East Village: stormwater optimisation to achieve Better Urban Water Management

East Village: optimisation des eaux pluviales pour une meilleure gestion de l'eau en milieu urbain

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RÉSUMÉ

L'impact du réchauffement climatique dans de nombreuses régions du monde est un climat qui s'assèche. Dans certains pays développés, cela a conduit à la construction d'installations de dessalement de l'eau de mer coûteuses et à forte intensité énergétique, utilisant l'osmose inverse pour l'approvisionnement en eau des villes. En conséquence, la planification urbaine doit répondre à des stratégies en faveur de systèmes d'eau efficaces et résilients au changement climatique. L'élaboration de nouvelles stratégies en matière de gestion des eaux pluviales urbaines qui vont directement de la recherche à la mise en œuvre nécessite une approche de partenariat avec de multiples parties prenantes, y compris des universités, des industriels et des promoteurs immobiliers. Dans le présent document, les résultats d'une nouvelle stratégie de planification urbaine visant à intégrer la gestion des eaux pluviales à l'obtention d'un système d'approvisionnement en eau urbain plus durable ainsi que de systèmes de contrôle intelligents sont présentés à l'aide d'une étude de cas. L'étude de cas est un développement urbain de *LandCorp* appelé East Village. East Village atteindra les meilleures pratiques en matière de gestion des eaux pluviales grâce à la mise en œuvre des principes de conception urbaine sensible à l'eau (WSUD) afin de gérer l'augmentation du ruissellement résultant du développement. Des données sur l'eau en temps réel provenant de toutes les sources seront mises à la disposition des résidents. Le modèle développé est transférable à d'autres développements de taille similaire.

ABSTRACT

The impact of global warming in many parts of the world is a drying climate. In some developed countries this has led to the construction of expensive, energy intensive seawater desalination plants using reverse osmosis for urban water supply. Accordingly, urban planning must respond with strategies for climate resilient and efficient water systems. Development of new strategies in urban stormwater management that come directly from research to implementation require a partnership approach with multiple stakeholders, including universities, industry and land developers. In this paper, the results of a new urban planning strategy to integrate stormwater management to achieve a more sustainable urban water system along with intelligent control systems are presented using a case study approach. The case study is an urban development by *LandCorp* called 'East Village at Knutsford'. East Village will achieve best practice stormwater management through the implementation of water sensitive urban design (WSUD) principles to manage the increased runoff resulting from development. Real-time water data from all sources will be made available to residents. The model developed is transferable to other similar sized developments.

KEYWORDS

Stormwater, urban planning, urban water management plan, water balance model, climate change.

1 INTRODUCTION

1.1 Background

The impacts of global warming vary around the world in type and severity. In the southwest of Western Australia one type of impact is a drying climate (McFarlane *et al.*, 2009, 2012, 2016). The severity of this drying climate has led to the construction of expensive, energy intensive seawater desalination plants using reverse osmosis for urban water supply to the capital city Perth. In addition, the practice of ocean outfalls from wastewater treatment plants in Perth is being changed to recycling with the first groundwater injection scheme having been built, again using reverse osmosis – expensive and energy-intensive. Accordingly, urban planning must respond with new strategies for climate resilient and efficient water systems in new urban developments in order to avert the need for more seawater desalination plants.

Development of new strategies in urban stormwater management that come directly from research to implementation require a partnership approach with multiple stakeholders, including universities, industry and land developers. Recent precedents in Australia that take this approach include Rosehill Waters and WGV in Perth as well as Aquarevo Melbourne.

In this paper, the results of a new urban planning strategy to integrate stormwater management to achieve a more sustainable urban water system along with intelligent control systems are presented. The case study is an urban development by *LandCorp* called 'East Village and Knutsford'.

LandCorp, the Government of Western Australia's (WA) land development agency, proposes to redevelop a former Museum Depot site (Lot 1819 Blinco Street, Fremantle) for residential purposes with a focus on affordability and sustainability, particularly energy and water efficiency. The site, now named East Village, forms part of the larger proposed Knutsford Street East redevelopment (City of Fremantle, 2016). The site covers an area of approximately 1.52 hectares within the local government area of City of Fremantle (CoF) and is located approximately 15km southwest of Perth CBD and 1km east of the Fremantle City Centre. Development of the site will incorporate significant research and innovation components delivered in partnership with *LandCorp*, Curtin and Murdoch Universities through the RENeW Nexus project. Supported by the Commonwealth funded Smart Cities and Suburbs Program, the ReNEW Nexus project will demonstrate innovation in the supply and trading of power and water in residential developments.

1.2 Aim

To achieve sustainable stormwater management outcomes while designing with the ecosystem services offered from shallow groundwater through an innovative Urban Water Management Plan. The objectives to be achieved at this site in relation to sustainable urban water management were:

1. Prepare a water balance model that integrates all streams of the local urban water cycle.
2. Conduct an options analysis of innovative engineered solutions for urban water systems at the case study site.
3. Identify the preferred option based on mains water savings, affordability, best available technology and acceptable operation and maintenance requirements.
4. Develop a system of metrology that optimises data collection, system control and dashboarding of data back to the occupants.

2 METHODS

An Urban Water Management Plan (UWMP) was prepared in line with the Better Urban Water Management (BUWM) guidelines (WAPC, 2008). It describes water efficiency and measures, groundwater and stormwater design and management as well as monitoring requirements for the site in addition to the on-going research and data gathering process. A UWMP is typically the only requirement for a subdivision of this scale with unconstrained hydrological characteristics. The UWMP was developed with reference to:

- Better Urban Water Management (WAPC, 2008)
- Urban Water Management Plans (DoW, 2008)
- Stormwater Management Manual for Western Australia (DoW, 2004-2007)
- Australian Rainfall and Runoff: A guide to flood estimation (ARR), (Geoscience Australia 2016).

Specific techniques used were: Climate data analysis; Water balance modelling; Engineered systems options analysis as well as Metrology and systems control.

3 RESULTS AND DISCUSSION

3.1 Results

Leading-edge water-based initiatives at East Village will provide a high level of sustainability due to the water efficiency and alternative water measures embedded in the development. These initiatives were designed as part of a larger water management strategy that can enable a transition over time, and as required, to allow alternative water sources to come online as a means of future-proofing the development.

The initiatives were derived from a larger analysis which considered a suite of options ranging from 'on -site only' systems (e.g. greywater reuse, plumbed rainwater) through to whole-of-precinct scale wastewater recycling and aquifer recharge schemes. The options considered for this development are outlined in the IUWM Options Analysis as are the assumptions used in the subsequent analysis. A range of criteria were used to rank the options and it included estimated water savings, site suitability, regulatory constraints, risk management and estimated costs to install and maintain.

It is recognised that both the timing and scale of the East Village development preclude a range of options that may ultimately be applicable to the larger Knutsford precinct. The relatively small size of the development precludes larger reuse options such as full wastewater recycling schemes for example, as economies of scale can't be achieved, while the ability to access a groundwater allocation means that groundwater for irrigation purposes is cost-effective. Nevertheless, consideration and due allowance to incorporate such potential systems in the future, as far as possible, was made. The ability to transition the strata bore infrastructure to one based on a recycled water source for example has been considered and represents a pathway to future-proofing the development.

It is intended that the learnings and data gathered from East Village will be used to help inform the larger Knutsford precinct development.

A comprehensive sub-metering program, with real-time data display, will be included in the development as part of the proposed block chain peer-to-peer water (and power) trading platform. This represents a first in WA (and possibly globally) and will provide a unique on-going dataset of water consumption, which can be used to inform improved water management and efficiency. The penetration, and mains water savings resulting from alternative water sources in residential dwellings will be assessed, as will the performance of the supporting technologies including strata (shared) bore and plumbed rainwater systems.

3.2 Discussion

The development is being undertaken via a fully designed 'built form delivery' approach that will ensure all 36 townhouses have high water efficiency fixtures installed. This will enable some flexibility with the product range while maintaining a performance requirement. It is envisaged that building controls will be put in place to ensure water efficiency is also embedded at the apartment sites to be developed subsequently to the 36 townhouses.

In addition to real time monitoring these efficiency measures will be complemented by the development's alternative water sources. The integrated combination of water efficiency and alternative water sources is projected to reduce mains water consumption to 23kL/person/year as compared to the Perth residential multi-residential figure of 106kL/person/year (WCorp, 2010). The design assumptions supporting this projection are described in the IUWM Options Analysis.

4 CONCLUSIONS

East Village will achieve best practice stormwater management through the implementation of water sensitive urban design (WSUD) principles to manage the increased runoff resulting from development. Use of the inherently high levels of permeability of the onsite soils in the WSUD techniques will enable the rapid infiltration of all stormwater up to the 100-year ARI on site. The role of stormwater and groundwater are critical in this development to create a rich urban landscape while acknowledging climate change, biodiversity, urban amenity & ecosystem services.

An extensive smart metering program as part of the RENeW Nexus project will enable the complete water balance of the Lot 1819 development to be derived using real data. This will consist of real-time monitoring of mains water, rainwater and tank level, bore water; determination of stormwater via the adjacent BoM weather station; and wastewater volumes determined by either a wastewater pump pit with metered rising main or alternatively internal sub-metering of one or more townhouses (this would

include sub-metering of the toilet/s and both kitchen taps). The final decision on which of these approaches is to be implemented is currently pending.

Real-time water data from all sources will be made available to the residents while usage of the strata bore will be overseen by the strata body.

4.1.1 Recommendations

The effective implementation of the UWMP requires ongoing involvement by relevant stakeholders with roles and responsibilities to be followed as defined in the UWMP. The long-term maintenance of the stormwater infrastructure, shared bore and landscape will be the responsibility of the Strata body.

The model developed in this UWMP is transferable to other similar sized developments. A public demonstration house with information displays as well as online portal as soon as the civil works are complete and public open days to the whole of East Village are recommended provide lessons for broader application.

LIST OF REFERENCES

CoF, 2016. Knutsford Street East. Local Structure Plan. City of Fremantle.

DAF, 2010. Phosphorus for high rainfall pastures. Department of Agriculture and Food, WA.

Department of Health, 2009. Draft Alternate Water Supply Guidelines – Stormwater and Rainwater, Western Australia.

Department of Health, 2010. Code of Practice for the Reuse of Greywater in Western Australia.

Department of Health, 2018. Email confirmation of conditions for shared bore. 6/08/2018, Western Australia.

DoW, 2004-2007. Stormwater Management Manual for Western Australia: Non-Structural Controls, Non-Structural Controls Best Management Guidelines. Department of Water.

DoW, 2008. Urban Water Management Plans. Department of Water.

DWER, 2018. Email confirmation of exemption from water services license, 7/08/2018, Department of Water and Environmental Regulation.

Douglas Partners, 2018. Report on Geotechnical Investigation. Proposed Mixed Use Residential Development Lot 1819 Knutsford Street, Fremantle, WA.

Geoscience Australia 2016, Australian Rainfall and Runoff: A guide to flood estimation (ARR).

McFarlane, D.J. (2016) *Will Perth have Enough Water for its Diverse Needs in a Drying Climate?*, in Boomtime Perth, Perth, UWA Publishing, 2016, pp. 209-237.

McFarlane, D.J., *et al.* (2012), *Climate change impacts on water yields and demands in south-western Australia*, Journal of Hydrology, Volume 475, 19 December 2012, Pages 488-498.

McFarlane, D.J., Smith, A., Bekele, E., Simpson, J. and Tapsuwan, S. (2009). *Using treated wastewater to save wetlands affected by climate change and pumping*. Water Science and Technology 59(2): 213-221.

RPS, 2008. Detailed Site Investigation. Lot 1819, Wood Street, Fremantle.

RPS, 2010. Draft Site Management Plan. Lot 1819, Wood Street, Fremantle.

RPS, 2011. Remediation and Validation Report. Lot 1819, Wood Street, Fremantle.

WA Government, 2018. [Online]. Geomorphic wetlands Swan Coastal Plain dataset. https://catalogue.data.wa.gov.au/dataset/geomorphic-wetlands-swan-coastal-plain/resource Accessed 14 May 2018.

Water Corporation, 2010. Perth Residential Water Use Study 2008-09. Water Corporation.

WAPC, 2008. Better Urban Water Management. Western Australian Planning Commission.