CRCWSC Research Synthesis

Discussion Paper | CRC for Water Sensitive Cities

IDEAS FOR BATAVIA COAST MARINA STAGE 2

CRC for
Water Sensitive Cities

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Date of publication: June 2015

An appropriate citation for this document is:
CRC for Water Sensitive Cities, 2015, Ideas for Batavia Coast Marina Stage 2.
Melbourne, Australia: Cooperative Research Centre for Water Sensitive Cities.

Foreword

The CRC for Water Sensitive Cities (CRCWSC) was the guest of the City of Greater Geraldton in 2013. During this visit we participated in the successful Water is Everything community workshops that helped to articulate a vision of water management within Geraldton. This vision highlights the importance of water management to the economic success and lifestyle of Geraldton. It also starts a dialogue on the way that water can transform Geraldton.

In 2014 we were invited to return, this time to apply the vision along with our research ideas to the urban development site of Batavia Coast Marina Stage 2.

A research synthesis workshop was held on 9-10 December and provided an opportunity to create a new future for this land in the heart of Geraldton. The way that we manage water will play a part in transforming this site from a largely unused landscape into one which creates an urban oasis with the reimagined railway station platform as a centrepiece. Equally, the urban design can provide new levels of self-sufficiency in terms of water services and can actually reduce the pressure on wider drainage, water supply and sewerage systems in Geraldton.

This exercise has been an important application of the CRCWSC's research in a regional context, highlighting the broad transferability of these ideas to a range of scenarios including those beyond large capital cities. It also provides a tangible example of the strength of the partnerships that have been developed with Geraldton, which will prove vital to the city's success in transitioning to a water sensitive city.

Prof Tony Wong
CEO, CRC for Water Sensitive Cities

How to use this report

This report outlines ideas identified from emerging research and international best practice as they might apply to Geraldton.

These ideas are integrated into a design that demonstrates how a water sensitive approach can address the water management, community wellbeing and infrastructure constraints at the Batavia Coast Marina site.

A key aim of the report is to model approaches that can have broader application across Geraldton or other regional centres as they move progressively toward the creation of more liveable, sustainable and resilient cities. This report provides a case study that we hope will inspire similar responses in other urban scenarios.

The design itself is conceptual. It is intended to provoke further analysis alongside other potential options but suggests a direction for the next stages of design evaluation at Batavia Coast Marina Stage 2 (BCM2).

The CRC for Water Sensitive Cities

The Cooperative Research Centre 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 is undertaking 34 research projects that address the key knowledge gaps that prevent the implementation of water sensitive practices. These projects span approximately 20 disciplines from the physical sciences, engineering, planning and climatology to the social sciences including economics, political science and behavioural sciences.

From research to synthesis

Synthesis projects provide a mechanism to integrate these diverse areas into site-based solutions. They are based on real case studies nominated by our industry partners and generate site-specific ideas for the implementation of our research outputs. The projects' deliverables are discussion papers that present contemporary ideas for water sensitive development practices. We hope that this will increase the capacity of all our industry partners to adapt our varied research findings to their needs.

Geraldton Research Synthesis Workshop

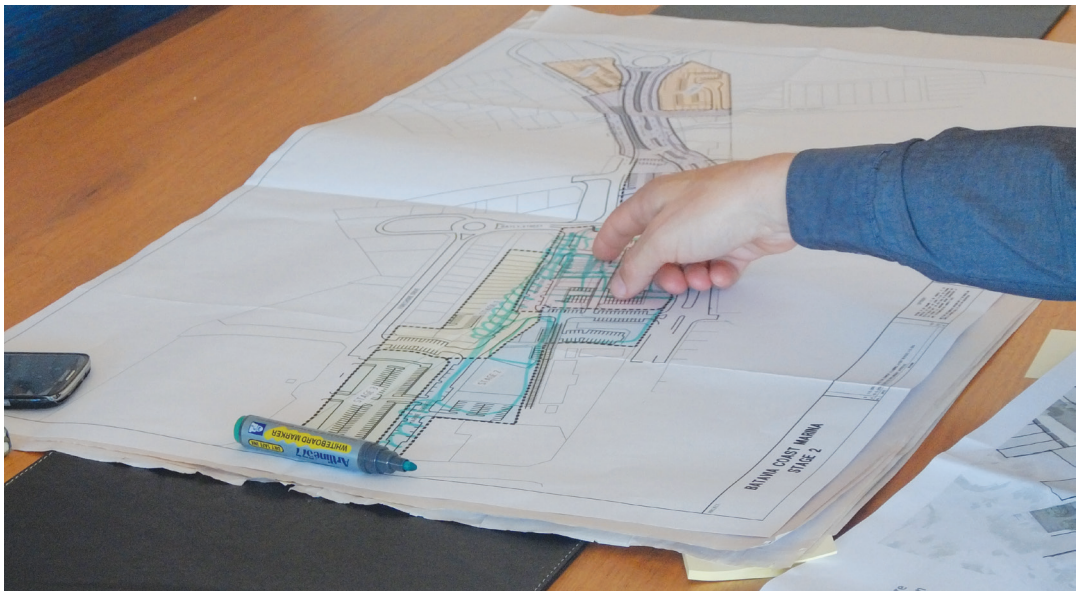
A research synthesis workshop was held at Mid West Development Commission's Geraldton offices on 9-10 December 2014.

The workshop was attended by representatives of the City of Greater Geraldton, the Department of Water, Water Corporation, Landcorp, Mid West Development Commission, Hames Sharley, Porters Consulting Engineers, Durack Institute of Technology, GHD, Realm Studios, New WAter Ways and Vigilante Landscapes along with the CRCWSC.

Attendees explored the opportunities and challenges of the BCM2 development and water management in Geraldton more broadly. Discussions focussed on three main areas:

- drainage challenges;
- urban design/public realm opportunities; and
- building design and technology innovation.

The synthesis workshop identified, critiqued and integrated a diverse range of ideas across these themes into a water sensitive design proposal.



Context

The City of Greater Geraldton is a regional port community located 424 kilometres north of Perth, Western Australia.

Geraldton has a Mediterranean climate. Winter brings the majority of its rainfall, which occurs in episodic rather than prolonged periods. Summer is characterised by high temperatures and strong southerly breezes that temper the summer heat.

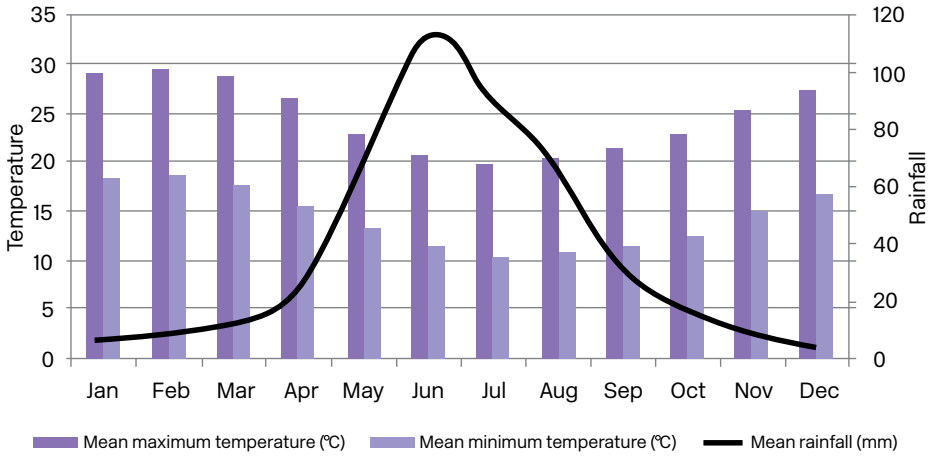


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Figure 1 -
The Geraldton climate (after ENV Australia and Essential Environmental, 2014)

Geraldton's economy is primarily structured around mining, agriculture, fishing and tourism. This, coupled with a number of proposed major projects in the area, including the Oakajee Deepwater Port, will continue to drive population growth throughout the next 10 years.

Water is Everything: a community vision for water in Geraldton

The City of Greater Geraldton partnered with the CRCWSC in a two-day Water is Everything summit in August 2013. This summit attracted over 200 participants from a range of stakeholder and partner organisations who collectively developed a vision for water:

Championing sustainable water solutions to become an ecologically proud community, one that values our precious water while maintaining a liveable and healthy environment for our city and its region: a "waterwise coast".

The Geraldton community is highly engaged and it is not surprising that this vision is reflected in the outputs of community consultation on the Batavia Coast Marina development. Here the community expressed a need to:

- reactivate the site by building on the current use of the old railway station which hosts a popular weekend market and provides a range of multi-functional spaces;
- link the foreshore with the town centre; and
- provide refuge from extreme weather.

Batavia Coast Marina Stage 2

Batavia Coastal Marina is an urban redevelopment project situated within Geraldton. Stage one of the redevelopment was completed in 2000 and the focus has now shifted to stage two.

Batavia Coast Marina Stage 2 involves the redevelopment of a six hectare precinct between the Geraldton Central Business District and the Batavia Coast waterfront marina. The City of Greater Geraldton, Mid West Development Commission, the Public Transport Authority of WA and LandCorp previously owned this land.

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Figure 2 - BCM2 (shaded area) is situated within the City of Greater Geraldton

Once complete it will offer a mix of commercial, residential and tourism developments within landscaped surrounds and public open space. The development will include approximately 30 houses and 150 apartments as well as commercial activities.

The stakeholders involved in strategic planning for the site describe a development that will:

- be responsive to the Geraldton's climate;
- compliment Geraldton's built heritage;
- provide servicing solutions for water, sewerage and drainage that adapt to the site constraints; and
- provide open space for connectivity and for shelter from weather conditions.

Expected water use

A water balance based on an estimate of 800 people[1] using the site on a typical day shows the following water flows through the site:

Water imported	approximately 44 ML/year
Sewage discharged	approximately 40 ML/year
Rainfall across the site	approximately 28 ML/year
Stormwater generated	approximately 17 ML/year

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Table 1 - Indicative water balance for the BCM2 site based on its ultimate population

Water management at BCM2

There are several issues that need to be considered in the development of a water servicing strategy for BCM2.

Stormwater: The existing stormwater network has limited additional discharge capacity. This is caused by siltation, infiltration inflow from the perched groundwater aquifer and storm surge conditions that restrict the performance of current drains. As a result, parts of downtown Geraldton are subject to flood inundation. In the absence of a citywide strategy for drainage management, individual developments are required to avoid or minimise stormwater discharge into the existing drainage network. At BCM2, 17ML/year of stormwater runoff will need to be managed so that it does not exacerbate flooding issues.

Growth in water demand: Demand for water is increasing as the city grows, and like many other regional cities water security is an important long term planning issue. The water balance indicates that the annual water demand for BCM2 will be 44ML/year, and although this is a small volume relative to Geraldton's annual water consumption of approximately 7050 ML/year (ENV and Essential Environmental, 2014), best practice dictates that this demand should be met with alternative sources where practical.

Water efficiency: Water use in Geraldton is dominated by residential use, however large volumes are also used to irrigate open space. This particular water demand is expected to increase in the future, prompting development of a Water Conservation Plan to better manage the groundwater allocations which currently provide the majority of this water. A tension therefore exists between the objectives of water security and the need to provide high quality open space in a challenging climate. The Geraldton foreshore provides an extensive landscaped open space area adjacent to the site, and provides a salient example of this opportunity: large volumes of bore water and scheme water are used to maintain the grassed areas along this popular foreshore.

Sewerage system upgrades: Sewage is planned to be discharged to an existing gravity sewer towards a pump station for conveyance to the Geraldton No. 2 Sewage Treatment Plant (STP) which has a capacity of approximately 1.94 ML/day. Recent odour issues have highlighted the need to upgrade the sewerage pump stations in Geraldton and the additional loads from BCM2 (40 ML/year) may be a catalyst for these works.

[1] Assuming~300 residents and~500 people per day associated with the commercial and retail activities

Public realm

With an extensive network of public open space already in place across Geraldton, the focus for BCM2 is on quality rather than quantity of open space.

Microclimate: A key way in which this can be achieved is by ensuring that the open space provides respite from Geraldton's harsh climate. This is particularly important as heat waves in Australian cities are predicted to increase into the future.

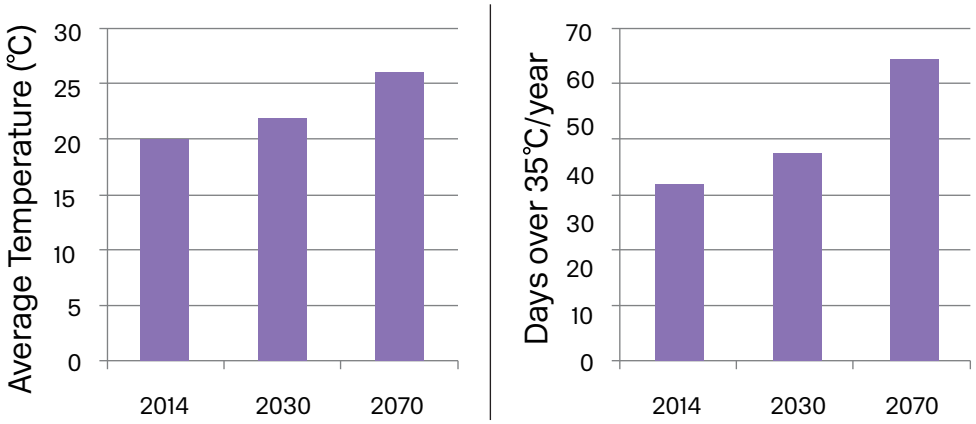

Figure 3 – Projected average temperatures and heat extremes in Geraldton (AECOM, 2010)

These increases have an implication for community health. There is a clear link between the heat vulnerability of the population and admissions to hospital emergency departments (CRCWSC, 2013). This relationship has been quantified through the specification of health thresholds. In Perth a maximum temperature of 43°C is a threshold for morbidity (seeing a rise in morbidity of 14%) and 44°C as a threshold for mortality (with a rise of 40%) (CRCWSC, 2013). Whilst these relationships are specific to Perth and need to account for local acclimatisation, it is reasonable to extrapolate the affect to Geraldton.

The urban form can influence these effects. CRCWSC research focuses on the role of water and vegetation and shows that these can play important roles:

- Land Surface Temperature (LST) during an extreme heat event can range from over 50 °C in unirrigated areas of the urban landscape to as low as 30°C over water.
- The LST under tree canopies on extreme heat days can be up to 10°C lower than exposed concrete areas (Coutts and Harris, 2013).

Geraldton is recognised for its large area of public open space but the typical urban form is dominated by impervious areas. If this urban form were to be replicated at BCM2 we would expect to see:

- combined roof and road area (including public open car parks) accounting for almost 50% of the area;
- less than 10% of the area covered by tree canopy; and
- very limited coverage by water (aside from the coast).

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Figure 4 – The Railway Station provides a focal point for the BCM2 site. It is both a part of Geraldton's history as well as a functional meeting place that hosts a popular community market

Heritage: The BCM2 site hosts the historic railway station. A community market held on the railway platform has become somewhat of a local institution. As a part of its integration with the local heritage, the BCM2 development should take inspiration from this feature.

Soils

Contamination: Soil contamination across parts of the site requires remediation to accommodate the planned residential zoning. Options to manage this include the relocation of services including roads, energy and communications services to minimise the area requiring remediation. The relocation of roads in particular has a strong influence on the drainage design for the northern half of the site.

From challenge to opportunity – a vision of a water sensitive future

A water sensitive BCM2 is a lush, green local environment supported by water collected on-site. Average water use per person in BCM2 is lower than the average for Geraldton. Discharges to stormwater and sewerage systems to centralised systems are minimised, controlled and form the basis of a wider strategy for improved water management across the city. These water, sewerage and drainage elements are combined into an urban form that celebrates the railway station, making this a central location where water, green space and community come together.

This vision can be achieved by applying the following design principles to the site:

Design principle 1 Isolate the site drainage from the existing city drainage infrastructure and groundwater by:

- using short, at-surface drainage runs to reduce the size of drainage catchments and decrease below ground conveyance size (dimensions and depth to achieve grade); and
- draining stormwater into a central location within the site to create a central outfall point for local drainage.

Design principle 2 Reduce the peaks in drainage and sewerage systems to eliminate capacity constraints in this infrastructure. These assets are typically sized to manage peak rather than average flow rates, and a reduction in peak flow rates will reduce operating costs as well as increasing the life of assets that are already at or near capacity.

Design principle 3 Transform the public realm landscape into an oasis that maximises microclimate benefits. Given that few shade species do well in local conditions, this landscape must be supported by a reliable water source.

This landscape can provide a dual function of passively cleansing the water that it collects.

Design principle 4 Harness water servicing assets and landscape elements in a single integrated design.

Design principle 5 Maximise on-site uses of fit-for-purpose water to reduce volumes discharged off site. To give effect to this principle, all water within the site will be managed firstly as a resource before any residual is planned for as a waste. This has the additional benefit of reducing the need to import scheme or bore water to the site.

Dubbo – a case study in the cooling benefits of irrigated green infrastructure

Dubbo (NSW) provides an example of the citywide benefit of landscape irrigation. Summers in Dubbo are harsh but the effects are reduced by the city's extensive public and private gardens which are supported by abundant irrigation. Figure 5 shows high-resolution satellite data for 13 January 2005, a day when air temperatures reached close to 40°C. It highlights a dry and hot rural landscape except for some notable areas of irrigation and the green areas of Dubbo CBD. Broadly, rural surface temperatures are ~50°C, while much of the urban landscape is 3-5°C cooler. As a consequence, creating irrigated green infrastructure in the urban landscape of Geraldton would have a similar cooling effect on the city as observed in the case of Dubbo.

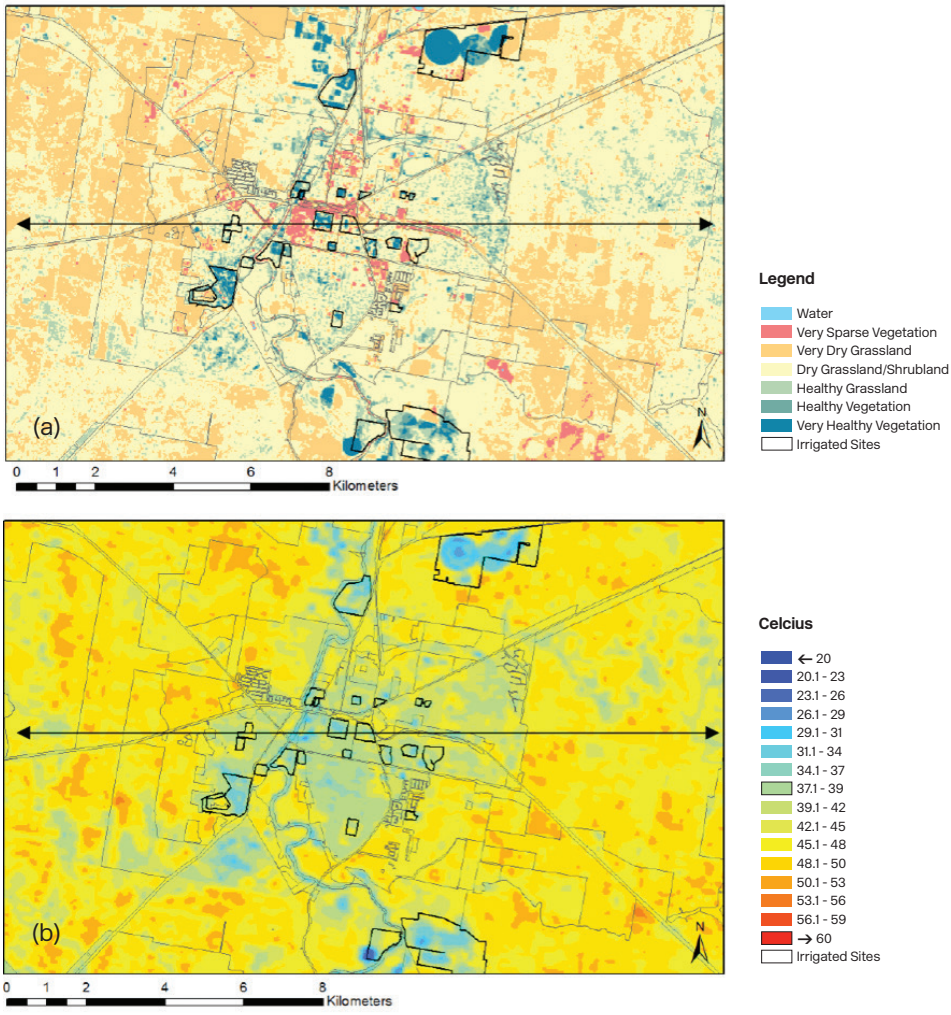

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Figure 5 - Landsat TM imagery data for Dubbo, Western New South Wales on 13 January, 2005 showing maps of (a) the vegetation greenness index (NDVI) converted to vegetation cover classes, and (b) the land surface temperature (LST). Dubbo occupies the middle of each image (CRCWSC 2013)

Ideas for a Water Sensitive BCM2

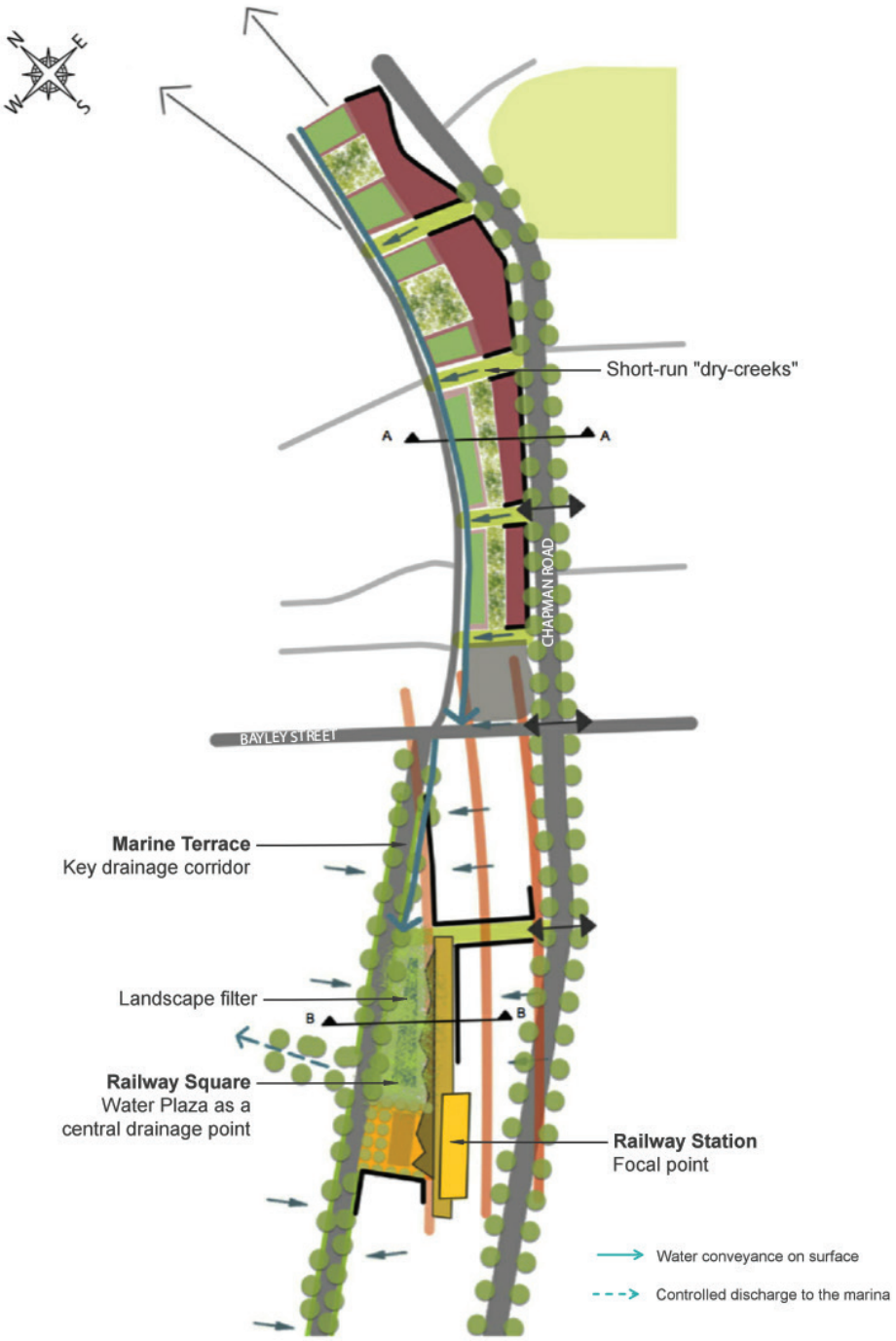

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Figure 6– Plan of a water sensitive BCM2 showing green corridors, short-run “dry creeks” and Railway Square landscape filter/storage (illustration credit- Realm Studios).

Drainage strategy for Geraldton

A whole-of-city drainage strategy can be developed that will relieve the pressure on existing stormwater infrastructure. The strategy will outline a strategic approach to deal with existing flooding "hotspots" in the city by addressing legacy issues and capacity constraints.

The costs of implementing this strategy will form the basis of a stormwater offset scheme for new developments.

Buildings

The drainage system begins at the building. Here, a combination of rainwater tanks in isolated sections of the development, along with green or living walls[2] in other parts, will capture, detain and treat rainwater before it enters the BCM2 drainage system.

Rainwater tanks will be managed by a system similar to Tank Talk[3]. This Victorian innovation allows a network of tanks to be remotely controlled so that they operate in unison and in anticipation of the weather. The network of tanks acts as a virtual stormwater detention. The levels of each tank are managed via a central control to empty it prior to a storm but otherwise keep it full. This allows the impact of the storm to be attenuated, thus reducing peak flows in drains.

Buildings without tanks will be designed with living walls along the building face that is sheltered from the prevailing winds. The planting media of the living wall will be connected to "light" grey water from the building or from a Marine Terrace recycled water source. These living walls form important landscape features that link with vegetation in the public realm to create the desired oasis effect.

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Figure 7 – Building design showing the integration of green walls and roof with living streams in the public realm to provide an integrated water sensitive urban design solution for BCM2. This elevation represents the cross section A-A in Figure 6 (illustration credit– Realm Studios).

[2] Green and living walls differ in their growing methods. Green walls use climbers, planted in the ground, which grow attaching themselves to the façade or to a supporting structure, while living walls are made of pre-vegetated panels, fixed vertically on the wall and containing their own growing medium (Dunnett and Kingsbury 2008).

[3] The Tank Talk smart technology tool monitors the water level in a rainwater tank and automatically releases the excess water at a controlled rate. http://www.iota.net.au/water/tank-talk/

Rethinking the drainage network

A key and immediate drainage strategy is to isolate the site drainage from the existing city drainage infrastructure so that the development does not exacerbate existing flooding problems. To achieve this, a central point of drainage is created so the development drains in on itself. From this point, controlled discharge goes directly to the marina.

The second priority is to avoid the influence of groundwater and storm surge conditions on the discharge capacity of the drainage network. To achieve this, storm runoff from the site will be conveyed "on surface" through a series of short-run "dry-creeks"[4].

In this strategy Marine Terrace becomes a key drainage corridor leading to a central drainage point in Railway Square. This requires some earthworks to reconfigure the site terrain (especially in the south-western section) so that storm runoff drains towards Railway Square. The Square itself also needs to be sunken to create the lowest point on the BCM2 site.

This action transforms the square into a water plaza. It will be dry for the majority of the time but following heavy storms the water level will rise and inundate Railway Square. This inundation is expected to be infrequent.

During these storm events, the water plaza will be inundated to a maximum depth of 0.5m over an area of approximately 2500 m^2.

		Scenario 1	Scenario 2
Wetland			
Surface area [m2]	1500		
H [m]	0.5		
Storage and re-use			
Toilet flush demand (residential + commercial) [ML/yr]	6.4		
Tank volume [KL]	5-10		
Volume supplied [ML/yr]		1.84	2.2
Plaza inundation area			
Surface area [m2]	2500		
H [m]		0.25	0.5

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Table 2 - Key design parameters of the stormwater reuse scheme

Scenario 1: Stormwater generated within the catchment
Scenario 2: Scenario 1 + harvesting stormwater from the Forrest Street stormwater pipe

[4]The term 'short-run' is used to explain storm runoff conveyance systems of small catchment areas that can be readily conveyed by surface channels (landscaped as creeks). These channels are typically of narrow width and shallow depth enabling them to be easily incorporated within street corridors as a streetscape feature.

Overflow will be controlled and directed to an existing stormwater pipe along Museum Way draining directly to the marina via a newly constructed stormwater pipe which itself is isolated from the city stormwater network. Between floods, when the square is not inundated, stormwater runoff from the site will maintain a moist soil environment to support the vegetation.

Railway square design

The Railway Station platform is a key determinant of the site design. It is a cultural driver that provides memories and opportunities to think about the built form of the area. The station lines and the adjacent railway lines, in conjunction with drainage strategy, will therefore determine the layout of BCM2.

At the Railway Station, decking will be used to extend the platform into the square to activate the space. This will merge with the vegetated landscape filter and storage (water plaza) that moves back under the decking. This area will be surrounded by vegetation to create a lush 'urban thicket' that creates a point of difference to other areas of Geraldton. The landscape filter itself will have hard edges and act as a stormwater detention basin.

Green corridors along Marine Terrace will extend this 'urban thicket' back into the development to provide shade and microclimate benefits.

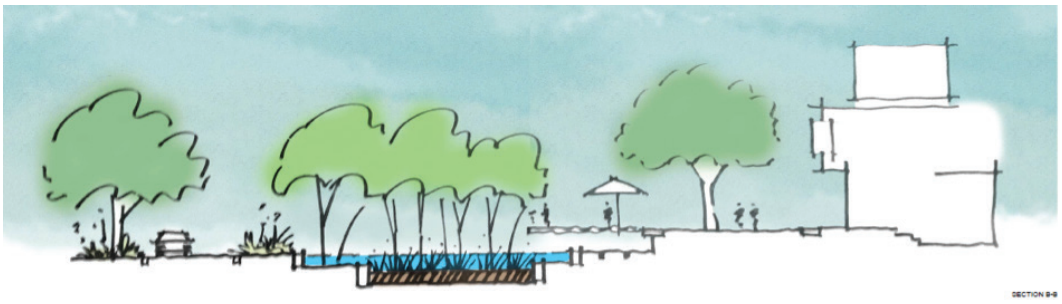

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Figure 8 – Railway Square design showing landscape filter, stormwater detention basin and urban thicket. This elevation represents the cross section B-B in Figure 6 (illustration credit– Realm Studios).

Stormwater reuse

As the central point for the drainage system, a ready supply of water will be brought into the square allowing the landscape filter and storage to become a harvesting site for stormwater reuse. Maximising the reuse of this resource has two main benefits:

- stormwater substitutes scheme water for demands on-site; and
- the use of stormwater reduces the volume that needs to be discharged into the marina.

These benefits will be achieved by matching the rainfall to a properly sized collection system and an appropriate end use. The aim is to size this system to optimise the dual objectives of stormwater detention and water reuse reliability.

Given this, the best demand is one that is closely matched to the volumes likely to be available. Toilet flushing suits this profile: it is a fit-for-purpose[5] use that is not influenced by seasonal patterns unlike other uses such as landscape irrigation.

Toilet flushing is estimated to be a 6ML/year demand for BCM2. The site can deliver a little over 1.8 ML/year in stormwater, which provides a meaningful substitute for potable water. Priority will be given to the connection of stormwater to public toilets in the commercial and retail areas of the development where this use forms a higher fraction of total demands.

Sewer mining

Creating a lush public realm requires good access to water to maintain the landscape vegetation. While the Railway Square landscape filter and short run creeks will be maintained by local stormwater runoff, other open spaces will be irrigated by accessing water resources from the sewer. A sewer mining plant can be located at either Pump Station No. 6 on the northern boundary of the site or Pump Station No. 1 near the intersection of Marine Terrace and Durlacher Street. The water pumped from the sewer will be treated through a sand filter to produce Class C or D[6] water of high nutrient content and containing a residual of pathogen, a risk that is managed by utilising subsurface irrigation to create a barrier to protect human health.

Sewer system

Scheduling of the pump station to convey sewage to Geraldton No. 2 STP will increase the efficiency of the STP and readily accommodate the increased load generated from the development.

[5] Fit-for- purpose refers to the matching of water quality and intended use, so that water sources of different qualities are utilised, but the risks of doing so are managed.
[6] EPA Victoria 2002

Benefits of a water sensitive approach

These ideas will transform the BCM2 site and provide a range of specific benefits.

(a)

(b)

↗
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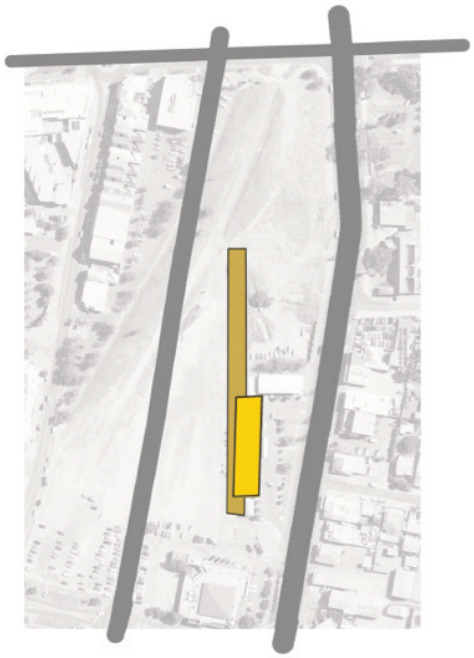
Figure 10 – Plan view of BCM2 showing the transformation of the northern (a) and (b) and southern ends of the site (c) and (d) into an urban oasis (illustration credit– Realm Studios).

(c)



(d)

Benefits include:

Less flooding - By managing all but the biggest storms within the BCM2 development, no additional load is placed upon Council's existing drainage system. Opportunities also exist to extract stormwater from the broader catchment to further reduce city wide drainage issues.

Avoiding relocation of Chapman Road and the intersection of contaminated soils - By adopting a short run drainage design, stormwater will be managed on the surface and within an urban form that accommodates the existing Chapman Road alignment.

Place making and property value - Creating a lush vegetated urban landscape in BCM2, in addition to the enhanced place making surrounding the existing railway station, delivers the community's aspirations identified through consultation.

Defer upgrade of the City of Greater Geraldton and Water Corporation assets - By retaining and reusing water on site and improving the scheduling of flows to drainage and sewerage systems, both peak and average volumes can be reduced. This reduces pressure on these systems, potentially deferring upgrades.

Microclimate - The creation of a well-watered, vegetated local landscape provides a microclimate that can be up to 10°C cooler than surrounding urban environments and up to 5°C cooler than surrounding (unirrigated) rural landscapes[7]. This provides significant public health benefits during heat waves.

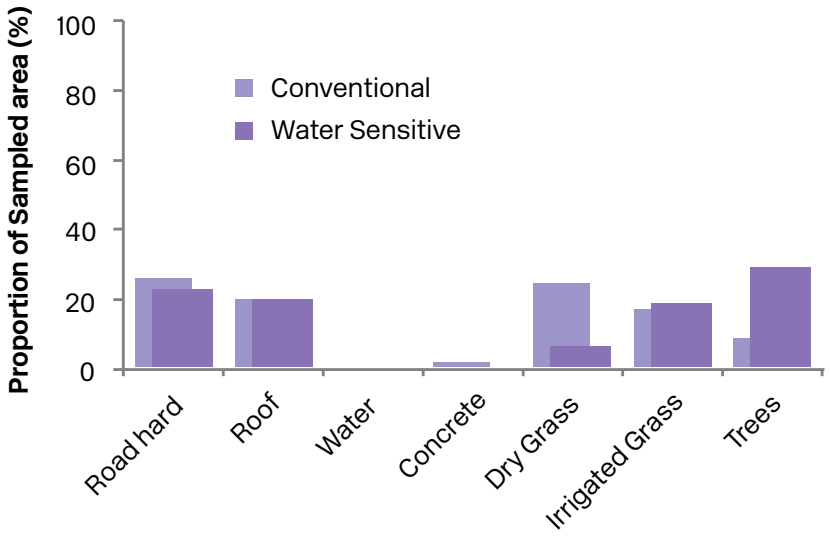
This benefit has been evaluated using the CRCWSC's Water Sensitive City Modelling Toolkit[8]. If 30% of the BCM2 site can be covered in irrigated green infrastructure (e.g. tree cover), then the area of the site that experiences extreme temperatures will be reduced by 40% during heat waves (Figure 10)[9].

[7]CRCWSC 2013

[8]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/

[9] 30% tree cover in the public realm is an aspirational goal. Experience suggests that it is difficult to achieve this level of tree cover without enlisting a contribution from the private realm.

(a)



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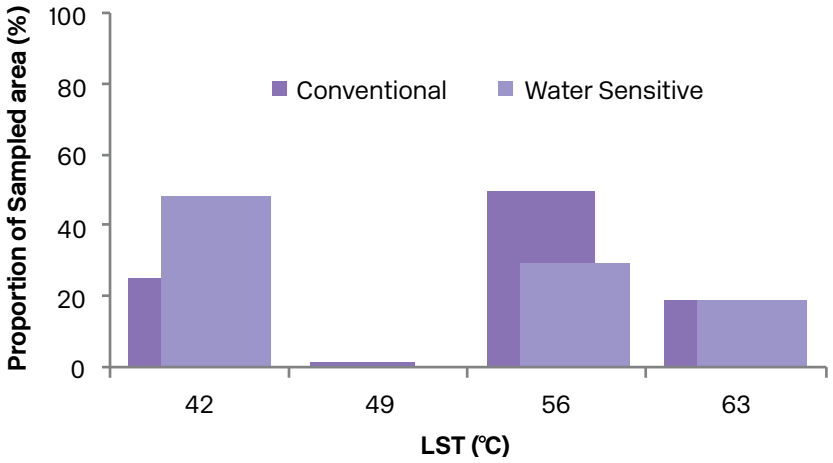

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Figure 11 – (a) The water sensitive strategy increases the area of BCM2 that is covered by vegetation and (b) decreases the exposure to extreme heat at BCM2[10]

[10]The 63 ºC range of LST corresponds mainly to roof surfaces. The roof area is constant across the two scenarios.

Conclusion

BCM2 can offer a point of difference in Geraldton's urban landscape. The ideas developed in the synthesis workshop can transform the site into a lush oasis that provides a range of benefits for the community whilst simultaneously helping the city's engineers to provide water, sewerage and drainage services more effectively.

These ideas are based on the central strategy of managing stormwater independently of the regional drainage system. This minimises interference and capacity issues in the existing drainage systems and creates a new opportunity to transform stormwater from a hazard into a resource. When coupled with other water resources on the site, this in turn creates an opportunity to irrigate a lush, green local environment as an alternative to disposing of this water. What therefore begins as a city infrastructure issue quickly becomes a place making strategy with much broader benefits.

This approach need not be confined to the BCM2 site. In this regard, the ideas generated provide insights into broader strategies for water cycle management at Geraldton that can address its legacy and growth challenges.

The success of the ideas in this report will depend on the extent to which they are consistently adopted in the final designs for the site. Notwithstanding the need for further design and analysis, this success will depend on how the ideas are championed by the various stakeholders. It is here that we return to the underlying strength of the Geraldton stakeholders. The participation in the workshop by the owners of the various drainage, water supply, urban planning and asset management plans, together with their expressed willingness to advance the BCM2 ideas, provides confidence that these issues will ultimately have an impact.

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