Guide to a Waterwise Development

The planning, design and approvals, and civil and landscape construction for OneOneFive Hamilton Hill.

WATER CORPORATION

Version 2.0

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Preface

This Guide to a Waterwise Development (Guide) is an outcome of the OneOneFive Waterwise Exemplar (WE) program which is seeking to understand how innovative waterwise initiatives and water sensitive urban design (WSUD) can become mainstream practice in Perth's development industry.

The Guide is informed by the processes for undertaking development of the OneOneFive Hamilton Hill 'Innovation by Demonstration' residential infill project by DevelopmentWA.

The 11.9ha development is located on the former Hamilton Senior High School site in the City of Cockburn. It will include 244 lots (312 dwellings) and a range of housing typologies.

DevelopmentWA is committed to providing leadership in demonstrating liveability and sustainability outcomes in urban development. The project team aim to set a new standard for residential infill development across the four elements of:

- Community wellbeing
- Environmental responsibility
- Economic health
- Design excellence.

The OneOneFive Waterwise Exemplar uses the OneOneFive Hamilton Hill residential infill project by DevelopmentWA to investigate and communicate how waterwise initiatives can become mainstream practice in Perth's urban development industry.

The program focuses on understanding waterwise development processes, overcoming barriers, sharing learnings and building capacity for improved urban water management among local government, developers and their consultants, in response to Perth's drying climate.

The Guide details a Waterwise Development Pathway, which consists of additional complimentary steps to the standard development processes (concept, masterplan, local structure plan and subdivision plan) and corresponding statutory requirements as outlined in Better Urban Water Management (WAPC, 2008, to be replaced with updated SPP 2.9 and Guidelines). These additional steps are intended to encourage better uptake of innovative water management practices in urban developments in order to achieve water savings, improved urban greening and liveability outcomes.

The Waterwise Development Pathway has emerged from navigating barriers encountered during the planning, design and approvals of urban water management approaches at OneOneFive Hamilton Hill, specifically:

- Localised stormwater infiltration for landscape hydration.
- The investigation of a non-drinking water supply (community groundwater bore).
- Advanced water efficiency in houses and landscape.

The OneOneFive Waterwise Exemplar is financially supported by Water Corporation, DevelopmentWA, and Department of Water and Environmental Regulation (DWER). Additional WE stakeholders such as the City of Cockburn and the project consultant team provide expertise and guidance. A Memorandum of Understanding (MoU) between Water Corporation and DevelopmentWA has been signed to ensure a partnership is in place for the delivery of waterwise outcomes at OneOneFive Hamilton Hill and to demonstrate leadership by state government organisations in urban water management.

The WE program consists of three phases:

Phase 1: Focused on the structure planning process and approvals for the site, and subdivision planning, design and approvals associated with Stage 1 of the development.

Phase 2: Coincided with the civil construction, landscape construction and land sales of Stage 1. Phase 2 focused on sharing the waterwise development process and messages via advocacy and engagement activities as well as capturing the learnings from Stage 1 development processes.

Phase 3: Commenced in January 2022 and includes the development and delivery of applied research to evaluate WSUD asset performance and monitor water use It also includes ongoing advocacy of waterwise initiatives, stakeholder engagement to co-design initiatives, documentation of the waterwise development process for increased understadning and knowledge sharing.

Learnings from the WE program Phase 1: planning, design and approvals; and Phase 2: civil construction, landscape construction and land sales; are captured in this version (2.0) of the Guide to a Waterwise Development.

Future versions of this Guide will include learnings from Phase 3 of the OneOneFive WE program as the project moves through to operation, maintenance, occupation and monitoring of water use. Emerging waterwise techniques and technologies will be tested in subsequent development stages, with the process documented and shared through industry forums, publications and updates to the Guide.

Figure 1: Waterwise Exemplar Phases and OneOneFive Hamilton Hill Development Stages


Total Area: 11.9ha
Lot Yield: 244 (estimate)
Dwellings: 312 (estimate)
Density: 48 dwellings/ha (total nett developable land)
Public Open Space: 16.28% (inc southern bushland)
STAGE 2
STAGE 1
STAGE 3

Contents

Context

The Guide to a Waterwise Development

This Guide details a Waterwise Development Pathway, which consists of additional steps to the current statutory planning process for urban water management in land development.

This pathway has been informed by the planning, design, approvals and construction learnings while implementing waterwise initiatives at OneOneFive Hamilton Hill. It includes opportunities for localised stormwater infiltration, an alternate water supply (community groundwater bore) for irrigation, and advanced water efficiency in buildings and the landscape. It is based on the identification of potential barriers and how these barriers might be overcome as part of the process of delivering a waterwise development with high quality urban greening and liveability outcomes.

The Waterwise Development Pathway is applicable to all types of residential development and can assist with implementation of initiatives often viewed as difficult by mainstream urban development industry. The intended audience includes land developers and land development consultants, local government and associated stakeholders.

Fact sheets and a case study with further information on planning, design, approvals, construction and costs are appended, including:

- Waterwise Development Site Process
- Permeable Paving Fact Sheet
- Water Harvesting Tree Pits Fact Sheet
- Roadside Landscape Feature Swales Fact Sheet
- Underground Stormwater Retention Systems Fact Sheet
- Community Groundwater Bore Case Study

As OneOneFive Hamilton Hill progresses, the Guide will be updated to include learnings captured on WSUD maintenance, water use monitoring and effectiveness of initiatives in achieving water use and cooler urban microclimate targets.

The waterwise initiatives and attributes planned for the development align with the relevant goals of a Water Sensitive City[1].

1 Identified by the former Cooperative Research Centre for Water Sensitive Cities www.watersensitivecities.org.au

Public Realm	
OneOneFive Waterwise Attributes	**Water Sensitive City Goals**
Tree retention and enhancement for urban cooling, ecological and amenity benefits. • Targeting a 30% canopy cover. • Retain approximately 77 existing trees. • Planting additional 350 trees in public realm.	Ensure quality urban space. Improve ecological health.
Retention of the natural topography of the site with made to fit stormwater controls. Large depth to water table and sandy permeable soils makes the site suitable for at-source stormwater control. At-source stormwater infiltration methods include: • Permeable paving in selected sections of roads and selected car bays. • Roadside swales for enhanced soil moisture, plant health and landscape aesthetic. • Water harvesting tree pits designed to support healthy tree growth and reduced reliance on irrigation. • Approximately 75% of lots to contain 1% Annual Exceedance Probability (AEP) event on lot to reduce size of stormwater infrastructure and promote localised infiltration. • Underground retention chosen over basins in response to retaining existing trees where possible.	Promote adaptive infrastructure. Ensure quality urban space. Improve ecological health.
The project aims to minimise impact on remnant vegetation areas where possible, therefore the design excludes the intrusion of surface level drainage infrastructure on these natural areas, using underground retention to optimise public open space (POS) outcomes for conservation, useability and amenity.	Ensure quality urban space. Improve ecological health.
Groundwater is available for irrigation of POS and private gardens, via a well-managed non-potable community groundwater bore scheme.	Promote adaptive infrastructure.
POS includes hydrozing, waterwise plants, soil conditioner and mulching. High efficiency irrigation system, including in-line drip to suitable locations. Remote irrigation management with weather-based scheduling and automatic alerts of abnormal water use.	Ensure quality urban space. Promote adaptive infrastructure. Improve productivity and resource efficiency.

Private Realm	
OneOneFive Waterwise Attributes	**Water Sensitive City Goals**
Private gardens designed in accordance with Design Guidelines with no more than 40% outdoor hardstand area (with a preference for permeable surfaces), waterwise softscaping with turf lawn limited to a maximum of 50% of the landscaped area.	Ensure quality urban space. Improve ecological health. Improve productivity and resource efficiency.
Irrigation must be connected to community groundwater bore scheme. A programmable automatic irrigation system including weather-based control must be used and set to relevant rostered watering days. Water efficient in-line drip irrigation must be installed for all garden beds and spray irrigation only for turf areas.	Promote adaptive infrastructure. Improve productivity and resource efficiency.
Rainwater tanks for houses on lots over 220m^2. Dual plumbing to toilets and washing machines for connection of rainwater supply (now or in future) and provide sufficient space for the installation of a rainwater tank (min 3,000 litres) close to downpipes with a minimum roof catchment of 70m^2, an external power outlet, a garden tap or mains water take off point and dual plumbing pipe work.	Promote adaptive infrastructure.
Water efficient fixtures and fittings: • Shower heads that use less than 7.5 litres per minute (WELS 3-star). • Taps to bathrooms, kitchen and laundry that use 6 litres per minute or less (WELS 3-star). • Dishwasher consumption of <=14 litres per use (WELS 5-star). • Washing machine consumption <=110 litres per use (WELS 4-star).	Improve productivity and resource efficiency. Increase community capital.
Promotion of waterwise behaviours including real-time feedback on water use and leaks via a smart digital platform.	Improve productivity and resource efficiency. Increase community capital.
Governance and Research	
OneOneFive Waterwise Attributes	**Water Sensitive City Goals**
Ongoing collaboration between stakeholders to ensure desired outcomes are met throughout the development process.	Ensure good water sensitive governance.
WSUD asset evaluation, water use and microclimate monitoring.	Improve productivity and resource efficiency.

Waterwise Perth

The current urban water vision for Perth is to become a leading waterwise city by 2030 and the Waterwise Perth Action Plan (DWER, 2019) sets the direction for this transition. With climate change impacts already experienced in Perth, such as reduced rainfall and increased temperatures, coupled with population growth, the way water is sourced, used and planned for in urban spaces is critical to achieving the vision.

As households and green spaces account for most of the water use in Perth by sector (53% and 15% respectively; DWER, 2019), the design of residential developments provides an opportunity for change. In addition, demonstration projects can provide an avenue to test, revise, validate and understand waterwise approaches.

The OneOneFive WE program supports the waterwise vision for Perth and responds to some of the associated strategic aims and actions as detailed in the Water Sensitive Transition Network[2] 2019 report and the Waterwise Perth Action Plan (WPAP) (DWER, 2019).

Water Corporation Waterwise Development Program

The Waterwise Development Program recognises best practice outcomes by developers creating waterwise communities. In 2019, the Program was expanded from a water efficiency focus to include outcomes that align with the principles of a waterwise city and goals from the CRCWSC Water Sensitive Cities Index[3].

Developments that meet the water category requirements of sustainability certification frameworks such as EnviroDevelopment, GreenStar, One Planet Living and the Living Community/Building Challenge are eligible for endorsement.

Gold recognition requires details of actions that demonstrate a commitment to achieving Water Sensitive City goals including:

- Governance and community capital
- Productivity, resilience and resource efficiency
- Ecological health and quality urban space.

Platinum recognition requires evidence on how a project demonstrates genuine industry leadership.

2 A network of champions formed to advance the water sensitive/waterwise journey for Perth.
3 www.watersensitivecities.org.au/solutions/wsc-index

Waterwise Perth Vision Statement

"A waterwise Perth is cool, liveable, green and sustainable, a place where people want to live, work and spend their time. It is a city where communities care about and value water, while making the best use of its various sources (groundwater, surface water, stormwater, seawater, wastewater). The city serves as a catchment and provides healthy natural environments, supporting a range of social, ecological and economic benefits." (DWER, 2019).

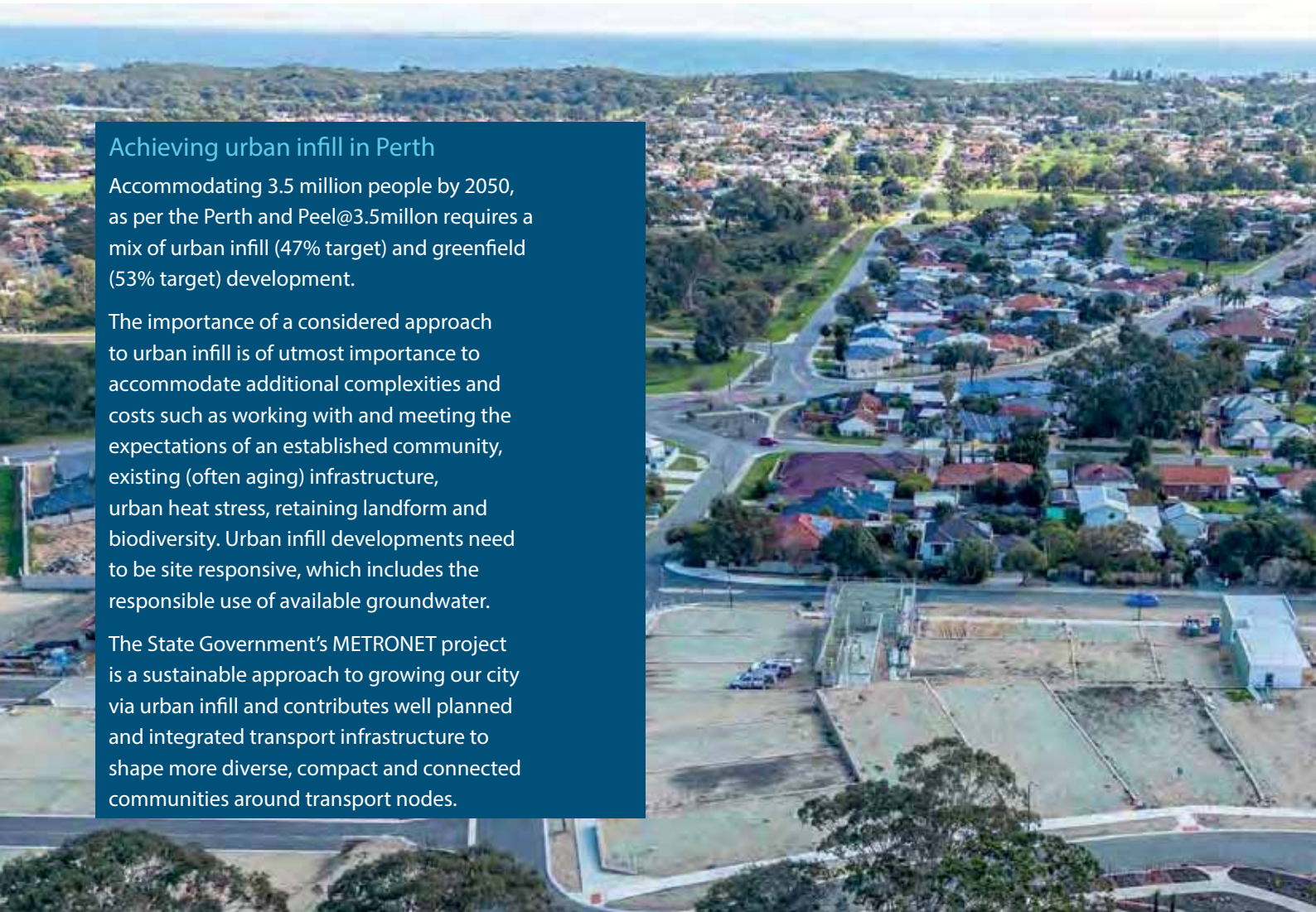
Using the Guide

Integrated urban water management (IUWM) approaches are dependent upon the site-specific context (physical, historical, social and economic), the aims and values of stakeholders and the proposed development approach or philosophy. There is no one size fits all. It is acknowledged that a large amount of Perth's urban growth will take place in areas where groundwater allocation is limited or unavailable, and where the hydrological conditions are more challenging than OneOneFive Hamilton Hill.

Nonetheless, the Guide to a Waterwise Development and the documented Waterwise Development Pathway is broadly applicable to all forms of residential development, particularly as there is a focus on embedding waterwise approaches into the project definition and vision early, ensuring the project team and stakeholder expectations align. The learnings are transferable to other development types (i.e. greenfield) and geographical contexts across Perth given the focus is on process, governance and engagement. Examples and key outcomes from OneOneFive Hamilton Hill are provided throughout the Guide as a working example.

Many of the barriers to mainstream implementation have been recognised at the post implementation stage; such as construction not matching design intent, unviable business cases, and operation and maintenance responsibilities (Sharma et al. 2016). It is hoped that over time, as more on-ground projects apply this Guide, it can evolve to incorporate additional learnings and case studies to ensure greater understanding, improved applicability and progress towards a more waterwise Perth.

The complete Guide to a Waterwise Development will add to the suite of urban water guides specifically written for WA, such as the Community Bore Guide (Water Corporation, 2018) and the West Australian Greywater Guide (Water Corporation, 2019).



Achieving urban infill in Perth

Accommodating 3.5 million people by 2050, as per the Perth and Peel@3.5millon requires a mix of urban infill (47% target) and greenfield (53% target) development.

The importance of a considered approach to urban infill is of utmost importance to accommodate additional complexities and costs such as working with and meeting the expectations of an established community, existing (often aging) infrastructure, urban heat stress, retaining landform and biodiversity. Urban infill developments need to be site responsive, which includes the responsible use of available groundwater.

The State Government's METRONET project is a sustainable approach to growing our city via urban infill and contributes well planned and integrated transport infrastructure to shape more diverse, compact and connected communities around transport nodes.

Preliminaries

This Guide is an outcome of an applied research approach used for the OneOneFive Waterwise Exemplar program to understand the process of WSUD planning, design and implementation, using the learnings from OneOneFive Hamilton Hill. Applied research is adopted when a problem needs to be solved, with the intent of a study to contribute the knowledge of that problem and findings to assist in developing solutions (Bickman and Rog, 1998).

The methodology to investigate the planning and approval process includes:

- Desktop review of guidelines, academic literature and anecdotal evidence on barriers and challenges to implementation of WSUD.
- Review of supporting policies, planning frameworks and governance arrangements.
- Data collection via stakeholder discussions/ workshops on planning and approvals process and observation.
- Data synthesis, reporting and recommendations (Guide to a Waterwise Development).

Rationale for IUWM and WSUD approach

Increasingly, Australian urban developments are incorporating IUWM with WSUD at a range of development scales such as greenfield, infill and retrofit (Sharma et al., 2012). IUWM is the long-term holistic planning that integrates multiple water sources with various stakeholders and urban planning (Byrne et al., 2018). WSUD is a part of IUWM focusing on solutions that incorporate the water cycle into the local context, including green infrastructure, to improve liveability and environmental outcomes (Furlong et al., 2016; Tjandraatmadja, 2018). Combined, these approaches aim to replace use of drinking water for non-potable consumption and reduce the strain on centralised sources with alternative sources such as rainwater harvesting; stormwater harvesting; groundwater extraction and treatment; greywater collection and treatment; and wastewater collection and treatment (Byrne, 2016; Sharma et al., 2012). Benefits include promoting a more natural water cycle, local source diversification, resource efficiency and providing decentralised solutions (Marlow et al., 2013). They also have the potential to increase biodiversity, ecological health, landscape aesthetic and amenity; which can add to the distinct character, identity and sustainability of a place (Johnstone et al., 2012; Lehmann, 2010) providing a context specific identity that connects the community to its natural and cultural context. Moreover, these urban water management approaches assist in managing public health, urban microclimates and heat mitigation (Johnstone et al., 2012).

Current opinion and consensus indicates that progress on changing from a traditional centralised water delivery approach to an integrated approach is slow, despite the technical and scientific aspects of urban water management being well understood; it is the institutional setting and capacity, financial considerations, flexibility with changing technology and community understanding/ acceptance that still requires attention (Keremane et al. 2017; Marlow et al. 2013). A review of water governance studies in Australia indicates that social and institutional barriers include: insufficient practitioner skills and knowledge, organisational resistance, lack of political will, limited regulatory incentives and lack of institutional capacity (Keremane et al. 2017). These barriers have appeared alongside the new paradigm of urban water management that began in the 1990s when conventional water management systems were recognised as unsustainable and began to change into water management systems integrated with land use policy, planning, development approvals process, construction, economics, regulation and legislation, education, social acceptance and community involvement (Mitchell, 2006), adding additional layers of procedural and operational complexity.

Wong and Brown (2008) suggest that transforming towards a Water Sensitive City[4] needs to focus on 'how' to ensure a connection between urban water management, urban design and social and institutional systems. Therefore, fostering good working relationships between stakeholders, well communicated processes, and demonstration projects need to accompany sound technical knowledge to assist in ensuring that future implementation of WSUD and IUWM is successful. The OneOneFive Waterwise Exemplar program aims to contribute to this required level of knowledge and shared learnings.

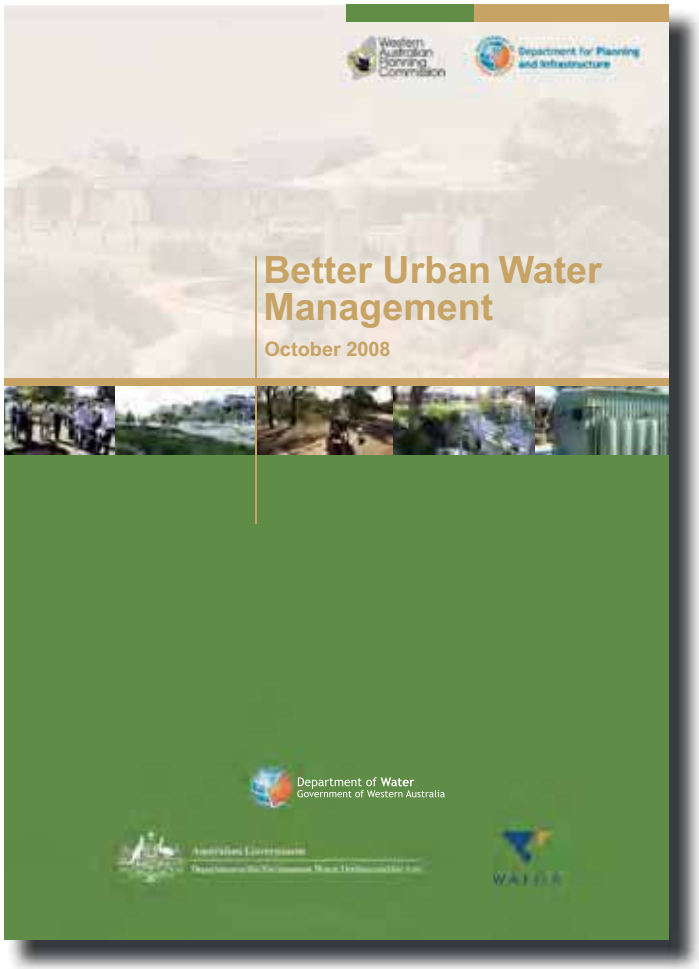
Technical guidelines (existing resources)

A comprehensive review of WSUD guidelines has been completed by Sharma et al. (2018) examining the national, regional, and local planning and design guidelines developed by various national, state, and local agencies for the sustainable implementation of WSUD systems. As noted by the authors (Sharma et al., 2018, p.75-76) "These guidelines help water professionals, designers, planners, and managers to plan, design, and implement these approaches based on urban development requirements, water quality and hydrology criteria, catchment characteristics, local climatic conditions, local regulations, and environmental and community considerations."

Practitioners have access to a variety of guidance documents where the science has been unpacked on various WSUD tools and systems. Sharma et al. (2018) provide links to specific guidelines and documentation for a variety of WSUD systems and techniques. Design criteria have also been outlined, with a focus on water quality management and protection. The review by Sharma et al. (2018) provides an excellent overview of the available technical guidelines and highlights the importance of considering the design objectives and site constraints during implementation and the various data requirements for WSUD system planning and design.

A key guidance document for WSUD implementation in Western Australia (WA) is Better Urban Water Management (BUWM) (WAPC, 2008). The BUWM process is designed to facilitate better management and use of our urban water resources by ensuring appropriate consideration of the total water cycle is given at each planning stage. BUWM provides guidance on the implementation of State Planning Policy 2.9 Water Resources (Government of WA, 2006). Note, at the time of writing, State Planning Policy 2.9 Water Resources and Planning for Water Guidelines is under review after the draft revised frameworks were open for public comment in 2021.

Table 1 summarises some of the available resources and guidelines that provide technical details specific to implementing WSUD in WA. Resources compiled for other states (e.g. Water Sensitive SA WSUD resources) are continually referred to, understanding that the application may need to be refined for use in WA.



4 www.watersensitivecities.org.au

Table 1: WA WSUD guidelines

Type	Summary	Resource
WAPC: Better Urban Water Management[5]	A framework for how water resources should be considered at each planning stage.	Checklists with technical considerations to aid preparation of water management strategy documents.
Department of Water and Environmental Regulation: Urban water design	DWER is responsible for protection, conservation and management of water resources, therefore provides advice and WSUD design brochures to guide implementation and links to formal BUWM.	www.water.wa.gov.au/urban-water/urban-development/urban-water-design www.water.wa.gov.au/urban-water/urban-development/stormwater/stormwater-management-manual (includes Decision Process for Stormwater Management)
New WAter Ways: knowledge sharing, education, science and training, advocacy and leadership, partnerships and bridging to provide easy access to best practice and make WSUD 'normal practice'	New WAter Ways provides links to resources on WA planning requirements and guidelines, including links to the Stormwater Management Manual for Western Australia (Department of Water 2004-2007). Comprehensive resource page of WA WSUD fact sheets and case studies. Training and events for local government and industry capacity building.	www.newwaterways.org.au/resources/policy-and-guidelines https://www.newwaterways.org.au/Resources/Case-studies-fact-sheets Research: 'Understanding barriers to WSUD in 2021' and 'Maintenance of WSUD assets by Local Governments in Perth'.
Local Government policy and/or guidelines	To provide specific guidance for WSUD relevant to the physical setting and preferred design approach of local government.	Melville: www.melvillecity.com.au/CityOfMelville/media/Documents-and-PDF-s/Stormwater-Quality-Management-Guidelines.pdf South Perth: www.southperth.wa.gov.au/docs/default-source/6-about-us/council/policies-delegations/environment-(built-and-natural)/p211-water-sensitive-urban.pdf?sfvrsn=b6f6fabd_11 Peel Harvey: www.epa.wa.gov.au/sites/default/files/Policies_and_Guidance/AppendixE_2.pdf
Water Sensitive Cities Australia Knowledge Platform	The former CRCWSC has developed case studies to help build a body of evidence that can support and encourage the adoption of research outcomes. WA examples are included.	www.watersensitivecities.org.au/case-study/
Non-drinking water guides	Community Bore Guide (WC) The West Australian Greywater Guide (WC)	www.joshbyrne.com.au/wp-content/uploads/2018/08/180412-Community-Bore-Guide-Reduced.pdf www.joshbyrne.com.au/wp-content/uploads/2019/12/190624-The-WA-Greywater-Guide-RS.pdf

5 State Planning Policy 2.9 Water Resources and Planning for Water Guidelines

Guidance on planning and design process

Whilst a variety of guidelines are available to inform technical design, the ideal process of implementation is not as widely understood or documented. Researchers and observers have provided guidance for IUWM and WSUD planning processes. Tjandraatmadja (2018) notes that adoption is still not mainstream. Clear targets and objectives require support and alignment of policy and legislation, cross agency collaboration and creation of new implementation roles to increase effectiveness, and flexibility and adaptability as needs and barriers change over time. Cook et al. (2015) suggests that effort has been made to incorporate the principles of WSUD into the planning and development process at state and local government levels, however actual implementation is left to local government through local planning schemes (e.g. City of South Perth WSUD Policy).

Some guidance and examples are provided on planning processes, either for broader IUWM planning processes (e.g. Maheepala et al., 2010) and for WSUD (e.g. SA Govt Department of Local Government and Planning, 2010) to help inform a consistent approach to the planning, design and decision making process of WSUD for urban developments.

Examples of planning and design processes that have informed the development of the Waterwise Development Pathway and adapted to suit the WA urban water planning and management context are summarised in Table 2.

Table 2: Guidance for IUWM and WSUD planning processes

IUWM planning process (Maheepala et al., 2010)	Designing a WSUD strategy for your development (SA Govt, 2010)	WSUD guidelines: South Eastern Councils (Melbourne Water, 2013)

• Convene a stakeholder group and engage a project champion
• Agree on objectives, measures and criteria
• Understand the current system
• Assess system performance and select portfolios (social, environmental, economic)
• Implementation planning
	12 step guide to the design process:
	• Understand the site
	• Identify objectives & targets
	• Identify suitable WSUD measures
	• Meet with council & relevant authorities
	• Conceptual site design (may occur before meeting)
	• Model base case
	• Locate WSUD measures
	• Model treated case
	• Objectives check
	• Finalise measures
	• Obtain approvals
	• Undertake detailed design
		• Step 1: Early planning
		  • Planning meeting
		  • Prelim site assessment
		  • WSUD strategy and targets
		  • Preferred WSUD systems
		  • Preliminary design, construction and maintenance considerations
		• Step 2: Site assessment
		• Step 3: Concept design
		• Step 4: Submission of concept design
		• Step 5: Detailed design
		• Step 6: Submission of detailed design

Waterwise Development Pathway

The Waterwise Development Pathway has been developed to address implementation issues identified by WA urban water professionals, development industry stakeholders and academic literature.

The Waterwise Development Pathway melds together previously published implementation processes (planning, approvals, design, construction) with the learnings from participation in BUWM as part of the OneOneFive Waterwise Exemplar program and OneOneFive Hamilton Hill project. It promotes a holistic and integrated developer led approach to ensure the role and impact of all urban water and WSUD initiatives are considered together, and alongside landscape, and sustainability initiatives for collective impact and better urban greening and liveability outcomes.

The Waterwise Development Pathway outlines additional steps alongside existing site development and BUWM processes, to achieve advanced waterwise outcomes. For the purpose of this Guide, the process has commenced at the Local Water Management Strategy (LWMS) stage, as per the OneOneFive Hamilton Hill experience and learnings, whereas the BUWM process includes the earlier two stages: Regional and sub-regional (e.g. Regional Water Management Strategy) and District (District Water Management Strategy).

The Waterwise Development Pathway currently moves through:

- Planning, design and approvals
- Construction, occupation, maintenance

The following sections of this Guide distill the components of the Waterwise Development Pathway. This spans planning, design, approvals and construction activities, using case study examples from OneOneFive Hamilton Hill and the OneOneFive Waterwise Exemplar program where relevant. Further content covering maintenance and water monitoring activities will be included as OneOneFive Hamilton Hill and Waterwise Exemplar program progress.

District Water Management Strategy

A OneOneFive DWMS was prepared by Essential Environmental (2015) to support rezoning of the site from Public Purposes – High School to Urban Development and was approved by the Department of Water (DoW, now Department of Water and Environmental Regulation (DWER)) in 2016. This planning component of the process took place before the OneOneFive Waterwise Exemplar program commenced.

The table presented demonstrates how the Site Development Process steps (column 1), the BUWM requirements (column 2), and the Waterwise Development Pathway activities (column 3) can run in parallel.

It is the Waterwise Development Pathway (column 3) that provides new information on a process that should encourage greater uptake of integrated waterwise initiatives for improved urban greening, liveability and ecological outcomes. These components are discussed in further detail throughout the Guide and a more detailed process is provided in Appendix 1.

Waterwise Development Site Process

	Site Development Process	Better Urban Water Management	Waterwise Development Pathway
Planning, design and approvals	Project definition, visioning & appointment of consultants	Urban water and hydrologist expertise required on the project team supported by a multidisciplinary project team (planner, civil engineer and landscape architect)	Establish waterwise aspirations • Waterwise and sustainability aspirations identified in the consultant's brief
	• Concept planning • Site and context analysis; constraints and opportunities • Identification of environmental assets • Identification of strategic drivers • Develop sustainability objectives • Community and stakeholder consultation	Local Water Management Strategy (LWMS) • Groundwater quality and level monitoring • Surface water quality and quantity (volumes, flow rates and flood level) monitoring • Water balance • Hydrological modelling • Infrastructure needs • Confirmation of potable, non-potable and wastewater servicing arrangeents • Management of water/ environmental assets and enhancement opportunities • Specific management practices for stormwater • Conceptual landscape outcomes	Project visioning and identification of waterwise goals (entire project team)
			LGA strategic direction and accreditation • Cross check LGA Waterwise Council status, Water Sensitive City Benchmarking and other strategic urban greening/liveability programs
			Establish stakeholder working group to inform and support waterwise initiatives
			Liaise with DWER regarding alternative water supply options (e.g. recycled water scheme or community bore) and undertake business case
	Master Plan • Decide suitable sustainability framework • Landscape Master Plan • Community and stakeholder engagement		Develop a Waterwise Strategy for the project: • Align w/ project team • Brief stakeholders (inc LGA)
	Local Structure Plan & technical reports • Establish land use, density and public open space (Landscape Master Plan) • Environmental features and protection • Movement network • Engineering and environmental requirements • Local Water Management Strategy • Community and economic development		Engage stakeholders on innovative waterwise initiatives
			Design responses to suit site specific requirements
	Subdivision Plan • Detailed civil and landscape design • Local development plan • Residential Design Guidelines	Urban Water Management Plan (UWMP) • Further detailed modelling • Final design and siting for water management infrastructure • Implementation plan for agreed environmental, water and landscape outcomes • Management of construction works	Stakeholder input into waterwise details, particularly LGA
			Waterwise program alignment with Design Guidelines
			Sustainability program certification
			Waterwise Development certification
Construction, occupation and maintenance	Civil works	Subdivision conditions to be met as Urban Water Management Plan is implemented	Civil works contractor understanding of intent Stakeholder participation in civil works construction of waterwise initiatives Sediment control and protection during construction Tree and habitat protection Community engagement
	Landscaping works		Landscape contractor understanding of intent Stakeholder participation in landscape construction
	Title and sales		Marketing and showcasing Resident and builder engagement prior to build
	Home construction		Resident and builder engagement
	Post development asset handover		Ongoing engagement with residents in collaboration with LGA
			Evaluation, knowledge sharing and continual improvement

The project definition stage is where the development intent is defined and a multidisciplinary team of technical professionals appointed. Waterwise aspirations need to be identified, as per the Waterwise Development Pathway.

Site Development Process	Better Urban Water Management	Waterwise Development Pathway
Project definition, visioning and appointment of consultants	Urban water and hydrologist expertise required on the project team supported by a multidisciplinary project team (planner, civil engineer and landscape architect)	Establish waterwise aspirations • Waterwise and sustainability aspirations identified in the consultant's brief

Establish waterwise aspirations

One of the first steps in creating a waterwise development is for the proponent to define the overall vision for the site, including establishing project objectives, sustainability goals and waterwise aspirations. Ideally, aspirations should be included in the consultant tendering process to ensure the appointed team can meet the required expectations for the project, align with the vision, sustainability goals and commit to achieving best practice outcomes. A project vision will be further defined and refined during the proceeding planning stages and the project-specific solutions and responses conceptualised and solved by the project team, however, these processes will be continually guided by the overarching vision and objectives of the project.

Waterwise aspirations and sustainable design principles should consider indigenous connections to the land and the natural landscape of the site (e.g. topography, remnant bushland, water bodies, environment and sustainability) and the current cultural and economic context in which it is situated. At this stage, the long-term value and co-benefits of adopting a WSUD approach should be considered and communicated. Early contact with local government environment and sustainability officers, in addition to engineers and planners, regulatory bodies and other relevant government agencies will assist in establishing waterwise aspirations and a common understanding moving forward.

An important aspect of OneOneFive Hamilton Hill is to retain the natural topography of the area. This is respectful to the traditional owners of the site, as it was a strategic lookout, connected to Fremantle and Cockburn coasts, lakes (Bibra Lake) and swamps to the East, and is connected by mythology, dreaming and a personal connection to country (Terra Rosa, 2017).

DevelopmentWA's commitment to sustainable development

DevelopmentWA defined their commitment to sustainable development in the tendering process. This included detailing the four sustainability elements that form DevelopmentWA's framework to integrate sustainable development across a range of projects: community wellbeing, design excellence, environmental responsibility and economic health.

Indigenous engagement was highlighted as an important part of the project, at all stages. A preliminary vision for the site was provided and objectives outlined, aligning with the four sustainable elements. Sustainability aspirations were also set with the desired multidisciplinary consultant team defined, including roles for urban design planning, architect, social/cultural/heritage consultants, environmental consultants, engineers, landscape architect, surveyor, arboriculturalist, property consultant, public relations and marketing.

In line with BUWM, a project team typically commences urban water related investigations and other related technical work from concept planning stage to inform the preparation of a LWMS.

Engagement activities often take place between a development proponent and other stakeholders as part of early site investigations prior to this stage. Urban water management considerations for the site may arise during these early engagement activities, however the commencement of concept planning and the LWMS process is a practical point to commence the Waterwise Pathway.

The LWMS is considered the most crucial stage of water planning as waterwise principles are demonstrated within the conceptual layout of roads, public open space and greater structure plan design (DWER, pers comm. 2020). At this point, technical consultants will have been appointed, and formal engagement with the Local Government Authority (LGA) and state agencies should begin.

Site Development Process	Better Urban Water Management	Waterwise Development Pathway
Concept planning • Site and context analysis; constraints and opportunities • Identification of environmental assets • Identification of strategic drivers • Develop sustainability objectives • Community and stakeholder consultation	Local Water Management Strategy (LWMS) • Groundwater quality and level monitoring • Surface water quality and quantity (volumes, flow rates and flood level) monitoring • Water balance • Hydrological modelling • Infrastructure needs • Confirmation of potable, non-potable and wastewater servicing arrangements • Management of water/ environmental assets and enhancement opportunities • Specific management practices for stormwater • Conceptual landscape outcomes	Project visioning and identification of waterwise goals (entire project team)
		LGA strategic direction and accreditation • Cross check LGA Waterwise Council status, Water Sensitive City Benchmarking and other strategic urban greening/liveability programs
		Establish stakeholder working group to inform and support waterwise initiatives
		Liaise with DWER, Local Government and/or service provider regarding alternative water supply options (e.g. recycled water scheme or community bore) and undertake business case
Master Plan • Decide suitable sustainability framework • Landscape Master Plan • Community and stakeholder engagement		Develop a Waterwise Strategy for the project: • Align w/ project team • Brief stakeholders (inc LGA)
Local Structure Plan & technical reports • Establish land use, density and public open space (Landscape Master Plan) • Environmental features and protection • Movement network • Engineering and environmental requirements • Local Water Management Strategy • Community and economic development		Engage stakeholders on innovative waterwise initiatives
		Design responses to suit site specific requirements

A LWMS (JBA, 2020) was prepared by Josh Byrne & Associates, in line with BUWM, WAPC 2008 and in conjunction with Hyd20 and TABEC, on behalf of DevelopmentWA to accompany the Local Structure Plan prepared by Hames Sharley (2018). The LWMS was approved by DWER on the 22nd April 2020.

Project visioning and identification of waterwise goals

Formal project visioning should be conducted once the consultant project team has been appointed. This includes the identification of waterwise and broader sustainability goals, with collaborative input from the development proponent and technical consultants. It is beneficial to engage with the LGA, DWER and Department of Biodiversity, Conservation and Attractions (DBCA) (when adjacent to or affecting the waters of the Swan Canning Development Control Area) at this point, particularly on difficult sites with severe water constraints. In these situations, it is likely that the LGA, DWER and DBCA are aware of the challenges and a joint vision for a successful outcome can be beneficial. Alignment of priorities can achieve multiple waterwise and liveability outcomes, and discussions should include intended capital costs, development yield, and future asset management and maintenance requirements to ensure vision aspirations are practical. Early engagement regarding vision, constraints, opportunities and project delivery is important to achieve a combination of best practice design outcomes and a smooth approvals process.

Establishing a vision

"HSHS VISION: The Hamilton Senior High School project connects generations of the local community providing an innovative, affordable, high quality liveable development that celebrates the elevated site, its educational history, and the rejuvenation of the broader area." (Hames Sharley on behalf of DevelopmentWA, 2019, p.22).

Note: work completed prior to the branding of OneOneFive Hamilton Hill refers to the project as the HSHS (Hamilton Senior High School) redevelopment.

Importance of OneOneFive Hamilton Hill site context in informing landscape and water responses to achieve liveability outcomes

The Landscape Master Plan Report (Josh Byrne & Associates, 2018) was created to give direction to landscape design intent for the development. It was based on the unique site context and responded to the site considerations. The following list details the landscape and waterwise initiatives proposed for the site and important site characteristics:

- Undulating topography, a central hilltop with excellent views and highly permeable sandy soils.
- Large depth to groundwater and no receiving waterways.
- Site situated as part of a larger ecological bushland reserve and habitat corridor.
- Cultural influences, both Indigenous and European communities are accurately reflected.
- 229 existing trees, with a total of 16% existing tree canopy. 34% of the mature trees were retained as part of the Landscape Master Plan, with the road layout designed for retention and expansion of canopy cover.
- A total of 350 new trees proposed to be planted across the site in public landscape areas, street verges and laneways; targeting a 30% canopy cover across the site (20% in public realm and an additional 10% in the private realm).
- A series of neighbourhood parks connected by landscape public access ways and verges ensuring easy access to green space.
- Nature based play is incorporated into the remnant vegetation areas to foster connection with the local environment.
- A range of landscape features including permeable paving, water harvesting tree pits, and vegetated swales to contribute to at-source infiltration of stormwater to enhance soil moisture, plant health, tree growth and contribute to urban cooling.

LGA strategic direction and accreditation

Although not a formal requirement of the development planning and approvals process, it is helpful to know whether a LGA is recognised as a Waterwise Council, as part of understanding their current position and aspirations. Integrated water management initiatives for a development project that align with LGA aspirations can reinforce an existing waterwise position or assist a local government in achieving improved Waterwise Council status, such as Gold or Platinum[6].

Knowing whether an LGA has undertaken Water Sensitive City Benchmarking[7] is also important as the results and action plan can align with proposed waterwise options and assist in discussions about on-ground actions that progress the LGA's waterwise journey. In addition, understanding an LGA's position on urban greening, liveability and strategic direction will help to identify opportunities for mutually beneficial waterwise initiatives.

6 www.watercorporation.com.au/Help-and-advice/Waterwise-business-programs/Waterwise-Council-Program/About-our-program

7 www.watersensitivecities.org.au/content/water-sensitive-cities-index

City of Cockburn - Platinum Waterwise Council

The Waterwise Council Program supports councils to improve water efficiency and water management to create waterwise communities and a Waterwise Perth.

Established in 2009 the program is a partnership between Water Corporation and DWER, with over 64 councils representing over 1.8 million residents.

The City of Cockburn has been endorsed as a Gold Waterwise Council since 2015 and was a joint winner of the Platinum Council of the Year in 2021 (WC, 2021). This was achieved through a variety of initiatives that amplify water efficiency and conservation within the City, such as implementing a Water Efficiency Action Plan; retrofitting City facilities with water efficiency measures, buildings and POS; diversion of stormwater to POS instead of outflow to the Port Coogee Marina; hydrozoning parks; and installing a waterwise demonstration garden at Lakelands Hockey Club.

The City has a Sustainability Policy and an Environmentally Sustainable Design (ESD) Requirements document which includes water reduction initiatives such as the use of alternative water supplies, water reuse systems and water conservation devices. City staff are tasked with leak reporting and water conservation issues with ideas discussed at team meetings. The City encourages residents to play a role in waterwise behaviours by offering residents a native plant subsidy scheme, waterwise verge rebate program and a home eco audit program.

City of Cockburn Water Sensitive Cities Index

The City of Cockburn council area was benchmarked using the WSC Index Tool in February 2018. As part of the OneOneFive Waterwise Exemplar program, an analysis of the Council's Twelve Point Plan was conducted to assess how the OneOneFive development and Waterwise Exemplar program can assist the City in its waterwise journey and ongoing reporting. Key areas of alignment include combating urban heat, understanding WSUD maintenance costs, greater protection and management of groundwater, and co-design of water sensitive projects.

Establish a stakeholder working group

A stakeholder working group should be established to support and inform the waterwise direction of the development. This group should be multi-disciplinary and multi-agency to ensure a holistic response towards site options and appropriate interrogation of waterwise initiatives as the site design progresses. Project consultants will need to be aware of stakeholder motivations and the challenge of finding deliverables that respond to collective viewpoints. Engagement need not be onerous, just committed, and expectations of the group should be agreed upon early on.

Ensure there is appropriate internal representation from local government departments covering environment, planning, engineering and parks, and a shared understanding of project principles. It is a common experience for development proponents and their technical consultants to hit barriers with LGA approval of waterwise initiatives. Having early engagement with City officers, and better still their buy in, and the benefit of their experience and insights, greatly increases the likelihood of a successful outcome.

OneOneFive Waterwise Exemplar program reference group

The OneOneFive WE Reference Group demonstrates leadership and commitment from several WA organisations wanting to achieve the long-term vision of a Waterwise Perth.

Representatives attend quarterly meetings to provide input and direction to the program and initiatives tested, as well as the advocacy and communication activities that are used to promote waterwise messaging for infill developments.

The OneOneFive WE Reference Group partner organisations include:

- Water Corporation
- DevelopmentWA
- Department of Water and Environmental Regulation (DWER)
- City of Cockburn
- Josh Byrne & Associates

Liaise with DWER and relevant stakeholders regarding alternative water supply options

Proposed alternative water supply systems for a site need to be discussed with DWER early in the planning process. These discussions will ensure options proposed are suitable for the site, the broader area and catchment. The intended service provider (e.g. LGA) needs to be engaged early on to provide input into design aspirations. Investigations should also utilise the 'Guidelines for the approval of non-drinking water systems in Western Australia' (DoW, 2013) for information on general considerations and specific approval requirements for establishing a non-drinking water system in an urban development.

The suitability of including an alternative water supply (such as a community groundwater bore or recycled water scheme) in a project will depend on a number of factors including the scale of the development, business case and the degree to which the development site is water constrained.

Traditionally, the development industry in Perth has not been successful in incorporating alternative water schemes into projects.

Interest in development-scale (and district-scale) alternative water schemes is growing in recognition of Perth's drying climate to ensure adequate water for the irrigation of public and private open space. Historical concerns over regulatory barriers are now largely unfounded. The greatest challenge is ensuring alternative water supplies have a robust business case to support viability.

Community groundwater bore scheme at OneOneFive Hamilton Hill

OneOneFive Hamilton Hill is fortunate to be located where there is an available groundwater allocation suitable for irrigation.

On this basis, a community groundwater bore scheme for the irrigation of residential gardens and POS was investigated, following the process outlined in the Water Corporation Community Bore Guide (Water Corporation, 2018). The process included:

- An initial investigation that indicated groundwater may be available for irrigation given the previous allocation for the irrigation of school grounds (e.g. via DWER Water Register and site groundwater investigations).
- An application submitted to DWER, detailing estimated irrigation requirements.
- A follow-up meeting with DWER to discuss site specific requirements and responsible groundwater use at the site, via metering and monitoring.
- An approved licence issued in May 2019.
- Conversations with the City of Cockburn regarding their support for a community groundwater bore scheme, resulting in the development of a business case (see appended Community Groundwater Bore Case Study).
- Agreement to design, install and operate a suitable system.

Develop a Waterwise Strategy

The early formation of strategies to approach water, energy, waste and other sustainability considerations is an important step in a project achieving its defined vision. The preparation of a waterwise strategy during the concept and master planning stages is an opportunity to document ideas and test waterwise scenarios that might be applied across the life of a development. It is a way to ensure that concepts are included early on in project team discussions and a chance to capture input from other stakeholders. It is also a way to identify opportunities for innovation. It is the thinking at this stage, that will play through to further levels of the design process, influencing infrastructure decisions, house design guidelines and landscape design outcomes amongst others.

For clarification, a Waterwise Strategy, is not the same as a LWMS as required under BUWM (2008), in that it is not a formal requirement for planning approval and is not prescriptive in what it covers. As per the other steps in Waterwise Development Pathway, it is intended to be complimentary to existing process and assist with improved outcomes.

A Waterwise Strategy would typically be developed by urban water consultants, in consultation with the rest of the project team, in response to an opportunities and constraints analysis of the whole site, and may present a range of options at differing levels of innovation for further investigation as the project design work progresses. A Waterwise Strategy can also be used as a tool to engage with an LGA if this has not been possible during previous stages. For example, a development proponent and representatives from the project team can present the scenarios to local government officers across the various disciplines to understand their respective positions. Waterwise Strategy scenarios can also be used as an ongoing reference point for decisions on initiatives to be implemented (or not) and can be used to shape the Structure Plan and associated technical reports, including the LWMS. The influence of a Waterwise Strategy goes beyond this and will ultimately inform what is documented at the subdivision level, included in project Design Guidelines, and ultimately delivered on-ground.

OneOneFive Waterwise Strategy and three proposed scenarios

A Waterwise Strategy was developed for OneOneFive Hamilton Hill (Josh Byrne & Associates, 2017a) in conjunction with a project-specific Energy Strategy (Josh Byrne & Associates, 2017b) and associated sustainability reporting activities. The Waterwise Strategy was completed as a project report but also informed the Structure Plan and LWMS, as part of Development Approval, and has been referred to in subsequent planning and design processes, such as the development of the UWMP.

The Waterwise Strategy consists of three scenarios:

- Baseline
- Best practice with innovations
- Highly innovative, demonstrative technology.

Each scenario builds on the previous with additional water saving initiatives, improved management options, inclusion of highly innovative technology and it will be used during detailed design of subsequent subdivision stages.

A workshop was held with the City of Cockburn to present the Waterwise Strategy scenarios early in 2018.

Note: the Waterwise Strategy is published as the 'HSHS Water Strategy' as it was completed prior to the development branding OneOneFive and the industry-wide adoption of the term 'waterwise' to encompass a holistic approach to water efficiency, liveability and water sensitive design.

Best practice with innovations scenario

The 'best practice with innovations' scenario water balance and decumulative water use graph shown below has been updated to include calculations on project occupation estimates and mandated initiatives in the Design Guidelines.

Through a combination of mains water reduction initiatives the project sets out to achieve significant water savings when compared to the average 106 kL/person/year (Water Corporation 2010 - Perth Residential Water Use Study) .

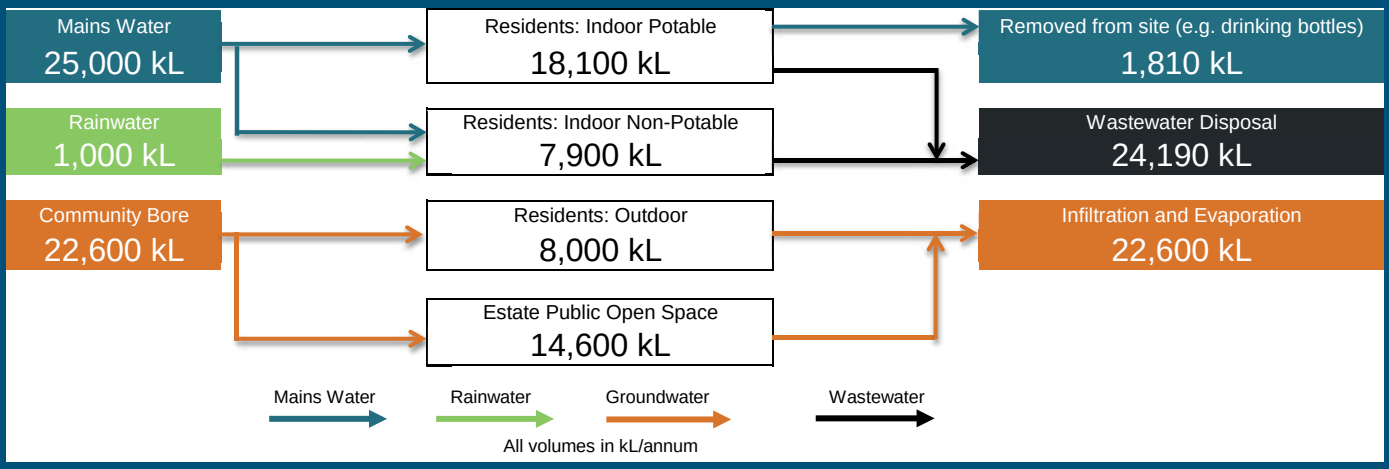


Figure 2: Water balance based on an irrigation rate of 7500kL/ha/yr for turf and garden beds

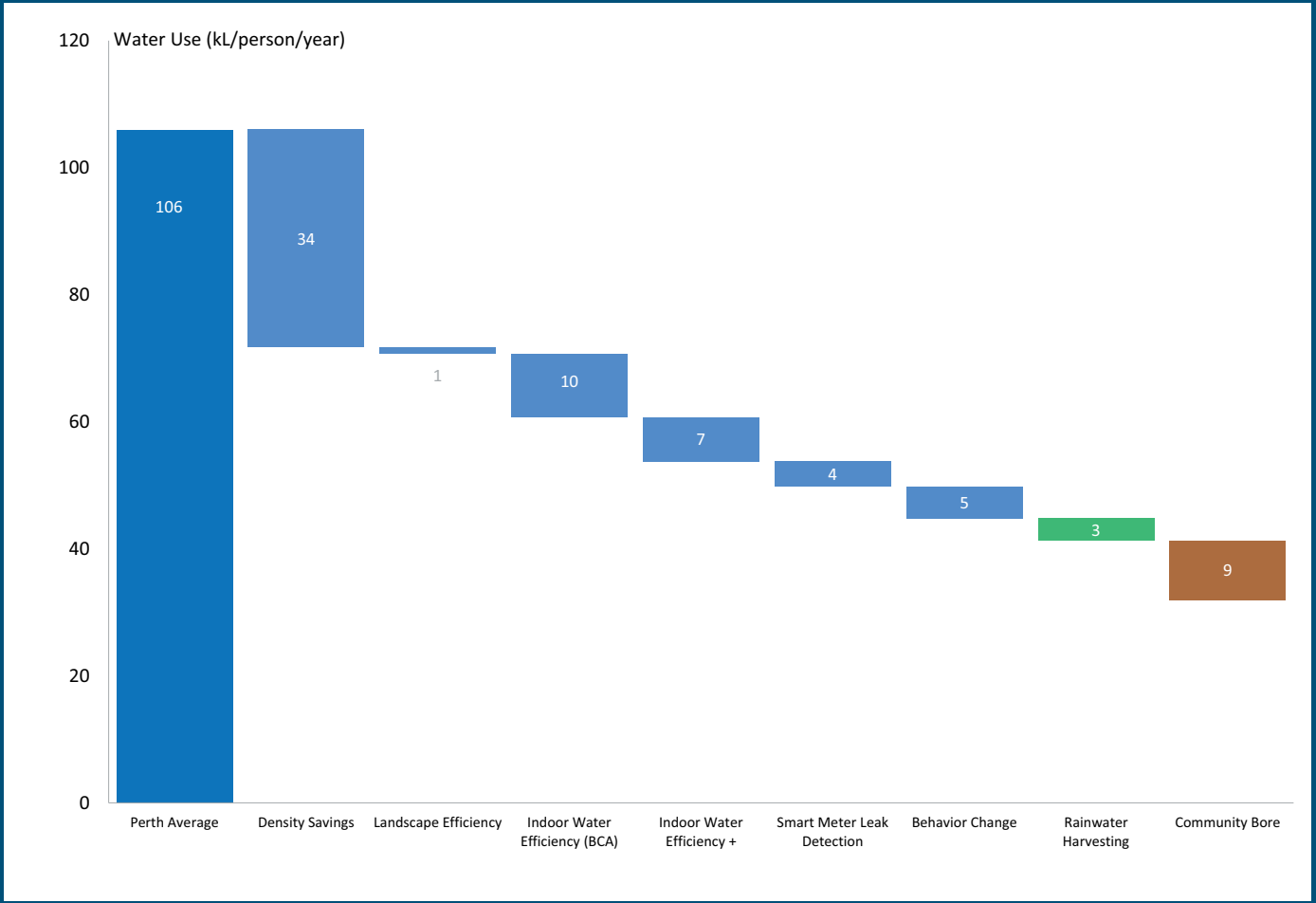


Figure 3: Decumulative graph of aspirational water use, including irrigation rate of 5000kL/ha/yr for garden beds

Engaging stakeholders in waterwise innovation

Innovative waterwise options should be presented to the stakeholder working group for discussion and feedback, ultimately resulting in an opportunity for approval and implementation.

Initiatives should be assessed in terms of site suitability, proposed/desired outcomes and stakeholder requirements, existing and future (i.e. local government maintenance regimes).

Stakeholder expectations may need to be managed with regard to the capital costs of initiatives, impact on development lot yield, and future asset management requirements.

Given the decision making process and final design outcomes, conversations between the development proponent, project team, LGA, DWER and relevant government agencies should be considered formally as part of the structure planning process. Formal reporting of conversations could be included to understand reasoning behind implementation of solutions.

Stakeholders should be encouraged to investigate options further on their own to increase understanding. This could include engagement with other LGAs who may have experience dealing with similar waterwise initiatives. This feedback can then assist with decision making.

OneOneFive Hamilton Hill stakeholder engagement

The process of planning and designing waterwise initiatives and WSUD options for OneOneFive Hamilton Hill included engagement activities that extended beyond the stakeholder working group and their associated teams/ colleagues. The City of Cockburn organised a meeting with the City of Fremantle to discuss the community groundwater bore scheme at the WGV development in White Gum Valley and a site visit was arranged. This allowed for experiential knowledge to be shared and, for the City of Cockburn, to understand how a community bore scheme of this type is implemented and operated.

The City of Belmont was also contacted regarding their experience implementing permeable paving in car bays. Information was provides on products reviewed and used, implementation and maintenance.

Design responses to suit site specific requirements

The importance of ensuring that waterwise initiatives, such as WSUD stormwater controls, respond to specific site conditions and local context cannot be over emphasised. All too often design details are reapplied across different projects resulting in sub-optimal outcomes. This process should be supported by:

- Reviewing relevant technical and process guidelines and case studies
- Sourcing relevant material from capacity building organisations such as the CRCWSC Knowledge Platform and New WAter Ways[8]
- Adapting existing applied examples and assessing demonstration projects for relevant learnings
- Ongoing correspondence with peers/ colleagues for examples and improved understanding
- Drawing on the design teams own experiential knowledge

Design iterations will be made in response to the above (plus feedback from stakeholders such as DWER and LGA officers) and will continue into the subdivision design and preparation of the UWMP, which demand a high level of detail. Final design approval of engineering and landscape assets that will eventually be handed over to a LGA will need their approval so their buy-in is critical. By this stage, specific waterwise initiatives and treatments should have already been identified with stakeholders and issues worked through, so this step is more about refinement and collection of additional evidence to ensure what is being proposed is appropriate and stakeholder concerns are addressed.

8 www.newwaterways.org.au

OneOneFive Hamilton Hill site characteristics and treatment response

For OneOneFive, the WSUD stormwater control treatments are very much determined by the specific site conditions (large depth to groundwater, sloping topography, remnant bushland and retaining existing trees), containing all water on-site and balancing the design of approaches with the City of Cockburn's preferences, given that they become the ultimate asset managers. The following table was included in the LWMS to ensure this context was well understood by all stakeholders.

Summary of site characteristics & requirements	Suitable treatment response
Steep topography in the northern part of the site.	Above ground stormwater retention (for infiltration) is not practical to implement. Under road retention approved by City of Cockburn.
Retain natural topography of the site where possible.	Level differences and steep grades require 3m high retaining walls and split-level lots. An alternative response would have resulted in greater re-contouring of the existing landform and clearing.
Terraced slopes located throughout the middle of the site.	Permeable paving with subgrade detention where appropriate in flat road locations and in car bays to City of Cockburn satisfaction.
Retain ridges of trees in between previous school ovals and other established trees where possible.	Retain trees for urban cooling and amenity benefits. Small stormwater events to be directed to rootzones where appropriate to reduce irrigation requirements. Installation of basins for stormwater management would require the removal of trees and therefore is not an appropriate response. Level of modification on site is limited.
Existing trees and service alignment.	Underground stormwater retention within road reserves to minimise impacts on trees and reduce conflict with service alignment.
Remnant bushland adjacent to site in the south.	Retain bushland, keep as natural as possible. This excludes any basins for stormwater management that would hydrate the landscape beyond bushland requirements and encourage management issues such as weeds.
Large depth to water table (approximately 40m).	Stormwater management to make the most of large depth to water table and allow for on site management, with no discharge to surrounding areas.
No requirement for stormwater treatment, only management.	There are no nearby open water bodies, no discharge to riverine environments or riparian zones and large depth to water table allows for management to be contained on site. Small events to recharge soil moisture in landscaped areas. Underground retention to manage major events.
Infiltration to occur as far up in the catchment as possible.	1% AEP contained on lot where possible, otherwise City of Cockburn requires on-site retention for 5% AEP.
City of Cockburn preferences for design.	Rationalise use of verge infiltration swales to achieve optimal balance between WSUD, drainage function and City maintenance requirements. Stormwater pits to be located prior to road intersections to prevent sheeting of water over roads.
Overall WSUD approach.	WSUD approaches are to suit the retention of existing trees and landform as much as possible. Retained trees and additional landscaping approach to benefit from on-site stormwater management to increase urban cooling benefits and reduce reliance on irrigation.

Scenario Tool

Utilising outputs from the former Cooperative Research Centre for Water Sensitive Cities (CRCWSC)

As noted, an important component of developing site appropriate responses is to utilise existing research and materials available, including innovative and emerging tools.

Several former CRCWSC tools were investigated in more detail to understand applicability to the site and the role in determining site responses. These included:

- TARGET Scenario Tool: a planning tool to assess the multiple benefits of green infrastructure solutions, with a specific microclimate model. Involvement in early program testing indicated the applicability of this product during planning and design and may be utilised for Stages 2 and 3.
- INFFEWS Value Tool: Investment Framework for Economics of Water Sensitive Cities consists of a Value Tool database of non-market valuation studies that can provide values on the intangible benefits of green infrastructure investments, based on other similar studies. This tool can assist with decision making and business case development. Outcomes indicated that increases in canopy cover can increase property prices; number and total area of public green space is significantly associated with greater mental wellbeing; small pocket parks can have positive impacts on mental health; and remnant bushland located near properties increases the value of properties.

The development planning stage requires the finalisation of the subdivision plan, local development plan and accompanying UWMP. An additional focus on ongoing engagement between stakeholders and the importance of supporting sustainability frameworks and waterwise aspects documented in a development's design guidelines is a crucial part of the Waterwise Development Pathway.

Site Development Process	Better Urban Water Management	Waterwise Development Pathway
Subdivision plan • Detailed civil and landscape design • Local development plan • Residential Design Guidelines	Urban Water Management Plan (UWMP) • Further detailed modelling • Final design and siting for water management infrastructure • Implementation plan for agreed environmental, water and landscape outcomes • Management of construction works	Stakeholder input into waterwise details, particularly LGA Waterwise program alignment with Design Guidelines Sustainability program certification Waterwise Development certification

Stakeholder input for waterwise detail

As the planning process proceeds into subdivision design and the UWMP stage, it is important that proposed waterwise initiatives are designed with input from all stakeholders. In particular, the project team and LGA representatives will be required to discuss initiatives. Ensuring representation from LGA engineers, landscape, environment and sustainability officers as part of these discussions is critical in the decision-making and acceptance process. It is at this stage of detailed design approval that stakeholders may express concerns with originally proposed approaches. Local government engineering departments may be unwilling to approve certain WSUD initiatives based on internal experience and precedence, lack of risk-taking culture or perceived (and realised) maintenance and budget concerns. These issues will require ongoing commitment to project vision and will often require additional discussions. This is where input from other internal local government departments can be invaluable, demonstrating how initiatives can achieve overarching council goals and aspirations, and how risks can be shared across departments.

Further, drawing on successful experiences from other LGAs can help inform planning and approvals approaches.

Discussion and review of waterwise initiatives at OneOneFive Hamilton Hill

Several meetings were held with City of Cockburn officers representing planning, engineering, building, environment and parks as part of finalising the Stage 1 Subdivision stormwater engineering design and UWMP. Detail on concepts that had previously been presented at the Structure Plan and LWMS review stage needed working through, and specific conditions for approval had to be negotiated. The spirit of collaboration established as part of the broader Project Reference Group process, as well as understanding the shared waterwise vision for the project was important in setting the tone for positive collaboration which led to a successful resolution of the proposed initiatives.

Waterwise alignment with design guidelines

Design guidelines are a common instrument in the development industry for controlling built form outcomes. In residential development, they are typically used to guide aesthetics in relation to building style and materiality. They can also used to establish sustainability considerations at the lot-level,such as waterwise outcomes including indoor water efficiency specifications, landscaping requirements and the use of lot-scale alternative water sources, like rainwater.

Well prepared design guidelines help residents and their chosen architect or building designer to design a home that promotes:

- Sense of community and wellbeing for future residents.
- Environmental responsibility.
- Design excellence.
- Prosperity through affordability.

Design guidelines are to be read in conjunction with local town planning schemes, local structure plans and local development plans; and should also apply the Residential Design Codes (State Planning Policy 7.3).

Each design element should include information on:

- Intent: the reason for the guideline and background on objectives.
- Objectives: the desired outcome that is sought for all development proposals.
- Compliance or design controls: a specific pathway to achieving objectives for each design element.
  Note: Alternate solutions can be provided to encourage innovation but it must be demonstrated that objectives can be met via solutions which improve design quality to the satisfaction of the design reviewer (i.e. estate architect).
- Design guidance for additional information on sustainable design, community interaction and architectural character to assist an applicant in achieving the objectives and compliance provisions.

Design guidelines should include information on the background context on approval processes, site vision and objectives, promoting good design, site context, built form character and landscape character.

Information on rebates or other financial incentives to encourage adoption of outcomes can be included.

It is important to ensure that there is alignment with advice (minimum compliance) and language set out in the relevant Water Corporation waterwise program materials.

OneOneFive Hamilton Hill Design Guidelines

The OneOneFive Hamilton Hill Design Guidelines were crafted to align with key development principles and Water Corporation Waterwise program messaging.

Landscaping initiatives for Your Garden include:

- Hardscaping provisions are for lots over 220m2 and include no more than 40% of external areas as hardstand, no more than 20% unshaded, no less than 25% of external areas as Deep Root Zone allowing for planting of full-size trees, and hardstand designed to maximise infiltration via permeable surfaces or directing runoff into gardens.
- Softscaping provisions include turf/ lawn limited to a maximum 50% of the landscaped area and must be a recognised Waterwise variety and trees planted so no to reduce winter solar access.
- Irrigation must be connected to the community groundwater bore supply.

Water Efficiency initiatives for Your Garden include:

- A programable automatic irrigation system including weather-based control connected to the community bore.
- Indoor and outdoor taps must not be connected to the community bore.
- Water efficient in-line drip irrigation must be installed for all garden beds.
- Spray irrigation only on turf areas.
- Irrigation controllers must be set to relevant rostered watering days in line with Water Corporation and Department of Water and Environmental Regulation requirements.
- Private groundwater bores are not permitted.
- Any outdoor swimming pool or spa must be supplied with a cover that reduces water evaporation and is accredited under the Smart Approved WaterMark scheme.

Water initiatives for Your Footprint include:

- All stormwater to the 1% AEP to be contained on lot with appropriately sized soakwells.
- Dual plumbing to toilets and washing machines for connection of rainwater supply (now or into the future) and provide sufficient space for the installation of a rainwater tank (min 3,000 litres) connected to a minimum roof catchment of 100m^2, an external power outlet, a garden tap or mains water take off point.
- Water fittings:
  - Shower heads that use less than 7.5 litres per minute (WELS 3-star)
  - Taps to bathrooms, kitchen and laundry that use 6 litres per minute or less (WELS 3-star)
  - Dishwasher consumption of <=14 litres per use (WELS 5-star)
  - Washing machine consumption <=110 litres per use (WELS 4-star)

Further information on private and public site initiatives is available for residents via the development website.

Sustainability program certification

A growing awareness of the importance of sustainable urban development has led to increased interest in the application of third party sustainability certification programs to land development projects.

Programs that enable automatic Waterwise Development certification include EnviroDevelopment, GreenStar, One Planet Living, Living Community Challenge.

Of particular relevance to the pathway discussed here is the water category of each of these programs, however other categories may include important water initiatives and approaches, with criteria frequently updated.

EnviroDevelopment[9]

Water Element criteria includes; reducing potable water demand and household potable water consumption, irrigation requirements to reduce the use of potable water for irrigation in the public realm and community facilities, reducing potable water usage in community facilities.

The Ecosystems Element also includes water criteria such as; requiring a stormwater management plan, details of site analysis and minimal disturbance from earthworks and construction, and urban ecology strategies to address urban heat, urban green space, climate change risk assessment and native plant species for landscaping.

Green Star Communities[10]

Green Star Communities Environment category "aims to reduce the impact of urban development on ecosystems". This category includes an Integrated Water Cycle credit, aiming to encourage and recognise best practice sustainable urban water management.

There are two performance pathways:

- Water Sensitive Urban Design – Performance Pathway (7 points): A. Minimum requirement for stormwater is met and B. Potable water consumption is reduced through the application of WSUD principles when compared to a reference project.
- Water Management - Prescriptive Pathway (5 points): available when it is demonstrated that the project applies best practice water management practices for alternative water sources and stormwater.

One Planet Living[11]

One Planet Living is a framework of 10 principles to achieve the vision of a world where we can live happily within the Earth's available resources. The Sustainable Water principle includes; using water efficiently, protecting local water resources and reducing flooding and drought. Actions include water efficient fittings, introducing swales and raingardens for reduced impacts of both drought and flooding, and using vegetation to clean water before returning it to the environment.

Living Community Challenge[12]

The Living Community Challenge is a framework for master planning, design, and construction. It is a tool to create a symbiotic relationship between people and all aspects of the built environment. The Water Petal intends to realign how people use water and to redefine waste in the built environment, so that water is respected as a precious resource. There is a net positive water imperative to ensure community water use and release must work in harmony with the natural water flows of the community and its surroundings. 100% of the community's water needs must be supplied by precipitation or other natural closed loop systems, and/or by recycling used community water, and must be purified as needed without the use of chemicals. All stormwater and water discharge, including grey and black water, must be treated and managed at the community scale, either through reuse, a closed loop system or infiltration.

9 www.envirodevelopment.com.au/how-envirodevelopment-works
10 www.new.gbca.org.au/rate/rating-system/communities
11 www.oneplanet.com/principles/sustainablewater
12 www.living-future.org/lcc

Waterwise Development certification

Waterwise Development certification needs to be formally assessed[12] and verified by the Water Corporation. This Waterwise Development program highlights the fundamental role that developers play in building waterwise communities and supports developers to implement water efficient principles in their estate to work towards the long-term plan to provide a sustainable water future for generations to come. Endorsement is automatic if the development has achieved certification via a sustainability program (e.g. EnviroDevelopment, Green Star, One Planet Living, or Living Community Challenge), however a developer will still be required to submit an application. The introductory section of this Guide provides further information on the requirements for Gold and Platinum Waterwise Development recognition.

12 www.watercorporation.com.au/Help-and-advice/Waterwise-business-programs/Waterwise-Development-Program/About-our-program

OneOneFive Hamilton Hill EnviroDevelopment Certification

EnviroDevelopment certification for OneOneFive Hamilton Hill was received in February 2020, with recertification achieved in 2021 and 2022. The development is certified in all six EnviroDevelopment elements: ecosystems, waste, energy, materials, water and community. The project received additional commendation for its commitment to sustainable waste practices by recycling and reusing 96% of demolition materials from the former Hamilton Senior High School buildings and infrastructure, exceeding the original target of 90%. Some of these recycled materials have been used as aggregate for the installation of WSUD at the development.

OneOneFive Hamilton Hill Waterwise Development certification

Waterwise Development endorsement for OneOneFive Hamilton Hill was received on the 18th June 2020. It was re-endorsed as a Gold Waterwise Development in October 2021 and then as a Platinum Waterwise Development in 2022.

Initiatives documented include: households to include plumbed rainwater tanks; non-potable water supply via a sustainably managed community bore; Design Guidelines to mandate household water efficient fixtures; requirement for a minimum of 70% plant species to be drought tolerant in private realm; landscape features in the public realm to contribute to at source infiltration and include drought tolerant species; efficient irrigation control and remote reading; addition of soil conditioner and mulching of landscaped areas; accessible potable water supply in community facilities (water fountains); public toilets with taps with a flow rate of less than 6 litres per minute; and waterless urinal.

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After development planning approval, civil works can commence. Civil works includes pre-construction activities such as demolition, screening and stockpiling materials, inspections, location of services and site set-up.

Civil works construction activities include earthworks and installation of infrastructure such as retaining walls; drainage, sewer and water reticulation; roadworks and paving; fencing and walls; electrical, lighting and communications; and disposal of contaminated materials.

The civil works stage for a waterwise development requires the implementation of waterwise initiatives such as WSUD surface treatments, WSUD stormwater controls and alternative water supply schemes (e.g. community groundwater scheme), as detailed during the planning and design process.

Effective implementation requires collaboration and a clear understanding of stakeholder roles and responsibilities.

Site Development Process	Better Urban Water Management	Waterwise Development Pathway
Civil works	Subdivision conditions to be met as Urban Water Management Plan is implemented	Civil works contractor understanding of intent Stakeholder participation in civil works construction of waterwise initiatives Sediment control and protection during construction Tree and habitat protection Community engagement

Civil works contractor understanding of intent

After a thorough site analysis, planning and co-design process, it is critical that the waterwise initiatives are implemented as agreed. The first step in this process is to develop a civil works tender that describes the guiding waterwise principles and key waterwise requirements that respondents must address. For example, the inclusion of WSUD to contribute to at-source infiltration of stormwater to enhance soil moisture, plant health, tree growth and contribute to urban cooling and providing high amenity greenspace and streetscapes will need to be clearly communicated during the procurement process, well before commencement of work.

Civil contractors should detail their understanding of the waterwise requirements and their proposed approach for tracking and reporting the construction of these in their tender submission.

Responsible water use during the earthworks and construction phase also needs to be considered and recorded as part of the commitment to achieving a waterwise development.

It is recommended that a representative from the stakeholder working group (established during the design phase) continue to work closely with the design and construction team and follow the proposed reporting (i.e. Site Management Plan) by the civil contractors to ensure that waterwise initiatives are implemented as intended. Design ideas may not completely translate to the detailed construction plans and specifications, therefore regular guidance from the working group or nominated representative can help achieve a better outcome.

OneOneFive Hamilton Hill civil construction sustainability reporting

Prior to civil works commencement at OneOneFive, the civil contractors agreed to regular sustainability reporting throughout all civil works stages such as site clearing; earthworks; construction of retaining walls and fencing; drainage, sewer and water reticulation; roadworks and paving; and landscaping coordination. This allowed for feedback, as well as a formal documentation on the construction processes of WSUD elements such as tree pits, swales and permeable paving; stormwater controls and community groundwater bore construction processes. In addition, details of waste management, materials tracking and end-use of stockpiled recycled materials required to meet other sustainability targets and EnviroDevelopment certification were provided.

Fortnightly meetings were scheduled between civil contractors, key consultants and DevelopmentWA to discuss and track all civil work and a separate ongoing agenda item for sustainability (water and waste) reporting to meet EnviroDevelopment and developer/ consultant team requirements was included.

Waterwise development: water use and approvals during civil construction

Early in the project the required licences were obtained from DWER for the use of groundwater for earthworks and construction, a licence to construct or alter a well, and a separate licence for the eventual irrigation of private space and public gardens via a community groundwater bore scheme.

It became apparent during the community groundwater bore construction process that the required licence to construct or alter a well had expired. The team acted quickly to resubmit another application for a licence to ensure the bore construction work would not be held up for too long. Good lines of communication had been previously established with DWER via their representation on the stakeholder working group, as well as during earlier required design work to ascertain groundwater availability and allocation, and via the Better Urban Water Management approvals process. Further, the leadership intent of the project has been communicated to align with DWER's aspirations. Building an understanding of common waterwise objectives enabled the application process to be efficiently dealt with and a new licence was quickly granted by DWER.

Stakeholder input in civil works construction of waterwise initiatives

Stakeholder understanding, commitment and collaboration is required to ensure the successful construction of waterwise initiatives such as WSUD stormwater controls and large scale fit-for-purpose alternative water supply schemes (community groundwater bore scheme). Stakeholders include the civil works contractor, relevant members of the project team (civil engineer, urban water consultant and landscape architect), site superintendent and the development manager, as well as relevant local government officers responsible for ongoing management of the assets.

Ideally all stakeholders should meet prior to commencing construction of WSUD elements. This is to confirm understanding of the plans, functionality and intent of WSUD features, and discuss any potential issues. Typically, the project civil engineer is superintendent during this stage. They are responsible for ensuring construction is as per the plans and meets construction certification requirements. It is important that they identify any issues or deviation from design and alert the team for response and rectification.

Stakeholder coordination and integration recommendations include:

- Designers should continue their involvement in the process to supervise construction and ensure waterwise initiatives are constructed and functioning as per design intent.
- Landscape architects should continue to work as part of the design and construction team to ensure alignment between stormwater management and landscape intent, and to select appropriate plants for the function required (i.e. to meet native plant targets or to provide a water quality function).
- Civil contractors will need to be aware of the possible impact of earthworks and infrastructure installation on waterwise initiatives, and care should be taken to ensure no detrimental outcomes. This is particularly important for erosion and sediment control to avoid impacts on the functioning of WSUD stormwater controls and pollution of waterways.
- The site superintendent will need to be informed of the specific construction requirements for waterwise initiatives implemented at the civil works stage, as part of their role to oversee all site works.
- LGA representatives should continue to be updated and included in the process so they are aware of any construction changes that may impact their future asset management. Designers and LGA officers should coordinate and share their inspection procedures and outcomes during construction and upon completion, to ensure all initiatives are correctly constructed or installed. Designers and LGA officers may provide checklists to assist with this, particularly for construction of WSUD stormwater controls. The LGA compliance officer will be required to inspect the WSUD stormwater controls to ensure they are built and established according to the plans approved by council.

Improving the process to meet WSUD design intent

Despite regular updates and ongoing stakeholder engagement with civil work progress, not all design intent was translated to on-ground outcomes during Stage 1 of OneOneFive Hamilton Hill.

Originally five water harvesting tree pits were proposed for Stage 1 civil works, however only three kerb openings were installed upon inspection. This was largely attributed to staff turnover, despite implementation of detailed handover procedures. The project team have considered how to overcome this for Stages 2/3, including the preparation of a schedule of the various WSUD stormwater control elements to ensure they are not overlooked.

Using waste for WSUD

The waste management processes at OneOneFive exceeded the recycling and reuse targets set for the development, resulting in the recovery of 96% of material from demolition.

Materials were processed and stockpiled on site, which was documented and managed by the civil engineering team for use in civil and landscape construction.

The installation of the recycled materials in WSUD elements was undertaken by the civil contractors. They were given a detailed briefing, they agreed to track the use of recycled materials and they committed to attend team meetings and provide material use updates throughout the civil works process, all of which resulted in the recycled aggregate being used as planned.

Materials were screened and used in the installation of the Eco-Aid and Stormtrap underground stormwater retention systems, as well as the permeable paving subbase. Total material reused for the installation of all WSUD elements included:

- Concrete and brick aggregate (662m3)
- Brick and tile aggregate (82m3)
- Concrete aggregate (76m3)

Sediment control and protection during construction

Care needs to be taken to ensure that large sediment loads from civil and building construction processes don't pollute waterways or impact (block) the establishment or function of constructed WSUD features.

Careful site management is required, and erosion control measures put in place. Consideration should be given to stabilisation after earthworks.

The Sediment Task Force[13] (WA) has published a range of information sheets to assist builders, developers, local government and residents to keep soil on site.

The level of protection required for WSUD stormwater controls depends on the WSUD element. For example, permeable paving requires careful management of sediment loads to avoid clogging, as well as consideration of traffic loads and heavy equipment during construction to avoid compaction and potentially reduce infiltration.

Controls can consist of a staged construction process, temporary fencing, signage to alert builders and contractors, barriers such as landscaping/street trees or physical bollards for protection. Large scale systems may require a detailed construction and establishment plan that includes protective measures.

Responsibilities between the contractors, consultants, and developers for sediment control can be poorly understood and poorly defined, leading to undesirable outcomes. Ongoing discussions can help overcome this and preferred control approaches should be clearly included in the tender process. Pre and post construction checklists can be helpful reminders to ensure protection measures are adhered to.

Tree and habitat protection during civil construction

An important feature of a waterwise development is protecting and promoting tree canopy and urban greening to ensure the delivery of quality urban space and cooler urban micro-climates.

Tree retention provides a way to achieve immediate benefits for a development, and where possible, tree retention should be identified and prioritised during the planning and design phases.

Retained trees require ongoing protection during construction to ensure they survive. This includes clearly marking and identifying trees on a map. Bunting should be erected around a tree to identify and protect it. The bunting should also help restrict vehicle and machinery access, which avoids further disruption. Supplementary watering should occur during dry weather, particularly in locations with previous irrigation regimes.

The importance of this should be clearly communicated to the civil contractors and construction stakeholder team. Qualified arborists may be required to provide specialist advice throughout the civil works process.

A waterwise development must also prioritise ecological health. This is important within the development area, as well as ensuring ecological connection with surrounding areas providing safe habitat links. The contribution of WSUD and landscape elements/plant selection for improving and enhancing local ecological systems should have been considered as part of the earlier design process. To ensure design intent is realised, careful planning and coordination between the project team and the civil contractor is required. Items to be considered include fencing of areas that will be cleared, and fauna trapping and relocation by a contracted qualified ecologist prior to clearing.

13 www.perthnrm.com/resource/sediment-management

Retained trees and WSUD construction at OneOneFive

Underground stormwater retention instead of basins were chosen during the design phase to minimise impact on existing trees.

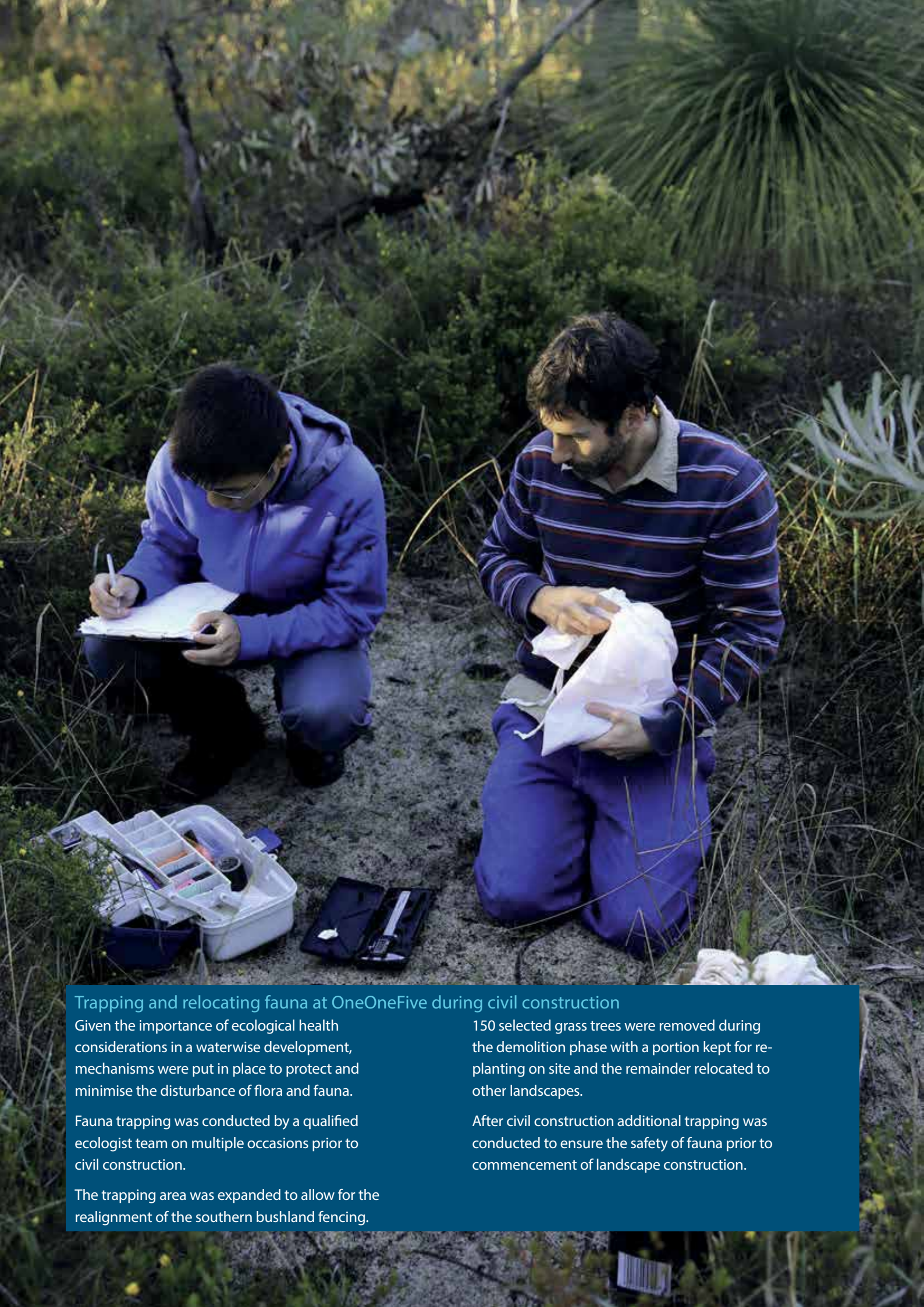
Retained trees were cared for during the civil construction phase via the implementation of tree protection zone fencing, which was installed prior to civil construction, and fortnightly tree watering between October-April.

The original construction methodology planned for the installation of the StormTrap underground stormwater retention system along Purvis St was revised to meet the site-specific requirements for tree retention and protection.

Effective access to install the underground stormwater retention system while accommodating a protected tree was identified as a concern by the civil engineers and contractors, so a new access track was built around the protected tree prior to work commencing.

A qualified arborist was engaged to inspect trees and provide advice on their ongoing health during construction. Despite careful planning and procedures the loss of some of the smaller trees was unavoidable.

New trees were planted to replace those that were lost after completion of works.



Trapping and relocating fauna at OneOneFive during civil construction

Given the importance of ecological health considerations in a waterwise development, mechanisms were put in place to protect and minimise the disturbance of flora and fauna.

Fauna trapping was conducted by a qualified ecologist team on multiple occasions prior to civil construction.

The trapping area was expanded to allow for the realignment of the southern bushland fencing.

150 selected grass trees were removed during the demolition phase with a portion kept for re-planting on site and the remainder relocated to other landscapes.

After civil construction additional trapping was conducted to ensure the safety of fauna prior to commencement of landscape construction.

Waterwise Streetscape Project

The Waterwise Streetscape Project demonstrates best practice implementation of waterwise verges for enhanced urban greening and quality urban space benefits. Implemented in the streets adjacent to the development, the project aligns with the sustainability and liveability concepts that underpin OneOneFive Hamilton Hill.

The project emerged when DevelopmentWA wanted to give residents living adjacent to the development the opportunity to be included as part of a broader vision for the neighbourhood.

The project is supported by Water Corporation, DevelopmentWA and City of Cockburn and includes a suite of material available for any resident to use to upgrade their own verge to a waterwise garden.

Materials include a Waterwise Streetscape fact sheet which includes advice on how to create your waterwise verge, as well as how to access the City of Cockburn verge guidelines, street tree requests and available rebates, subsidies and grants. Links were also provided to Water Corporation's step by step guide to creating a waterwise verge.

Residents were also given a 115 Hamilton Hill Waterwise Streetscape Design Guide which includes design guidance and a plant palette to assist with creating cool, green and waterwise streetscapes.

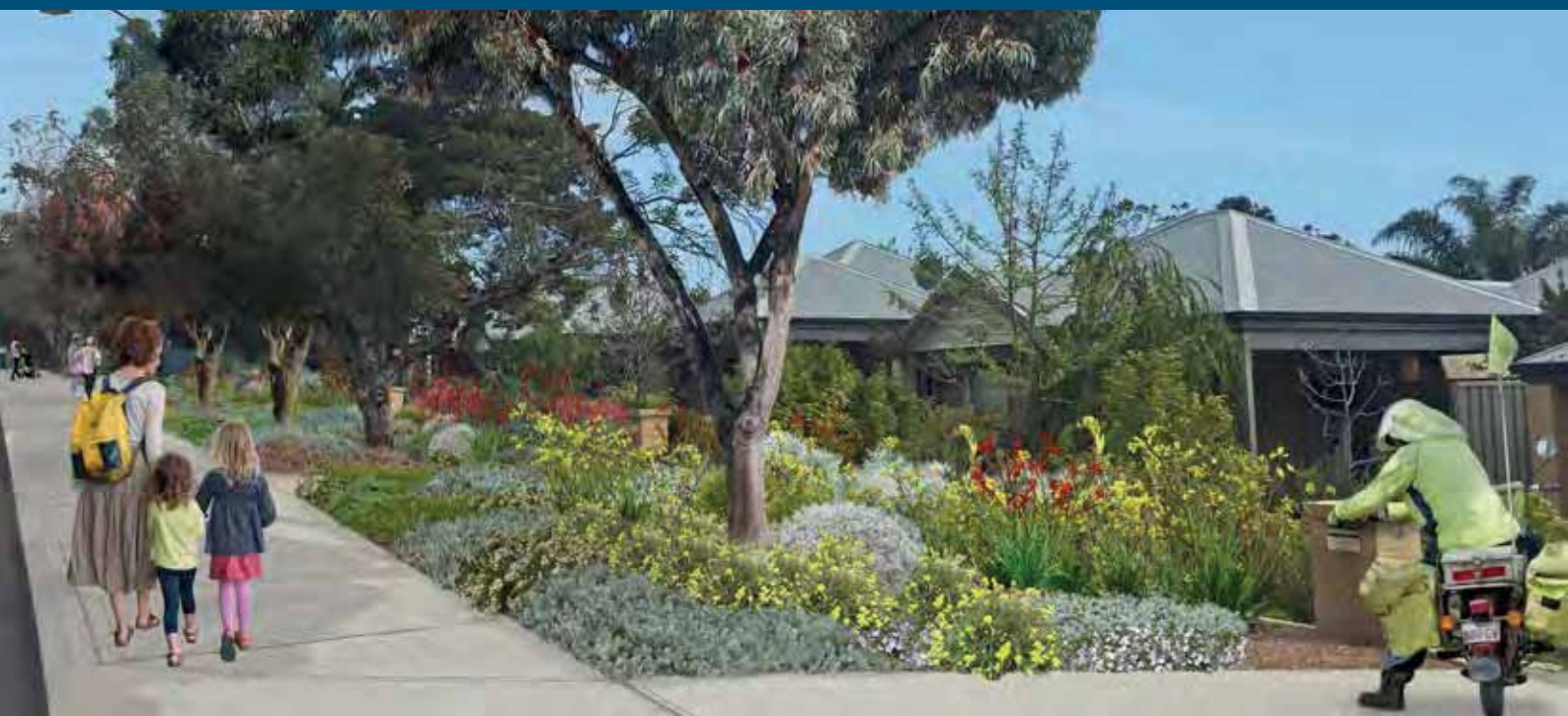
The OneOneFive Waterwise Streetscape project[14] has been completed on Purvis St adjacent to the OneOneFive development and was undertaken during the development civil works phase.

The project included resident information sessions, one-on-one verge design consultations, the supply and planting of additional street trees by the City of Cockburn and ongoing assistance to help residents install waterwise verges at a streetscape level, including City of Cockburn incentives/rebates and initial earthworks assistance from civil contractors at OneOneFive.

In addition to extending the urban greening outcomes and benefits of a waterwise development, this project was also able to demonstrate the ability to coordinate civil works processes for broader community outcomes.

The project includes the landscaping of seven Department of Communities (DoC) verges from irrigated turf to waterwise verges, each including a street tree. These demonstration verges aim to provide valuable information on the costs savings for DoC in transforming traditional irrigated turf verges into waterwise verges.

14 developmentwa.com.au/projects/residential/oneonefive-hamilton-hill/overview - refer to Streetscape Design Guide in 'Useful Links and Downloads' section.



Community engagement

Waterwise development civil works should be undertaken in a way that is sympathetic to the surrounding residents and community. At a minimum, the community should be kept informed of progress and attempts should be made to minimise negative impacts. At best, the community should be included in the waterwise journey. This provides an opportunity to explain initiatives and improve water literacy, as well as raise awareness of the benefits of waterwise outcomes for liveability and wellbeing. Developers may consider engaging residents via letters, holding community events at key project stages, inviting feedback on civil works processes and providing opportunities for involvement in the design of waterwise development initiatives (if appropriate) for the site. Waterwise developments provide benefits beyond the site boundaries and if the existing community is engaged with the process, it can encourage wider positive change and transition to a more waterwise future.

The community and civil works at OneOneFive

Community engagement has been ongoing during the development of OneOneFive Hamilton Hill to help it integrate with the surrounding residential area and provide benefits to existing residents. The following community engagement activities were undertaken during the civil works phase:

- Community information session (30th March 2021) to introduce the OneOneFive water story and OneOneFive Waterwise Streetscape Project.
- Resident community information session (11th August 2021) with approximately 40 community members to provide an update on the developments and an update on the proposed waterwise initiatives to help increase water literacy.
- Log of resident queries/issues and responses to these during civil works to ease the disruption for surrounding residents.
- Residents that had experienced disruptions from civil and utility works as a result of local water and electrical service upgrades were promptly assisted by the project team and civil contractors with tidy ups, replacement plants and mulch.
- Excavation and installation of Purvis St stormwater retention system was arranged to minimise access disruptions for local residents.

Landscaping Works

A waterwise development requires landscaping components that align with the waterwise and sustainability principles. It is here that a combination of water efficiency measures, such as irrigation requirements; urban greening and habitat initiatives; and completion of WSUD stormwater controls with vegetation come together.

Ideally, landscape architects should have been included in all previous project stages and as part of the working group to ensure landscape design and delivery is integrated with all development design. During landscaping works the focus is on ensuring all waterwise initiatives are implemented as per the planning and design process, as per the UWMP, landscape technical specification and any additional design discussions/drawings by the project team.

Site Development Process	Better Urban Water Management	Waterwise Development Pathway
Landscaping works	Subdivision conditions to be met as Urban Water Management Plan is implemented	Landscape contractor understanding of intent Stakeholder participation in landscape construction

Similar to the civil construction phase, the expectations for the waterwise development needs to be included in the landscape tender documents. This should include the guiding waterwise principles for the development and key waterwise requirements that respondents must address. For example, the contribution of landscaping to complete construction of waterwise initiatives, such as WSUD swales and water harvesting tree pits, should describe the additional benefits the development is seeking, such as at-source infiltration of stormwater to enhance soil moisture, plant health, tree growth and the bigger picture contribution to providing high amenity and cooler urban spaces. If groundwater has been approved and included for irrigation purposes then best practice requires landscape contractors to provide ongoing monthly reports on groundwater use and should be clearly communicated in the tender package.

The successful contractors will need to demonstrate their understanding of the waterwise development intent and be ready to provide progress updates to the site superintendent, design team, development manager and waterwise development stakeholder working group. Ideally, this would be during regular site meetings, with an agenda item dedicated to discussing and documenting progress in achieving/implementing sustainability and waterwise initiatives.

OneOneFive landscape technical specification

The landscape technical specification developed for OneOneFive Hamilton Hill Stage 1 includes additional information on the project vision and sustainability objectives.

Additional sustainable and waterwise development information in the landscape technical specification includes:

- EnviroDevelopment accreditation and the need to comply with waste avoidance and resource recovery, including a landscape resource recovery list of materials salvaged on site, such as recycled bricks and timber habitat logs, and details of where they are to be installed.
- Waterwise Exemplar with waterwise initiatives including localised infiltration of stormwater, community groundwater bore scheme servicing public realm and residential lots, waterwise plantings and efficient irrigation.
- Habitat and biodiversity including the importance of protecting the remnant bushland, fauna relocation, planned landscaping inspired by local flora and fauna, with the inclusion of habitat features and a plant palette comprised of predominately local native species. The emphasis on habitat and biodiversity also links with the waste recovery initiatives such as salvaged logs to be used as habitat features.
- Tree and native vegetation preservation, including retention of mature trees for shade and habitat, as well as inclusion of new trees planted with the aim to achieve a 30% tree canopy target.
- Soil conditioner to be made from local FOGO (Food Organics-Garden Organics) derived material, sourced from the Resource Recovery Group, and requirements to ensure microbial activity in soil amendment is retained.
- Mulch maintained to a depth of 75mm
- While the Stage 1 landscape technical specification included a summary of the OneOneFive Waterwise Exemplar, the details required for implementation of WSUD features and groundwater reporting was not clearly articulated. The project team have reflected on how this will be improved for Stages 2/3 and will include required sections in the tender package, ensuring landscape contractors agree to regular waterwise reporting via meetings and provision of formal documentation as per meeting minutes, written reports and photos.

WSUD and landscaping for habitat enhancement

A waterwise development includes consideration of how water systems or assets help to protect and restore ecological health and provide quality urban space.

A Habitat Enhancement Strategy was developed by the project landscape architects for OneOneFive Stage 1. This strategy ensures water sensitive urban design and urban greening initiatives are contributing to broader ecological benefits via careful design. The strategy also assists in meeting sustainability reporting requirements, including the waterwise development criteria where a commitment to achieving ecological health needs to be demonstrated.

The landscape design included a Habitat Enhancement Strategy which allows for the safe movement of native fauna via habitat structures. It also includes measures such as permeable fencing, quenda crossings, habitat logs, bird nesting boxes, insect hotels and bird watering stations. Designs were informed and reviewed by an urban ecology specialist to ensure rigour.

The Stage 1 landscape plant palette demonstrates the use of native flowering plants to attract birds and native bees. The inclusion of native planting on street verges throughout the development and adjacent streets provides important linkages for fauna movement, while the prioritising of tree retention and enhancement of tree canopy provides corridors for movement and cool, shaded streets. In addition, roads throughout the development have been designed to encourage the slow movement of traffic for safety.

Stakeholder input in landscape construction

Successful implementation of waterwise initiatives depends on the co-ordination of stakeholders during landscape construction. This stage must include a member from the stakeholder working group to ensure waterwise direction and intent continues momentum and the outcomes are successful. Additional meetings and site visits may be required from all members of the project team to overcome issues as they arise. Ongoing liaison with the LGA may be required to address issues and provide progress updates.

A key objective for implementing any WSUD stormwater control is that the functional stormwater management requirements are achieved while providing a landscape aesthetic and amenity that fits with the waterwise development criteria. Ideally landscape work should begin soon after civil works to prevent sediment build up and potential damage to WSUD features such as swales and permeable paving. This will require liaison between all contractors, the developer and LGA.

Irrigation requirements will need to align with advice from DWER, WC, and LGA. This will include adhering to watering days, obtaining water use data and reporting if a groundwater allocation is in use, and ensuring irrigation systems are in-line with LGA specifications and requirements or as otherwise agreed during planning and design.

Trialling irrigation initiatives with the City of Cockburn

The OneOneFive project team originally proposed the use of drip irrigation for water efficiency in all public realm garden beds (POS and streetscapes), with sprinklers to be limited to turf areas. The City of Cockburn expressed apprehension with drip irrigation due to line blockage and difficulty to repair.

The project consultant team produced a detailed advice note outlining the rational for drip irrigation; including an overview of design, installation, inspection and handover process; and contact details of other local government irrigation managers with success and experience in using drip irrigation. The City's concerns were not appeased, and the team suggested that due to slope and exposure, and to assist with the waterwise exemplar narrative, that drip irrigation might be a worthwhile feature to test and evaluate. A plan was provided indicating areas where drip irrigation testing might be useful, including narrow road side garden beds and swales.

After an on-site meeting to discuss the trial, the City confirmed the use of drip irrigation in the proposed areas, with the use of sprinklers to remain in POS areas. The project team agreed to notify the city of the final dripline layout and testing, prior to mulching, and to provide updates on the outcomes of the trial, in the hope that the use of drip irrigation might be expanded for Stages 2 and 3 of the development.

Importance of aligning design detail across civil and landscape stages

Stage 1 WSUD design meetings with the City of Cockburn outlined that the purpose of the water harvesting tree pits was to assist with the establishment of healthy trees and to reduce ongoing irrigation requirements, rather than any significant contribution to the reduction of stormwater flow.

The design indicated that six water harvesting tree pits should be installed as trials for Stage 1 however, during landscape construction superintendency it was realised that only three water harvesting tree pits had been installed, and not to the agreed design standard. Further investigation indicated that civil and landscape construction plans did not align.

While the agreed number of tree pits were shown on the landscape drawings, only five were shown in the civil works and two of those in the southern POS area were not designed as water harvesting tree pits (no kerb openings).

Further, the landscape plans did not detail specific installation requirements for the water harvesting tree pits, instead they indicated typical tree planting and mulching detail.

By the time the inconsistency had been noted the trees had already been installed as usual.

This meant the three locations with kerb openings for water harvesting tree pits needed to be re-constructed with the correct grading and recycled brick aggregate gravel, as well as re-installation of the trees.

The southern area of Stage 1 where the kerb openings had not been installed during civil works to create water harvesting tree pits were subsequently planted with smaller trees that require less water.

Greater attention to the design and installation of water harvesting tree pits is now a priority for Stage 2 and 3. This will include clarification of the definition of a water-harvesting tree pit, to detail the added function of hydrating the landscape and contributing to overall tree canopy, rather than functioning purely as a stormwater control.

Also refer to Appendix 3 fact sheet: Water harvesting tree pits at OneOneFive Hamilton Hill.

Street tree plan

The project landscape architects challenged the City's preferred street tree list with the aim of increasing biodiversity benefits and enhancing local character through the inclusion of local native species, along with other suitable native WA and Australian trees. Upon negotiation the following approach was agreed:

- A mix of trees from the City of Cockburn street tree list were incorporated, including Eucalyptus torquata, Eucalyptus cladocalyx nana and Eucalyptus leucoxylon rosea.
- The use of Tuart and Jarrah within large verges in key positions on the street plan to create canopy, biodiversity, habitat, and food source to support OneOneFive's strong vision of sustainability and ecological biodiversity. Ecological outcomes will be enhanced as these species can provide a source of food and habitat for birds, bees and insects, including Black Cockatoos.
- Tuart and Jarrah trees were only used in select verges that are appropriate for larger trees. Existing Tuart trees around the development are valued by the community and nearby councils have set a precedence for including Tuart trees in larger verges.
- The use of Agonis flexuosa in areas adjacent to permeable paving to see if the water harvesting from the paving increases tree vigor and reduces reliance on irrigation.
- The incorporation of Melaleuca preissiana as street trees in the roadside swales which have been designed to mimic 'winter wet depression' ecological features.

After Local Development Plan approval by local government, as per the approved sub-division plan and in accordance with State Planning Policy and relevant Town Planning Schemes, the lot plans can be developed and sales process commence.

Survey plans include the official record of the legal boundaries of the lot and will contain information on lot sizes, shape and dimension. Certificate of Title is an official land ownership record and includes a legal description of the land, notifications, interests and encumbrances.

A waterwise development benefits from having a sales agent that understands the sustainability concepts and waterwise initiatives, and can clearly communicate these to prospective buyers, or know where to direct them for further information.

Site Development Process	Better Urban Water Management	Waterwise Development Pathway
Title and sales	Subdivision conditions to be met as Urban Water Management Plan is implemented	Marketing and showcasing Resident and builder engagement prior to build

Marketing and Showcasing

At this point there is a requirement to ensure the sustainability intent and guiding waterwise principles are effectively communicated to buyers and future residents. The developer will need to make sure they engage sales agents that are conversant in the sustainability intent of the project, and are supported by a development manager or estate architect that can provide additional technical details when required.

The ease and effectiveness at which a sales agent can communicate the sustainability features to a buyer depends on several factors.

- Younger and typically first home buyers may be more aware of the importance of incorporating sustainability features into a home. However, it is becoming more common amongst older demographic to request this, noting there will always be a segment of the community that don't care and just want an affordable home.
- Some areas may have sustainability principles already embedded in the local community, making the discussion with potential buyers easier.
- Ability to understand prospective buyers and not to overwhelm those who might be new to thinking about incorporating waterwise and sustainability initiatives into their home.
- Knowing the extent of the estate agent's knowledge. Some sales agents may be used to selling in areas where sustainability is high on the agenda. Others may be new to explaining these features and therefore need to be aware of the limitations of their knowledge and where to direct buyers for the information required. Developers need to be aware of this and ensure the appropriate support is in place to assist sales agents to comfortably discuss the required sustainability features.
- Design Guidelines and Estate Architects are key mechanisms to aid with communicating sustainability and waterwise requirements, and Design Guidelines need to be clear, concise and not overwhelmingly technical.
- Developers need to choose sales agents that are across the detail of the sustainability initiatives and can speak with some authority so it can be introduced in a positive sales context. Some buyers may not have come across this process before, particularly first home buyers, and will require some nurturing.

- Estate agents should be able to celebrate initiatives and advise buyers of the increased comfort, the long-term affordability, and that they will be building a house they can live in longer, with increased value at completion that can then be passed on to other buyers.
- Communicating the sustainability features as easy to achieve and maintain is helpful – these are normal things buyers would want to have anyway.
- Sales agents that are experienced in communicating sustainability features will know when the best time is to introduce features. For example, some initiatives will be easier to talk about when visiting the lot and a direct reference can be made.

Sustainability and sales

Overall the sustainability initiatives are regarded as a positive attribute of the sales process at OneOneFive. Communicating the increased comfort, the long-term affordability and increased value at completion that can then be passed on to future buyers has assisted potential buyers to overcome any initial objections or concerns about adhering to sustainability initiatives. Buyers have welcomed the idea of having a rainwater tank, a community bore and guidance on waterwise landscaping and irrigation as required under the Design Guidelines. The initiatives have been easy to communicate and there is additional support to the sales agents from the Design Guidelines and Estate Architect, as well as a specific development webpage with advice for architects and builders.

Advocacy activities

Effective communication can assist with mainstreaming waterwise developments. A communication plan should be developed with the stakeholder working group identifying communication opportunities with key audiences such as government organisations, industry associations, research organisations and relevant community groups.

Communication activities can be tailored to suit the specific project messaging and include presentations, stakeholder briefings, workshops, meetings, community information sessions, site tours, written communication for magazines and newsletters and preparation of resources and fact sheets.

Resident and builder engagement prior to build

At this stage, purchasers and their builders are typically required to engage in an approval process to ensure houses are designed and built in accordance with relevant development plan and design guidelines, including those promoting waterwise outcomes.

Early marketing can help facilitate and should include the listing of the development manager or estate architect contact details, as well as technical advice to ensure interested purchasers and their builders are properly informed.

Building representatives may also contact the sales agent on behalf of a prospective buyer. During these discussions it should be made clear that there may be an additional layer of complexity as part of the process but if the appropriate guidance is already in place, in clear design guidelines and supporting technical notes, then this will be much smoother.

Developers may also consider having a preapproved list of builders that are committed to achieving waterwise and other sustainability goals of the development, and who can be promoted to buyers.

Stage 1 Design Guidelines and Estate Architect at OneOneFive

New lot purchasers are provided with a carefully prepared suite of information to ensure their future house and garden will meet the sustainability requirements of the development. This includes the OneOneFive Hamilton Hill Design Guidelines, fact sheets and guidance notes. This material is available via the development website.

An approval process has been developed with an Estate Architect available to assist owners and builders with interpreting the design guidelines and Local Development Plan (LDP).

The approval process includes:

- Review: Review your Contract of Sale, the Design Guidelines (DG) and Local Development Plan (LDP) to understand the requirements for your house and land.
- Design: Work with your architect or builder to prepare a concept design that meets the requirements of the DG and LDP.
- Concept design submission: Submit concept designs to DevelopmentWA's Estate Architect for approval.

- Detailed design submission: Submit detailed drawings (including Livable Housing Assessment) to DevelopmentWA's Estate Architect for final endorsement: .

  NOTE: If your submission is not supported at concept design or detailed design stages, then the design will need to be amended and resubmitted. The Estate Architect will provide guidance to assist you in meeting the requirements.

- Compliance approval: Submit a 'Notice of completion' certification from your Builder to the City of Cockburn and DevelopmentWA's Estate Architect to confirm achievement of required outcomes.

Waterwise Incentive Package

DevelopmentWA's Waterwise Incentive Package (valued at $10,000) is available to support the implementation of waterwise practices at OneOneFive Hamilton Hill, including rainwater harvesting, localised stormwater infiltration, waterwise landscaping and irrigation.

The package includes:

- $7,500 for builders to go towards the cost of additional soakwells for stormwater storage (1% AEP required to be contained on lot), rainwater tank (minimum 3,000L, connected to minimum 100m^2 roof catchment), and dual plumbing to supply rainwater to toilets and washing machine.
- $2,500 for owners to go towards a waterwise landscaping and irrigation system, with weather-based irrigation controller, installed by a Waterwise Specialist Landscaper and Irrigator.

Documentation is required to demonstrate the inclusions and payment can be claimed after completion of works.

Next Steps

The next steps for developing this Guide are stepped out in Phase 3 of the OneOneFive Waterwise Exemplar. Phase 3 will continue to capture learnings from Stage 1 of the development, as well as inform the design and construction of WSUD and waterwise initiatives for Stages 2/3, building on the waterwise experiences of Stage 1.

Phase 3 will focus on evaluation, knowledge sharing and continual improvement. This phase forms an important part of building an evidence base to demonstrate how waterwise initiatives can become mainstream practice for urban development in Perth. Phase 3 activities include:

- Advocacy and stakeholder engagement:
  - Ongoing collaboration and co-design of waterwise initiatives to be implemented for Stages 2/3.
  - Delivery of advocacy and communications activities such as presentations, site tours and partner materials/reports.
  - Updates to Waterwise Development Pathway and Guide.
  - Ongoing stakeholder engagement via the OneOneFive Waterwise Exemplar Reference Group.
- Technical activity:
  - Understanding WSUD maintenance requirements for permeable paving, water harvesting tree pits and roadside landscape feature swale.
  - Evaluation of WSUD performance for stormwater management, urban heat mitigation and urban amenity/aesthetics.
  - Research Pilot: OneOneFive Waterwise Smart Metering Pilot Project to inform requirements for a water use data platform prior to connection to future residents at OneOneFive Hamilton Hill.

The design and methodology for the Phase 3 research pilot has evolved over the Waterwise Exemplar phases. Phase 1 included the early development of a smart platform proposal for monitoring and evaluation via data gathering elements and data storage and use. Phase 2 focused on further refinement, including the development of a monitoring and evaluation schematic and selection of the preferred device and platform (Huey™) to trial for water use data verification and the impact of prompts and alerts on changing behaviour.

Phase 3 will commence with the recruitment of participants for the pilot project as well as installation of monitoring equipment at OneOneFive. This will include LoRaWAN gateways, weather stations and thermography sensors. Reporting will be included as part of the next iteration of this Guide, which will verify and evaluate waterwise initiatives and processes to better inform future implementation of waterwise developments.

Site Development Process	Better Urban Water Management	Waterwise Development Pathway
House construction	Subdivision conditions to be met as Urban Water Management Plan is implemented	Resident and builder engagement (ongoing)
Post development asset handover		Ongoing engagement with LGA and local residents
		Evaluation, knowledge sharing and continual improvement

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Appendix

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APPENDIX 1 - Waterwise Development Site Process

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Waterwise Development Site Process

	Site Development Process	Better Urban Water Management	Waterwise Development Pathway
Planning, design and approvals	Project definition, visioning & appointment of consultants	Urban water and hydrologist expertise required on the project team supported by a multidisciplinary project team (planner, civil engineer and landscape architect)	Establish waterwise aspirations • Waterwise and sustainability aspirations identified in the consultant's brief
	• Concept planning • Site and context analysis; constraints and opportunities • Identification of environmental assets • Identification of strategic drivers • Develop sustainability objectives • Community and stakeholder consultation	Local Water Management Strategy (LWMS) • Groundwater quality and level monitoring • Surface water quality and quantity (volumes, flow rates and flood level) monitoring • Water balance • Hydrological modelling • Infrastructure needs • Confirmation of potable, non-potable and wastewater servicing arrangeents • Management of water/ environmental assets and enhancement opportunities • Specific management practices for stormwater • Conceptual landscape outcomes	Project visioning and identification of waterwise goals (entire project team) LGA strategic direction and accreditation • Cross check LGA Waterwise Council status, Water Sensitive City Benchmarking and other strategic urban greening/liveability programs Establish stakeholder working group to inform and support waterwise initiatives Liaise with DWER regarding alternative water supply options (e.g. recycled water scheme or community bore) and undertake business case
	Master Plan • Decide suitable sustainability framework • Landscape Master Plan • Community and stakeholder engagement		Develop a Waterwise Strategy for the project: • Align w/ project team • Brief stakeholders (inc LGA)
	Local Structure Plan & technical reports • Establish land use, density and public open space (Landscape Master Plan) • Environmental features and protection • Movement network • Engineering and environmental requirements • Local Water Management Strategy • Community and economic development		Engage stakeholders on innovative waterwise initiatives Design responses to suit site specific requirements
	Subdivision Plan • Detailed civil and landscape design • Local development plan • Residential Design Guidelines	Urban Water Management Plan (UWMP) • Further detailed modelling • Final design and siting for water management infrastructure • Implementation plan for agreed environmental, water and landscape outcomes • Management of construction works	Stakeholder input into waterwise details, particularly LGA Waterwise program alignment with Design Guidelines Sustainability program certification Waterwise Development certification
Construction, occupation and maintenance	Civil works	Subdivision conditions to be met as Urban Water Management Plan is implemented	Civil works contractor understanding of intent Stakeholder participation in civil works construction of waterwise initiatives Sediment control and protection during construction Tree and habitat protection Community engagement
	Landscaping works		Landscape contractor understanding of intent Stakeholder participation in landscape construction
	Title and sales		Marketing and showcasing Resident and builder engagement prior to build
	Home construction		Resident and builder engagement
	Post development asset handover		Ongoing engagement with residents in collaboration with LGA Evaluation, knowledge sharing and continual improvement

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APPENDIX 2 - Permeable Paving Fact Sheet

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Permeable paving at OneOneFive Hamilton Hill

OneOneFive by DevelopmentWA is a residential infill development located on the former Hamilton Senior High School Site in the City of Cockburn. The project is a 'waterwise exemplar' through the application of Water Sensitive Urban Design (WSUD) principles and waterwise practices, including localised stormwater management to support landscape plantings and contribute to urban cooling.

This fact sheet documents the permeable paving treatment installed during stage 1 of the project, as approved under the Subdivision Plan and accompanying Urban Water Management Plan (UWMP).

WATER CORPORATION

What is permeable paving?

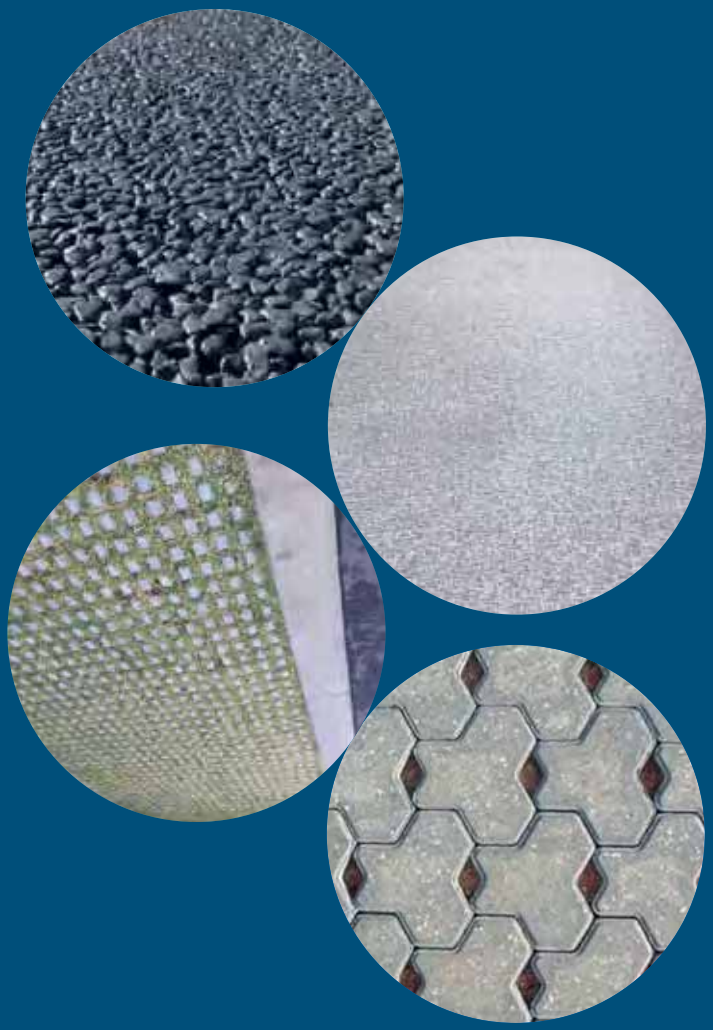
Permeable paving is a load bearing pavement structure that allows water to infiltrate into the soil below to provide an 'at-source' stormwater control. It is best suited to low traffic roads, car parks, driveways and pedestrian areas. There are four main types of paving used:

1. **Porous asphalt**
Similar to conventional asphalt except fines are removed to create greater void space, and additional binders are used to provide greater durability and prevent breakdown.

2. **Pervious concrete**
Fines in the mix are reduced to maintain interconnected void space, resulting in a coarser appearance than standard concrete.

3. **Grid pavement systems (plastic or concrete)**
Modular grids filled with turf and/or gravel that allow infiltration through the surface.

4. **Permeable modular interlocking pavement**
Drainage through aggregate-filled gaps between pavers. Note: the pavers themselves are not permeable.



Benefits

Urban areas consist of large amounts of impervious surfaces, such as roads, driveways and parking bays. Extensive paved areas affect the water cycle by increasing the volume of water runoff during peak events. This impacts downstream flooding and requires increased drainage infrastructure. Using permeable paving can provide benefits such as:

- Reduced stormwater runoff volumes.
- Reduced or eliminated pipe and pit costs.
- Localised wetting of soil to aid landscape plant growth.
- Reduced urban heat through evaporative cooling from water stored under the paving, and increased evapotranspiration from vegetation accessing additional moisture..
- Increased groundwater recharge via infiltration of subsoil.
- Improved stormwater quality, which prevents transfer of pollutants to other areas.
- Increased landscape aesthetics.

Planning, design and approval for permeable paving at OneOneFive

Site suitability for permeable paving (structure plan and local water management strategy (LWMS) stage – concept landscape and engineering design)

Permeable paving was proposed as a part of the integrated WSUD approach to managing stormwater on site.

The project team assessed options for including permeable paving to capture and infiltrate small rain events where they fall.

Original concepts considered the implementation of permeable paving at all driveway cross-overs and car bays, as well as flat sections of road. This concept evolved through the structure planning and subdivision design process.

Engagement with LGA and leading experts (structure plan and LWMS stage)

The project team undertook a workshop with City of Cockburn staff who represented planning, engineering, parks and environment departments. As well as other at-source stormwater control options, the benefits, design, typical inspection and maintenance activities for permeable paving were discussed.

The project team liaised with the City of Belmont to understand their previous experiences with permeable paving (in parking areas).

In addition, members of the project team connected with researchers and practitioners in Adelaide to better understand experiences with different products, including the management of issues such as clogging and weed management. A permeable modular interlocking pavement product was selected based on demonstrated success.

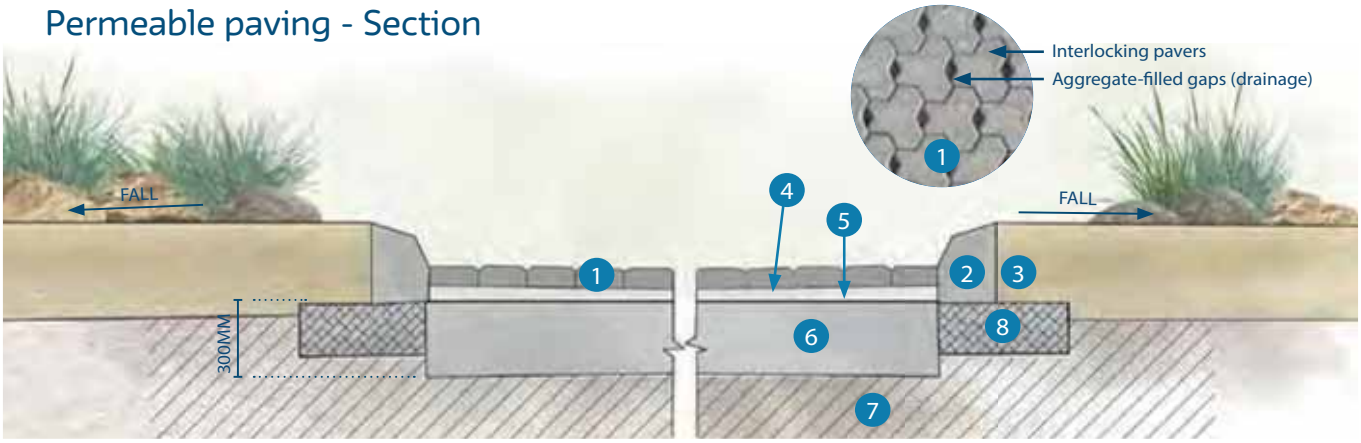
Refinement of WSUD stormwater controls (subdivision design and UWMP stage – detailed landscape and engineering design)

The range of localised stormwater control typologies were refined during design development and overall a more conservative approach was adopted for Stage 1 of the development based on feedback from the City of Cockburn. The use of permeable paving (as well as water harvesting tree pits and roadside landscape feature swales) was limited to the most practical and high impact areas, with learnings to be factored into the potential expansion of their use in subsequent development stages.

Detailed design (finalisation of subdivision plans and UWMP)

The project team addressed the City's requirements while not compromising the WSUD and sustainability vision for the project. During these initial discussions the City's preference was for permeable paving in car bays only for ease of maintenance and repair, however the project team highlighted the importance of including permeable paving on suitable (flat) road areas as a WSUD demonstration initiative that would be a first for Perth. In addition, the City agreed to use permeable paving for all on-street car bays and in three proposed road areas, with the clause that any failure should be reinstated by the developer before asset handover.

Permeable paving - Section



Legend

1. Permeable pavers
2. Semi-mountable kerb
3. Landscape soil
4. 30mm thick bedding (2-5mm aggregate)
5. Geogrid and Geotextile
6. 300mm thick permeable base (10mm-40mm aggregate)
7. Compacted sub-grade
8. 250mm compacted road base

Construction – lessons learned

Permeable paving treatments, locations and details were reviewed by the project civil engineers and urban water consultants prior to construction.

The Midland Brick Aqua Tri-Pave 80mm was chosen in the pewter shade because of its lower solar absorption rating compared to other colours.

The pavers were installed as per the manufacturer's instructions, which took approximately four weeks to complete during March and April 2021.

Road sweeping was ongoing throughout the civil construction process, occurring as needed to reduce the likelihood of clogging.

Recycled material that had been stockpiled during demolition was screened and used as aggregate for the for the permeable paving subbase.

The City of Cockburn queried the use of permeable paving 2-5mm stone infill because of safety and maintenance concerns. As a result the City monitored the permeable paving infill to ensure it did not become a tripping hazard and to confirm that it could be maintained by the City's normal street sweeping procedures.

Maintenance checks by the City's Operation Supervisor approximately 12months post construction indicated that gravel aggregate infill had been removed and gaps were appearing in the pavers, with their investigation indicating that it is most likely due to vehicular movement.

The City sought guidance from the civil engineers, which demonstrates the strength of the relationships formed by the project team. The issue was then investigated by the civil engineer team and paving contractors resulting in agreement that street sweeping was likely to have contributed to the issue.

The contractors recommended that the voids be re-filled with a 2-5mm washed aggregate however, the civil team referred to recommendations from the Concrete Masonry Association of Australia for the design and construct of permeable pavers, which suggest a 1-3mm clean, uniformly graded aggregate used for joint filling. It was also advised that the sweeper stay off the permeable pavers.

The performance of the pavers will be continue to be monitored by the City and project team.

Cost of installation

Permeable paving: $145/m2.

Standard asphalt road construction: $42m2.

A direct cost comparison demonstrates that the permeable paving is around three times more expensive than standard asphalt road construction.

This calculation does not consider additional benefits such as the reduction in drainage infrastructure elsewhere in the catchment as the result of reduced stormwater flows. In addition, there are long term benefits from reduced urban heat through evaporative cooling from water stored under the paving, and increased evapotranspiration from vegetation accessing additional moisture.

Next steps

Future versions of this fact sheet will include additional information on maintenance and performance of permeable paving implemented in Stage 1, as well as design approaches for development Stages 2/3.

Based on the initial performance of permeable paving in Stage 1, planning for Stages 2/3 will include additional permeable paving locations in road areas, laneways, and car bays where it is deemed to provide the most effective cooling and passive irrigation benefits. The final design will be informed by the ongoing performance monitoring of the permeable paving locations in Stage 1.

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Department of Water and Environmental Regulation

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APPENDIX 3 - Water Harvesting Tree Pits Fact Sheet

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Water harvesting tree pits at OneOneFive Hamilton Hill

OneOneFive by DevelopmentWA is a residential infill development located on the former Hamilton Senior High School Site in the City of Cockburn. The project is a 'waterwise exemplar' through the application of Water Sensitive Urban Design (WSUD) principles and waterwise practices, including localised stormwater management to support landscape plantings and contribute to urban cooling.

This fact sheet documents the water harvesting tree pits being installed in Stage 1 of the project, as approved under the Subdivision Plan and accompanying Urban Water Management Plan (UWMP).

WATER CORPORATION

What is a water harvesting tree pit?

The term tree pit (or tree well) refers to the location and 'hard landscaping' arrangement that trees are planted into within paved areas. Tree pits can be designed in a way where they can contribute to 'at-source' stormwater control by receiving runoff from adjacent surfaces. These are referred to as 'water harvesting' tree pits. They can also act as 'bio-filters' to improve stormwater quality through considered use of planting media and root zone drainage, however this function is normally limited to situations where stormwater quality management is a specific issue.

Benefits

Built-up urban areas can be hostile environments for establishing trees. Root zone space is often limited due to space constraints from paving and services, such as cables and pipes. Radiant heat from paving and roads can also lead to moisture stress. A major benefit of integrating tree pits with stormwater drainage is that the additional water they receive supports healthy growth and reduces reliance on irrigation.

Other benefits include:

- Additional moisture provided to trees increases evapotranspiration which aids urban cooling.
- When water harvesting tree pits include good quality structural soils with adequate pore space, they can contribute to local stormwater retention and infiltration. This takes pressure off downstream stormwater drainage infrastructure required in public open spce (POS) and it enhances usability.
- If required, water harvesting tree pits can be designed to act as biofilters that assist with water quality improvement.

Planning, design and approval for water harvesting tree pits at OneOneFive

Site suitability for water harvesting tree pits (structure plan and Local Water Management Strategy (LWMS) stage – concept landscape and engineering design)

The design for OneOneFive is targeting a 30% tree canopy across the development which includes the planting of 350 new trees in public areas such as streetscapes. The high depth to groundwater at the site means that trees are highly dependent on irrigation for establishment. The use of water harvesting tree pits was identified as a way to reduce ongoing irrigation requirements through passive watering.

Engagement with LGA (structure plan and LWMS stage)

The use of water harvesting tree pits was discussed at workshop that included City of Cockburn officers representing planning, engineering, parks and environmental departments. Importantly, the connection between the use of water harvesting tree pits and the performance of new tree plantings in relation to meeting the tree canopy target was made. Various pit designs were discussed utilising valuable experience from both the project team and City officers. It was also acknowledged that the contribution of the pits to the reduction to overall stormwater flows would be relatively minor, and their main purpose was to aid in the establishment of healthy trees and reduce ongoing irrigation requirements. Tree pits would not be designed as bio-filters given that stormwater quality was not a specific issue at this site, although their inclusion would contribute to better stormwater quality and reduced stormwater flows by capturing some first flush events.

Refinement of WSUD stormwater controls (subdivision design and UWMP stage – detailed landscape and engineering design)

The number and location of water harvesting tree pits was refined in line with the progress of civil engineering and landscape design. Further refinement of pit design was undertaken by the project team using previous experience of both successes and failures. Additional research of designs implemented on other projects around Australia was also considered, noting that the eventual design would need to be suitable for the relatively unique sandy soil conditions of OneOneFive (and other areas of Perth).

Detailed design (finalisation of subdivision plans and UWMP)

Detailed design of the pits was finalised by the project team, with a review undertaken by City of Cockburn officers as part of the Stage 1 engineering design and UWMP submission. Key considerations at this stage included:

- Ensuring trees have adequate irrigation for establishment (and maintenance) watering in the event that stormwater harvesting volumes are inadequate.
- Ensuring that the edges of the tree pits are stabilised to prevent subsidence and scouring.
- Elimination of trip hazards by addressing final levels between top of pit soil level and surrounding paving.
- Use of non-floating mulch, or other means of mulch stabilisation, to prevent mulch washing away in heavy storm events.

Construction – lessons learned

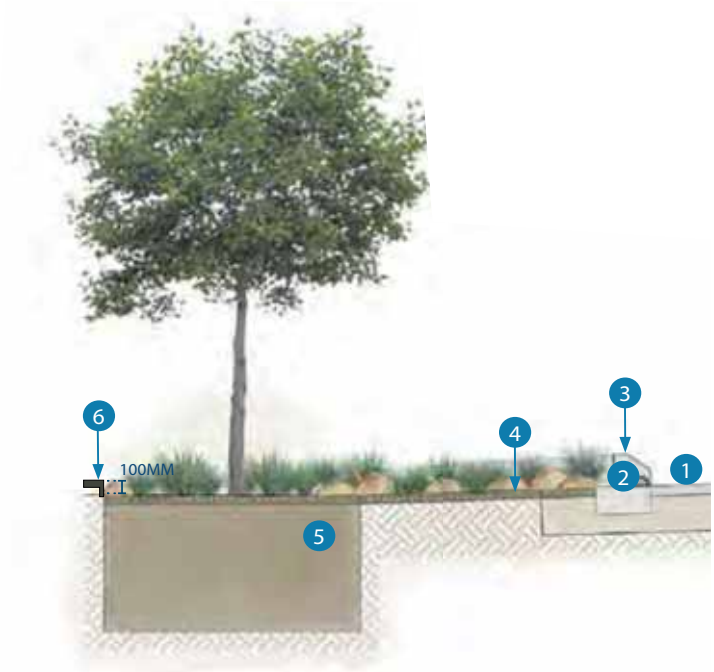
The primary role of the water harvesting tree pits trialled for OneOneFive Hamilton Hill was to assist with the establishment of healthy trees and to reduce ongoing irrigation requirements, with minor contribution to the reduction of stormwater flow. Water harvesting tree pits complement other waterwise initiatives as part of a balanced approach to stormwater management, landscape hydration and urban greening. Design discussions determined that water harvesting tree pits should not be located alongside permeable paving as infiltration in these locations will already assist with street tree irrigation and growth.

Initially six water harvesting tree pits were earmarked for installation in Stage 1. During landscape construction superintendency it became apparent that only three were allowed for the civil works phase and not to the intended design. Further investigation indicated that the final locations and design details in the civil and landscape construction plans did not align.

By the time the inconsistency had been noticed the trees had already been installed as standard street tree plantings. As a result, two locations with required kerb openings for stormwater inflow were rectified with suitable grading, screened recycled brick aggregate gravel and reinstalled trees, and the third will be constructed following completion of the adjacent house construction works. The three other locations will remain as standard tee planting arrangements.

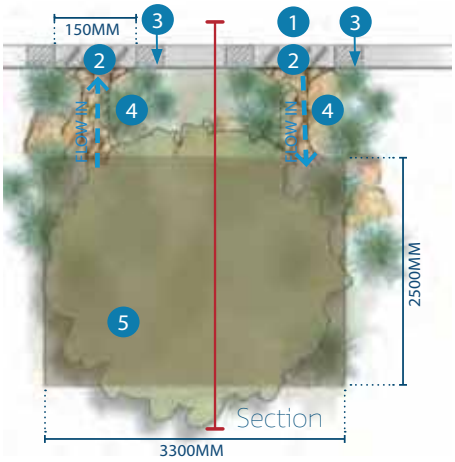
The experience highlights the importance of close coordination between members of the project team and their contractors to ensure design intent is translated to on-ground outcomes as intended and these learnings will be taken into the design and construction phases of Stages 2 and 3.

Water harvesting tree pit - Section



Note: This section is a typical representation and variation may occur due to nature of tree & site.

Water harvesting tree pit - Plan



Legend

1. Road pavement
2. Flush kerb with notched opening
3. Transition kerb
4. Stone mulch channel
5. Planting media (with bio-filtration media if required)
6. Adjacent finish to sit 100mm above tree pit soil

Cost of installation

Civil contractor costs:

- Kerb opening: $489 each.

Landscape costs:

- Trees: $152 each.
- Mulch: $98/sqm, with approx. 3sqm per pit.
- Planting media: $4.80/sqm, with approx. 3sqm per pit.

Next steps

Future versions of this fact sheet will include additional information on performance of water harvesting tree pits implemented in Stage 1, as well as design approaches for development Stages 2/3.

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APPENDIX 4 - Roadside Landscape Feature Swales Fact Sheet

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Roadside landscape feature swales at OneOneFive Hamilton Hill

OneOneFive by DevelopmentWA is a residential infill development located on the former Hamilton Senior High School Site in the City of Cockburn. The project is a 'waterwise exemplar' through the application of Water Sensitive Urban Design (WSUD) principles and waterwise practices, including localised stormwater management to support landscape plantings and contribute to urban cooling.

This fact sheet documents the roadside landscape feature swales installed in Stage 1 of the project, as approved under the Subdivision Plan and accompanying Urban Water Management Plan (UWMP).

WATER CORPORATION

What is a swale?

Swales are grassed or vegetated channels used to collect stormwater, which then infiltrates into the ground. Bio-filtration swales comprise a channel with vegetation and layers of soils of differing particle size and nutrient retention ability to filter and improve stormwater quality, as well as slowing and reducing runoff. Swales can be used in median strips, road verges, within allotment landscaping and in parklands, and are best suited for slopes between 2% and 5%.

Benefits

Swales are a cost-effective way of dealing with stormwater by enabling local infiltration and reducing peak volume impacts on downstream drainage infrastructure.

Depending on their design, swales can also be used to treat stormwater by removing nutrients and other contaminants.

Swales are a good way to harvest water off roads and paving where it can be directed to plants, reducing the need for irrigation and helping with urban cooling. This is the main reason they are being used at OneOneFive.

Other benefits of roadside swales include:

- Lower capital costs than conventional piped systems.
- Dense plantings can help with removal of pollutants including sediments, nutrients, hydrocarbons and heavy metals, particularly during first flush events.
- Swales vegetated with native plants increase biodiversity and habitat.
- Reduced need for stormwater pipes and drainage infrastructure in public open space (POS) which enhances useability and reduces maintenance and asset replacement costs for local government.

Planning, design and approval for roadside swales at OneOneFive

Site suitability for roadside swales (structure plan and local water management strategy (LWMS) stage – concept landscape and engineering design)

The project team proposed that vegetated swales should be integrated with kerb-side drainage throughout the site where possible. Configuration needed to consider car bays, service alignment, road widths, pedestrian movement and safety, and overall slope and urban design intent. Across the site, the greatest opportunity for roadside swales is where roads are adjacent to POS/green areas.

Engagement with LGA (structure plan and LWMS stage)

The OneOneFive project team presented WSUD swale concepts to the City of Cockburn. Concerns were raised over the level of services required to maintain POS and streetscapes with swales, with these concerns being taken into the next stage of design.

The project team also liaised with Department of Water and Environmental Regulation (DWER) officers to discuss their concerns over the lack of median vegetated swales for treatment and conveyance function. It was identified that the road reserve widths do not facilitate median swales. Once the greater urban design vision for the project was explained, along with the local site context that was guiding the application of WSUD, the DWER officers were confident with the project team's approach.

Refinement of WSUD stormwater controls (subdivision design and UWMP stage – detailed landscape and engineering design)

Swale design and location were further scoped, responding to site circumstances and City of Cockburn requirements, including:

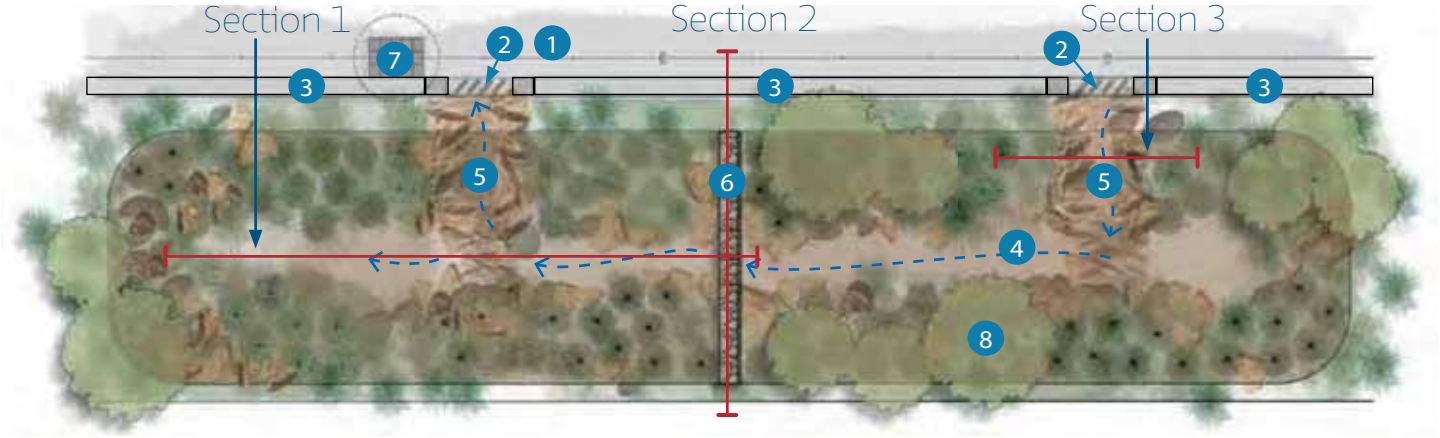
- Recognising that there was often limited room in verges for swales in a number of streets due to driveways, footpaths and car bays.
- The City's preference for fewer and larger swales located closer together for ease of maintenance.
- The City's concerns regarding flush kerbs next to POS areas requiring adequate stabilisation to avoid potential erosion.

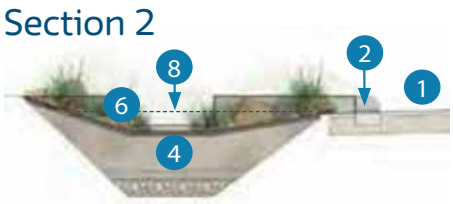
Detailed design (finalisation of subdivision plans and UWMP)

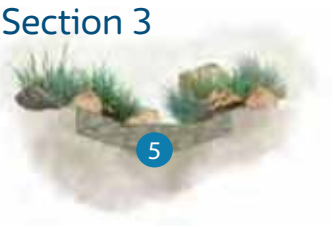
To support the ongoing performance of swales, the City requested that DevelopmentWA ensure swales are functioning, with vegetation in good condition at the time of handover following a two-year consolidation period, as well as a commit to resolving any defects.

*Note: Swale dimensions will vary depending on topographical features, such as verge width or slope.

Roadside swale - Plan







Legend

1. Road pavement
2. Flush kerb with notched opening
3. Barrier kerb
4. Bio-filter media (as required)
5. Rock pitched channel
6. Rock pitched weir
7. Grated inlet pit
8. 1 EY event

Construction – lessons learned

Three swales were installed along Blackwood Avenue and one along Kwenda Approach with a total holding capacity 22.8m^3. Swale construction took place as part of civil construction processes towards the end of 2020 and early 2021. Swale landscaping was completed April/May 2022.

There were no issues reported during civil or landscape construction of the swales however the swale design for Stages 2/3 won't include bioretention media given the large depth to ground water, which will reduce the cost of installation.

Example plants for the landscape feature swales include:

Street trees

- Eucalyptus torquata (Coral Gum) on each corner.
- Melaleuca preissiana (Stout Paperbark/Moonah).

Plant mix

- Anigozanthos humils (Catspaw).
- Hemiandra pungens (Snake bush).
- Patersonia occidentalis (Western Patersonia).
- Poa poiformis (Coastal Tussock Grass).
- Conostylis aculeata (Prickly Conostylis).
- Eremophila glabra (Kalbarri Carpet Emu Bush)

Cost of installation

Civil installation

- Total cost = $19,653 or 22.8m^3 at $862 per m^3
- Over excavation of swale (one item @ $2,268).
- Bio-retention media including stone mulch, sandy loam, well graded sand and drainage layer ($15,117).
- Kerbing and verge shape modifications (64m @ $35 p/m = $2,268).

Landscaping costs per swale:

- Trees $152 each.
- Plants $3 each @ 8 plants per sqm.
- No irrigation has been installed as there should be enough hydration when fully functioning.
- No mulch has been installed as the plants will eventually fill the space as they grow and this design approach also prevents any mulch being washed away during rainfall events.

Next steps

Future versions of this fact sheet will include additional information on performance of the landscape feature swales implemented in Stage 1, as well as design approaches for development Stages 2/3.

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APPENDIX 5 - Underground Stormwater Retention Systems Fact Sheet

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Underground stormwater retention systems at OneOneFive Hamilton Hill

OneOneFive by DevelopmentWA is a residential infill development located on the former Hamilton Senior High School Site in the City of Cockburn. The project is a 'waterwise exemplar' through the application of Water Sensitive Urban Design (WSUD) principles and waterwise practices, including localised stormwater management to support landscape plantings and contribute to urban cooling.

This fact sheet documents the underground stormwater retention systems installed in Stage 1 of the project, as approved under the Subdivision Plan and accompanying Urban Water Management Plan (UWMP).

WATER CORPORATION

What are underground stormwater retention systems?

Underground stormwater retention systems help store and infiltrate stormwater runoff, as well as treating water by removing gross pollutants. They can be used to supplement or substitute above ground retention basins and can accommodate a range of storm events depending on sizing.



Benefits

Even with the use of 'at-source' stormwater control methods like permeable paving, tree pits and roadside swales, additional measures are required to deal with stormwater from heavy rainfall events. It is typically a requirement of development approval that stormwater be managed within the development site or maintained to pre-development runoff rates, frequencies and volumes. A common approach to achieving this is to use above ground retention basins located in public open space (POS). Where space is limited, or where creating basins might impact existing trees, underground retention chambers are a good option. Underground retention can be installed under roads, parking bays and landscaped verges making them very space efficient.

Other benefits include:

- Useful in areas where above ground retention basins are not practical or desirable.
- Installation under roads avoids conflict with desire to retain mature trees, meaning that natural areas of a site can remain undisturbed.
- Temporary storage of runoff, with release into the environment through infiltration into the soil.
- When located around a site, they distribute stormwater and make it available to deep rooted vegetation.
- Optimisation of POS for recreation and conservation.

Planning, design and approval for roadside swales at OneOneFive

Site suitability for underground stormwater retention (structure plan and local water management strategy (LWMS) stage – concept landscape and engineering design)

The free draining soils and large depth to groundwater at OneOneFive make the site well suited to localised stormwater infiltration. Initially a combination of cost effective above ground basins and site responsive underground retention was considered.

Engagement with LGA (structure plan and LWMS stage)

There are a number of underground retention systems available on the market. City of Cockburn engineering officers indicated their preference to use StormTrap during preliminary stormwater engineering design discussions as they have experience with the application of this product.

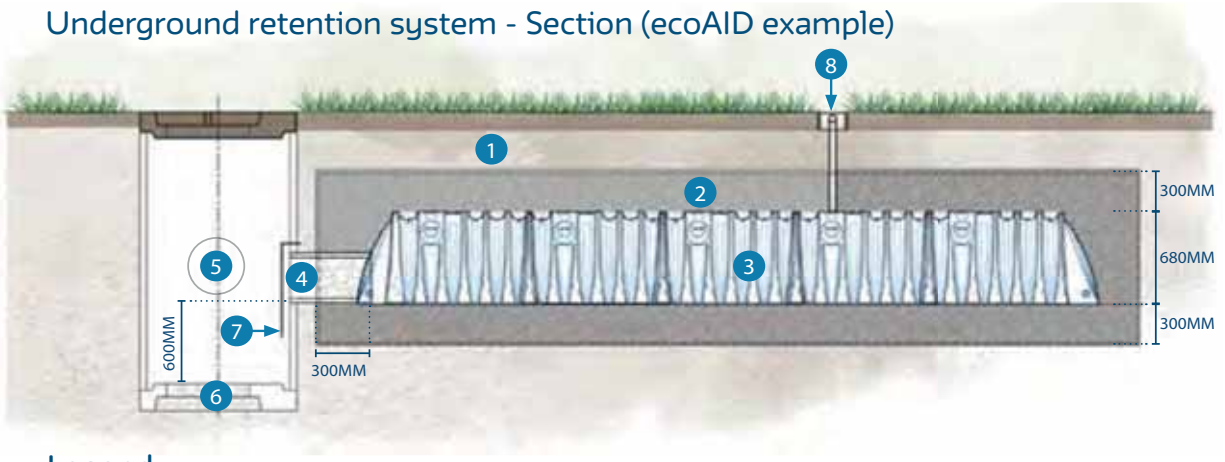
After further design work during structure planning and development of the LWMS, the project team preferenced underground stormwater retention over above ground basins due to the sloping nature of the site and to avoid impacting the root zones of existing trees.

It was decided that above ground basins would not be used in the southern bushland area of the site (despite available space) as it would create artificial wetting patterns and increase the likelihood of invasive weeds.

Refinement of WSUD stormwater controls (subdivision design and UWMP stage – detailed landscape and engineering design)

Three underground retention products were investigated; ecoAID, TunnelWell and StormTrap. The project team suggested ecoAID be used throughout the site, including under roads, as it has a lowest cost, the lowest embodied carbon value and requires the use of drainage aggregate available in plentiful supply on site in the form of screened crushed recycled concrete and bricks from the demolition of the old Hamilton Senior High School buildings. The project team also had successful prior experience with ecoAID in similar applications on other projects.

Underground retention system - Section (ecoAID example)



Legend

1. Compacted backfill
2. 19-50mm washed crushed demolition aggregate
3. ecoAID EC-1000 drainage cells
4. 300mm ø drainage pipe
5. Bubble up pit to 300mm ø stormwater overflow drainage pipe
6. 19-50mm crushed demolition aggregate
7. Sand baffle
8. Air vent to valve box

Detailed design (finalisation of subdivision plans and UWMP)

City of Cockburn engineering officers would only accept the use of the StormTrap product under roads, with access chambers located within verges to allow maintenance without obstructing vehicle movements. The southern end of Purvis Street was an exception, with the Tunnelwell product considered because of low traffic movement. The ecoAID product was to be installed under the turf in the southern bushland area. This was seen as a reasonable compromise by the project team, especially as the majority of required retention volume will be achieved through the use of the ecoAID product.

Construction – lessons learned

The proposed use of Tunnelwell was reviewed during civil construction meetings and as a result it was decided to proceed with installation of two products: StormTrap and ccoAID.

There was a requirement to use recycled aggregate from on-site demolition processes for base and fill as a lower cost and lower emissions option that aligned with the OneOneFive sustainability values. The use of recycled aggregate required more detailed pre-construction planning for the installation, with civil contractors required to liaise with Geofabrics (ecoAID) and Structerre engineers. Screening of aggregate stockpile was required by Densford to remove <10mm and >60mm material, and approximately 600m3 was produced.

EcoAID cell installation and backfill took approximately four weeks to complete.

The installation of StormTrap in Purvis Street required a review of the construction methodology to protect existing street trees and create an access track around an identified tree. Completion of this section was postponed until after resident engagement on detours and preparation work for the installation was complete.

Regular drainage inspections by DevelopmentWA, Tabec and City of Cockburn occurred during construction.

Cost of installation

Underground stormwater retention system costs include:

- StormTrap: $725/m3.
- ecoAID: $247/m3.

The inclusion of on-lot retention of stormwater via appropriately sized soakwells resulted in a 175m3 reduction in downstream storage requirements in the southern-most catchment. Estimated cost savings of this are $43,225 for a catchment sized 17,600m2.

Next steps

Future versions of this fact sheet will include additional information on performance of the underground stormwater retention systems and on-lot retention via soakwells implemented in Stage 1, as well as design approaches for development Stages 2/3.

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APPENDIX 6 - Community Groundwater Bore Case Study

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OneOneFive Hamilton Hill community groundwater bore case study

OneOneFive Hamilton Hill by DevelopmentWA is a residential infill development located on the former Hamilton Senior High School site in the City of Cockburn. The project is a 'waterwise exemplar' through the application of Water Sensitive Urban Design (WSUD) principles and waterwise practices.

A community groundwater bore scheme has been implemented for the development as part of a suite of waterwise initiatives that uses locally available groundwater in a sustainable way for the irrigation of public and private gardens.

This Case Study documents the implementation of a community groundwater bore scheme for the development as guided by the Water Corporation Community Bore Guide (JBA, 2018).

WATER CORPORATION

What is a community groundwater bore?

A community bore supplies groundwater via a reticulated network to a residential development for irrigation of both public realm green space and private gardens.

Benefits

Community groundwater bores can provide a sustainable water supply for both public and private irrigation if implemented in a location with available groundwater and as part of a suite of integrated urban water management options and water efficiency measures that reduce overall water use.

Benefits of community groundwater bores include:

- Potential to provide a well-managed, fit-for-purpose alternative non-drinking water supply.
- Maintain or increase urban greening and improve local amenity.
- Maximised water efficiency if implemented with waterwise approaches such as water metering, efficient irrigation systems and waterwise landscape design.
- Reduced energy intensity and carbon emissions compared with mains water supply.
- Replace the need for individual household bores.

Water Corporation Community Bore Guide

The Water Corporation Community Bore Guide was developed to provide information for land developers, local governments or other service providers on the planning, technical, operational and governance aspects of community bores. It ensures that community bores are designed, implemented and managed to suit site specific conditions and prevent overuse of Perth's precious groundwater. It contains two sections:

A Community Bore Checklist

The Checklist provides an introduction to community bores and a suggested four stage process to assist in site specific implementation. Stages include:

- 1. Planning
- 2. Designing
- 3. Installing & Commissioning
- 4. Operating & Maintaining

Community Bore Report

The report contains additional detail on the suggested four stage process, as well as a 'Concept to Operation' flowchart, a developer to service provider handover procedure, insights into stakeholder experiences from previous community bore implementation and examples that support the process of implementation.

OneOneFive Hamilton Hill Case Study

The project team followed the processes set out in the Water Corporation Community Bore Guide and the Waterwise Development Pathway to ascertain the suitability of a community groundwater bore for the irrigation of public open space (POS) and private gardens at OneOneFive Hamilton Hill.

This Case Study details the application of the planning, design, installation and commissioning stages of the Community Bore Guide. Operation and maintenance stages will be provided as the development progresses.

Table 1: Aligning Waterwise Development Pathway and Community Bore Guide processes

Waterwise Development Pathway	Stage	Community Bore Guide
Establish waterwise aspirations.	Not included as a stage in the Guide but the community groundwater bore option may emerge as part of establishing waterwise aspirations.	
Concept planning, master plan, local structure plan & technical reports/local water management strategy (LWMS)		
Project visioning and identification of waterwise goals.	Not included as a stage in the Guide but the community groundwater bore option may be a part of project visioning.	
LGA strategic direction and accreditation.	1. Planning	Strategic alignment.
Establish stakeholder working group.	1. Planning	Community bore stakeholder working group.
Liaise with Department of Water and Environmental Regulation (DWER) regarding alternative water supply options.	1. Planning	Groundwater availability; approvals required.
Develop a waterwise strategy.	1. Planning	Community bore concept and proposed site design; hydro-geological conditions; water balance.
	2. Designing	Site requirements and master planning.
Engage stakeholders on innovative waterwise initiatives.	1. Planning	Commitment from a community bore service provider (commence); operating & ownership principles (commence); cost recovery mechanisms (commence).
Design responses to suit site specific requirements.	1. Planning	Hydro-geological conditions; water balance.
	2. Designing	Integrated water management; technical design.
Subdivision plan/urban water management plan (UWMP)		
Stakeholder input into waterwise details.	1. Planning	Commitment from a community bore service provider (finalise); operating and ownership principles (finalise); cost recovery mechanisms (finalise); benefit/risk assessment.
	2. Designing	Integrated water management; technical design.
Waterwise program alignment with Design Guidelines.	2. Designing	Site design guidelines.
Sustainability program certification.	1. Planning	Strategic alignment.
Waterwise Development certification.	1. Planning	Strategic alignment.
Civil and landscaping works/subdivision conditions to be met as UWMP is implemented		
Stakeholder engagement in construction phase.	3. Installing & Commissioning	Installation and commissioning.
Marketing & showcasing.	4. Operating & Maintaining	Operation and maintenance.
Resident and builder engagement.		
Ongoing engagement with residents in collaboration with the relevant LGA.		
Evaluation, knowledge sharing and improvement.		

1. Planning

Groundwater availability

Confirm that there is groundwater available in the area for abstraction.

Groundwater was initially assessed using the Perth Groundwater Map (www.water.wa.gov.au/maps-and-data/maps/perth-groundwater-atlas) and examining the existing school licence on the Water Register Site (8 Purvis St Hamilton Hill - maps.water.wa.gov.au/#/webmap/register). Preliminary hydrogeological investigations and discussions with DWER indicated groundwater was available at the site, therefore the project consultant team were able to proceed with planning considerations.

Stakeholder consultation

Establish a working group to include all necessary stakeholders in the implementation process early on.

DevelopmentWA defined their overall intent for the site early on including sustainability goals, waterwise aspirations and project expectations. Early project visioning and identification of waterwise goals was undertaken by the project team, with the community groundwater bore scheme identified as part of the proposed integrated approach to sustainable water management.

The OneOneFive Waterwise Exemplar (WE) program provided an avenue for stakeholder consultation, with the formation of the Reference Group comprising of representatives from Water Corporation, DevelopmentWA, DWER, City of Cockburn (the City) and Josh Byrne & Associates (JBA). Stakeholders provided direction on all water initiatives, including discussion on site suitability and community groundwater bore messaging.

Early and regular engagement took place with the City to introduce and develop the concept. This occurred via the City's involvement in the WE Reference Group, as well as specific community groundwater bore meetings including concept presentations to staff from Planning, and Environment and Parks departments.

Community groundwater bore planning stakeholders

OneOneFive Hamilton Hill community groundwater bore planning Stakeholders:

- DevelopmentWA
- City of Cockburn
- Water Corporation
- Department of Water and Environmental Regulation
- Josh Byrne & Associates
- Tabec
- Total Eden

Community groundwater bore concept and proposed site design

Clearly define the purpose for implementing a community groundwater bore (e.g. to increase urban greening; improve water efficiency) and consider the suitability of the proposed development size, composition and initial estimated water requirements.

The strong sustainability principles underpinning OneOneFive led to the development of a Waterwise Strategy which includes a water vision and three water management scenarios, ranging in levels of innovation. Preliminary development analysis and master planning of proposed lots, housing typologies, POS and landscape design informed the strategy and suite of initiatives, which included a community groundwater bore scheme. Responding to the local context, a drying climate, warmer conditions (with potentially increased water demand) and requirements for healthy and resilient greenspace were also key considerations at this stage.

Commitment from a community groundwater bore service provider/manager

Identify who will be the ultimate owner and operator of the scheme, e.g. local government, and seek support and approval before furthering planning and design.

The project consultant team held an initial workshop with the City to discuss the community groundwater bore concept. To assist with their decision-making process, the City requested that a business case be developed to examine options for the site.

Version 1.0 of the Business Case for Proposed Community Groundwater Bore Scheme (Business Case) was prepared in March 2020 and included four options for the site:

1. Community groundwater bore for the whole site.
2. Community groundwater bore in specified area of the redevelopment only.
3. Implement a number of shared bores throughout the site.
4. 'Business as usual' (BAU): groundwater to be used for irrigation of POS only.

After considering these options, the City requested that a more detailed business case (version 2.0 - 18/9/20) be developed. This was supported by DevelopmentWA and the City, and it was used to better understand the proposed irrigation requirements, benefits, risks, costs and cost recovery mechanisms associated with Option 1 - implementing a community groundwater bore that meets public and private irrigation requirements for the whole development compared to Option 4 - business as usual.

Version 2.0 of the Business Case includes a detailed analysis of resources required as well as four cost recovery options to consider: Volumetric $/kL water consumption; Specified Area Rate (SAR); bore to supply water for public irrigation only; and community groundwater bore supplied at no charge (City to cover all ongoing costs). A strategic overview of the system, schematic design, pumping infrastructure and indicative costs for planning, design, installation and operation were also included. Irrigation specialists, Total Eden were engaged to design the scheme and provide detail on the above items. A final decision regarding the City's commitment to the proposed scheme is still pending at the time of compiling this Case Study.

Hydro-geological considerations

Understand the analysis of groundwater, water quality and hydro-geological conditions of the site, as per the approved LWMS and/or UWMP.

Detailed site investigations were conducted as a requirement of the Local Water Management Strategy (JBA, 2020). The results indicate a large depth to groundwater (approximately 40-55m below ground level), sandy soils suitable for infiltration and no groundwater dependent ecosystems or defined waterways located near the site. These conditions support the implementation of a community groundwater bore; however iron levels indicate iron filtration is required to prevent staining and adverse impacts on bore and pump equipment. This consideration has been included in the schematic design and business case in terms of ongoing management requirements.

Water balance

A detailed analysis of current and projected water demand for public, private and environmental needs is required to ensure the bore is a sustainable and viable option.

Initial irrigation estimates for public spaces and private lots were calculated as part of the Waterwise Strategy scenario modelling. These original irrigation estimates were used to lodge a water licence application with DWER.

Irrigation estimates were later updated to provide a more accurate understanding of proposed water use according to dwelling type and estimated outdoor garden space, using the approved sub-division plan (Hames Sharley, drawing SD100, revision Z) as part of developing the Business Case version 2.0. The irrigation estimates are included in Table 2, and assume a 7,500kL/ha/yr irrigation rate for gardens and turf areas. Detailed irrigation design included seasonally adjusted waterwise application, minimised groundwater use via hydrozoning and reduced application rates.

Table 2: Irrigation demand estimates for public and private realm at OneOneFive (rounded)

Realm	Development areas (m2)	Development irrigation demand (kL/year)
Public Access Way (PAW)	376	254
Public Open Space (POS)	21,723	7,478
Road Reserve	3,4767	6,893
Total public	**56,866**	**14,624**
Single dwelling sites	52,079	7,670
Group dwelling sites	10,155	1,126
Total private	**62,234**	**8,796**
Totals	**119,100**	**23,420**

The irrigation estimates (Table 2) were further reduced based on proposed water efficiency measures, such as irrigation efficiency and landscaping requirements in the Design Guidelines, and these figures were used to inform a water balance for the whole development. Estimated water use highlighted the importance of alternative water supply options in meeting residential and POS water demand. Further reductions are planned, with the City aspiring to a 5,000kL/ha/yr irrigation rate for established garden beds and reductions as per the Waterwise Perth Action Plan (DWER, 2019).

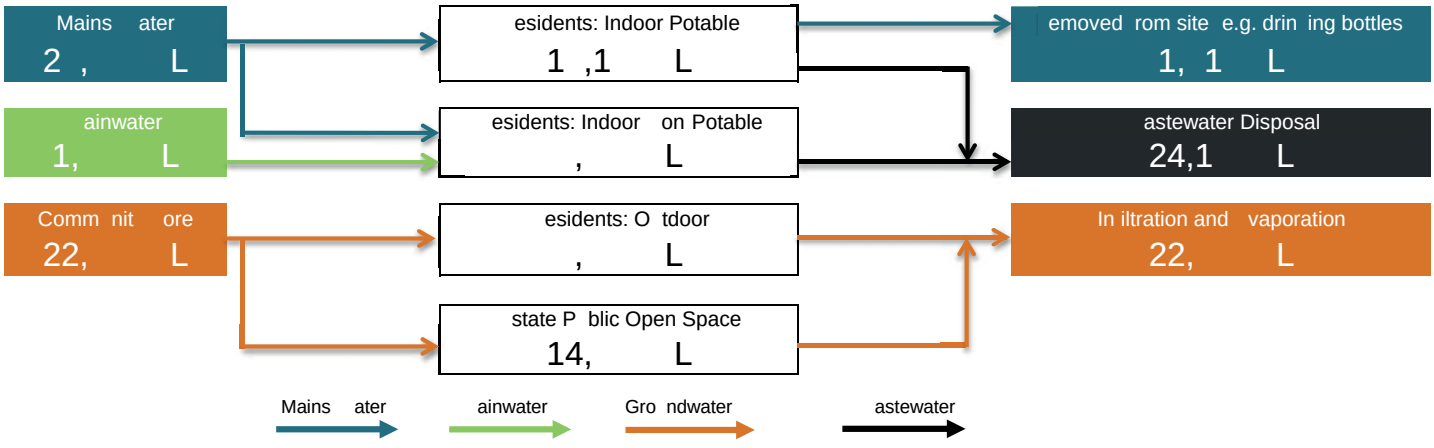


Figure 1: Water balance for whole development (7500kL/ha/yr irrigation rate used for estimates)

Approvals required

DWER licences are required to construct a bore, if an existing bore cannot be used, and to abstract groundwater.

A water licence application was lodged by project consultants on behalf of DevelopmentWA via Water Online, the customer portal for DWER. In addition, the project team met with DWER staff to better understand groundwater allocation in the area, existing bore ownership and requirements for demolition, construction, POS establishment and ongoing irrigation. A Licence to Take Water for irrigation of private and public gardens ((GWL202809(1)) and for earthworks and construction purposes (GWL202810(1)); and A Licence to Construct or Alter Well (CAW202811(1)), were granted by the Minister in May 2019.

Operating and ownership principles and framework

Roles and responsibilities of stakeholders needs to be clearly defined for all stages of implementation.

DevelopmentWA agreed early on to take a lead role in the planning, design and installation of the proposed community groundwater bore scheme. In the spirit of collaboration, and considering potential mutually beneficial outcomes, DevelopmentWA and the City split the cost to develop the Business Case, which ended up being used as the main planning framework.

When the scheme was implemented, it was handed over the City, who became the owners and operators. These roles and responsibilities were outlined in the Business Case, which included itemised operational activities, and associated costs, for the City to consider and plan for as part of its decision-making process.

Capital and operating costs and cost recovery mechanisms

An initial feasibility study provide a clear understanding of costs to the developer, local government and residents.

All capital costs to implement a community groundwater bore at OneOneFive were covered by DevelopmentWA.

Operational, maintenance and ongoing replacement costs were determined by the Business Case, based on costs in Table 4.

Table 3: Initial estimated costs to install and commission the community groundwater bore

Realm	Major items	Estimated capital cost
Public Realm only	Bore, pumping plant, mainline, iron filter, sub-metering and irrigation application systems.	$495,468
Private Realm additional cost	Upsized pumping plant, addition of buffer tank, additional mainline, private bore meters, hosting and data management for dashboards.	$378,760
Public and Private Realms combined	Complete system.	$874,228

Table 4: Estimated annual costs to operate and maintain

Estimated annual costs	
Public Realm	$23,753
Private Lots	$8,259
Combined	$32,012

Calculations were based on NPV calculations of operational cost estimates provided by the City and Total Eden for the following activities:

- Inspection (fortnightly).
- Supervision and central control system maintenance (weekly).
- DWER report (annual).
- Iron filtration unit replacement (every 30 years).
- Iron filter vessel replacement (every 10 years).
- Irrigation pump replacement (every 10 years).
- Bore pump replacement (every 10 years).

- Pipe & connection repairs (annual).
- Iron filter servicing (annual).
- Irrigation pumpset & bore maintenance (annual).
- Data account (annual).
- Combined public and private electricity consumption (annual).

Cost recovery options were presented as shown in Table 5. Each option had its own benefits and risks that the City considered alongside the broader urban greening and liveability benefits, which were achieved by using a locally available, less energy intensive source of water.

Table 5: Cost recovery options (preliminary costs - considered in the Business Case)

Cost recovery options	Operations costs: combined public and private	Proposed cost recovery charge (private lot use)	Annual cost per lot (private lot use)	The City's annual cost	Notes
Cost option 1: Volumetric $/kL water consumption All lots	$32,013	Volumetric charge: $0.96/kL	$32.08	$23,753	Actual volumetric charges to residents are estimated to range approx.: $15-$70
Cost option 2: Specified Area Rate (SAR) All lots	$32,013	SAR equating to $31.18 per lot.	$31.18	$23,753	The single SAR rate means some households pay significantly less than under a volumetric charge, while many pay more.
Cost option 3: Bore for irrigation of POS, residents to irrigate with mains water No lots	$23,753 (public only)	No cost recovery - residents pay for their own mains water use directly to Water Corporation.	$60.77 (based on mains water tier 1 tariff)	$23,753	This option means that residents can only water two days per week, rather than three with the bore connection. Also need to consider energy and GHG intensity of mains water (refer Table 6).
Cost option 4: Community groundwater bore supplied at no charge to residents, city to cover all ongoing costs (goodwill option) All lots	$32,013	No cost recovery - City covers costs of public and private irrigation supplies.	$0	$32,013	Simplifies management although managing overuse becomes difficult.

Strategic alignment

Consider local government strategic direction and sustainability initiatives; and developer sustainability certification programs to ensure a community groundwater bore aligns with goals and principles of all stakeholders.

The City of Cockburn are a Gold Waterwise Council, have completed a WSC Indexing benchmarking assessment and have a strong sustainability and environmental responsibility focus in their Strategic Community Plan 2020-2030. Sustainability is identified as one of their core values and the City is able to demonstrate its commitment and showcase leadership in sustainable water use as a Gold Waterwise Council and via the Waterwise Exemplar program.

The community groundwater bore scheme met the City's 'Environmental Responsibility', 'Community, Lifestyle and Security' and 'City Growth and Moving Around' criteria. The fit-for-purpose water supply provides water for the establishment of green and cool streetscapes and connected high quality POS; includes measures to ensure appropriate management and protection against overuse; and when implemented as part of a suite of water supply options and water efficiency measures, ensures maximum water savings for the development.

Benefit/risk assessment

A detailed benefit/risk assessment ensure planning considerations are captured and future scenarios are planned for, minimising any unintended risks.

The benefits of implementing the community groundwater bore scheme at OneOneFive include:

- No capital cost to the City. All design, installation and commissioning of the system is at DevelopmentWA's expense.
- Creation of high amenity cool urban green space for residents and for use by the Hamilton Hill community and visitors.
- A well-managed, fit-for-purpose water supply ensures responsible use of groundwater.
- Support by the Design Guidelines to assist residents in appropriate waterwise garden design.
- Improved water efficiency via automated irrigation systems (i.e. no watering during daytime, rain periods or during winter sprinkler ban), metering, detection and prompt resolution of leaks and over consumption.
- Third pipe infrastructure can be used for a climate independent recycled water scheme if groundwater supply/allocations should change in the future.
- Contributing to achieving a Waterwise Development and Exemplar status, as part of a suite of integrated water sensitive urban design and water efficiency measures.
- Lower cost of irrigation water supply to the end user when compared to mains water.
- Fit-for-purpose supply that uses less energy than mains water, as per comparisons detailed in Table 6.

Table 6: Community groundwater bore energy intensity, energy savings and emissions estimates

	Energy and emissions	Estimate
Energy intensity of irrigation water supplied.	Community groundwater bore.	0.62 kWh/kL
	Mains water.	1.57 kWh/kL
Carbon intensity of irrigation water supplied.	Community groundwater bore.	0.46 kg CO2e/kL
	Mains water.	1.16 kg CO2e/kL
Energy saved by providing bore water to private irrigation.		13,810 kWh/year
Carbon saved by providing bore water to private irrigation.		6,663 kg CO2e/year
Emissions reduction in private lot irrigation (Private irrigation only).		65%
Emissions reduction - overall irrigation carbon footprint (Public & Private combined).		38%

A detailed assessment of potential risks and proposed treatments, as per the Business Case, are in Table 7. Early identification is important for successful implementation.

Table 7: OneOneFive community groundwater bore risk assessment

Identified risk	City of Cockburn risk assessment	Proposed treatment
Further depleting Perth's precious groundwater source with overuse (unintended overuse by residents or unintended leaks).	Moderate	Ongoing monitoring is required and mechanisms in place to prevent overuse.
Unclear roles and responsibilities for ongoing operation and maintenance.	Moderate	Clearly define roles produced and accepted by asset owner.
Disengaged or uninformed future residents.	Substantial	Information to be provided at the point of sale and during design and construction of house and garden.
An ineffective or inaccurate billing system.	Low	Respond to instances of excessive consumption. Regular communication through City of Cockburn channels and SMS alerts to property owners.
Community groundwater bore scheme may become unfeasible in the future.	Moderate	The design includes a contingency to connect to mains water for maintenance, or even as a permanent change if ever required.
Potential health risks such as unintended uses and potential cross connection.	Moderate	Lots come with the irrigation supply connected directly to an irrigation controller, supplied and commissioned at DevelopmentWA's expense. Information packs issued at property purchase. Ongoing management is required via signage, appropriate use of purple pipe to denote non-drinking water and provision of information to users/residents.
System failure.	Substantial	Regular service and maintenance as per specifications. Development of a suitable platform for communicating failure responses could be considered (e.g. SMS alerts to residents).

2. Designing

Development requirements

The final development specifications such as number of lots, housing typologies, POS size and type and overall landscape design intent are required to accurately estimate water demand and size of infrastructure required.

A detailed development analysis was conducted to estimate the irrigation demand based on the lot yields in the approved subdivision plan prior to commencement of stage 1 of the development.

Lot yields for Stages 2 and 3 have been updated and changes will be required to adjust the calculations for irrigation demands for the whole of development.

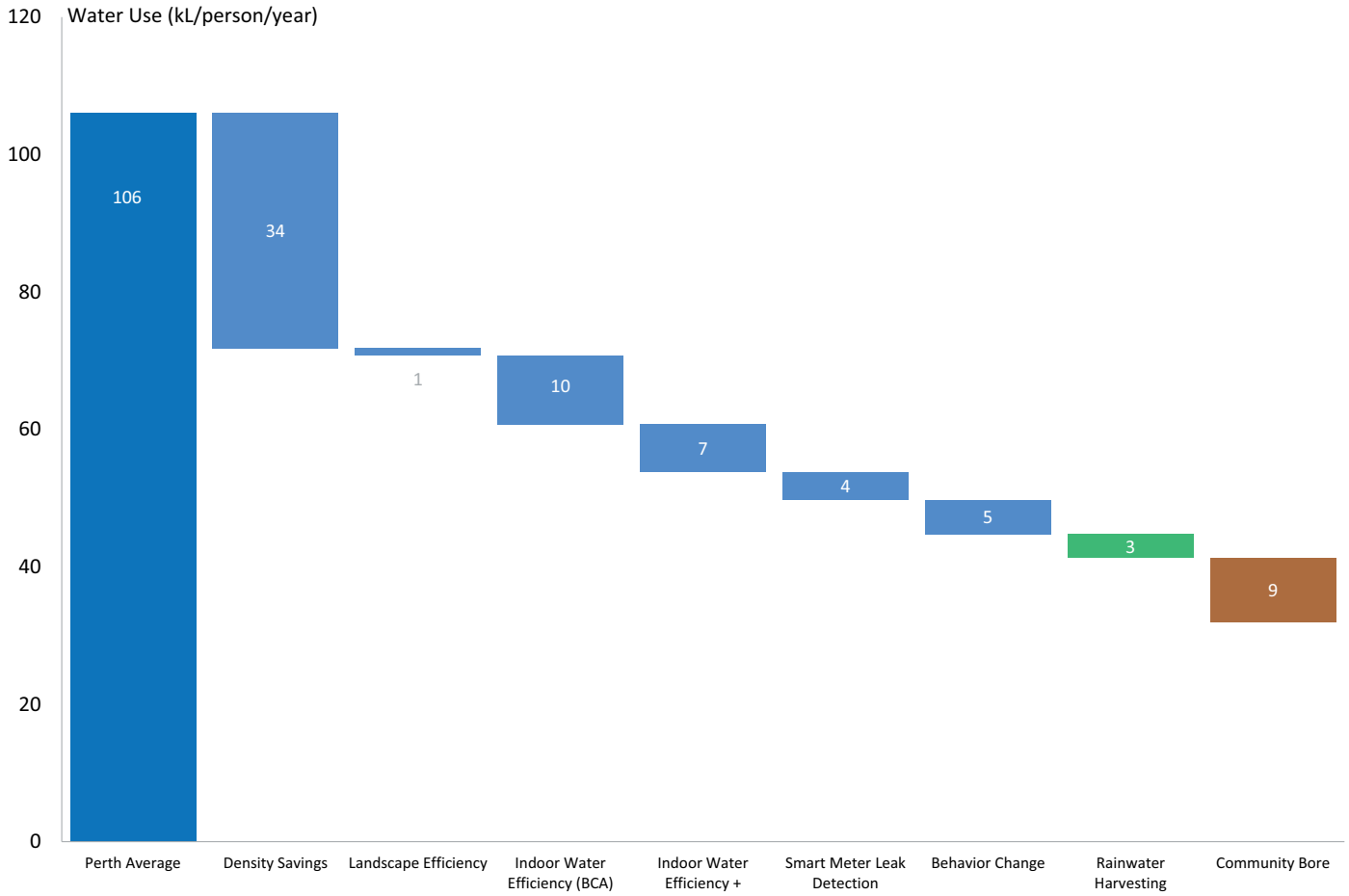
Integrated water management

For effective water management and improved water efficiency, the implementation of a community groundwater bore needs to be part of an integrated approach to water management and water sensitive urban design.

The suite of initiatives to reduce water use at OneOneFive Hamilton Hill include:

- WSUD features:
  - Permeable paving in flat sections of road and on-street car bays.
  - Water harvesting tree pits in the public realm.
  - Roadside bio-filtration swales.
  - On-lot management and containment of the 1%AEP (100 year storm event) using appropriately sized soakwells.
  - Underground stormwater retention at the development-scale.
- Water efficiency measures to reduce water use, such as higher density residential zoning and water efficient fixtures and fittings, as per the Design Guidelines.
- Alternative water sources to support vegetation health and enhance urban cooling, such as: greywater ready plumbing in lots over 270m^2 and rainwater tanks in lots over 220m^2 with dual plumbing connected to toilet and washing machine.
- Landscape design to reduce water use and enhance urban cooling/local amenity.
- Smart metering of POS irrigation for leak identification and efficient management.
- Water efficiency measures for private irrigation mandated in the Design Guidelines, such as a weather based programable automatic irrigation system set to rostered watering days, efficient in-line drip irrigation for garden beds and spray irrigation for turf areas only.
- Community groundwater bore to provide a source of water for irrigation of private gardens and POS, as per this Case Study and subject to City of Cockburn approval.

The combined impact of the aspirational water saving initiatives are depicted in the decumulative graph below, demonstrating a significant mains water reduction when compared to the 106kL/person/year Perth average (Water Corporation, 2010).



Decumulative graph showing water savings on private lots

Design guidelines

Effective use of a community groundwater bore is achieved via use of design guidelines informing residents of recommended landscape and irrigation design.

OneOneFive Design Guidelines include compliance provisions for responsible and sustainable use of groundwater to be supplied to the private lots. These provisions include:

- A programable automatic irrigation system including weather-based control must be used and be connected to the community groundwater bore supply provided by the developer.
- Indoor and outdoor taps must not be connected to the community groundwater bore supply.
- Water efficient in-line drip irrigation installed for all garden beds.
- Spray irrigation may be used for turf areas only.
- Irrigation controllers must be set to relevant rostered watering days in line with Water Corporation and Department of Water and Environmental Regulation requirement.
- Private water bores are not permitted where access to a community groundwater bore supply has been provided.

Technical design

Identify the specific technical requirements such as size and type of tank, pumps, filtration and pipes.

Irrigation specialist subconsultants NewGround Water Services were engaged to design the scheme, as part of developing the Business Case. The technical design includes schematics/plans and a strategic overview report, including budget costings. Providing the technical design detail at this stage of the implementation process assisted stakeholders with the decision-making process and provided an easy pathway for implementation.

NewGround Water Services conducted a demand and capacity analysis to determine the pump size and irrigation infrastructure required to optimise the supply of water to private lots, POS and PAW. This included factoring in compliance with permanent water efficiency measures (sprinkler restrictions), groundwater licence conditions and other implementation measures to reduce the risk of excess watering and groundwater overuse.

The scheme is designed so that private residential lots receive irrigation water at a maximum supply rate of 20 Litres Per Minute (LPM) and POS, PAW and road reserves 780 LPM. Outside of the winter switch off period residential lots can irrigate a maximum of three times per week, with the irrigation cycle based on street numbers as per DWER's sprinkler roster. The maximum recommended application of 30mm/week or 10mm can be applied in summer and the smart weather-based irrigation controllers that respond to rainfall events and reduce watering applications in Spring and Autumn. To reduce the risk of groundwater overuse the watering window has been be restricted to a maximum of four hours between 6pm and 9am. Operationally, residential lots be set up in two watering groups.

POS, PAW and road reserves have been provided with irrigation water five times per week, with the maximum application rate of 40mm/week or 8mm per application during summer and other rates seasonally adjusted.

At the design stage, the community groundwater bore system for OneOneFive included:

Bore
A new bore with a pumping capacity of 7 litres per second. The depth to water is 53m and depth to bore 65m. Casing material is DN200 uPVC Bore-casing to a length of 59m and a 9m stainless steel screen is required.

Bore pump
A 9.2 kW Grundfos SP30-9 bore pump to fill a below ground tank.

Iron filter
An iron filter unit. This includes a 36" filter tank, with a filter enclosure (3mx3m footprint) sunk 1m below ground for less visual impact, and four 1800x1200mm concrete pit (soak wells) for backwashing.

Tank
A storage tank for water supplied from the bore. One Graf EcoBlock below groundwater storage tank (18.6m x 9.6m x 1.11m) with a gross stored volume of a minimum of 180kL installed 800mm below the finished ground to give the tank a heavy duty bearing capacity of 40 tonnes.

Pump station
The contractor is responsible for the sealing of the below ground tank, wet well and transfer pipes to maintain water tightness. Concrete wet wells and transfer pipe installed as part of the works. Three submersible pumps and one low flow pressure pump of non-corrosive construction. Pump motors fitted with stainless steel motor cooling shrouds. Pumps suspended on galvanised steel pipe with specifications provided for discharge flanges, discharge assembly and wet well pit covers. The pump station water meter is a DN150 Bermad 900 series hydrometer, linked back to an irrigation controller and any data gathering hardware.

After consideration of the business case, City of Cockburn and DevelopmentWA decided that a community groundwater bore would be installed at OneOneFive Hamilton Hill.

The business case presented four cost recovery options for the City of Cockburn: volumetric charging; specified area rate (SAR); no charge to residents for supply with all costs to be covered by the City; and scheme water supply to be used for residential garden irrigation with groundwater used for POS only (i.e. business as usual/reference case).

An important component of the City's decision making was that the additional operational costs of the community bore could be covered by the increased rates from the development. In addition, OneOneFive Hamilton Hill includes smaller lots and reduced garden sizes due to increased density, and therefore reduced requirements for garden irrigation. Some negotiation was required between DevelopmentWA and the City of Cockburn to reach an agreement on the timing for scheme handover.

The City will eventually take on the community groundwater bore asset but DevelopmentWA are to retain responsibility until four years after the last lot is sold. This ensures enough time for houses and landscaping to be completed, for full rates from the development to be coming to the City to cover ongoing operational costs, and for any potential issues with community groundwater bore connection and irrigation to be resolved.

3. Installing & Commissioning

Installation of civil infrastructure

Qualified professionals to undertake and document required site works to ensure appropriate and effective installation of civil infrastructure.

The final plan for the community groundwater bore was reviewed August 2020 and further updated in September/October 2020. Updated community groundwater bore drawings captured design changes to meter locations and sizes and were re-issued in November 2020.

Installation of underground connection to scheme water and community groundwater bore water for most of Stage 1 lots commenced in November 2020. Community bore reticulation installation was approximately 40% complete by early December 2020, with landscape consultants then required to inspect and confirm meter locations. By mid-January 2021 the community groundwater bore reticulation was 80% installed (and 95% of the sewer reticulation laid), with Purvis St works remaining. By the end of February 2021 all community groundwater bore connections to lots were complete, with the extension to the future bore required later.

Towards the end of completion (April 2021), Water Corporation requested that meter boxes include additional labels and that the inside tap-work be painted lilac to comply with Australian Standards for identification non-potable water supply. Further work was again required during April 2021 to install communication pits at meter locations in four POS and verge areas.

As with all civil infrastructure installation at OneOneFive Hamilton Hill, consideration and protection of existing trees was required and adhered to by contractors.

The existing bore that was used to irrigate the high school grounds was used by civil contractors during construction, with a new water licence and annual allocation obtained in 2019 for this purpose.

Installation of bore, pumps and POS irrigation infrastructure

Qualified professionals are required to ensure appropriate and effective installation of community bore, pumps and tanks, and irrigation infrastructure such as pipes, meters and irrigation controllers.

Licence

Licence applications to take water for irrigation; earthworks and construction; and to construct a well were lodged and approved in 2019. The Licence to Construct or Alter Well (CAW202811(1)) was valid from 28 May 2019 to 27 May 2021 however because of delays in the commencement of construction, it had expired by the time contractors were ready to commence drilling for the new bore at OneOneFive Hamilton Hill. The Department of Water and Environmental Regulation (DWER) were contacted and the oversight explained, with the request for a fast-tracked licence renewal if possible, with a new licence application submitted online. The new licence was approved within three days and drilling of the new bore could proceed on site. The early inclusion of DWER representatives as part of the stakeholder working group meant that they were aware of the project's waterwise aspirations.

New bore construction

The old Hamilton Senior High School bore was to be decommissioned by September 2021. The new bore hole drilling commenced 5th October 2021 and was completed 18th October 2021. It was specified that the bore depth would be 65m and at a minimum diameter of 305mm to allow the installation of the bore casing and gravel pack material. Upon installation, the driller was required to drill to a depth of 75m, 10m over the originally specified depth.

Bore construction details are as follows:

- Production casing: PVC 200mm to 66m.
- Screen: stainless steel screen 200mm 66-75m.
- Gravel pack: from 5metres-75m.
- Annular fill: cement deal to 5m.
- Geophysical log: sands and limestone.

A rotary mud drilling method was used and the well development was airlift, which took 10 hours. Submersible pump testing indicated a volumetric flow of 10 litres per second. Static water level was recorded as 52.29 m with the measurement taken from the top of the casing. The final draw down, the distance between the static water level measured prior to the test and the water level measured at the end of the pumping test, was 1.64m. There was one minute instant recovery time for the 10l/sec test rate.

Infrastructure installation

Bore pumps: Pumps for main irrigation included two Grundfos SP30-7 submersible pump, 7.5kW motor size with 17.2 amps. The pump for minor irrigation is a Grundfos SP14-13 submersible pump, 3.0kW motor size with 8.1 amps.

A 9.2 kW Grundfos SP30-9 bore pump was installed to fill the below ground storage tank.

Iron filter: A 36" Elliots iron filter tank on a concrete pad (3m x 3m x 120mm thick) was sunk 1m below ground for less visual impact. Four 1800mmx1200mm soakwells were included for backwashing, with a PVC discharge pipe between iron filters and soakwells.

Meter: A Bermad 100mm Flanged 900 series Hydrometer, was installed at the end of November 2021. Water was not used significantly until February 2022 after landscape planting had commenced. Landscape contractors are required to provide monthly bore water readings, as per the DWER water licence conditions and these are uploaded to DWER via Water Online, as per the licence conditions.

Tank: A Graf EcoBlock below groundwater storage tank (18.6m x 9.6m x 1.11m) with a gross stored volume of a minimum of 186kL was installed 800mm below the finished ground to give the tank a heavy duty bearing capacity of 40 tonnes.

Installation issues were encountered with irrigation water storage tanks found to be leaking by landscape contractors in mid-January 2022. The irrigation contractors were tasked with investigating and landscape contractors advised that there are options to irrigate direct from the bore if necessary, before the leaks are resolved. Leaks were fixed by the end of January and a detailed investigation indicated that the wet well had been leaking. Evidence of repair was provided.

Decommissioning previous bore: Landscape construction contractors were also responsible for decommissioning the previous Department of Education bore (licence number 155 453 with an annual allocation of 77,775kL). The previous bore was cut 1m below ground level and the bore filled with concrete from 1m below ground to 78m where the base of the screen.

Lot scale

White text: Requirements, limitations and restrictions relating to the connection to and use of the community bore must be clearly articulated to lot developers and residential owners or occupiers.

Groundwater for garden irrigation will be available to lots three days per week in line with the agreed community bore allocation arrangement. The benefits from the additional watering days include the ability to establish gardens and promote tree canopy to assist with urban cooling within the development. In addition, groundwater supply for lot-scale irrigation can be produced at less than half the energy cost of mains water with 65% less greenhouse gas emissions.

The OneOneFive Hamilton Hill Design Guidelines Stage 1 Lots 1-11, 41-67 include a compliance provision that all homes are required to connect a programmable automatic irrigation system, including a weather-based controller, to the community groundwater bore supply. A purple water meter is to be provided to each lot by DevelopmentWA.

Residents are informed via the Design Guidelines that irrigation controllers must be set to relevant rostered watering days in line with Water Corporation and Department of Water and Environmental Regulation requirements. Indoor and outdoor taps must not be connected to the community bore supply and private bores are not permitted.

A Waterwise Incentive Package is available to support the implementation of waterwise practices at OneOneFive Hamilton Hill. This includes incentives for builders and owners. Owners are eligible to receive an incentive payment of $2,500 (ex GST) if they include the following items:

- The installation of waterwise landscaping as per the OneOneFive Design Guidelines by a Water Corporation Waterwise Specialist landscaper to the front and back yard of the home.
- The installation of an irrigation system as per the OneOneFive Design Guidelines by a Water Corporation Waterwise Specialist irrigator, including the provision of a dedicated solenoid valve and submain line to the verge. The verge to be planted, and drip irrigation installed by the estate landscape contractor once houses are built.
- The inclusion of a weather-based irrigation controller (e.g. Hunter Hydrawise).

A statement must be provided by a Waterwise Specialist landscape or irrigation contractor to the Estate Architect to verify compliance of installation with Design Guidelines to claim payment. In addition, the contractor will need to confirm that a handover session has been undertaken with the homeowner to ensure they understand how to manage the landscape and irrigation system and irrigation guidelines.

Next steps

Community bore connections are now available for all lots and a further understanding of the system operation and maintenance will be gained once houses are constructed and private landscapes established, with homeowners able to utilise the community groundwater bore for irrigating gardens. The next update to this case study will detail the experience of operating and maintaining the community bore at OneOneFive Hamilton Hill, as per the final steps of the Community Bore Guide. As decided during the development of the business case, the OneOneFive Hamilton Hill community bore will remain a DevelopmentWA asset for four years after the last lot is sold, as per the City of Cockburn terms of agreement. Future updates documented here on maintenance procedures, metering, monitoring and assessment assist the City of Cockburn with understanding the requirements and responsibilities when eventual asset handover occurs.

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Government of **Western Australia**
Department of **Water and Environmental Regulation**

DevelopmentWA

City of Cockburn

JOSH BYRNE & ASSOCIATES LANDSCAPE SUSTAINABILITY COMMUNICATIONS

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