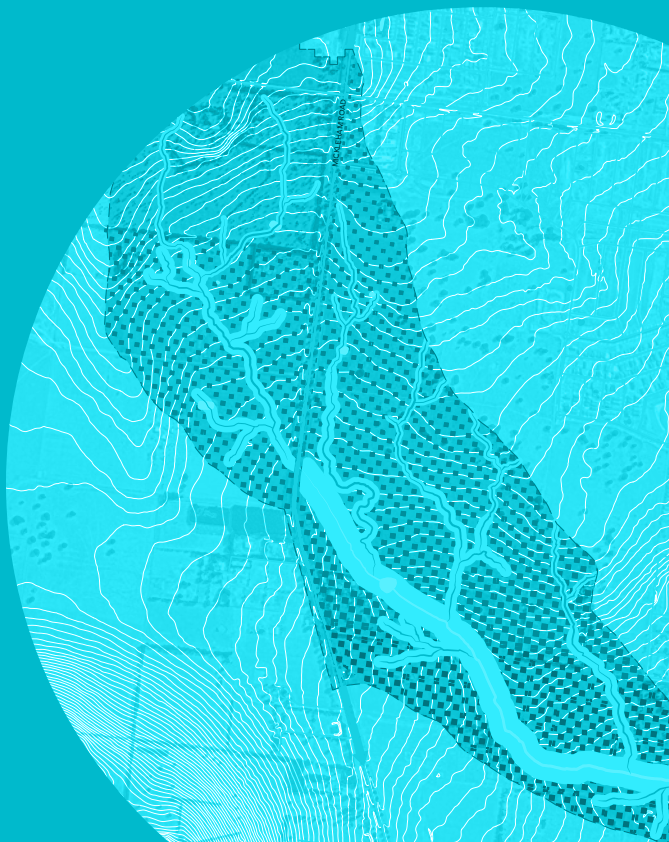
PROTECTION OF HEADWATER STREAMS

Ideas for Aitken Creek



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Protection of headwater streams: Ideas for Aitken Creek

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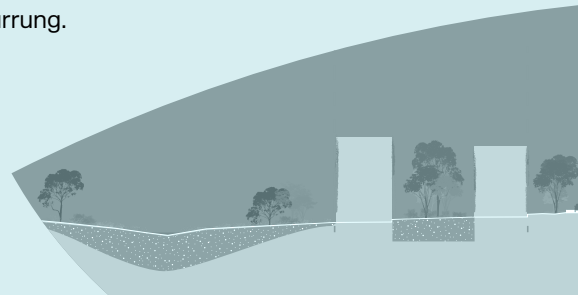
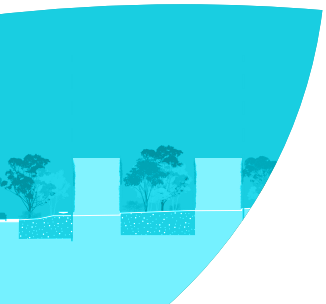


Table of contents



Introduction

The ‘Protection of headwater streams: Ideas for Aitken Creek’ project identifies solutions to address the challenges faced by headwater streams in the context of increased urban development. The project focuses on Aitken Creek in Melbourne as a case study, to develop novel solutions that could be applied to protect headwater streams in locations across the region and Australia. By addressing the identified barriers to implementing these solutions, and leveraging the lessons learned, the project aims to promote enabling conditions for headwater stream protection under pressure from urban development.

The project objectives include identifying real and perceived barriers to achieving better outcomes for headwater streams, providing a case study of novel solutions and lessons learned that can be applied to other headwater locations undergoing urbanisation, developing high-level concept designs (artist impressions) for Aitken Creek to assist a wider audience in understanding potential solutions, and building a compelling case for protecting headwater steams in Melbourne.

Melbourne Water (MW) and the University of Melbourne (UoM) under the auspices of the Melbourne Waterway Research-Practice Partnership joined forces with Water Sensitive Cities Australia (WSCA) to undertake this process. The report is based on ideas generated by these researchers, together with experts from the water and development industries and other stakeholders. It does not represent a commitment nor endorsement of these ideas by these organisations but rather, Aitken Creek served as a real life case study to support in depth discussion and generate potential solutions.

Aitken Creek
Photo: Melbourne Water

Connecting ecological systems and increased urban density

About the process

The project used a case study approach, based on the Aitken Creek Catchment in Melbourne, Victoria. This case study was designed to stimulate new thinking about protection of headwater streams, while acknowledging the practical limits of implementing these in Aitken Creek itself, given the Precinct Structure Plan (PSP) had already been approved.

A 2-part workshop process drew on multiple disciplines and perspectives to help define the problem confronting headwater streams across Greater Melbourne and identify possible solutions using Aitken Creek as a canvas. The workshop process included presentations from experts in various fields related to headwater stream protection and urban development, and was followed by discussions and collaborative sessions to brainstorm and refine ideas to address the specific challenges for Aitken Creek.

The first workshop identified and refined the problem definition by drawing on multiple disciplines and perspectives and then identified the types of solutions needed to protect headwater streams. The second workshop developed practical and implementable ideas that addressed the opportunities identified in workshop one. Both workshops included a diverse cross-section of relevant disciplines, expertise and perspectives.

This report provides an overview of the workshop process and includes a series of ideas and concept designs that can be applied to Aitken Creek and similar locations. Artist impressions and conceptual designs were also developed to illustrate potential interventions for Aitken Creek.

Experts at the second workshop

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Box 1. Knowledge synthesis: Ideas for "..." workshops

Knowledge synthesis is a facilitated design process that combines emerging research with local expertise to develop practical ideas that address urban challenges. Using a workshop format, participants explore problems and agree on the shared parameters and language. Together, the participants arrive at tangible propositions for solving the problem, with benefits clearly defined. The collaborative nature of knowledge synthesis helps to break down barriers between disciplines and develops new insights that can be applied in a practical way.

Experts and perspectives

The 2-part workshop series was attended by representatives from 16 organisations. These experts represented a wide range of disciplines and perspectives, including science (e.g. ecology, hydrology, geomorphology), engineering, planning, architecture, state government, local government, Traditional Owners, consultants and industry, landscape architecture, economics and water utilities. In addition, 11 experts (see Table 1) from academic, industry, government and cultural disciplines provided key insights and perspectives.

Table 1: Expertise and perspectives

Expert	Organisation	Perspective
Dr Moss Imberger	University of Melbourne	Science
Rephael Lankri and Jordan Smith	Wurundjeri Woi-wurrung Cultural Heritage Aboriginal Corporation	First Nations / Traditional Owners
Alex Gunn	Victorian Department of Energy, Environment and Climate Action	Regulation / Policy
Jaime Tainton	Water Studio	Engineer / Consultant
Katy Marriott	Melbourne Water	Water manager / provider
Assoc. Prof. Leon Barmuta	University of Tasmania	Science
Prof. Alex Felson	University of Melbourne	Landscape architecture
Philip Birtles	Sydney Water	Water manager / provider
Dr Holly Kirk	RMIT University	Science / Urban design
Prof. Chris Chesterfield	Monash University	Urban water governance
Jamie Ewert	Alluvium Consulting	Workshop 2 design and facilitation

This multidisciplinary collaboration helped to ensure a comprehensive approach to addressing the challenges and opportunities associated with safeguarding Melbourne's headwater streams into the future.

Organisations participating at workshops

Melbourne Water

The University of Melbourne

Monash University

RMIT University

Victorian Department of Energy, Environment and Climate Action

Hume City Council

Wurundjeri Woi-wurrung Cultural Heritage Aboriginal Corporation

Yarra Valley Water

REALMStudios

Streamology

Water Studio

Jacobs

Alluvium Consulting

University of Tasmania

Sydney Water

Water Sensitive Cities Australia

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Experts at the second workshop

Part one: defining the problem

1.1 Why protect headwater streams?

Headwater streams are the starting points of river networks, and arguably one of the most important components of the stream network. Yet this importance is often not reflected in how we identify, value and protect these streams.

Headwater streams like Aitken Creek, in Melbourne's north, typically comprise a substantial portion (70–80%) of the total stream network by length (Wohl, 2017). They are the primary source of water and help moderate the flow of water and nutrients to downstream networks. They play a significant role in carbon retention and decomposition, nutrient cycling and the movement of sediment and organic matter. They also serve as the first line of defence against contaminants and promote downstream flood control. More holistically, they offer vital benefits for a broad range of ecosytem services (e.g. provisioning, regulating), social and cultural values. Moreover, they provide habitat for common, rare and threatened speacies (Mainstone et al., 2016), contributing to regional biodiversity and the functioning of nearby ecosystems.

Melbourne's Healthy Waterways Strategy (Melbourne Water, 2018) recognises the importance of headwater streams for their collective benefit across the region and aims to protect them amid future urban development. Achieving this requires clarity around the suite of potential innovative solutions from a cross-section of stakeholders, including policymakers, planners, developers, consultants and waterway managers, that can navigate a range of challenges including adequate environmental protection, liveability, affordable housing, and industry capability and capacity.

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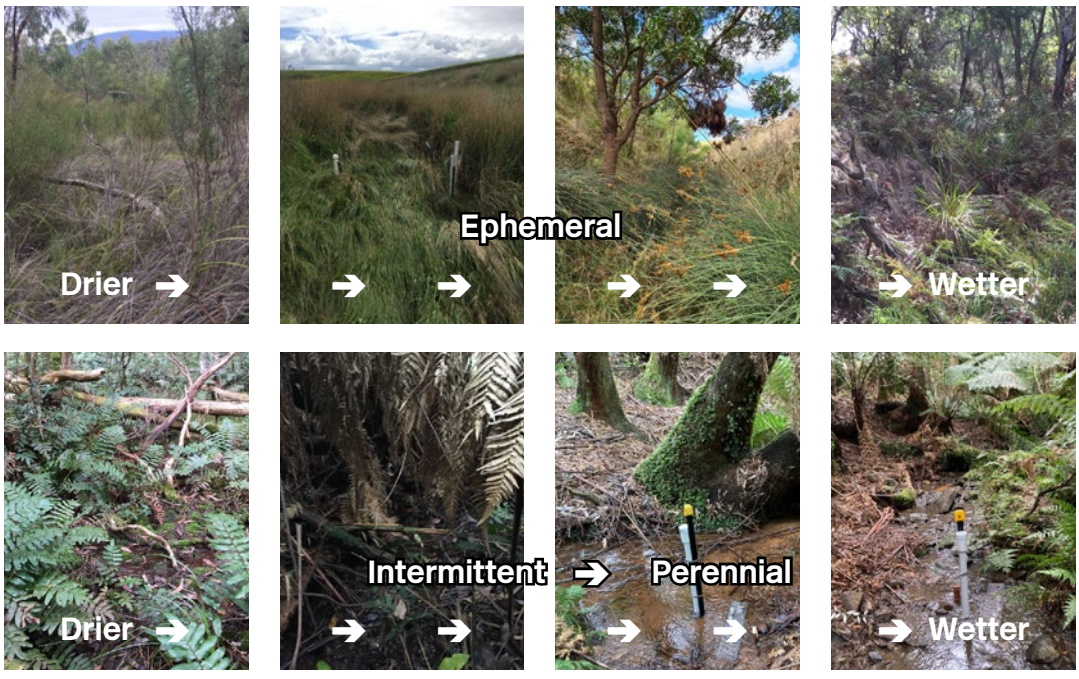
Headwater Streams definitions by Dr Moss Imberger

Source: Waterway Ecosystem Research Group, University of Melbourne



1.2 Headwater streams are under pressure

Headwater streams are under significant pressure due to rapid land-cover and land-use changes, particularly in urbanising areas worldwide (Imberger et al., 2023).

Due to their small size and water volumes, headwater streams are extremely sensitive to their surroundings and are often not well protected, for the most part because their typically intermittent flows or subtle channel forms may result in them being omitted or overlooked in formal stream network maps and urban planning processes. Legislation, policy and partnerships are important, but lead times in planning and regulation, and compliance remain obstacles.

While these streams are crucial for preserving ecosystem health, biodiversity, natural stream flows and water quality, as cities expand, headwater streams are frequently lost through piping or channelisation as part of the urban development process and a focus on flood protection. This can lead to increased pollution, altered hydrology and downstream habitat degradation. Urban development typically also replaces naturally permeable surfaces (e.g. grasslands, forest, wetlands, agriculture) with less pervious surfaces (e.g. paved surfaces, roofs, compacted soils), increasing the frequency and magnitude of surface runoff, disrupting nutrient and sediment flows, impacting stream ecology and increasing contaminant concentrations (Imberger et al., 2023; Richardson, 2020). This also negatively affects downstream river networks, for example, by diminishing access to resources and increasing nitrogen export to downstream areas, contributing to eutrophication (Richardson, 2020).

Aitken Creek exemplifies other headwater streams with existing planning approvals around Melbourne.

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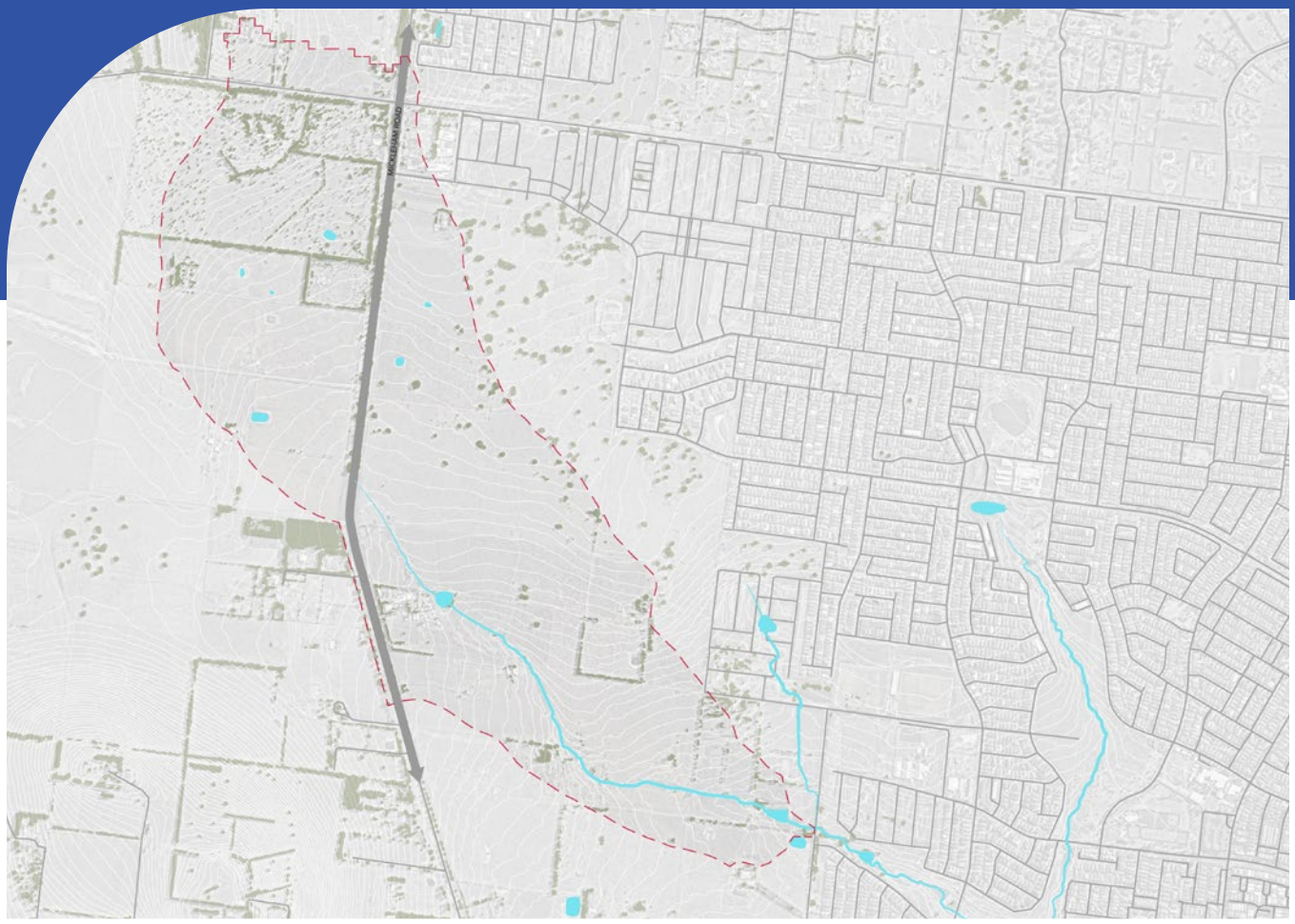
Aitken Creek
Photo: Melbourne Water

1.3 Aitken Creek

Aitken Creek is an ephemeral headwater stream that rises in an agricultural landscape and flows through suburban Craigieburn and meets Merri Creek at the Craigieburn Grassland Nature Reserve. Aitken Creek is under significant pressure due to progressive urban development in its catchment.

Protecting Aitken Creek is essential for maintaining the ecosystem services described in Section 1.1. A systematic and planned approach engaging all stakeholders is necessary to protect Aitken Creek, including its environmental, social and cultural values. This includes raising awareness about the importance of headwater streams and changing perceptions from seeing these systems as insignificant depressions in the landscape, particularly in areas where headwater streams may not always hold surface water, to recognising them (Imberger et al., 2023).



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Aitken Creek, an under pressure headwater stream

1.4 The problem to be solved

To fully protect Aitken Creek, almost all the excess stormwater generated by adjacent urbanising areas , i.e. the volume of runoff above what would have contributed to streamflow in the pre-urban state, must be prevented from reaching the stream.

This raises the following critical questions:

1. **How do we deal with large volumes of water?**
2. **How do we ensure enough space in the landscape for solutions?**
3. **How do we ensure the systems and processes support desired outcomes?**
4. **What needs to change in our waterway and urban planning processes to protect headwater streams in the future?**

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Identifying headwater streams

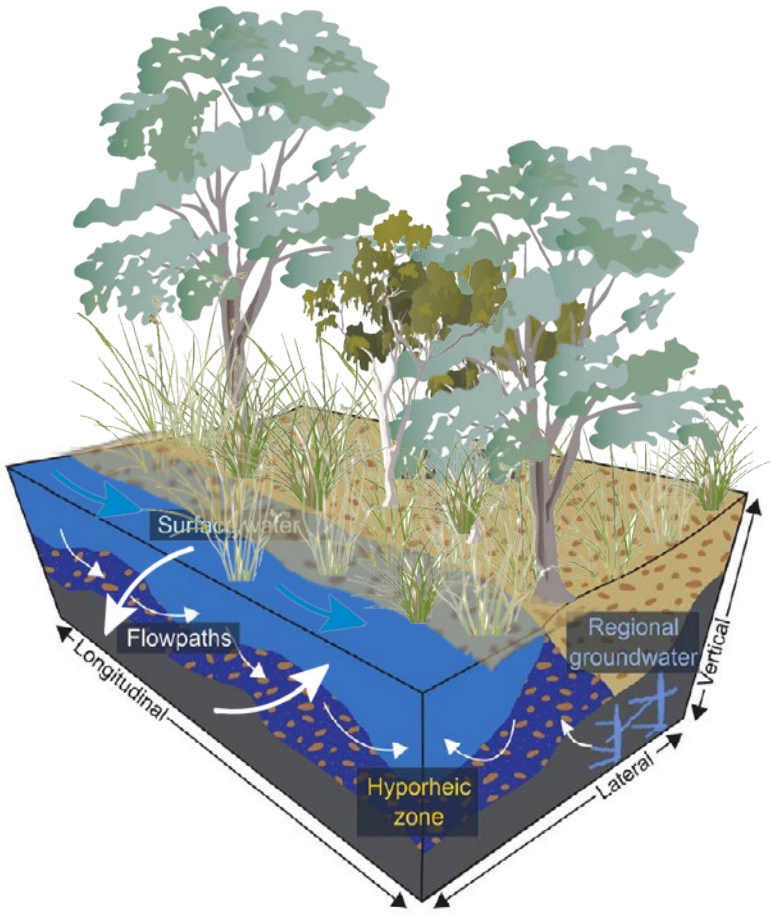
Part two: a deeper understanding of the issues

2.1 What does science say?

Dr Moss Imberger
University of Melbourne and
Associate Professor Leon Barmuta,
University of Tasmania

Headwater streams are the beginning of the river network and the smallest streams in the network. They occur where catchment flows accumulate sufficiently to produce surface flows that sort sediments, create persistent channelled banks, and sustain aquatic and semi-aquatic flora and fauna communities. Headwater streams vary widely in their appearance and characteristics, even across the relatively small region of Greater Melbourne. Some are spring-fed and hold surface water throughout the year but many hold water only during wet portions of the year or shortly after rainfall events. Because they often don't hold surface water, headwater streams can appear to be terrestrial, rather than aquatic, systems. However, even when there are long periods without surface water, there are significant periods of subsurface water.

Headwater streams are different to other parts of the river network because they are more tightly linked with their riparian zones, groundwater environments and catchments more broadly. Because of this, they are more strongly affected by disturbances in their catchments.



Despite their small size, headwater streams often make up 60–80% of river networks by length. Recent updates to the Melbourne Water stream network have added more than 14,000 km (or 55%) to the stream network, much of which is headwater streams. Headwater streams are important because they provide habitat for common, rare and threatened species. Species often differ between headwater streams so, collectively, they make a large contribution to regional biodiversity. Headwater streams are also critical to the integrity of the overall river network. From an ecosystem services perspective, headwater streams provide multiple provisioning, regulating and cultural ecosystem services (e.g. local climate regulation, hydrological regulation, pollutant removal, flood protection) and cultural (e.g. recreation, aesthetics, spiritual and Traditional Owner cultural values) services.

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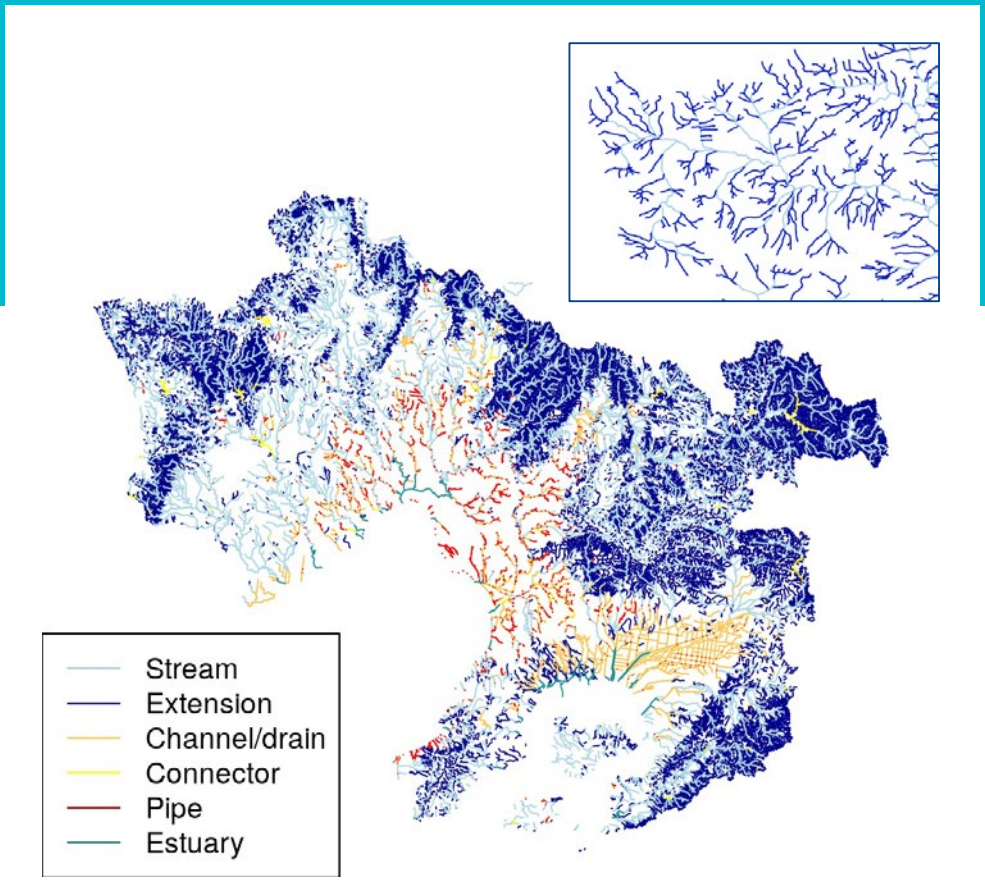
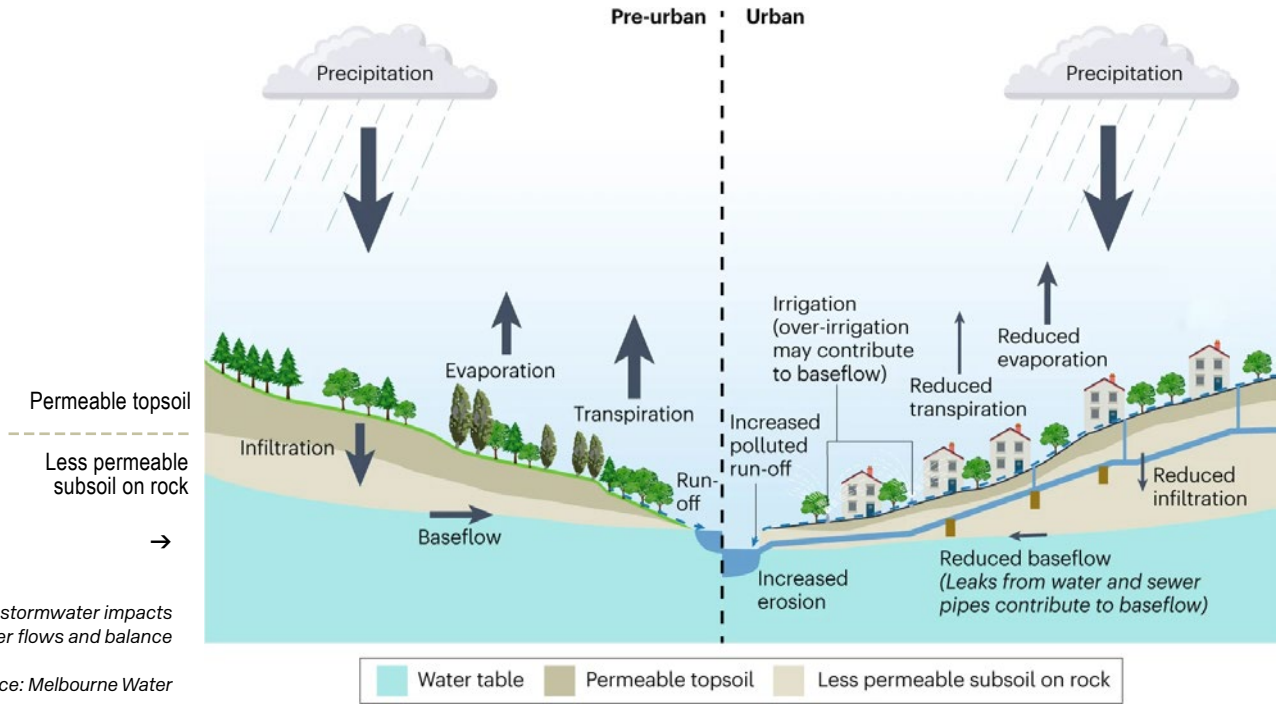
Three-dimensional connectivity of headwater streams. Moss Imberger, University of Melbourne



Melbourne Water stream network colour-coded by type (Source: Walsh 2023).

The inset is a close up of a section of the stream network in the north-east region and shows the extent of additional stream length (stream extensions) provided by the recent update.

However, headwater streams are being lost and degraded by urban development at increasing rates. It takes very little urban land-use in a catchment to degrade the structure and function of headwater streams. In an urbanising future with a drying climate, services such as clean water, cool microclimates, flood control and recreation are increasingly important. Like other urban streams, conventional urban drainage is the primary threat to their health.



Urban stormwater impacts on water flows and balance

Source: Melbourne Water

There is still much to learn about headwater streams in urbanising areas. Based on insights from our workshops, here are four guiding principles for their protection:

1. **Prevent them from being replaced with underground pipes.**
2. **Prevent excess urban runoff from entering them.**
3. **Protect the character of stream channels, including preventing them from being replaced with enlarged, rock-lined constructed waterways.**
4. **Understand where they are in your regiom.**

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Wetness zones associated with the water lines

2.2 What does traditional knowledge tell us?

Jordan Smith and Rephael Lankri from the Water Program at the Wurundjeri Woi-wurrung Cultural Heritage Aboriginal Corporation (WWCHAC), the Registered Aboriginal Party for Wurundjeri Woi-wurrung Country

The Wurundjeri Woi-wurrung people have an unbroken relationship with Country, caring for this land, its waterways, its plants and animals for tens of thousands of years. A core purpose of Wurundjeri Woi-wurrung Corporation is the protection, preservation and revitalisation of Wurundjeri Woi-wurrung culture, values and cultural practices. The concept and understanding of Country is complex and not something that can be easily articulated in this short report. The following quote, however, has been selected to help convey Wurundjeri Woi-wurrung perspectives on Country: "*Country is the source of all life. Country is alive and continuing. The land is our mother, our strength and power, everything*".

A key message relating to protecting headwater streams is that all of Country is interconnected. Waterways extend beyond the water itself, beyond the bed, the bank and the riparian zone. Waterways need their land to breathe, swell and flood. The following quote from Wurundjeri Woi-wurrung elder, the late Aunty Margaret Gardiner relating to the Birrarung (Yarra River), and that equally applies to headwater streams, reminds us of this:

> The Birrarung needs its lands, like we need water. Without water, there is no life, without its lands, there is no Birrarung. The river needs its lands.

The importance of Aitken Creek and the surrounding Merri Creek catchment for the Wurundjeri Woi-wurrung people is reflected in the following quotes:

> Like other waterways around Melbourne, the land around Merri Creek was used by Wurundjeri people as a university, chemist and supermarket and remains a valuable resource for the future generations. The area has ochre, scarred trees, artefact scatters sites. — Annette Xiberras, Wurundjeri Woi-wurrung elder

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Aitken Creek
Photo: Melbourne Water

> Merri Creek and its tributaries would have been used as travel routes, and the grasslands would have been good for hunting and for the collection of seed and grasses. Collin Hunter, Wurundjeri Woi-wurrung elder

Examples of seeds and grasses include Kangaroo Grass, bulbs and lilies (particularly murrnong). Like much of Wurundjeri Woi-wurrung Country, this area was managed through the use of fire and many generations of burning regimes.

> The sites left by our ancestors connect us to our past and are physical ongoing connection to Country and how the land was used by our people and a culture that is still living". Uncle Ronald Terrick, Wurundjeri Woi-wurrung elder

Wurundjeri Woi-wurrung elder Aunty Di Kerr describes her connection to Merri Creek:

> When I am along the Merri Creek I can feel my Mother, Grandmother and ancestors. It helps me heal in regard to colonisation and the wellbeing of our people.

Typical urban development and associated impervious surfaces are significant threats to waterways, Country and culture. This includes:

- Excess stormwater runoff that leads to stream erosion and potential impacts to artefact scatters, scarred and sacred trees, ochre deposits, shells middens and other important cultural places
- Increased pest plants and animals that reduce native biodiversity
- Physical modification of the landscape, such as land clearing and draining of wetlands altering the movement of water throughout Country
- Decreased access to Country and opportunities to maintain cultural practices, and visit important places.

We must give waterways their space, limit development near them and allow them to express their natural processes. This includes limiting the volume and velocity of stormwater runoff into headwater streams and downstream waterways. Further, maintaining culture and caring for Country requires:

- **Recognising the interconnectedness of Country:** A headwater stream and the land that surrounds it, along with the plants and animals, water and soil, are all connected as part of an integrated system. The health of one part, influences the health of the other parts.

- **Wurundjeri land management practices including cultural burning:** Caring for Country is a crucial way of maintaining current cultural practices, such as cultural burns to restore and maintain the health of Country.

- **Living culture and intergenerational knowledge:** Mark Gardiner, a ranger on the Narrap Team, WWCHAC's land management team, has described the importance of Caring for Country and intergenerational knowledge sharing:

  Healing Country calls on all of us to continue to strive for greater protection of our lands, our waterways, sacred sites and our cultural heritage from exploitation, desecration and destruction. Healing Country also means healing our people – through Healing Country and finally resolving many of the outstanding injustices which impact on the lives of our people. As a Narrap Ranger I'm working hard with a great team of strong deadly Aboriginal and multicultural men and women towards these goals in Healing Country, so that future generations may one day live in a healthier ecosystem and continue the practice of caring for Country. It gives me a huge sense of pride being a Narrap Ranger knowing the works we do on Country. My spiritual connection to Country as a Wurundjeri man only gets stronger knowing that healing mother earth, in turn, makes for a brighter future for my kids and future generations to come.

- **Traditional Owner involvement in decision making:** Traditional Owners need to be involved in decision making relating to what happens on Country, which includes protecting headwater streams. This can happen through partnerships with Traditional Owner groups and embedding them in processes and resourcing them to be equal partners in all aspects of projects, plans, policies and strategies. Traditional Owner self-determination of this involvement is also very important.

2.3 What role does legislation and policy play?

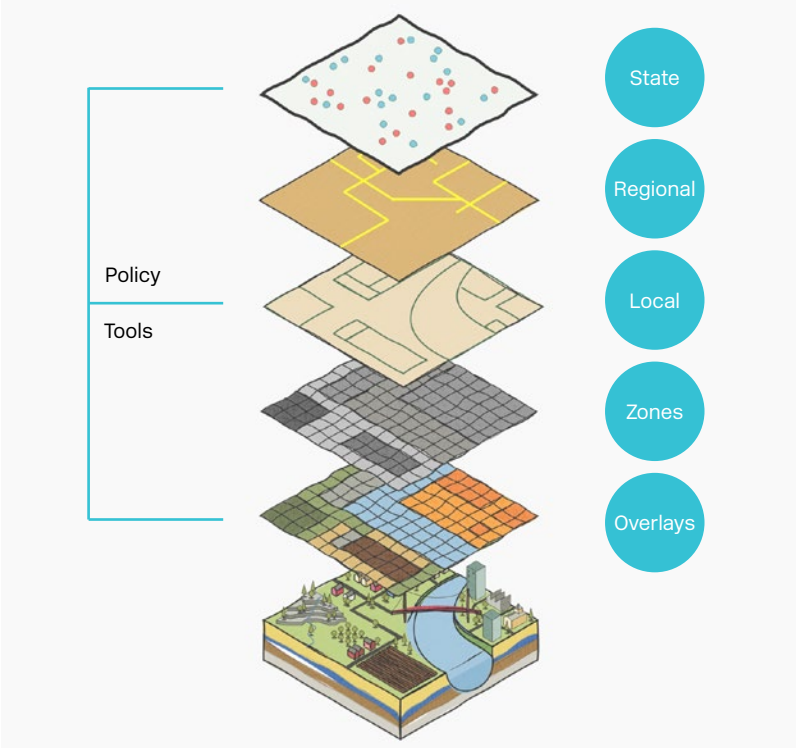
Alex Gunn
Department of Energy, Environment and Climate Action

From a government perspective, the effective protection of headwater streams involves several crucial considerations. Defining a headwater stream as a waterway is fundamental for evaluating planning and protection responsibilities. It is also essential to identify and plan for community needs related to the uses and values of these streams, developing and implementing schemes for their protection and enhancement. Policy considerations therefore adopt a 2-pronged approach, addressing both environmental and community needs and responsibilities.

The Victorian Government has made several commitments to protect headwater streams. The ***Water Act 1989*** governs the rights to use and control all surface water, while the ***Planning and Environment Act 1987*** accounts for the protection of water flows, quality, environmental values, landscape and cultural heritage sites. These acts also cover rivers, watercourses, their corridors and adjoining land in urban development projects. The State Planning Policy Framework includes clauses related to the environmental and landscape values of water bodies and wetlands, and infrastructure development related to water and stormwater management (Clauses 12.03, 14.02, 19.03-3, 19.04-4, 54, 55, 56 and 58).

There are other statutory tools that have the potential to add to the protection of headwater streams. The ***Flora and Fauna Guarantee Act 1988*** lists potentially threatening processes that must be given consideration by public authorities when exercising their functions. These include alteration to the natural flow regimes of rivers and streams and increase in sediment input into Victorian rivers and streams due to human activities. Additionally, the ***Aboriginal Cultural Heritage Management Act 2006*** while not specifically targeting headwater streams, apply to waterways in general. The government aims to strengthen the links between water and land management planning to meet liveability standards. The Water Act defines streams based on their channel form or regularity of water flow, with catchment size used to assess flow regularity. Where waterways are formally designated, which in Melbourne Water's waterway management region include all streams with a catchment greater than 60 hectares, the responsible waterway manager must identify and plan for state and local community needs relating to the environmental, Aboriginal cultural, social, recreation and economic values of waterways.

The manager can develop schemes to protect and enhance land and waterways and plan activities to improve aquatic ecosystem health. In the Port Phillip and Westernport region, Melbourne Water is the delegated authority. Regarding catchment-related stormwater and drainage management, Melbourne Water and local governments share roles, responsibilities and resources, though these roles are not always clearly delineated.



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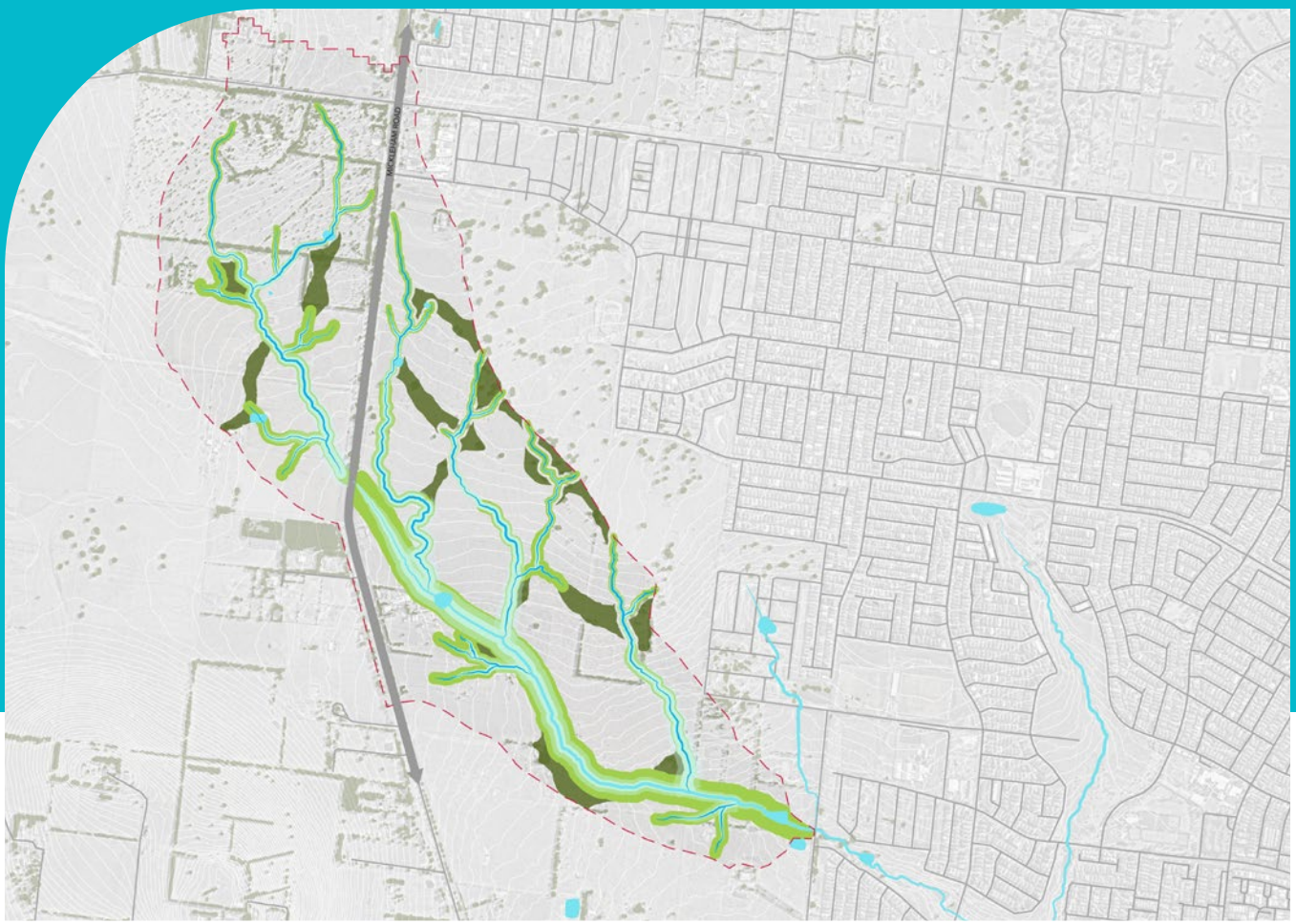
Adapted from the Victorian Department of Transport and Planning, detailing the structure and operation of the Victorian planning system



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Biodiversity values aligned with headwater streams and wetness

2.4 What is the development industry's perspective?

Jaime Tainton
Water Studio

The impacts on headwater streams are driven by development and construction decisions as cities expand. Developers face many considerations, including perceived economic losses associated with reducing the amount of developable land due to the need to set aside land for headwater stream protection. Additionally, many landowners, ecological consultants and stream managers struggle to recognise headwater streams, which can appear as slight depressions in the landscape, unless they are mapped, formally recognised and this information is accessible to stakeholders (Imberger et al., 2023). Without clear definitions and explicit mapping, headwater streams risk being disregarded as legitimate streams requiring protection (Wohl, 2017). If the areas needing protection or their ecological values are not clearly defined, developers may not be obligated to preserve these regions, potentially sacrificing them in favour of net developable land.

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Source: Jaime Tainton, Water Studio, 2023

Headwaters can be effectively protected through partnerships with developers and urban planners by considering several critical parameters, including clarifying how much land can be developed and how much must remain protected. The sequence of development progression needs careful management to mitigate issues if upstream areas are developed before downstream infrastructure is in place. Strategies should align with the Victorian Government's commitment to building 800,000 new homes by 2034 while ensuring the protection of headwaters near urban and semi-urban settlements. Design considerations and developer incentives should be included to either adapt or challenge the current functioning of an area.

For developers, protecting headwater streams offers several advantages. It can enhance sustainability branding, appealing to environmentally conscious buyers. Proximity to green open spaces can positively impact house prices in the neighbourhood. While these are important considerations from a developer's perspective, the Victorian Planning System already includes provisions to make development planning more inclusive of environmental values. For instance, a Section 173 Agreement can be used to append suitable design guidelines to the property title to ensure water values within and around urban development boundaries are managed appropriately.

However, there are limitations to strategies, guidelines and recommendations that use language like 'may' and 'should'. For example, there is nothing in the Healty Waterways Strategy 2018 that mandates developers to take specific actions.

Part three: gaining solutions inspiration

3.1 Integrating ecological and cultural perspectives in urban planning

Professor Alex Felson
University of Melbourne

The concept of 'design experiments' combines research experiments with urban planning to bridge the gap between ecological research and urban design. This approach fosters collaboration between ecologists and designers to enhance public spaces and adapt to climate impacts. An example is the Earth Stewardship Initiative by the Ecological Society in the United States, which implements large-scale adaptation strategies.

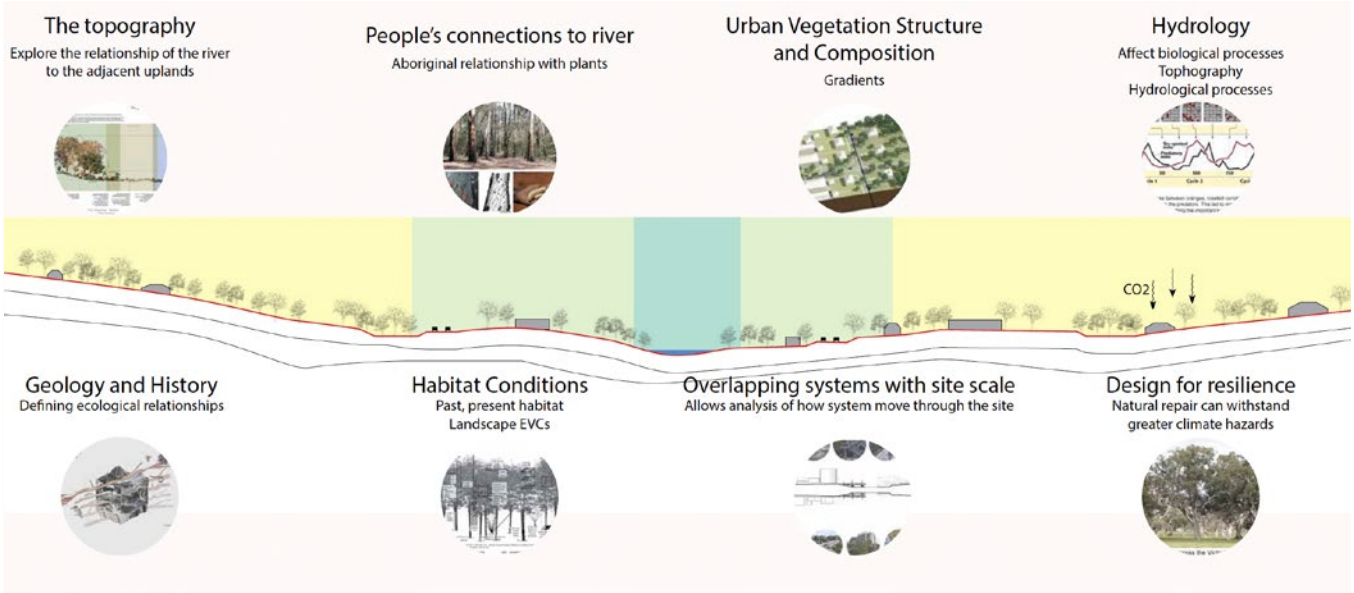
A key aspect of this methodology focuses on the catchment components of urban areas, and reevaluating boundaries and land use practices based on ecological data. This method has been applied in projects like New York City's reforestation plan and a comprehensive urban forestry study, including a factorial study on tree species and soil amendments. The approach aims to incorporate ecological health into city planning by emphasising the ecological contributions of urban green spaces.

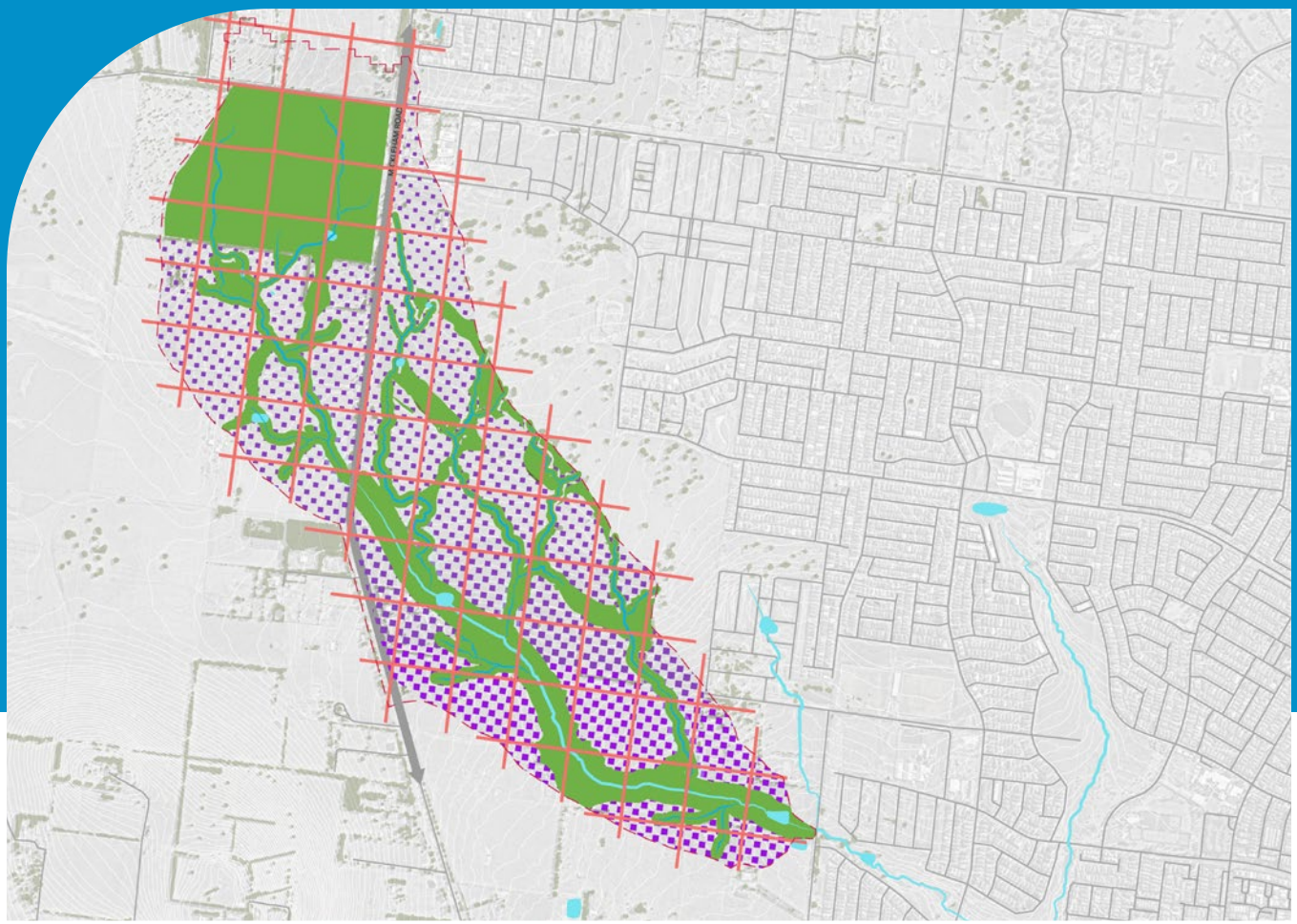
Looking ahead to 2100, the Climate Adaptation Strategy developed by Merri-bek City Council with Traditional Owner perspectives aims to integrate viewsheds into future planning through Geographic Information Systems (GIS) mapping. A viewshed is the geographical area visible from a specific vantage point, encompassing all the surrounding landscape and features within the observer's line of sight. The concept of viewsheds can be used strategically to maintain rural and agricultural characteristics in urban developments. By aligning development plans with natural and cultural landmarks, these projects aim to enhance ecological corridors and buffer zones, going beyond regulatory requirements to preserve environmental and aesthetic values. The forward-thinking Climate Adaptation Strategy seeks to reshape urban parks by categorising them into functional types, revisiting and revising urban spaces for future needs.

Cultural understanding also plays a significant role in Merri-bek City Council's planning efforts. By incorporating Traditional Owner knowledge and perspectives into the Climate Adaptation Strategy, the goal is to shift the status quo and expand the scope of planning beyond conventional buffer zones. This includes reimagining song lines (traditional paths representing the movement and stories of Traditional Owners) to guide urban planning in a way that respects and integrates cultural heritage.

Design experiments demonstrate multidisciplinary knowledge

Source: Alex Felson, University of Melb, 2024





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Integrating urban and ecological systems

The synthesis of these approaches demonstrates a holistic strategy for urban planning that combines short-, mid- and long-term goals. By using ecological and cultural insights, this planning process addresses immediate urban challenges while preparing for future environmental conditions, ensuring sustainable and culturally respectful development. Successful applications in various projects illustrate the potential for ecological and cultural integration to enrich urban environments and governance structures, offering several advantages for developers, including reduced time seeking approvals and enhanced reputation.

3.2 Biodiversity sensitive urban design: Integrating ecology into urban planning

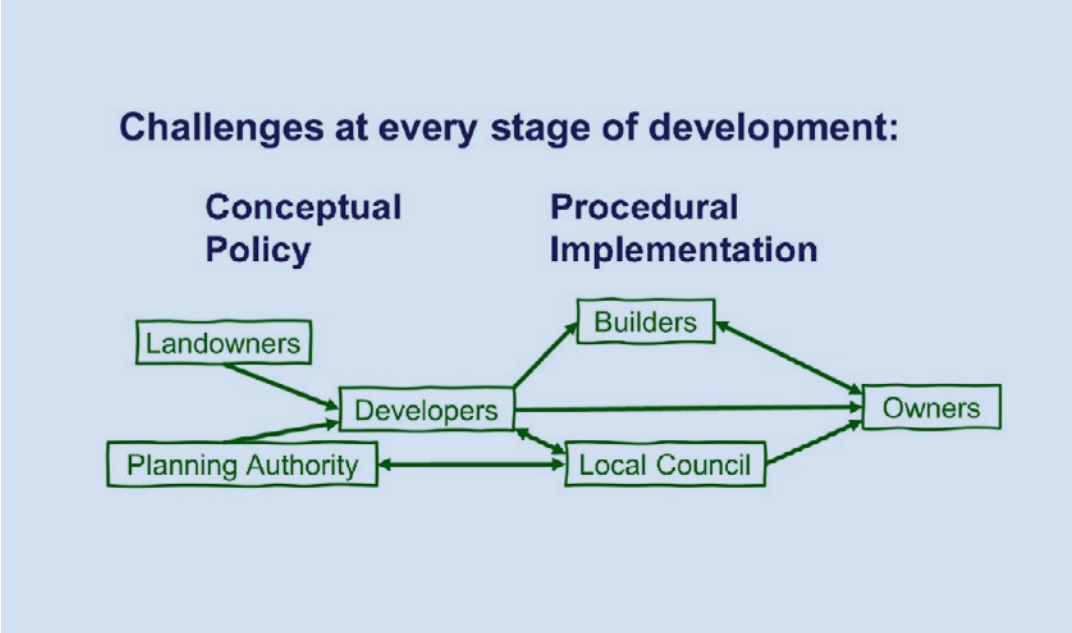
Dr Holly Kirk
RMIT University

Current urban development practices often fail to adequately cater to both human and environmental needs. The concept of Biodiversity Sensitive Urban Design (BSUD) seeks to transform urban development by integrating ecological considerations directly into development processes to ensure that urban growth supports biodiversity (Kirk et al., 2021).

Traditional urban development tends to create spaces that do not support the diverse ecological systems that are vital for maintaining the overall health of the environment. These development practices often lead to habitats lacking necessary features to support common urban wildlife such as birds, butterflies and bees, thereby reducing biodiversity. Moreover, such development practices disconnect people from their natural surroundings, impacting their mental and physical wellbeing.

BSUD aims to address these shortcomings by advocating for urban designs that produce a net positive effect on nature. This approach involves planning urban landscapes that not only accommodate human activities but also actively enhance biodiversity and sustain ecological processes. It is achieved by incorporating natural features that support wildlife and their natural behaviours, such as pollination and species migration.

Despite the pivotal role that builders play in determining what is economically viable to construct, they are often not included in conversations about BSUD. This exclusion can hinder the adoption of BSUD principles, as economic viability remains a crucial factor in determining whether sustainable practices are implemented. Legislative endorsement of BSUD in South Australia and the development of specific BSUD guidelines in the ACT highlight a growing recognition of the importance of ecological considerations in urban planning. Such legislative actions are crucial for the broader adoption and implementation of BSUD principles.



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Source: Holly Kirk, RMIT 2024

A local example of BSUD in action is the Hazelwynde Development Project which lies within the Beveridge North West PSP. A major landowner has been heavily involved in the planning process, which has included extensive engagement with the community and various stakeholders. This engagement ensures the development meets human-centric needs, such as housing and services, and integrates nature-centric objectives that enhance local biodiversity.

Further, the approach suggests rethinking urban forms by avoiding building right up to property boundaries to allow more space for natural habitats. This can be complemented by reimagining small urban parks to be ecologically functional rather than just recreational. Additionally, the concept of biodiverse streetscape design introduces the possibility of increasing soil and vegetation in urban areas, which can significantly enhance the ecological functionality of these spaces.

In summary, BSUD represents a transformative approach to urban development that prioritises ecological sustainability alongside enhancing human wellbeing. By fostering richer, more resilient urban ecosystems, BSUD aims to create urban environments where both people and nature can thrive. This approach not only addresses the immediate needs of urban residents but also contributes to the long-term sustainability of urban areas, making it a crucial consideration for future development projects.

→

Source: Croeser et al. 2022

Phillip Birtles
Sydney Water

3.3 Integrating flow-based water sensitive urban design in Western Sydney

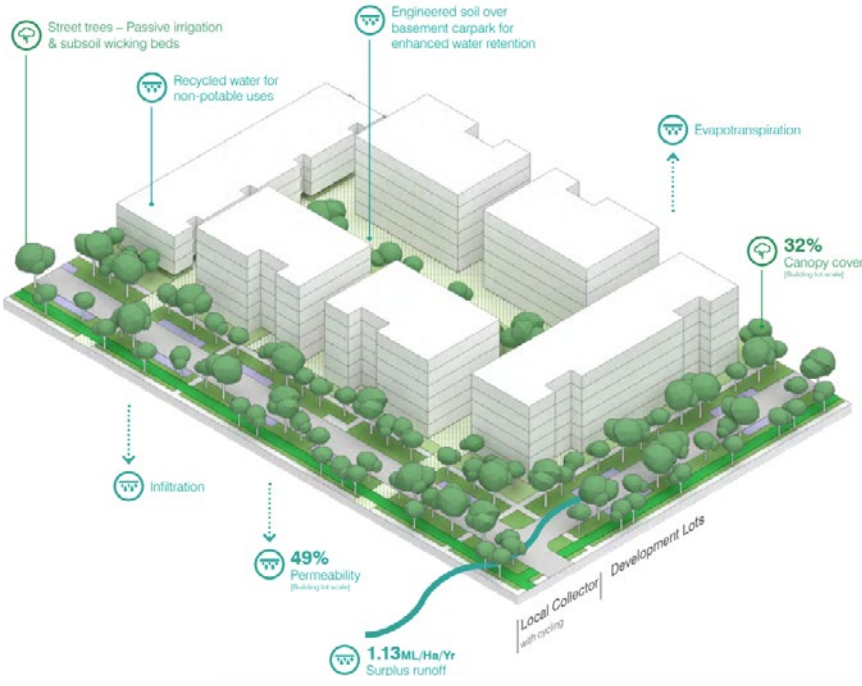
Sydney Water, the designated stormwater manager for Western Sydney, is considering how best to manage waterways in Sydney's growth areas, including headwater streams, such as Wianamatta–South Creek.

It has adopted a water sensitive urban design (WSUD) approach that integrates flow-based targets with urban planning to address the impact of urbanisation on waterway ecosystems. The New South Wales Government has established criteria for water quality and flow to protect these ecosystems, based on tipping points in ecosystem resilience related to urbanisation's impact on flow and pollution. To maintain waterway health, runoff volumes from urban development should not exceed 2 ML/ha/year for headwater streams.

Sydney Water has adopted a catchment-based strategy to achieve these WSUD targets. This approach relies less on lot-scale WSUD measures, focusing instead on concentrating, infiltrating and ultimately harvesting stormwater runoff at catchment scale. This strategy is designed to maximise regional water reuse across private and public realms, and keep excess stormwater out of waterways.

As part of the strategy, Sydney Water proposed 14 urban typologies that maximise green spaces, canopy cover and permeable surfaces, with minimal structural changes to building form. These typologies have been embedded in planning documents for areas such as Mamre Road and the Aerotropolis.

Water sensitive streets also play a central role in this strategy and planning documents. Recognising that managing WSUD in streets is often an operational challenge for councils, the proposed design employs only minimal filtration devices such as passive irrigated street trees, swales and French drains. This can reduce operational costs while maintaining co-benefits from shade canopy. The main WSUD functions of these streets is to increase the efficiency of regional stormwater harvesting schemes by collecting and channelling stormwater to extraction wetlands or ponds lower in the catchment.



This regional harvested stormwater is combined with recycled water to provide a high reliability, regional alternative water source that is distributed to green spaces and other demands throughout the catchment. By treating stormwater and recycled water as a single alternative supply, Sydney Water overcomes competition between institutions for water demand.

Sydney Water has also established a dedicated, internal stormwater management team to reduce the risks associated with this strategy. The team exists to improve alignment between water planning, urban planning and development across the Aerotropolis. This team works closely with other agencies and developers to ensure the WSUD strategy is integrated into broader urban planning, approved and implemented on the ground.

3.4 Integrating water sensitive practices in urban planning

Professor Chris Chesterfield
Monash University

The failure to effectively integrate water management and urban planning is a significant challenge for protecting headwater streams. It is often caused by misalignment between urban planning and water planning processes. A CRC for Water Sensitive Cities research project on this issue found urban planning and water management are often treated as separate processes with different and often disconnected goals (Tawfik, S. and Chesterfield, C. 2020). This approach makes it difficult to create space for WSUD in new developments that protects waterway corridors and maximises water reuse.

The research specifically considered how water outcomes are considered at different spatial scales in urban planning. It found a need to better define water outcomes at each scale of the urban planning process, ranging from state level (e.g. what sustainable water management objectives are expressed in state planning strategies, which form a head of power for planning by councils and others?) through to lot scale (e.g. how are sustainable water outcomes delivered through the building code and individual planning permits and how does this align with utility connections and permits?). Once the urban planning process 'knows' what outcomes to deliver, it will then coordinate agencies and resources to do so; the reverse is also true.

This gap between urban planning and water planning is particularly evident in corridor level planning. For greenfield development, growth corridor planning is a key part of state planning processes. It coordinates objectives, funding and delivery of critical infrastructure across multiple local government areas and development master plans. An equivalent mechanism could not be identified for water planning, either in terms of scale or for the whole water cycle. So, integrating water outcomes into corridor scale urban plans relies on urban planners, who must interpret myriad water planning documents. The absence of water management planning at the corridor scale is a missed opportunity to create sustainable urban water systems, e.g. when current WSUD targets introduced at the precinct or lot scale come too late or are too small to meaningfully impact corridor plans that are already finalised.

The research identified a need for a new 'corridor scale' of water planning. This need aligns with other observations within the urban water sector that it is difficult to plan regional scale IWM projects that cross multiple Precinct Structure Plans, local government areas and/or river catchments. Yet such projects are emerging as critical in efforts to match demand and supply for alternative water sources. It also aligns with calls for more 'landscape perspectives/scale' in urban planning (See Alex Felson, section 3.1) as a transformative action to protect and restore ecosystem service and cultural values via the urban planning process.

These recommendations are beginning to be picked up, e.g. by the Waterways of the West Ministerial Advisory Committee, which aims to address the challenges of managing waterways in urban settings. That body's recommendations focus on improving regional planning for interconnected blue-green corridors and the need for integrated water planning to ensure effective coordination among councils, Melbourne Water, retail authorities and developers across precincts and structure plans. (Waterways of the West, 2021).

Summary

The role of effective planning and urban design is a central theme across all four perspectives. The benefits of integrating ecological research into urban design and planning was highlighted through initiatives such as the Earth Stewardship Initiative and Merri-bek City Council's Climate Adaptation Strategy. They highlight the value of combining ecological data with urban planning to enhance public spaces, adapt to climate change and incorporate cultural heritage.

BSUD focuses on how urban development can also foster biodiversity and ecological processes, thus ensuring cities balance human needs with environmental sustainability. The Hazelwynde project demonstrates the practical application of these principles, achieving both human-centric and nature-centric goals.

In Western Sydney, Sydney Water's flow-based WSUD approach focuses on improving waterway health by managing stormwater through regional strategies and innovative design elements, reducing runoff, and promoting green infrastructure. Finally, the need to better align urban planning functions including land use and water serving planning across different scales is essential to achieve sustainable outcomes. These efforts underscore the importance of planning and design at all scales, and in incorporating ecological and water sensitive practices to build resilient, sustainable and culturally respectful urban environments.

Part four:
Ideas for Aitken Creek

4.1 Strategy for protecting headwater streams

The perspectives from Part Three were synthesised and translated for the specific context of protecting the headwaters of Aitken Creek. The resulting strategy is built around 3 strategic principles:

1. Above all else, manage excess stormwater flows. Managing stormwater flow in the Aitken Creek catchment is intentionally prioritised over water quality management as the critical strategy for protecting headwater streams.

2. Plan at a landscape/corridor scale to create broader Caring for Country opportunities that regenerate ecosystems and reflect cultural perspectives while also managing excess stormwater.

3. At a more granular scale, create alternatives to conventional greenfield development approaches. Use new housing and open space typologies that: create physical space to regenerate biodiversity; avoid the channelisation and piping of waterways; and minimise the disturbance and compaction of delicate soil structures.

This strategy creates a multi-layer mechanism to efficiently harvest excess stormwater and facilitate infiltration at scale:

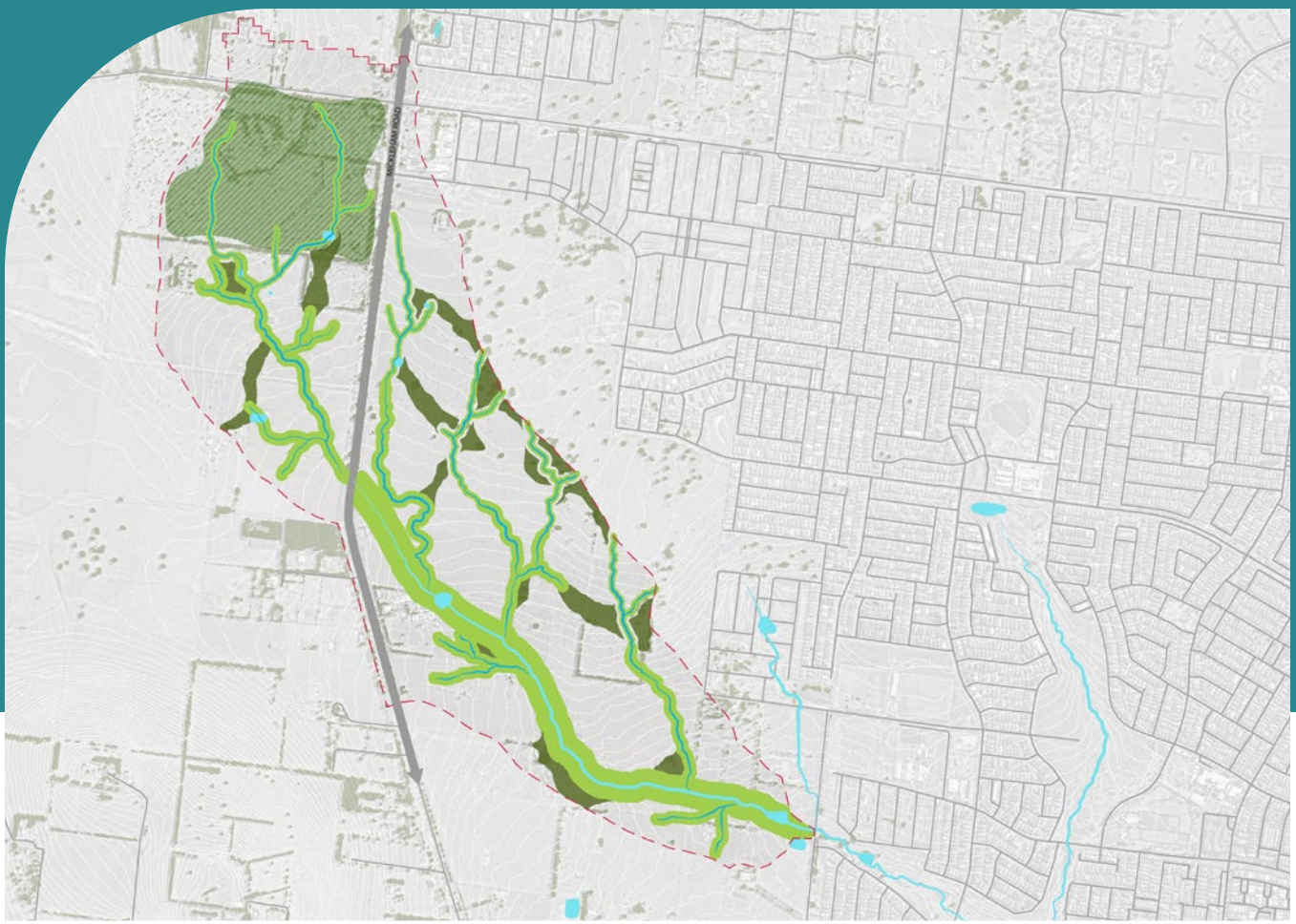
- At the lot scale, by enhancing biodiversity and ecosystem services through passive watering techniques

- At the street scale, where the drainage system is reimagined as part of a stormwater harvesting scheme

- By optimising the catchment for harvesting of stormwater in the ‘middle zone’ between the lot and the waterway

- By protecting the predevelopment waterway and infiltration zones, avoiding channelisation and piping of waterways; and minimising the disturbance of delicate soil structures.

The individual ideas for Aitken Creek are summarised in Table 2 and described in more detail in Section 4.2.



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Biodiversity values aligned with headwater streams and wetness

Table 2. Ideas for Aitken Creek

On-ground ideas	Details
1. Multifunctional waterway corridors	Integrate waterway, riparian zone and multifunctional zones
2. Living headwater streams	Designate and protect headwater streams in development, including soak areas in conservation zones
3. Drainage schemes that retain water	Design drainage schemes with distributed detention to retain low flows within the catchment and facilitate reuse
4. Soil sensitive urban design	Incorporate soil sensitive practices in urban design and civil works
5. Regional / precinct stormwater harvesting	Harvest stormwater for open space irrigation rather than lot-scale reuse
6. Water sensitive housing typologies	Use different densities to create green spaces while maintaining development yield
7. Water and biodiversity sensitive streets	Design urban landscapes and streets to retain water and support biodiversity including grasslands
Enabling ideas	**Details**
1. Recognise, define and map headwater streams	Map these areas in advance of changes to urban growth boundaries as well as clarify where they occur within the existing urban boundary
2. Communicating responsibility for development impacts on headwater streams	Define the role of the urban planning sector in protecting headwater streams
3. Corridor-scale integrated water management planning	Implement integrated water management planning across catchments and precincts
4. Establishing adaptive revision triggers for PSPs	Create an adaptive process for plan revisions such as PSPs and mandated recycled water areas
5. Shifting to an 'all options' approach to alternative water sources	Adopt an 'alternative water' approach rather than focusing solely on stormwater and recycled water in isolation
6. Establishing effective governance structures	Assign responsibilities for headwater stream protection to a team in Melbourne Water and align agency service standards for sustainable development to ensure green ideas are delivered
7. Reducing the market risk for premium greenfield housing	Create incentives and reduce risk for new housing models

4.2 Detailed ideas for Aitken Creek

On-ground idea

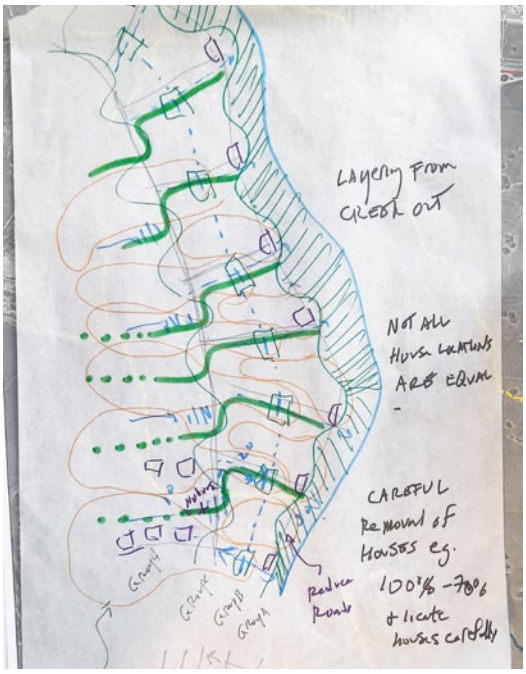
1

Multifunctional waterway corridors

A multifunctional waterway corridor enhances both ecological and community benefits.

The waterway corridor includes 2 distinct 'functions':

- an ecological zone (including the riparian zone) typically matching the 1% Annual Exceedance Probability (AEP) floodplain. This zone supports biodiversity functions.
- a utility waterway zone, comprising a variable width corridor running parallel to the ecological zone. This is intended to intercept stormwater before it reaches the stream channel, and its management objectives are more utilitarian. Stormwater assets within this zone either slow the flow of water, allowing it to soak into the ground or evapotranspire to the atmosphere, or concentrate stormwater for reuse.



On-ground idea

2

Living headwater streams

Maintaining functioning headwater streams requires the preservation of natural waterway features such as waterway depth, width, gradient, roughness and sinuosity. Rather than piping or engineering headwater streams, development practices could adopt a 'living stream' approach that mimics predevelopment stream character. This may include retaining pools and ponds to support diverse aquatic habitats, protecting soak and sponge areas within open spaces and conservation zones, and integrating these elements into urban planning. For example, remnant groundwater-dependent ecosystems, like River Red Gums near Aitken Creek, should be safeguarded by keeping excess stormwater away from these trees to prevent waterlogging and preserve their health. These red gum areas could be incorporated into the multifunctional corridors in Idea 1.

The living streams concept focuses on protecting already degraded headwater streams. These streams are often modified by earlier practices like agriculture and now require further modification to accommodate urbanisation. It is generally easier to protect an already modified stream from additional impact than it is to return a stream to a more natural condition later when stressors such as urbanisation are increasing. Therefore, defining what constitutes a natural headwater stream and planning for its protection should include designing an interface with the urban drainage system to ensure functionality and sustainability.

On-ground idea

3

Drainage schemes that retain water

Drainage systems for headwater catchments keep water out of waterways. They prioritise water harvesting and infiltration, rather than simply managing stormwater discharge.

This involves aiming for near-zero discharge for the majority of rainfall events, reflecting what happens in pre-development conditions, but providing public safety by designing deeper high-flow drainage channels that are engaged only for larger storms.

In this type of drainage scheme, shallow surface drainage (e.g. networks of spoon drains, green corridors, raingardens, passive tree watering and swales) can be used to facilitate reuse, infiltration, evaporation and transpiration, while ensuring deeper soil structures are protected and sodic soil disturbance is minimised. Streets can be designed to direct surface flows towards WSUD features and other reuse infrastructure. Incorporating green corridors, detention basins and parks into the drainage network can slow and redirect water to reducing velocities and increasing surface detention.

Advanced drainage solutions, such as smart detention basins equipped with sensors and automated controls, can also be used to maximise detention capacity by pre-emptively releasing or harvesting water before anticipated storms (Fletcher et al., 2024).

On-ground idea

4

Soil sensitive urban design

Soils are disturbed by civil works, including the installation of trunk drainage. Soil sensitive urban design aims to preserve soil structure during construction, and in the layout of the master plan. It involves minimising deep drainage and associated excavation works, and 'cut and fill', because these activities can severely disrupt soil structure, leading to erosion, loss of soil fertility and degraded natural habitats. Retaining large, functional and connected areas of deep soil in the urban fabric were also seen to be important.

Soil sensitive urban design, WSUD and BSUD practices can be complementary.

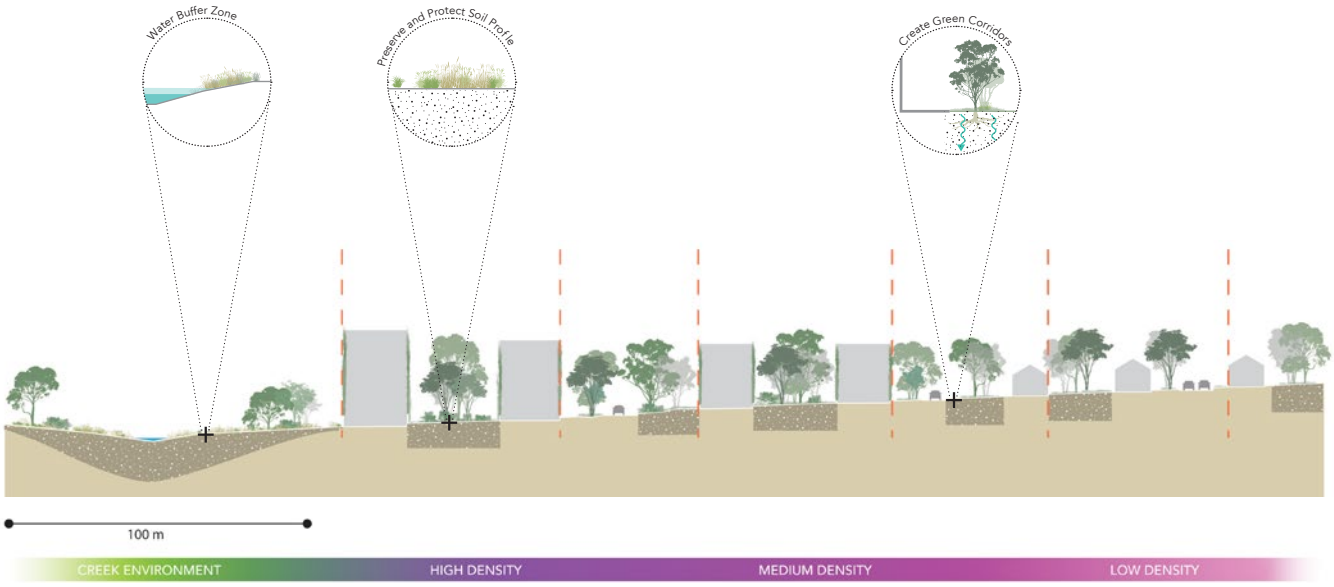
On-ground idea

5

Regional / precinct stormwater harvesting

A regional or precinct-scale stormwater harvesting strategy centralises the collection of stormwater, optimising harvesting yields by intercepting flows lower in the catchment. This approach supports precinct-scale reuse applications such as irrigating open spaces (Fletcher et al., 2024) or even helping to sustain some agricultural practices on the rural land adjacent to Aitken Creek. Centralised systems such as this are more likely to be efficient and cost-effective than decentralised lot-based systems (Wong, 2006).

A regional stormwater harvesting system is more likely to involve specialised infrastructure and may be best managed by a responsible authority such as Melbourne Water or Yarra Valley Water. This may allow the stormwater harvesting to be integrated with existing or planned recycled water systems to enhance reliability and utilise a single distribution network.



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Holding contours and soil profiles for green infrastructure

On-ground idea

6

Water sensitive housing typologies

This idea employs housing density as a lever to create additional space for WSUD and greening. It focuses on distributing housing densities within the development to promote higher density housing in strategic locations, reducing building footprints in other locations and providing more functional green space, without sacrificing the developers' yield nor the PSP's target population.

The Craigieburn West PSP is not intended to have a high-density character, and so this idea should be applied sparingly and strategically:

- Low-density development is preferred in the upper catchment to create a seamless interface with surrounding rural land uses and preserve natural landscapes.
- High-density housing is preferred in the lower catchment because it enhances development yield to offset encumbered land (e.g. for the multifunctional waterway corridor). This placement maximises the value of the development while retaining green zones connected to the waterway corridor and public open spaces.
- Medium-density development serves as a transition between low- and high-density areas. This density provides balance, maintaining enough open space for stormwater management and/or harvesting while supporting a sufficient population density to sustain local amenities and services. Medium-density areas can include a mix of housing types and green infrastructure, promoting biodiversity and enhancing urban resilience (Morison & Brown, 2011).

Water sensitive housing also integrates BSUD and WSUD principles to ensure all density types contribute to ecological, hydrological, social and economic sustainability.

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Wianamatta Street Trees artist impression, Bligh Tanner (2020)

Diversifying the urban form

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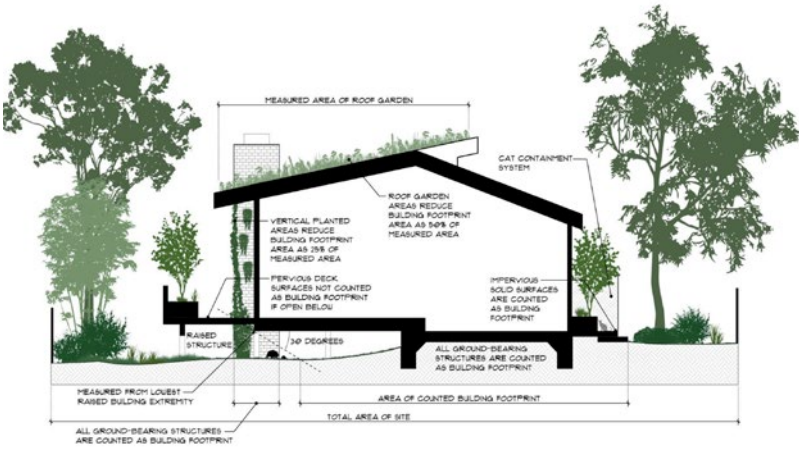

For example, urban design should also establish connections between density zones, key destinations and waterway corridors, promoting a network of green infrastructure. By creating 'fingers of green' as communal spaces and active transport corridors, urban areas can support biodiversity, improve amenity values and contribute to the health and wellbeing of residents. The design should also adopt BSUD principles to blur the lines between built environments and natural landscapes, fostering harmonious integration of urban and ecological systems (Ignatieva & Ahrné, 2013).

On-ground idea

7

Water and biodiversity sensitive streets

Streets provide valuable opportunities for sustainable water management, biodiversity improvement and even urban agriculture. By incorporating features like asymmetrical street designs with pedestrian paths on one side and greening on the other, shared crossovers and stormwater boulevards, streets can create space for BSUD and WSUD that combine to enhance urban resilience and ecological health, promoting sustainable urban environments (Threlfall et al., 2016; Wong, 2006).

A WSUD/BSUD street differs from a regular street by integrating sustainable water management features**,** such as permeable surfaces, swales, raingardens and bioretention systems, to capture, filter and reuse stormwater. It also incorporates space for trees and vegetation to enhance biodiversity, reduce urban heat and improve aesthetics. The street's drainage system directs stormwater flows to passively water these plants. In contrast, a regular street prioritises vehicular traffic and typically relies on hard surfaces and underground pipes to quickly channel stormwater away, leading to higher runoff, potential flooding and minimal environmental or community benefits.

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Source: GHD

Plantings may emphasise urban agriculture to support food security, local economies and community engagement (Grewal & Grewal, 2012; Lovell, 2010). Alternatively, plantings may reflect predevelopment grassland landscapes, with extensive use of native grasses and minimal tree cover. A third planting option is based on the idea of an urban forest to provide thermal comfort and applying 'cool ways' strategies to create active transport links that connect key destinations and offer protection to pedestrians on hot days.

4.3 How can change be enabled?

The on-ground ideas challenge conventional practice and policy in the domains of water planning and urban planning. Existing planning processes and instruments that misalign urban and waterway planning could be revised and strengthened. Addressing these gaps is crucial for protecting headwater streams.

The enabling ideas in the following sections were also developed during the workshop and are designed to help bridge the existing gap between urban planning or water planning more broadly, ensuring more integrated and sustainable outcomes for future projects.

Enabling idea

1

Recognise, define and map headwater streams

To effectively protect headwater streams, it is essential to first define, identify and map these areas. This definition and mapping involve using hydrological and environmental data to accurately locate and classify headwater streams to support their designation as waterways under the *Water Act 1989*. Detailed mapping should include both the streams and surrounding waterway corridors, which must be wide enough to provide adequate buffers from the adjacent urban development. These buffers are vital for protecting the ecological integrity of the streams, incorporating natural floodplains and riparian zones that support diverse habitats and mitigate flood risks (CRC for Water Sensitive Cities, 2017). In the Melbourne Water area, waterways are automatically designated under the Water Act, which eliminates the administrative step of designation following identification of the waterway.

In the context of urban boundary expansions, it is crucial to visually represent headwater streams and their corridors on planning maps for areas slated for future growth. This visual delineation helps planners and developers recognise the importance of these water features, ensuring their integration into urban planning processes.

Additionally, defining the values and management requirements of these waterway corridors in advance is key. This includes setting guidelines for water quality protection, maintaining natural hydrological processes and preserving biodiversity. Embedding these requirements into all levels of planning ensures headwater streams are consistently considered in both urban development and water management strategies (Ko & Choi, 2023).

→

Aitken Creek
Photo: Melbourne Water

Enabling idea

2

Communicating responsibility for development impacts on headwater streams

The General Environmental Duty (GED) framework under the *Environment Protection Act 2017* already provides a mechanism to effectively manage the impacts of urban development on headwater streams. This idea connects with the designation of headwater streams as waterways (Enabling idea 1) and involves identifying and clearly defining specific impacts that are incorporated in the current 'state of knowledge' (e.g. EPA Victoria, 2021), such as increased surface runoff, sedimentation and changes in hydrology due to urbanisation. Specifically, councils must develop a stormwater management plan that identifies the risks posed by urban stormwater under the Obligations of Managers of Land or Infrastructure (Government of Victoria 2024). This requirement could be strengthened by defining impacts and explicitly considering headwater streams.

Understanding the mechanisms behind these impacts is crucial for describing how construction and land use changes affect headwater streams. For instance, urbanisation disrupts natural hydrological cycles, increasing erosion and sedimentation while introducing pollutants into stream ecosystems (Booth & Jackson, 1997). Incorporating these identified and agreed impacts into GED obligations ensures the responsible parties are accountable and empowered to manage the environmental risks associated with development.

→

Holly Kirk's presentation

Enabling idea

3

Corridor scale integrated water management planning

Integrated Water Management (IWM) plans aim to unify water management practices across the disjointed roles, responsibilities and objectives for managing the urban water cycle. They promote sustainable outcomes amid urban growth, climate change and environmental challenges. IWM planning is designed to foster collaboration among stakeholders, including local governments, water authorities and community groups, and provide a strategic framework that guides local and precinct-level water management initiatives.

While IWM is being successfully used at a PSP and river basin scale in Victoria, there is a gap at corridor scale (see section 3.4). This gap is a barrier to the planning of larger-scale reuse projects that cross multiple PSPs, or connect PSPs to peri-urban agriculture opportunities.

Victoria's IWM Framework and PSP frameworks already include provisions for IWM planning, and both could be extended to include corridor-scale planning.

Enabling idea

4

Establishing adaptive revision triggers for PSPs

Current PSPs and mandated recycled water areas can become outdated as new knowledge and risks arise. To address this, an adaptive PSP process could be developed that includes compulsory, event-based or knowledge-based revision triggers. These triggers, such as significant changes in the state of knowledge or changes in related strategies that underpin a PSP, would ensure PSPs and IWM plans continue to reflect the latest scientific understanding and environmental conditions and achieve their stated objectives.

There are already precedents for this. Early examples of adaptive planning include Melbourne's Urban Growth Boundary Review, which updates PSPs based on new environmental and planning data, and Sydney's Metropolitan Strategy, which incorporates regular reviews to reflect changing conditions (City of Melbourne, 2019; NSW Government, 2018).

Changes to a PSP may have material financial implications for the development sector. The intent is not to unfairly change the rules of the game, and so safeguard mechanisms must accompany revision triggers.

Government can implement an adaptive PSP process by strengthening policies and regulations mandating regular reviews and updates, supported by adequate resources and governance structures. Capacity building for planners and stakeholders, and ongoing research and development also support adaptive planning and generate innovative solutions for urban water management (Wong et al., 2020).

Enabling idea

5

Shifting to an 'all options' approach to alternative water sources

Traditionally, water management has treated stormwater, recycled water and potable water as separate elements of the water cycle. However, a more integrated approach is required that optimises the use and management of all urban water sources. One approach leverages existing third pipe infrastructure to combine stormwater and recycled water into a unified resource, ensuring a reliable supply with high-security alternative water (Water Research Foundation, 2018).

The benefits of this approach are multifaceted. Treating stormwater and recycled water as parts of a single alternative water supply system minimises competition between these sources. This integration improves the reliability of alternative water supplies and further reduces reliance on potable water for non-potable uses (Melbourne Water, 2020), and makes the urban water system more reliable and predictable (CSIRO, 2017).

Enabling idea

6

Establishing effective governance structures

Assigning responsibility for oversight of the cross-functional process of headwater stream protection to a team within Melbourne Water could help to champion sustainable practices, including advising PSP development and updates, integration of WSUD and BSUD principles, and other relevant matters. This team could provide training, support and oversight, address regulatory and technical challenges, ensure compliance, coordinate stakeholders, and streamline planning and construction processes.

Another governance strategy involves mapping the roles of various entities in greenfield development to identify and resolve service level discrepancies that hinder headwater stream protection. Aligning service standards across these entities would involve harmonising regulations, streamlining approval processes and promoting collaborative planning from the outset. This approach would enhance coordination, ensure consistency in sustainable development practices and lead to better planning outcomes.

Enabling idea

7

De-risking the market for premium greenfield housing

One of the on-ground ideas for Aitken Creek is to adopt water sensitive housing typologies, including premium, higher-density options. This is novel for a greenfield growth area such as the Aitken Creek catchment, and developers may be wary of market risk in selling such a product.

Public institutions such as government and the water sector can play a pivotal role in de-risking this investment. There is a public good outcome in promoting sustainable housing in greenfield areas, and one way to achieve this is to build a market for premium development associated with sustainable, natural landscapes. There is also an opportunity for sustainable housing to command higher market prices due to long-term cost savings and its appeal to environmentally conscious buyers (World Green Building Council, 2013; US Department of Energy, nd). A de-risking policy needs well defined objectives, a good valuation proposition and a clear exit strategy.

There are precedents of public investment in pilot sustainable water projects, such as Aquarevo and Lynbrook in Victoria. Other models, such as sponsored design competitions and innovation incentives (e.g. grants or subsidies for developers), can foster cost-effective sustainable housing solutions.

Other supporting strategies include the following:

- Collaboration between government agencies, private developers, and community organisations is crucial for pooling resources and ensuring diverse perspectives are considered. This collaboration also provides an opportunity to design housing that caters to a variety of household types, such as singles, couples without children, and retirees, rather than focusing solely on 3-4 bedroom family homes.
- Engaging communities in planning and raising public awareness can create market demand for premium developments and housing.
- Addressing hesitancy in adopting new approaches involves evidence-based advocacy, supportive policies and regulations, and training programs for industry professionals.

Conclusion

This report highlights the critical importance of preserving headwater streams like Aitken Creek in the face of urban development. Headwater streams play a vital role in maintaining ecosystem health, biodiversity and water quality, yet they are under significant pressure from urbanisation and climate change. What is clear is the conventional approaches to waterway planning, urban planning and urban development are failing headwater streams, and change is required. This report outlines a multi-faceted approach to address these challenges, emphasising the integration of scientific research, traditional knowledge and innovative urban planning practices.

Key recommendations include implementing multifunctional waterway corridors, preserving natural stream features and adopting soil sensitive urban design principles. Innovative stormwater management strategies, such as precinct-scale stormwater harvesting and distributed detention solutions, are essential to protect these vital waterways. Additionally, the report advocates for integrating water sensitive and biodiversity sensitive design principles into urban planning to enhance both environmental and community benefits.

Effective protection of headwater streams requires a collaborative and innovative approach involving stakeholders from various sectors, including government agencies, developers, environmental organisations and local communities. Establishing dedicated governance structures, such as a headwater stream development team, and optimising regional integrated water management planning are crucial steps in achieving sustainable outcomes. Further, building a business case for sustainable housing can drive market demand for environmentally friendly development practices.

Overall, the report provokes discussion on alternative ways to plan urban growth in headwater stream catchments like Aitken Creek, ensuring their ecological, cultural and social values are preserved for future generations. By debating these recommendations, stakeholders can work together to mitigate the impacts of urbanisation and promote resilient, sustainable urban growth.

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Appendix 1: expert list

Name	Organisation
Kimjan Achilles	Yarra Valley Water
Assoc. Prof. Leon Barmuta	University of Tasmania
Julia Bennett	Hume City Council
Prof. Nigel Bertram	Monash University
Phil Birtles	Sydney Water
Stephanie Brown	Department of Energy, Environment and Climate Action
Dr Matthew Burns	University of Melbourne
Prof. Chris Chesterfield	Monash University
Dr Rhys Coleman	Melbourne Water
Luis Correia	Melbourne Water
Katharine Cross	Water Sensitive Cities Australia
Jamie Ewert	Alluvium Group
Prof. Alex Felson	University of Melbourne
Vivienne Fraser	Melbourne Water
Ben Furmage	Water Sensitive Cities Australia
Angela Ganley	Hume City Council
Alex Gunn	Department of Energy, Environment and Climate Action
Dr Belinda Hatt	Melbourne Water / University of Melbourne
Dr Moss Imberger	University of Melbourne
Dr Holly Kirk	RMIT University
Rephael Lankri	Wurundjeri Woi-wurrung Cultural Heritage Aboriginal Corporation
Chris Manning	Water Sensitive Cities Australia
Katy Marriot	Melbourne Water
Mohsin Rahman	Hume City Council
Dr Kathryn Russell	University of Melbourne
Dr Peter Sandercock	Jacobs
Jon Shinkfield	REALMStudios
Michael Simon	Water Sensitive Cities Australia
Jordan Smith	Wurundjeri Woi-wurrung Cultural Heritage Aboriginal Corporation
Jamie Tainton	Water Studio
Dr Geoff Veitz	Streamology
Smriti Venkatraman	Water Sensitive Cities Australia
Wira Yan	Jacobs

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