idea 8).

Appendix 3 summarises the key design parameters of a drainage strategy based on this approach.

[11] *These flows refer to the Q10 flows. Flows larger than this will occur, on average, every ten years*

*Figure 12. Typical secondary street section showing the design of blue corridors (image credit: Realm Studios)*

*Figure 13. Example of podium green walls on the Medibank building, Bourke Street, Melbourne (left) and as proposed at Fishermans Bend (image credit: Realm Studios)*

*Figure 14. Examples of street scale treatments for stormwater using tramways in Paris (left) and Houston (centre) and a water plaza concept of a multi function flood retarding basin in Rotterdam (right)*

**7. Precinct scale pressure sewer**

A pressure sewer system allows reduction in peaks in sewerage through scheduling of flows. This system, using appropriately sized holding tanks for each building, can reduce peaks to the local waste water treatment plant as well as minimise wet weather infiltration into sewers by maintaining positive pressure.

Pressure sewer is particularly suited to Fishermans Bend as it allows use of smaller and shallower pipes to address the site constraints. Using South East Water's ECO project on the Mornington Peninsula[12] as a benchmark, it is reasonable to assume that pipe sizes can be reduced by approximately 30% and that shallow boring techniques can minimise interaction with groundwater tables.

A pressure sewer also allows staging of sewerage services for each precinct. Each precinct can be serviced via an independent sewer network with a single, temporary point of connection to the existing wide grid sewer system. This allows easy retrofit to a Fishermans Bend wide network and therefore retains options for different configurations of the local sewerage treatment plant in the future (see Idea 4).

## c. Ideas for the building scale

**8. Podium design**

Being a contaminated site, the design of buildings is envisaged to adopt the approach of an elevated podium public realm with minimum sub-terrain structures. The proposed podium design of buildings can be harnessed to increase the efficiency of the drainage and greywater recycling ideas.

As shown in Figures 9 and 10, the podiums and walls of individual buildings form an integral part of the drainage infrastructure.

*[12] Along the Mornington Peninsula more than 16,000 properties currently rely on septic tanks and onsite treatment plants to manage household sewage. Due to ageing, failing or poorly maintained septic tanks, there is evidence of waste polluting groundwater, waterways and the environment in the region. To address this, South East Water is rolling out one of the largest pressure sewer constructions in Australian history*

*Figure 15. Green walls, podiums and roofs will be a feature of water sensitive buildings (image credit: Realm Studios)*

These areas capture, detain and treat stormwater and become important contributors to the precinct wide green infrastructure. They provide multiple ecological functions including water cleansing, water harvesting, flood management, microclimate enhancement and increased biodiversity. They also provide amenity, building insulation, screen car parks (which occupy the lower levels of podium buildings) and filter light, noise and air for building occupants.

Living and green walls will be placed to maximise effectiveness. The precinct scale road network facilitates this with its east to west configuration. Nevertheless some frontages inevitably face direct sun and will be the priorities for the placement of green infrastructure.

Decisions about the extent and design of green infrastructure will affect the water balance. The anticipated water demand from green walls is 1-5 litres/day per $m^2$ (Hopkins et al, 2010) (with seasonal variation within this range), which may be met with rainwater or greywater[3].

Podiums also establish a mezzanine level that position building front entrances at the elevated level (e.g. at second storey) with car parking below. An example of this approach is provided by Southbank (Brisbane, Queensland) which has car parks below the main boulevard, and HafenCity (Hamburg), which features buildings elevated 4-5m above ground level.

These areas create a connected mezzanine level throughout precincts to be used during flood events when the ground level is inaccessible. This is an extension of the design of the Highline in New York (Figure 16) which provides a 2.5km linear open space that is elevated above the streetscape.

*Figure 16. The Highline in New York provides an elevated 2.5km link through Manhattan's lower west side*

*[13] A more detailed water balance can quantify the volumes needed to complement rainwater in sustaining the green infrastructure*

**9. Intelligent systems**

At building level, provide tenants with information and real-time control over resource use. If established for integrated water and energy management, this can include fit-for-purpose water production, sewerage management, flood mitigation, reticulated hot water and space heating and cooling controls and lighting controls.

These intelligent networks can have a broader benefit of managing peaks across the networks through scheduling of sewage discharge (see Idea 7) and also pre-emptive release of water from rainwater tanks in anticipation of an imminent storm of high intensity. An example is South East Water's Tank Talk system[14]. With rainwater tanks located beneath the podiums and above ground, the tanks can be remotely controlled to allow pre-emptive release into the public realm to manage drainage peaks.

**10. Alternative water harvesting**

The harvesting of water at building scale is enhanced by the podium design. The hydraulic head provided by the podium design:

- allows stormwater to be transported via roads to irrigate open space corridors in the precinct, and grey water to be returned to the local waste water treatment plant
- provides sufficient pressure for membrane filtration (which needs about 1m head) if required for greywater pre-treatment on site
- can passively pressurise the sewers, thus reducing inflow and infiltration

Within buildings, light greywater that includes basins, showers and laundry will be separated and collected for reuse (see Idea 2).

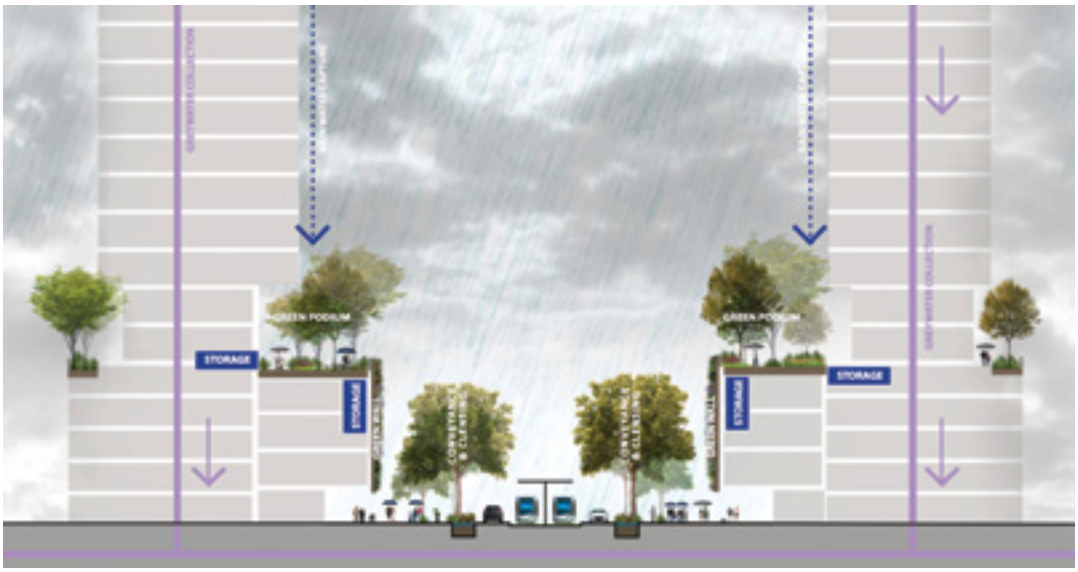



*Figure 17. Podium scale building development highlighting opportunities for a third pipe to collect greywater for reuse and maximising horizontal areas for green infrastructure (image credit: Realm Studios)*

*[14] Tank Talk, incorporating the OneBox technology, monitors the water level in a rainwater tank and automatically releases the excess water at a controlled rate. If rainfall is expected, Tank Talk will pre-emptively drain to provide new capacity to capture and hold the incoming stormwater. This will limit the possibility of downstream stormwater overflows and flooding*

**11. Adopt world leadership building ratings**

There are multiple pathways available for designers and occupants to achieve energy and water efficient buildings (see Figure 11).

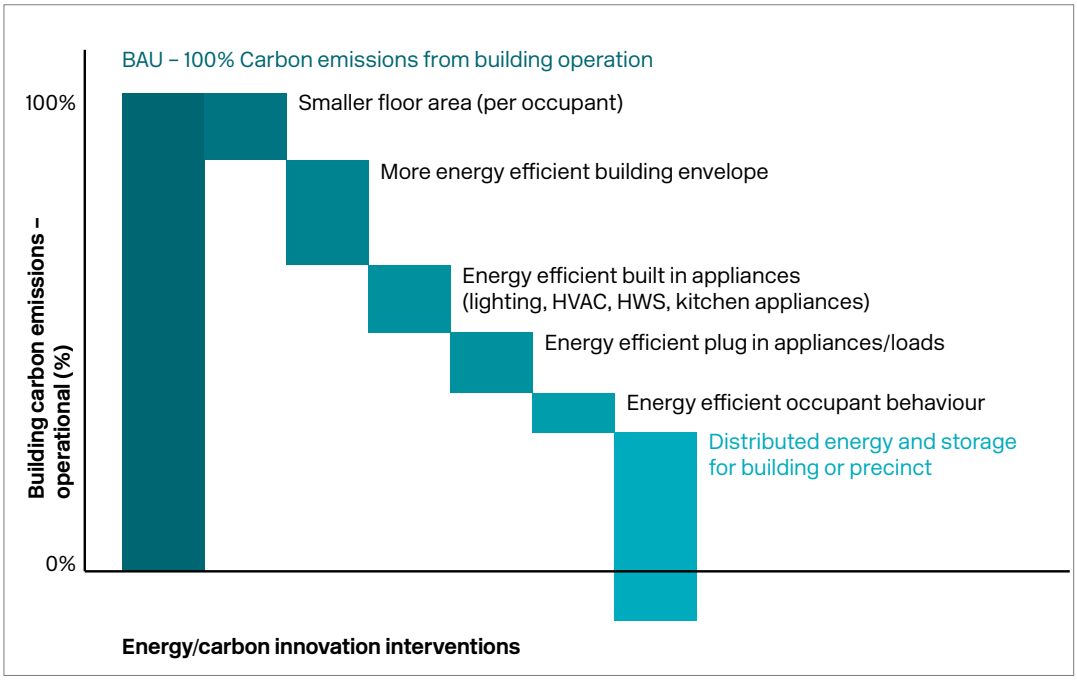



*Figure 18. Staircase of measures to reduce building operational energy and carbon emissions*

These measures highlight the importance of the design process in ensuring that the costs of energy and water intensive processes (such as heating, cooling and lifting) are transferred from mechanical and electrical systems (with associated OPEX expenditure) to building architecture through the design process.

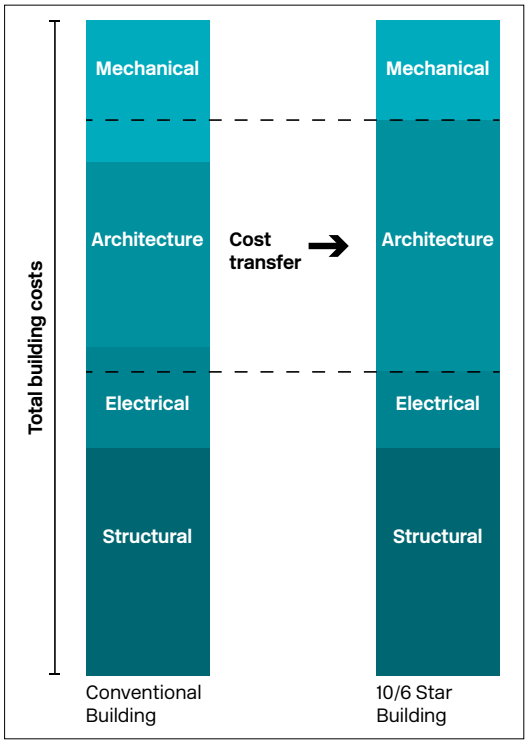



*Figure 19. Integrated design can transfer costs from electrical and mechanical systems to building architecture*

Several national rating systems are used to influence the design stage of residential and commercial buildings. For residential buildings the Nationwide House Energy Rating Scheme (NatHERS) is nationally mandated in the Building Code of Australia, while for commercial buildings, the National Australian Built Environment Rating Scheme (NABERS) is used.

A shift from traditional, and beyond best practice, to world leadership performance (represented as 10 star (NatHERS)/6 Star (NABERS)) for all buildings (viz. advanced facades, hybrid HVAC, energy efficient lighting and water heating, distributed generation and storage, water harvesting, wastewater reuse and green roofs) delivers:

- 43% reduction in annual energy use and carbon emissions
- 51% reduction in water demand
- 30% reduction in lifetime carbon emissions
- 10% boost in occupant productivity.

Innovative building design is a necessary but not sufficient step in maximising carbon mitigation. Distributed solutions will also be required across the four precincts, with rooftop photovoltaic and rooftop solar thermal likely to be the most cost effective options at this scale. To install further distributed renewable energy systems in medium to high-rise developments would mean moving towards vertical façade mounted photovoltaic systems. As the cost of photovoltaic decreases, vertical façades become increasingly technically and economically possible. These integrated systems add value by incorporating multiple functions (weather proofing, electricity, heat, cooling, daylighting and insulation) compared with current products. Other precinct based energy systems include cogeneration/trigeneration using natural gas or biogas derived from renewable sources.

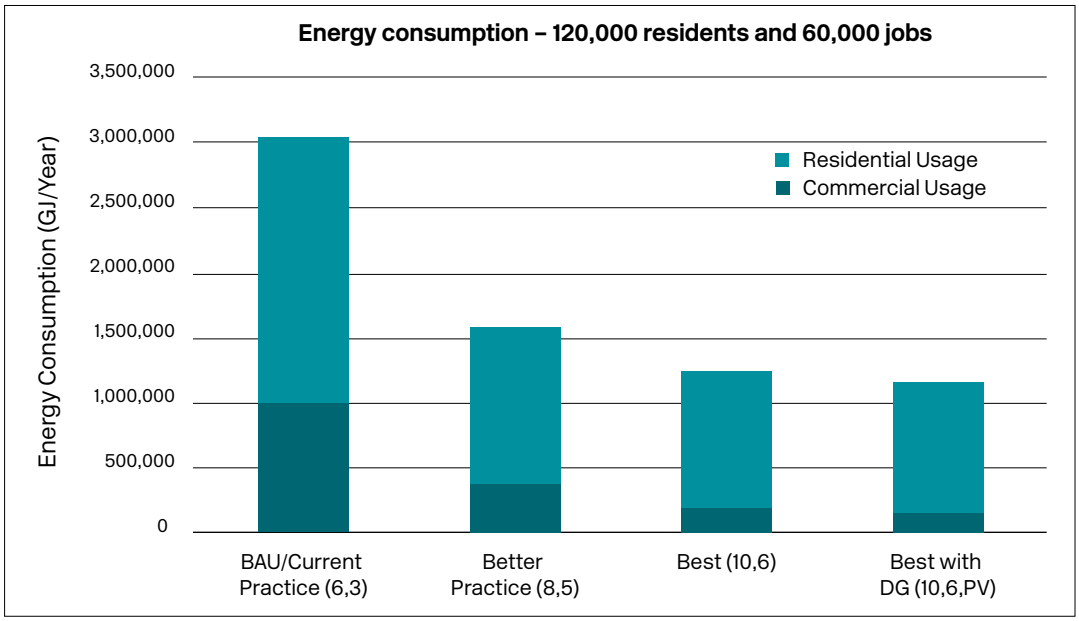



*Figure 20. Improvement in energy use by moving to world leading rating design*

# d. Ideas for implementation

Attention also needs to be given to the administrative and governance functions needed to deliver the technology and urban design ideas. Examples of this need include facilitating infrastructure planning, preparing business cases across multiple agencies, and managing partnerships with developers.

**12. Liveability contribution scheme**

While Ideas 1-11 can defer or replace numerous conventional approaches to water and energy management, they will only be successful if there is a consistency of application across the three scales at Fishermans Bend. If any building or precinct reverts to a traditional approach then this invalidates the water sensitive strategy as a whole.

This highlights the need to provide incentives for the developers to become early adopters, while also ensuring that the costs are equitably shared.

A Liveability Contribution Scheme will achieve this by coordinating and sharing the costs of liveability infrastructure. The strategy will be funded by financial contributions paid when development occurs. A basis of contributions will need to be determined but may consider the degree to which individual buildings contribute to Fishermans Bend wide metrics (such as area of green infrastructure). It is intended that these metrics will be achieved through a combination of on-site and regional assets.

**13. Coordinating body**

The contribution scheme reinforces the need for an effective governance structure. Traditional structures offer a diffuse perspective of success and delivery agencies manage their individual risk accordingly. The result is often a lack of coordination.

Other developments across Australia have demonstrated the consequence of ignoring coordination. Major central infrastructure is prioritised as a catalyst for development investment but pre-empts strategic planning at a finer scale, effectively locking out innovation in future estate planning by skewing the business case away from distributed solutions.

By its nature, Fishermans Bend will be shaped by the many developers and planning authorities making the issues of coordination paramount. A coordinating body (nominally a 'Fisherman's Bend Authority') could be created as a broker and banker to:

a. Provide and implement a Blueprint for the development of privately held land in a coordinated way.

b. Deliver a whole-of-development public infrastructure strategy (water and energy utility, public open spaces, blue-green corridors for drainage and flood conveyance) and establishment of a liveability contribution scheme to implement this public infrastructure. It coordinates contributions from all developers across the site and through time to ensure that 'vision critical' land and regional infrastructure is provided.

c. Coordinate innovation, for example a water servicing strategy that includes a rainwater to potable trial.

The architecture of this body will need to include a clear exit strategy to ensure that the handover of governance responsibilities (e.g. to the relevant local authority) is clear.

**14. Evaluation to inform future redevelopment policy and practice**

Fishermans Bend is one of many future redevelopment opportunities and provides an opportunity to develop the capacity for a 'Metropolitan Planning Authority' style authority that continuously learns and adapts in the context of planning high density redevelopment scenarios.

The idea is to trial, evaluate and learn in a policy sense to establish a model that works in redevelopment contexts and may be different to greenfield models currently used to accommodate Melbourne's sprawling growth.

# Fishermans Bend economic assessment

The business case for Fishermans Bend should consider the reasons for and against a given water servicing strategy, taking into account:

- opportunity costs[15], such as any additional risk of adopting the water sensitive approach or the foregone benefits of adopting a traditional approach
- 'market' as well as 'non-market' benefits to ensure that the full community value is realised[16]

To support this, a business case framework is suggested, supported by a preliminary assessment of the water sensitive ideas.

**Core services**

All options must firstly pass the hurdle of delivering core services to Fishermans Bend. These include water supply, sewerage, and drainage services, the metrics for which are already well understood. Performance in these areas is typically based upon cost effectiveness and resource efficiency to reduce the burden on existing water supply, sewerage and drainage systems.

Relative to a traditional water servicing approach[17], the water sensitive ideas can potentially deliver:

- a **62% reduction** in volumes of potable water imported or 31% compared with a Class A alternative water approach (potable usage is reduced to 74 litres/person/day)
- a **70% reduction** in sewerage discharge to the Western Treatment Plant
- a **43% reduction** in the size of rainwater tanks (from 192KL to 110KL) needed to meet drainage standards and best practice stormwater quality standards (see Appendix 3)
- a **43% reduction** in building energy use and hence a lower carbon footprint
- a reduction in stormwater drainage infrastructure through the use of surface conveyance of stormwater.

**Additional, non-market benefits**

In addition, the ideas deliver a number of non-market benefits that are a key to achieving the vision for Fishermans Bend (Places Victoria 2013). These benefits include a healthier bay by reducing the harmful discharge of urban stormwater and treated sewerage, and enhanced amenity and health benefits through the creation of an irrigated, green and shady urban environment that also provides connectivity throughout precincts to encourage active transport. The improvements to urban heat mitigation are a further benefit that will contribute to the reduction in hospital admissions for heat stress in this high-density community (Table 3).

*[15] An opportunity cost is the value of something that is given up by selecting a particularly option*

*[16] Considering non-market benefits in the business case is a way to incorporate the value of goods and services that, while not traditionally bought or sold, are critical to the objectives for the development*

*[17] A traditional approach is defined as connection to centralised potable supplies to meet all water demands, connection to Western Treatment Plant to remove and treat all sewerage and upgrade of piped drainage to manage stormwater and flooding. Stormwater quality will be treated to current best practice (pollutant reduction: TSS 85%, TP and TN 45%)*

*Table 3. Non-market benefits and performance*

| Benefit | Context at Fishermans Bend | Evaluation |
|---|---|---|
| **Stream health** Healthier waterways and bays achieved by reducing the discharge of urban stormwater and treated sewage | Fishermans Bend has no natural waterways within the site. The adjacent reach of the Yarra River is dominated by tidal influence (in terms of flows) and its broader catchment (for water quality).<br><br>Port Phillip Bay is an important ecological system and is affected by nitrogen loads, including those from Fishermans Bend. | The drainage strategy achieves required water quality (pollutant reduction: TSS 85%, TP and TN 45%) and manages the most frequent peak flows (~ 3 year ARI).<br><br>Western Treatment Plant (WTP) is managed under EPA Victoria licence and typically 3.7% of sewage is recycled. Sewer discharge to WTP is reduced by 70%. |
| **Microclimate** Health benefits through the creation of an irrigated, green and shady urban environment | The Fishermans Bend site is currently rated low in terms of heat vulnerability, likely a result of the current population[20]. The challenge is to maintain this current vulnerability rating whilst increasing the density and population. | The threshold for mortality and morbidity[19] in Melbourne lines the range of 39-44°C (CRCWSC, 2013). Plummer Street was modelled using the Water Sensitive City Modelling Toolkit[18]. On a peak hot day, land surface temperatures of 58°C were estimated on road surfaces. These temperatures can be reduced by 10°C using tree canopy cover (Coutts and Harris, 2013), and the Toolkit estimated that a 30% coverage of Plummer Street by irrigated green infrastructure will reduce the areas under extreme temperatures by more than 50%. |
| **Amenity** The creation of a green and functional urban environment | Fishermans Bend contains a number of existing parks and open spaces. However more than 90% of the areas planned to be public open space are privately owned[21], requiring either costly acquisitions or an alternative strategy to build amenity. | The cumulative area of green infrastructure across Fishermans Bend is likely to be considerable. This area can be calculated based on more detailed design and used as a surrogate of amenity improvements.<br><br>An increase in the extent of vegetation in the suburb of Port Phillip to the level of Albert Park would increase property values between 8.62% and 15.57%. These suburbs are immediate neighbours of the Fishermans Bend site and indicate that this effect is transferable to Fishermans Bend. |

[18] http://www.mappingvulnerabilityindex.com/

[19] *Based on $T_{max}$ temperature – daily maxima*

[20] *The Water Sensitive City Toolkit is a modelling tool that enables users to understand the stream health (hydrology, water quality and erosion), peak flow (minor flood reduction) and urban heat mitigation performance of an urban design scenario.* http://watersensitivecities.org.au/research-integration-designing-with-run-off-in-mind/

[21] http://www.theage.com.au/victoria/government-faces-340-million-bill-over-planning-blunder-20140810-1027o9.html

**Using non-market benefits in decision making**

By their nature, these benefits are likely to be assessed within frameworks such as multi criteria analysis (MCA) that enable market and non-market elements to be considered together. By definition non-market values do not have an associated funding stream, meaning that MCA is most useful when ranking options that have similar financial costs and are equally likely to be implemented.

An MCA approach assumes that the non-market benefits are material. It is important to validate this by clearly identifying and describing these benefits, determining whether they are indeed valued by end users and if so, whether the options can affect the delivery of these outcomes.

Table 4 outlines CRCWSC (2014) research to identify the the economic value of these non-market benefits. Where Willingness to pay (WTP) is greater than 0, it shows that individuals perceive a benefit to them. The size of this value will vary between individuals and communities based on factors such as household income.

Monetised values are also provided for readers wishing to compare both market and non-market benefits using a common measure (dollars). Where applicable, a range is provided.

*Table 4 – Willingness to pay (WTP) for non-market benefits*

| Benefit | Is the benefit valued by community? | Economic value |
|---|---|---|
| **Avoiding water restrictions** | WTP > 0<br>This is a real benefit | Average WTP to avoid stage 1&2 restrictions is $10.74/person/year<br>(95% confidence interval is $5.77 to $17.17) |
| **Cooler temperatures** | WTP > 0<br>This is a real benefit | Average WTP: $3.04 payment/person/year/ 2°C reduction (95% confidence interval is $0.15 to $6.56) |
| **Improved amenity** | WTP > 0<br>This is a real benefit | Average WTP: $0.49/person/year<br>(95% confidence interval is $3.09 to $5.62)<br><br>Raingardens increase property prices by 6% (within 50m) and 4% (within 100M) |

The business case for the water sensitive option is therefore based on:

- outperforming a traditional approach in the delivery of core services; and
- delivering a range of other social and environmental benefits which are valued by end users.

Importantly, this business case can be substantiated with research showing that the benefits are valued by the community as well as by modelling tools that can quantify the expected size of the benefit.

# Conclusion

The Ideas for Fishermans Bend deliver innovation over three scales - whole of Fishermans Bend, precinct scale and allotment scale. This highlights the importance of urban design as the integrative platform to deliver these outcomes and to provide a seamless transition between ideas at the three scales. This integration enables four key outcomes to be provided:

1. Water security: in a broadest sense that looks beyond water supply security to include flood, environmental and governance issues that are vital to the future of cities.

2. Low carbon living: considering the water-energy nexus upfront in planning and highlighting the significance of design guidelines for individual buildings in transforming precinct wide water and energy performance.

3. Liveability: once all the issues of subsistence have been addressed through water security, attention turns to other aspects that address microclimate, amenity and sense of place.

4. Productivity and economic efficiency: adopting a no-regrets approach to infrastructure planning and expenditure to ensure the community achieves the best possible return on its investment in the precinct over the long term.

At the regional scale, the central spine frames the urban design of the site. It becomes a focus of drainage via the podium development and minimises underground stormwater drainage infrastructure to address issues of site contamination and shallow groundwater tables. Allotment on-site detention is also vital to achieve the drainage objectives given the constraints on site.

To push for a higher level of mains water substitution and delay augmentation of centralised systems, it becomes essential to deliver potable water from local sources. This can be achieved by redefining the third pipe system as a collection system for greywater. This transforms alternative water from a demand limited problem into a supply limited opportunity. The high density, high rise form of Fisherman Bend enables this scheme to operate with minimal energy costs by harnessing gravity for the collection and treatment of greywater.

Street typology and allotment design is also a major consideration, and directly influences the microclimate. Modelling shows that Fishermans Bend will experience temperatures as high as 55°C during a typical 37°C day without intervention. Depending on the degree of greening of the site, the proportion of area exposed to this high temperature can be reduced.  This will have direct public health benefits.

The business case combines these benefits into a value proposition for utilities, councils and developers alike. For the community, the primary aim is to avoid water restrictions. For Fishermans Bend this will affect public open space and water security solutions to maintain a lush, green environment. The community also wants to protect waterway health. In Fishermans Bend this means protecting the health of Port Phillip Bay by reducing the load of nitrogen discharged. Here consideration is given to the sources and pathways for nutrients – both via stormwater and via sewerage discharged from Western Treatment Plant. The community also wants the microclimate and amenity benefits that water can provide. Where these benefits can be delivered in a single solution, there is an opportunity for developers to implement this within their buildings and to capture this value.

The challenge lies in the coordination needed to ensure effective implementation and thus realisation of these benefits. The governance design for Fishermans Bend therefore needs to foster a common agreement of what the future looks like in the level of innovation so that there is goodwill and commitment across the stakeholders for implementation. The CRCWSC and CRCLCL have clarified this innovation potential and the next step for industry is to explore risk sharing, coordination, funding options to ensure that these ideas move forward.

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# Participants

The following organisations participated in one or more of the Fishermans bend workshops:

**CRC for Water Sensitive Cities**

**CRC for Low Carbon Living**

**City of Melbourne**

**City of Port Phillip**

**City West Water**

**Department of Environment, Land, Water and Planning**

**Department of Health and Human Services**

**Department of Transport, Planning and Local Infrastructure**

**EPA Victoria**

**GHD**

**Melbourne Water**

**Metropolitan Planning Authority**

**South East Water**

# Appendix 1 – Alternative water scenarios

*Table 1. Comparison of volumes (per person) used, reused and discharged in different alternative water scenarios[1]*

| Scenario | Traditional | Class A recycling | Greywater to potable | Greywater to potable + rainwater |
|---|---|---|---|---|
| | Vol (L/p/day) | Vol (L/p/day) | Vol (L/p/day) | Vol (L/p/day) |
| **Demand from central water supplies** | 193 (100%) | 107 (55%) | 74 (38%) | 42 (22%) |
| **Alternative water source** | 0 | 86 (45%) | 119 (62%) | 151 (78%) |
| **Discharge to WTP** | 171 (100%) | 85 (49%) | 52 (30%) | 58 (34%) |

The following three scenarios demonstrate the residential water balance from different alternative water sources and demand configurations.

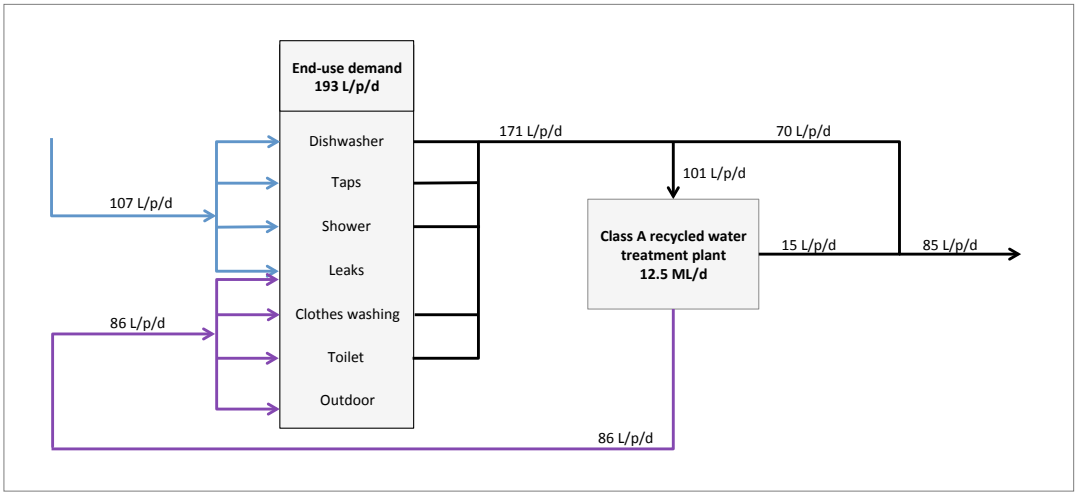



*Figure 1. Class A third pipe scenario. This scenario is demand limited*

[1] *These scenarios are further outlined below*

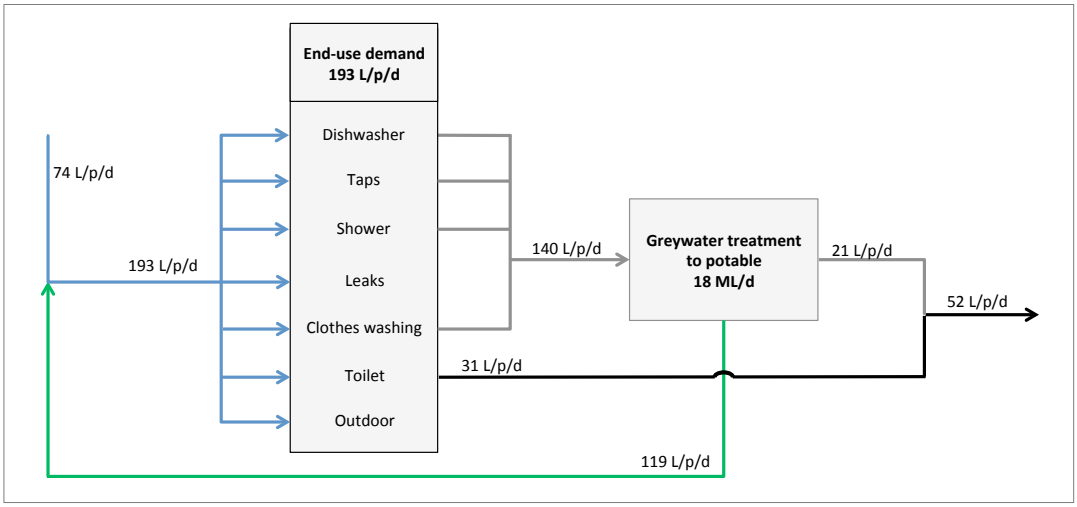



*Figure 2. Potable reuse scenario. Here dual collection pipes separate grey and blackwater; greywater is recycled to potable standard and distributed via potable network. This scenario is supply limited*

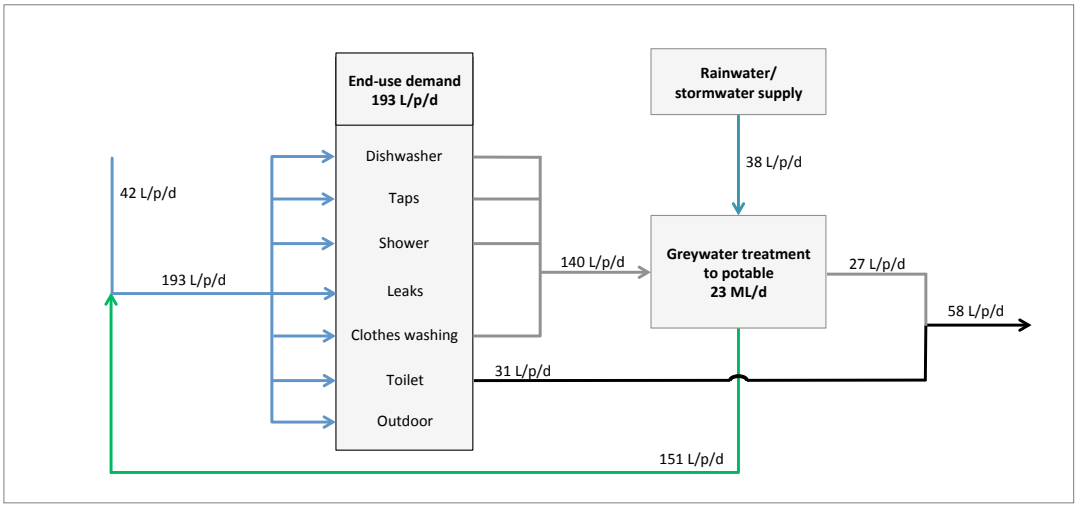



*Figure 3. Potable reuse plus rainwater scenario. This scenario is supply limited*

# Appendix 2 – Risk management considerations

*Table 1. Risk management considerations of greywater to potable water compared with Class A recycling*

| Risk/impact | Class A reuse | Greywater to potable reuse |
|---|---|---|
| **Demand risk** | Low due to community acceptance of Class A water for internal and external non-potable water demand | Low due to increased number of end-uses |
| **Source water quality risk** | Likely exposed to a high variability in contamination issues if regional sewers are used as a source for local sewer mining | Low if light grey water is used avoiding sources such as kitchen waste Chemical risks from greywater are lower than for recycled sewage provided that the inappropriate discharge of domestic chemicals is controlled |
| **Energy and carbon implications** | High if local treatment is used | High (higher than Class A option). Pathogen removal will be required necessitating an energy-intensive process. Offsetting this, short-run distribution at precinct-scale may negate the need for chlorine dosing. |
| **Regulatory risk** | Low as approval likely to be granted | High due to treatment of greywater for potable use |
| **Cross-connection risk** | Low as recycled water operates at a lower pressure than potable water | Low due to pressure differential |
| **Increased auditing & monitoring requirements** | High due to potential human interaction | High at treatment plant due to potable requirement |
| **Impact on sewer network** | Potential for blockage due to low flow volume/high solids concentration | Potential for blockage due to low flow volume/high solids concentration |
| **Impact on Western Treatment Plant** | Increased COD[2]/nutrient concentration (potential benefit) | Increased COD/nutrient concentration (potential benefit) |
| **Biosolids** | If local WWTP is used, biosolids management will be required. An ultimate population equivalent of 120,000 will generate ~1,000t of biosolids/year | Low |
| **Flexibility in design and operation** | Low due to no spare capacity in network | Increased due to spare capacity in network |

[2] *Chemical Organic Demand (COD) provides an indirect measure of organic components in water by giving the mass of oxygen consumed per litre of water (Clesceri et al., 2005)*

# Appendix 3 – Design parameters of the drainage strategy

The following parameters are provided to outline the Fishermans Bend drainage strategy.

*Table 1. Key design parameters of the drainage strategy*

| Key design parameters | | |
|---|---|---|
| **Bioretention/Bioswale** | **Main boulevard** | **Other typical roads** |
| Bottom width [m] | 4 | 2 |
| Extended detention depth [m] | 0.2 | |
| **Stormwater retention approach (rainwater tanks in each building)** | | |
| Tank volume [KL] | 110 | |
| Detention time [hr] | 48 | |
| **Inundation area for Q5 (top of the bioretention + green middle strips)** | | |
| Base width (on top of the 0.2 h of the bioretention) [m] | 8 | |
| Detention depth [m] | 0.4 | |
| **Inundation area for Q10 (part of the road will inundate)** | | |
| Base width [m] | 10 | |
| Detention depth [m] | 0.25 | |
| **Green walls (10% of the buildings)** | | |
| Water demand per building [kl/yr] with seasonal distribution* | 200 | |
| Volumetric reliability [%] | 85 | |

**Annual seasonal demand distribution for Melbourne (Mitchell et al., 2008)*

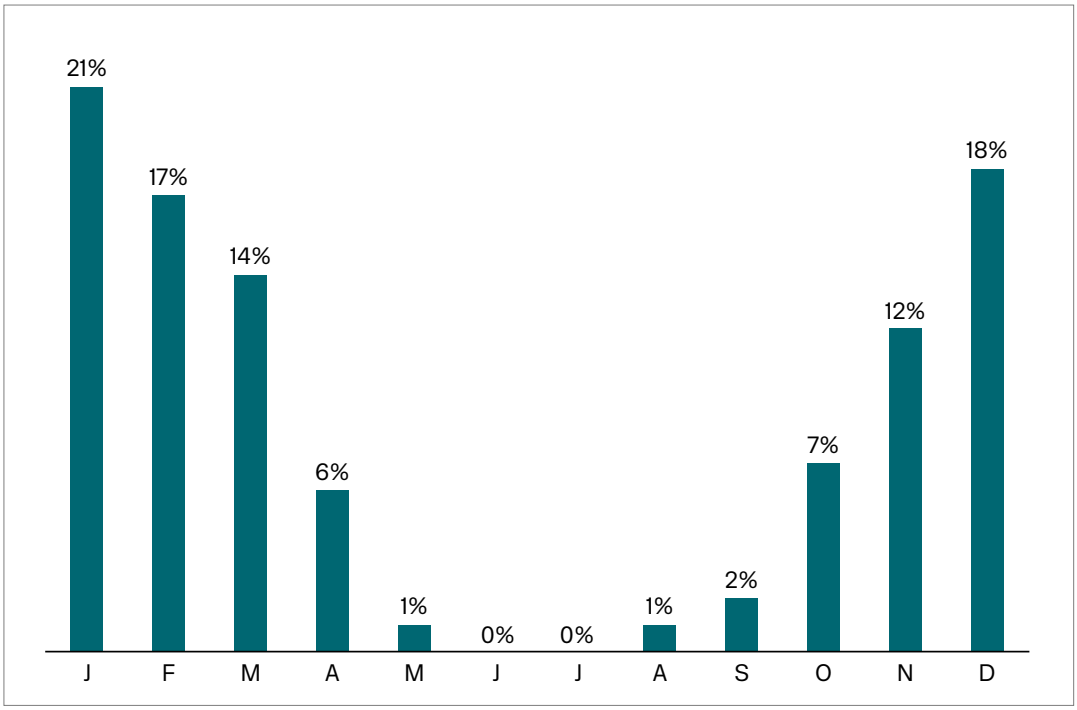
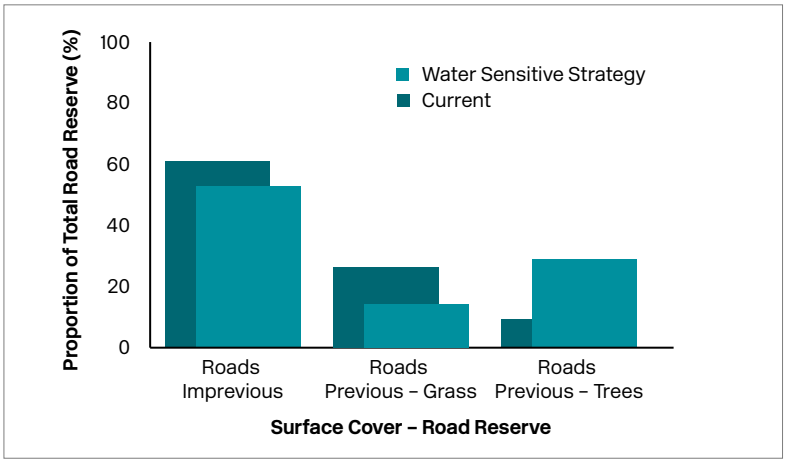



*Figure 1. Annual seasonal demand distribution for Melbourne (Mitchell, V., N. Siriwardene, H. Duncan and M. Rahilly, 2008, Investigating the Impact of Temporal and Spatial Lumping on Rainwater Tank System Modelling, International Conference on Water Resources and Environment Research, Modbury, SA, Engineers Australia)*

# Appendix 4 – Water Sensitive City Modelling Toolkit results

The Water Sensitive City Toolkit was used to evaluate the microclimate benefits of the water sensitive approach. Microclimate impacts are estimated based on differences in green infrastructure and how these differences affect extreme summer land surface temperatures (LST).

The graph below shows results for the Plummer Street road reserve. It shows the coverage and temperature for two scenarios, with LST as high as 58°C estimated on the road surface during heat waves.



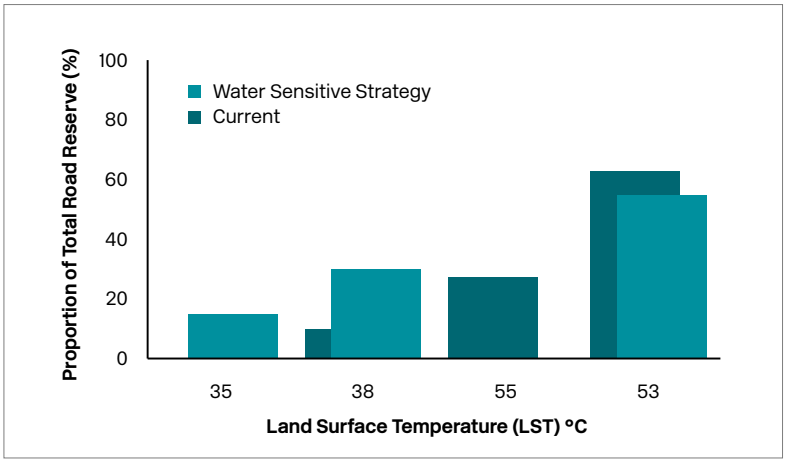




*Figure 1. Proportion of road reserve with the different land covers and proportion of road reserve area under different LST ranges*

The water sensitive scenario increases the tree canopy coverage and delivers a reduction in area of Plummer Street experiencing extreme temperatures.

# CRCWSC Research Synthesis

**Discussion Paper** | CRC for Water Sensitive Cities


**CRC for Water Sensitive Cities**

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