An Investigation into Integrated Urban Water Management and its implementation in Melbourne, Australia

A thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy

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Declaration
I certify that except where due acknowledgement has been made, the work is that of the author alone; the work has not been submitted previously, in whole or in part, to qualify for any other academic award; the content of the choose an item is the result of work which has been carried out since the official commencement date of the approved research program; any editorial work, paid or unpaid, carried out by a third party is acknowledged; and, ethics procedures and guidelines have been followed.

Casey Alexander Morton Furlong

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List of Thesis Publications

Journal papers (in order of appearance in thesis)


Reports (in order of appearance in thesis appendices)


Conference papers (published)


Conference papers (adapted post-conference into journal papers)


18. Furlong, C., De Silva, S., & Guthrie, L. (2016). Understanding Integrated Urban Water Management as an ideology, method and objective. *OzWater*, Melbourne, Australia, May 2016. *(I was invited by the Australian Water Association to redo my presentation from the Young Water Professionals conference because it was well received)*


Conference papers (abstract only)

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List of abbreviations

AWA  Australian Water Association
BAU  Business as usual
Capex  Capital Expenditure
CBA  Cost Benefit Analysis
CHMP  Cultural Heritage Management Plan
CSIRO  Commonwealth Scientific and Industrial Research Organisation
DELWP  Department of Environment, Land, Water and Planning (Victoria)
ESC  Essential Services Commission (Victoria)
GWP  Global Water Partnership
IUWM  Integrated Urban Water Management
IWRM  Integrated Water Resource Management
LGA  Local Government Area
MCA  Multi-Criteria Assessment
MWC  Melbourne Water Corporation
NPV  Net Present Value
OLV  Office of Living Victoria
Opex  Operational Expenditure
STP  Sewerage Treatment Plant
WSUD  Water Sensitive Urban Design
Preface (personal background)

Between 2011 and 2013 I was working in various teams within Melbourne Water Corporation (MWC), including the Integrated Water Strategy team. This team was involved in various elements of Integrated Urban Water Management (IUWM) including facilitating integration of traditionally segregated teams, integration between MWC and other organisations, planning wastewater and stormwater reuse projects, and also the IUWM strategies/plans that identified and assessed opportunities for such projects.

During this time I observed many difficulties and hurdles being faced by practitioners. Most of these hurdles related to the fact that IUWM is an emerging practice. There was limited experience and few existing policies and procedures to draw on. When dealing with practical issues such as contracts, funding and pricing for reuse projects, the team, and the wider department around the team, was forced to learn by doing. Various methods for conducting IUWM strategies/plans to identify and compare IUWM projects were implemented, and the process for each differed from the last. Overshadowing all of this work there was a lack of clarity around what the Victorian Government, and the state’s various regulators, wanted or would accept in relation to IUWM projects, such as how much additional cost could be justified and how.

Due to the emerging nature of IUWM there was also a lack of research on which to draw. Technical issues such as treatment train design and water quality specifications appeared to be relatively well understood. However it appeared to me that other practical issues relating to planning processes such as project management, risk management, option selection, and financial evaluation were not well covered by research. There were no detailed case studies of past IUWM project or strategy processes which could be used as the basis for future efforts.

These observations led me to instigate and design the current research and submit a research proposal to both MWC and RMIT University at the end of 2012. The intention of the research was to make some progress towards a systematic, documented understanding of IUWM, using case studies, in order to inform and improve future planning processes.
Summary

Integrated Urban Water Management (IUWM) is an emerging practice which involves, among other things, the integrated planning of water supply, sewerage and drainage services, and consideration of alternative water sources such as wastewater and stormwater reuse projects. These reuse projects are referred to in this thesis as “IUWM projects”. This research has aimed to deepen and increase the understanding of the IUWM concept, and the practicalities of its implementation within Melbourne. The primary methods of the research have included consultation with 43 experts from 25 organisations, an industry survey, and seven in-depth IUWM project planning case studies which are included in Appendix B. Over its seven body chapters (Chapters 2 – 8), the research covers a range of aspects which relate to IUWM as a concept, and the planning of IUWM projects in particular.

The first three phases of the research (Chapters 2 – 4) establish the research context. The research program began with a literature review on the international origins of integrated approaches in the water management field which determined that 26 different terms have been used to identify concepts similar to IUWM, tracking their use over time and comparing their definitions. Next, industry experts were consulted to conceptualise water governance arrangements in Melbourne, how they have changed over time, and what impact they have had on the implementation of IUWM. It was found that there is currently limited consensus within Melbourne’s water sector on how IUWM should be implemented, and that no particular governance structure is required to implement IUWM, so long as planning processes are well-designed. An industry survey was then conducted which further demonstrated that the term IUWM means very different things to different experts, and that there is a conceptual disconnect between the objectives associated with the IUWM concept, and the methods and approaches which are associated with it.

In order to gain a greater understanding of IUWM implementation, it was determined that some detailed IUWM project planning case studies would be required. The first step towards this goal (Chapter 5) was to research the history of planning theory, and then undertake a comparison of existing water planning conceptual frameworks in order to find a framework that could be used to enable systematic, consistent analysis of past IUWM project case studies. It was found that existing frameworks have a number of conceptual gaps, including the absence of iteration between planning recommendations and “decision taking” (approvals, financing and regulation). An original framework was created to fill conceptual gaps, and refined through consultation with industry experts.

Seven IUWM infrastructure project planning case studies (three wastewater reuse projects and four stormwater reuse projects) were then selected in collaboration with Melbourne Water Corporation for analysis using the original planning framework. Meetings were held with relevant project managers to determine the context, processes, and outcomes of each case study, and then documented in case study reports which are included in Appendix B.

It was found (Chapter 6) that these projects are being planned in a decentralised manner, with only one of the seven involving coordination from a metropolitan/city scale strategic process. It was also determined that many of these projects have experienced difficulties with approvals and implementation, with only three of the projects having been implemented. Major process impediments to implementation are demonstrated to be a lack of effective communication between key players, and the absence of agreed financial evaluation processes.
Through detailed analysis of case study processes (Chapter 7) it is demonstrated that (a) project risks need to be taken more seriously, (b) financial evaluations require more consistency and justification, and (c) the current funding avenues for IUWM projects, which have generally included Federal and State Government grants, may not be available in the future. Therefore it is proposed that some form of regional water industry forum or committee be set up, with representation from all water utilities and regulators, to function as a peer-review system for IUWM projects. This would enable Melbourne’s water industry to collectively determine which projects give the most benefit to the wider system and therefore which should be given priority access to available funding.

After the completion of the in-depth case study analysis one final investigation was conducted (Chapter 8). This involved an analysis of an additional nine case studies, this time on Melbourne’s IUWM strategy processes, which are the formal decision making and planning processes through which IUWM projects are often identified and considered. This investigation demonstrates how future IUWM infrastructure projects are being identified, and the difficulties and issues which are involved in this process. The analysis found a variety of inconsistencies between strategies in relation to setting of environmental and liveability objectives, and finds that by not utilising scenario planning the strategies failed to consider resilience to future uncertainties around population and climate change.

Overall it is concluded that IUWM is a loosely defined concept, with many associated objectives and methods. Further work is required to define various methods for implementing IUWM and comparing them in terms of effectiveness in various contexts. The narratives and case studies included in this research program provide initial examples of attempts to implement IUWM. These demonstrate that implementing IUWM is challenging and does not always work out as planned. Therefore the following specific recommendations are proposed for Melbourne’s water sector, as well as any other cities/countries which intend to adopt a similar IUWM approach:

1. All researchers and practitioners should carefully define IUWM and similar terms if they are to use them, as they mean different things to different people
2. During times of water sector reform, it is preferable that reform initiatives are led by professionals with some level of public water management experience, rather than private sector consultants and content-free business managers
3. Water infrastructure planning frameworks and processes should: (a) acknowledge and record when political and community preferences influence planning outcomes, (b) consider cost-apportionment implications of each potential infrastructure option, before putting forward a recommendation, and (c) be considered as iterative process between planning recommendations and “decision taking” (approvals, financing and regulation)
4. During the planning of IUWM projects, risks should be considered seriously during final decision making processes. It is not justifiable to assume that all risks can be dealt with through effective project management and stakeholder engagement
5. Regional and/or sub-regional collaborative policy, strategy development and oversight is required in order to promote effective creation and implementation of IUWM projects and strategies
Chapter 1: Introduction

1.1 History of Urban Water Management

Urban water management has traditionally involved the provision of water supply, sewerage and drainage services to customers through a network of buried pipes (Marlow, et al., 2013). In Australia these services are planned and managed by government owned water utility corporations, or municipalities, with oversight from state government departments and semi-independent economic, environmental and health regulators (Byrnes, 2013).

In recent history the urban water management field has evolved through a number of phases. This began with the construction of dams and the supply of water to cities. Due to public health problems associated with human effluent, the next phase of urban water management involved sanitation services, first via horse-and-cart, and later through sewerage pipes. This was followed by the creation of stormwater drainage pipes and retarding basins to prevent flooding (Brown, et al., 2009). Some countries utilise combined wastewater (sewage) and stormwater sewers, although this is not the case in Australia (Carleton, 1990). Traditionally these urban water systems have focused on “the protection of human health, ensuring reliable water supply and minimizing flooding; often with minimal consideration of the environmental and ecological impacts” (Sharma, et al., 2010).

A series of challenges has contributed to continual development of the urban water field up to the present day. The major challenges are population growth and migration, climate variability and climate change (Vörösmarty, et al., 2000; Alcamo, et al., 2007). Increasing populations, urbanisations, and the passage of time, have led to pollution, deforestation, intensive agriculture, water scarcity, urban flooding, aging infrastructure and many other issues (Grimm, et al., 2008; Sharma, et al., 2010).

From the 1970s onwards, in many developed countries such as Australia, environmental concerns have led to a focus on treating sewerage and stormwater to protect receiving environments from pollution and excess nutrients. This occurred initially through environmental regulations and sewerage treatment plant upgrades and then later through the treatment of urban stormwater (Brown, et al., 2009; Brown & Clarke, 2007).

The adoption of urban stormwater treatment technologies into cities is referred to in Australia as Water Sensitive Urban Design (Sharma, et al., 2012; Potter & RossRakesh, 2007), and in the United States as Sustainable Urban Drainage Systems and Green Infrastructure (Fryd, et al., 2012). The main technologies which are considered to mitigate the environmental damage of urban stormwater are wetlands, raingardens and swales (bio-filtration devices), and also rainwater (rain before it touches the ground) and stormwater (rain after it touches the ground) harvesting and reuse (Wong, 2006).

From the 1990s onwards water scarcity has in many countries led to a focus on alternative water sources such as water reuse (Asano & Levine, 1996). The most common type of water reuse globally has been the use of treated wastewater for agriculture, industrial cooling and river flow augmentation (Levine & Asano, 2004). In arid and semi-arid areas of the developed world, such as North America, Australia and southern Europe, wastewater reuse is particularly focused on agriculture (Sato, et al., 2013; Barker, et al., 2011). More recently there has been an emerging trend towards wastewater reuse for a wider variety of purposes. This includes both potable and non-
potable uses such as drinking, toilet flushing and garden and park watering (Grant, et al., 2012). In Australia there is currently no wastewater reused for potable purposes (Australian Academy of Technological Sciences and Engineering, 2013). Non-potable recycled water is in some localities delivered to residential and industrial customers through separate water supply pipes, known as “dual supply” or “purple pipes” (Ferguson, et al., 2013).

In Australia there is now also a push for stormwater harvesting and reuse for the potable and non-potable uses listed in the above paragraph. This is partially related to water scarcity and drought concerns, but also due to environmental concerns around the degrading effect of urban stormwater on waterways as part of the current climate of environmental awareness (Ferguson, et al., 2013; McArdle, et al., 2011), and also because these projects are considered to increase urban liveability (Hodge, et al., 2014).

In comparison to the provision of traditional water services such as water supply from dams, and wastewater and stormwater transfer to receiving bodies, wastewater and stormwater reuse increases the complexity of urban water management (Bell, 2012; Fam, et al., 2014). This occurs for many reasons including:

1. many reuse schemes and WSUD projects cannot achieve full-cost-recovery so need to be financed in innovative ways (Molinos-Senante, et al., 2013; Knights & McAuley, 2009)
2. larger variety of relevant stakeholder organisations due to straddling of traditional jurisdictional boundaries (both geographically and by involving multiple water services) (Makropoulos, et al., 2008; Mitchell, 2006)
3. reuse is an emerging practice, meaning there is a lack of experience to draw on (Makropoulos, et al., 2008; Mitchell, 2006)
4. a lack of clear regulations and government policies (Mukheibir, et al., 2014)

1.2 Integrated Urban Water Management

This brings us to the topic of this thesis: Integrated Urban Water Management (IUWM). As the various papers in this thesis will make clear, IUWM is a loosely defined concept, known by a variety of different names, and perceived in a variety of different ways. However as it is the focus of this thesis it is important at this stage to give a definition. The Global Water Partnership defines IUWM in the following way (Global Water Partnership, 2012):

*Integrated urban water management (IUWM) offers a set of principles that underpin better coordinated, responsive, and sustainable resource management practice. It is an approach that integrates water sources, water use sectors, water services, and water management scales:*

- *It recognises alternative water sources.*
- *It differentiates the qualities and potential uses of water sources.*
- *It views water storage, distribution, treatment, recycling, and disposal as part of the same resource management cycle.*
- *It seeks to protect, conserve and exploit water at its source.*
- *It accounts for nonurban users that are dependent on the same water source.*
- *It aligns formal institutions (organisations, legislation, and policies) and informal practices (norms and conventions) that govern water in and for cities.*
It recognises the relationships among water resources, land use, and energy.

It simultaneously pursues economic efficiency, social equity, and environmental sustainability.

It encourages participation by all stakeholders

Reports by international organisations such as the World Bank, Global Water Partnership and SWITCH project which use the term IUWM have a broader focus than much of the Australian literature (Global Water Partnership, 2012; Closas, et al., 2012; Howe, et al., 2011). In Australia, IUWM is specifically associated with the planning of wastewater and stormwater reuse into cities in order to provide alternative water sources and protect receiving environments (Mitchell, 2006; Ferguson, et al., 2013). IUWM in the sense that the term is used in this thesis specifically relates to:

1. coordinated planning of all water services (water supply, sewerage and drainage) (Mukheibir, et al., 2014; Makropoulos, et al., 2008; Dobbie & Brown, 2013)
2. consideration of decentralised wastewater and stormwater reuse opportunities (Mitchell, 2006; Ferguson, et al., 2013; Sharma, et al., 2010)

For the purposes of this thesis the researcher has conceptually separated IUWM into three parts: IUWM in general; IUWM strategies; and IUWM (infrastructure) projects. This has been done because IUWM as a concept is extremely broad and loosely defined, although IUWM as a strategic planning process, and IUWM as a physical infrastructure project, are specific practices. Therefore discussing the IUWM concept can be very confusing without making such a clarification.

“IUWM in general” refers to the definition above, as is the focus of Chapters 3 and 4.

“IUWM strategy” is used here to mean long term water infrastructure servicing strategies which compare all water infrastructure options for a specified area, with a particular focus on investigating opportunities for water reuse, and attempt to select and recommend the most beneficial infrastructure solutions. IUWM strategies are the subject of Chapter 8 in this thesis. One example of an IUWM strategy, taken from Chapter 8, is the “Pakenham East Servicing Plan 2015” which involved three organisations, investigated options for a new 6,500 lot residential area, attempted to find the best overall option out of five possibilities using cost benefit analysis, and recommended the implementation of either non-potable wastewater or stormwater reuse.

“IUWM (infrastructure) project” is used here to mean one specific decentralised stormwater or wastewater reuse infrastructure project. These are described as “decentralised” (Sharma, et al., 2010) because the economics of reuse require that reuse demand exist in relatively close proximity to the source water, and therefore such projects must be distributed throughout a city close to wastewater and stormwater sources (Marsden Jacob Associates, 2013). Generally after an “IUWM strategy” is completed, stakeholders make a decision about which “IUWM infrastructure project” should be implemented. Once this decision is reached further planning processes are employed to assess the chosen project. This more detailed planning process includes project management, risk management, technical evaluation, financial evaluation, funding, and approvals/regulation. IUWM infrastructure projects are the subject of Chapters 6 and 7, and Appendix B. An example of an IUWM infrastructure project is the Kalkallo Stormwater Harvesting project which has been built in Melbourne’s north (case study report included in Appendix B7).
This is further illustrated by Figure 1 taken from Chapter 8.

![Figure 1 - Visualisation of “IUWM strategies/plans” as opposed to “IUWM projects”](image)

It should be noted that the use of terms like IUWM, will have different connotations depending on the country, or city, in which it is being used. For example an integrated approach to water in the Netherlands will emphasise sophisticated drainage and flood mitigation approaches. An integrated approach to water in Israel or California is likely to focus on approaches to combining desalination and wastewater reuse technologies. There does not appear to be evidence that there is any methodology or set of detailed policies for implementing IUWM that have been adopted across a range of cities with different contexts and priorities. To avoid any confusion, this thesis focuses directly on the application of the IUWM concept within Melbourne, Australia. Although its findings are likely to be applicable to cities with similar climatic and socio-economic contexts, the direct comparison of water governance and infrastructure contexts across cities and countries is a task which is outside the scope of this thesis.

1.3 Situating the current research in relation to previous research

Each of the research chapters included in this thesis is in a publication format and has its own literature review. However none of these chapters include a discussion of how the overall research program is situated in relation to various academic research fields and institutions, and so this will be explored briefly in this section to help the reader in obtaining the correct frames of reference for this research. The intention here is not to duplicate literature review sections of later papers, but rather to explore how they fit together, and help the reader put the topic in perspective.

A logical point to begin such a discussion is with a statement outlining the discipline that the research fits within. This research is inherently interdisciplinary (Braga, 2001), but fits suitably within Civil Engineering, because Civil Engineers are at the nexus of urban water challenges (Galloway, 2012). It has elements which also relate to environmental engineering, project management, water resources, economics, policy studies, urban planning, and planning in a broader sense (such as strategic, rational, and business planning).

There are a number of academic institutions which have conducted substantial research into areas related to the current research program. One is the Cooperative Research Centre for Water Sensitive Cities which operates out of a number of major universities. The most notable research by this...
centre has been on the topic of transitioning towards Water Sensitive Urban Design and Sustainable Urban Water Management (Wong, 2006; Brown, et al., 2009; Ferguson, et al., 2013; Brown & Clarke, 2007). Another institution is the Melbourne Waterway Research-Practice Partnership which focuses on urban stream ecology (Walsh, et al., 2001; Walsh, et al., 2012). Also, experts from the CSIRO’s urban water department have continued to publish academic papers during and after their time at the CSIRO (Marlow, et al., 2013; Sharma, et al., 2010; Sharma, et al., 2009).

There are a number of major water industry funded research initiatives which have been conducted by academics and consultants. This research relates to IUWM planning (CSIRO, 2010), and specific planning processes for IUWM projects, such as risk management (Institute of Sustainable Futures, 2013), and financial evaluation (Marsden Jacob Associates, 2013), as well as research relating to potable reuse (Australian Academy of Technological Sciences and Engineering, 2013).

There also exists a substantial amount of literature written directly by water industry practitioners which deals specifically with the kinds of IUWM projects and strategies which are considered in the current research. Each of these papers generally records the narrative of IUWM projects (Price & Gale, 2014; Vanderzalm, et al., 2015; Ross, et al., 2014; Cunningham & Stapleton, 2013) or strategy case studies (Wilson, et al., 2013; O'Halloran, et al., 2012; Overman, et al., 2015).

A list of the literature review topics covered in each chapter is shown here:

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<td>8</td>
<td>IUWM strategies</td>
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A substantial proportion of the literature which is available on IUWM, is dedicated to the identification of “implementation barriers” (issues which are preventing the broader application of IUWM principles and practices). These barriers can be summarised as follows:

- Unclear, fragmented roles and responsibilities and unsuitable governance approaches (van de Meene, et al., 2011; Brown, et al., 2011; Furlong, et al., 2016; Lloyd, 2002; Roy, et al., 2008)
- Lack of regulatory incentives/framework (Brown & Clarke, 2007; Brown & Farrelly, 2009; Lloyd, 2002; Sharma, et al., 2012)
- Risk perceptions of practitioners, regulators and community (Brown, et al., 2009; Sharma, et al., 2012; Brown, et al., 2011)
- Lack of evidence of capital, operations and maintenance costs/requirements (Brown, et al., 2009; Sharma, et al., 2012; Sharma, et al., 2016; Roy, et al., 2008)
- Limited past experience (Sharma, et al., 2012; Marlow, et al., 2013)
• Lack of industry capability (Brown, 2005; Brown & Farrelly, 2009; Lloyd, 2002; Sharma, et al., 2016; Roy, et al., 2008)
• Absence of consistent financial assessment methodologies that capture externalities (Lloyd, 2002; Sharma, et al., 2012; Marlow, et al., 2013; Furlong, et al., 2017)
• Funding limitations (Brown & Farrelly, 2009; Sharma, et al., 2016; Roy, et al., 2008)
• Lack of communication between practitioners (Brown & Farrelly, 2009)

These previously identified implementation barriers have therefore been used to guide both the overall conceptual development of this thesis, as well as the specific research questions, as explained in the following section.

1.4 Research gaps, overarching aim and targeted questions

While keeping previous research and identified implementation barriers in mind, identification of further research gaps in this area is relatively straight-forward because IUWM projects are still “relatively new and involve increased complexity [and] there are wide knowledge gaps in their planning, design, implementation, operation and management, which are impeding their uptake” (Sharma, et al., 2010). Literature that exists on emerging water management practices “often contain aspirational proposals and little detail on how planning is being undertaken in practice” (Malekpour, et al., 2015). Therefore the process involved in identifying relevant research gaps involved identification of key issues of relevance, and then specific literature searching to determine if these issues are discussed in existing academic literature. Knowledge gaps which were found in the academic literature include:

1. No clear understanding of the origins of IUWM and how it relates to concepts such as Sustainable Water Management and Integrated Water Resource Management
2. Lack of detailed discussion of the recent governance structure changes (such as the implementation of the Office of Living Victoria) that have been implemented to facilitate efforts towards integrated planning in Melbourne’s water sector
3. Lack of research into industry perceptions of the meaning and specific methods of IUWM
4. Lack of discussion around appropriate frameworks for planning IUWM projects and strategies
5. Lack of understanding of how IUWM projects are currently planned and approved, at what scales and by whom
6. Lack of understanding of how detailed planning and business case development for individual IUWM projects is currently being done including:
   a. Risk management – how are risks being considered
   b. Financial evaluation – how are project financials being considered
   c. Funding – how are projects being funded
7. Lack of knowledge in relation to how IUWM strategies are being conducted to identify and compare potential future IUWM projects including
   d. Option identification and shortlisting
   e. Option selection and decision making
   f. Consideration of complex issues such as urban liveability, resilience and climate change
The overarching aim of the research was to deepen and increase the empirical understanding of IUWM and its implementation within Melbourne. The seven knowledge gaps identified above have been used as the basis for designing seven targeted research questions in order to enable the achievement of the overarching aim. These research questions each form the basis of one chapter/journal paper in the body of this thesis. The research questions are:

1. What are the international origins of integrated approaches to water management, how are these approaches referred to, and what are the differences between these terms?
2. What water governance structures are in place in Melbourne, how have they changed over time, and what impact has this had on the implementation of IUWM?
3. What are the industry perceptions of IUWM in terms of what it means, what it specifically involves, and how relevant it is as a concept?
4. What planning framework can be used to plan IUWM projects and assess IUWM project case studies?
5. How are IUWM projects currently planned and approved, by whom, and at what spatial scales?
6. How are risk management, financial evaluation and funding processes currently done for IUWM projects?
7. How are IUWM strategies currently being conducted, and how are they considering complex issues such as liveability, resilience and climate change impacts?

1.5 Research methods

1.5.1 Research philosophy and approach

Answering the research questions required a range of methodological approaches which are described in detail in the methods sections of Chapters 2 – 8. In order to approach such a diverse array of questions the researcher has been forced to adopt an overarching research philosophy of “pragmatism”, used here to mean prioritising “what is practical” above “what has been done in previous academic research” (Feilzer, 2010).

The questions addressed in this research program have been predominantly qualitative in nature. In order to answer these questions the researcher has undertaken the position of “researcher as observer”. In this role “the researcher observes a complex environmental management situation with an interest in understanding the factors at play” (Ison & Watson, 2007). The researcher has done this predominantly through industry consultations with a wide-range of experts.

In total 43 industry experts, from 25 organisations, have been consulted over 63 meetings. These experts have represented a range of organisational types as shown in Figure 2 below. A list of the experts consulted over the research program has been included in Appendix A. These experts were consulted at various stages of the research for various purposes as is described in the methods sections of Chapters 3, 6 and 7 and summarised in the Research Overview section below.

In order to gain in-depth information a qualitative embedded multiple case study approach (Yin, 2009) (described in Chapters 6, 7 and 8) and an industry survey (described in Chapter 4) were also employed. Figure 3 shows the major data source for each of the chapters of this thesis.
Figure 2 - Organisations types of consulted experts

Organisational types of consulted experts

- Retailer: 37%
- Government body: 18%
- Academic: 14%
- Bulk supplier: 7%
- Private: 12%
- Local Government: 12%

Figure 3 - Major data sources for each chapter

<table>
<thead>
<tr>
<th>Data source</th>
<th>Chapter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing literature</td>
<td>2. Analysing the terminology of integration in the water management field</td>
</tr>
<tr>
<td>Industry survey</td>
<td>3. Governance of IUWM in Melbourne, Australia</td>
</tr>
<tr>
<td>Consultation with 43 industry experts</td>
<td>4. Understanding IUWM as an ideology, method and objective</td>
</tr>
<tr>
<td>Seven in-depth IUWM project case studies</td>
<td>5. Developing a water infrastructure planning framework for the complex modern planning environment</td>
</tr>
<tr>
<td>Nine descriptive case studies of IUWM strategies/ plans</td>
<td>6. Planning scales and approval processes of IUWM projects</td>
</tr>
<tr>
<td></td>
<td>7. Risk management, financial evaluation and funding for wastewater and stormwater reuse projects</td>
</tr>
<tr>
<td></td>
<td>8. An empirical assessment of nine integrated Urban Water Management plans</td>
</tr>
</tbody>
</table>
1.5.2 Research overview

The first phase of the research involved investigating the context, in terms of international origins of IUWM, understanding the Melbourne water governance structures, and also determining the industry perceptions of what IUWM means.

This began (Chapter 2) with a thorough literature review into a variety of terms such as “Integrated Water Management”, “Integrated Water Resource Management”, “Sustainable Water Management” etc. Usage of terms over time was tracked, and definitions of terms were compared in order to establish to what degree terms represent similar concepts. This process enabled the researcher to piece together a narrative around the history of integrated approaches in the water management field.

Next (Chapter 3) Melbourne’s water governance structures were determined through a combination of literature reviews and industry consultation. A focus was placed on determining how these structures have changed over time and whether different structures have had an impact on the implementation of IUWM in Melbourne. Additional targeted consultations were held with experts who were involved in recent governance structure changes, and their opinions were sought on the effectiveness of recent IUWM efforts such as those by the Office of Living Victoria. These efforts by the Office of Living Victoria included a number of large scale “IUWM strategies”.

Following on from this (Chapter 4) an industry survey was conducted to clarify expert perspectives on IUWM, receiving responses from 34 industry practitioners by the time this Chapter was written. Survey responses are included in Appendix C. This survey included short answer open ended questions enquiring about what experts believed the term IUWM’s meaning includes, what the objectives of IUWM are, what specific methods IUWM involves, and also a multiple choice answer section enquiring how relevant the concept of IUWM is to urban water management efforts at the present time and in the future.

The combination of knowledge on international origins of IUWM, the Melbourne water governance structures, and water industry perspectives provided the required context from which to explore IUWM in more depth. It was determined that detailed “IUWM project” planning case studies were required, but that in order to systematically investigate case studies a consistent, generic planning framework would be necessary. This planning framework would provide the list of planning steps that should be investigated within each of the in-depth “IUWM project” case studies.

The next stage of the research therefore involved selecting an appropriate planning framework for this task. This was begun by a literature review on the history of planning theory in the general sense, from rational planning, through to more recent concepts such as strategic planning, and Lichfield’s “General Planning Process” (Lichfield, et al., 1975). The findings from this literature review were used as a frame of reference from which to view and compare existing planning frameworks which are referred to in water industry literature. It was determined that some issues identified in the literature review, were not covered in existing planning frameworks, and so an original framework was designed to fill these gaps. This draft framework was verified and refined through targeted consultation with water industry experts. The final version of the original planning framework includes nine planning components: Context, Integrated project management, Community & stakeholder engagement, Option identification & shortlisting, Technical evaluation, Option selection, Governance & regulation, Financing, and Outcomes.
Having completed the planning framework it was possible to begin selecting “IUWM project” planning case studies for in-depth analysis. This was done through identifying a long list of 14 potential project planning case studies and then selecting eight from this list. This case study selection process is described in the methodology section of Chapter 6. For the readers benefit this section of Chapter 6’s methodology is replicated here:

Through discussions with industry experts it was eventually agreed that eight nested project planning case studies should be investigated for this research. This number was selected on the basis that in order to answer the research questions it was absolutely necessary to investigate a spread of projects. A total of eight projects allowed the inclusion of public and private, small and large, utility and local government lead, successfully implemented and also projects which did not achieve implementation. If a spread of projects was not included it would not be possible to draw potential logical generalisations to the broader population (Thomas, 2011), in this case IUWM projects in Melbourne.

17 experts were consulted during this phase, in relation to selecting the most appropriate project case studies and also for collecting information on these. Selection was done through creating a long list of 14 case studies from which eight were selected. Criteria through which eight were selected related to a) availability of information – including factors such as documentation available and political sensitivity, b) independent/succinct planning processes, and to a lesser extent c) a spread of organisations, types of projects and project outcomes. The final selection was informed by a targeted workshop held at Melbourne Water Corporation with the Water Services Delivery team held in September 2014.

It should be noted that one of these eight was discontinued as a case study halfway through analysis, and so has been included in Chapter 6, but not included in Chapter 7, and never written up as one of the case study reports included in Appendix B. This case study was discontinued for two reasons: the research already included two case studies that were led by that particular water utility, and also that it was considered to be politically sensitive and controversial in some respects.

Case study data was gathered through meetings with experts from involved organisations, typically the project manager. Two meetings were held in relation to each case study: the first to establish the project background and processes and gather documentation, and the second to verify the information in the case study reports. Case study narratives were recorded in a consistent manner using the nine planning components listed in the original planning framework, allowing case studies to be easily compared to each other.

Analysis of the “IUWM project” case studies involved two phases. First case studies were analysed individually through documenting and interpreting the project narratives and perspectives of the involved expert(s) who were consulted in relation to which parts of the case study’s planning process worked well or did not work well. These seven in-depth case study reports are included in Appendix B. Second case studies were analysed in relation to each other to identify patterns and trends. This thesis includes analysis of the case studies in relation to specific issues listed in the research questions: planning scales and approval processes (Chapter 6); and Risk management, financial evaluation and funding (Chapter 7), which have been extracted from the case study reports.
Towards the end of the research program an opportunity eventuated to collaborate with MWC to investigate an additional nine descriptive (as opposed to in-depth) “IUWM strategy” case studies (see section 1.2 for definition). These recent “IUWM strategies” are the processes through which the next generation of Melbourne’s “IUWM projects” are being identified and selected for implementation. This investigation was already underway at the time that the researcher became involved, with case studies already selected and analysis already undertaken. The researcher’s role in this investigation involved exploring how these findings fit within the wider research and industry context. Without the researcher’s involvement this work would have never been published as an academic work, and a knowledge gap would not have been filled.

The final stage of the research program involved the authorship of the Introduction and Conclusion chapters of this thesis.

1.6 Thesis structure

This thesis includes 9 chapters. The current chapter is the Introduction, which has been designed to introduce the concept of IUWM, establish the focus of the research, and how the body chapters relate to each other in a cohesive narrative. Chapters 2, 3 and 4 set the context for the research.

Chapter 2 discusses the international origins of integrated approaches within the water management field, and compares the usage and meaning of popular terms, beginning to set the broader international conceptual context for the research. Chapter 3 investigates the water governance structures in Melbourne, how they have changed over time, and the impact of different governance structures have had on the implementation of IUWM, as well as giving a brief introduction to Melbourne’s recent “IUWM strategies”. Chapter 4 discusses the meaning of IUWM, and the specific methods that it involves, informed by the results from a survey sent to industry experts.
Chapter 5 explains the steps the researcher went through to develop a planning framework to use on the IUWM project case studies. This framework was used to develop the case study reports which are included in Appendix B. Chapters 6 and 7 discuss the case studies in relation to a number of specific issues: planning scales and approval processes; and Risk management, financial evaluation and funding. Chapter 8 discusses a set of “IUWM strategy” case studies.

Chapter 9 is a review and conclusion chapter which discusses the achievement of the research objectives, limitations of the research, areas which require further research, and the overall conclusions which can be drawn from the research program.

Please note: references for each body chapter are provided at the end of the appropriate chapter. References for the Introduction and Conclusion chapters are provided at the end of the thesis.
Chapter 2: History and terminology of integrated approaches in water management field

2.1 Introduction

This chapter considers the various terms that have been used to identify integrated approaches within the field of water management. The researcher was prompted to write this chapter predominantly due to their own confusion regarding the relationship between various, apparently similar terms such as “Integrated Water Management (IWM)”, “Integrated Water Resource Management (IWRM)”, and “Total Water Management”. This chapter also serves as a broad introduction to the field of water management, and its evolution over time, as part of establishing the context for this academic thesis.

The chapter also outlines an original argument that the proliferation of such terms has hindered knowledge sharing between scholars of various fields, and that knowledge sharing can therefore be increased through (a) scholars using the most widely recognised terms, and (b) scholars considering the proliferation of terms while undertaking literature searches. Post publication the researcher decided to adopt the terminology of “IUWM”, even though it is not the most frequently used term, due to it being used by high profile organisations such as the World Bank, Global Water Partnership and CSIRO.

This chapter is made up of a journal paper which has been published in Water Policy, a journal of the International Water Association, and its original appendices.

The practical implications of this chapter are:

- IUWM is not an Australian invention, its roots lie in a complex international development of ideas over more than a century.
- There are many different terms for concepts similar to IUWM, and so it is important for researchers and practitioners to clearly define concepts when they are used, both in terms of theories and in terms of practical applications and examples. Otherwise collaboration between practitioners and/or researchers will face limitations, as they will have trouble understanding each other. This is also true for the online dissemination of research and case studies.
Analysing the terminology of integration in the water management field

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Abstract

The idea that water management should take an integrated approach has become the global paradigm over the past two decades. This new paradigm has come to be known by many different names. This paper explores the use, history and meaning of these competing terms, and discusses the possible implications of this term-proliferation. The literature indicates that a minimum of 26 distinct terms have been used. The use of different terms appears to have underwritten a belief that each term identifies a distinctly different field of study. After analysing sample definitions and subject areas for the eight most frequently used terms, it has been determined that some terms do have fundamental differences and others are essentially the same. This unnecessary term-proliferation contributes to a ‘knowledge silo’ effect, impeding knowledge-sharing and research advancement within the water management field. It is recommended that both academia and industry start actively considering term-proliferation when searching and publishing literature.

Keywords: Integrated water management; Integrated water resource management; River basin management; Total water management; Urban water management; Water cycle management

Introduction

What does ‘integrated’ mean?

Beginning in the 19th century with the widespread construction of water reservoirs and sewered cities, the field of water management has traditionally operated within a relatively simple template: as a utility that provides services to customers. In this context water managers were responsible for meeting service standards for segregated services at the lowest cost possible. Having segregated services...
with their own service standards meant that separate water supply, sewage and drainage teams could monitor situations and wait until action was required. This ‘conventional’ approach was straightforward and aimed to avoid complexity by utilising large standard centralised solutions (Mitchell, 2006). Under this management style, in many locations the environment suffered from pollution and was largely neglected in decision making. Where environmental action was taken, it was usually targeted at well-defined, localised and independent problems (Vugteveen & Lenders, 2009).

Over the past two decades the field has gradually evolved to encapsulate a broader set of considerations, such as ecosystem protection, urban liveability and interactions with the economy. This shift in considerations was closely associated with the sustainable development agenda, which came to prominence over approximately the same period (Ioris, 2008).

To make informed decisions and pursue the goals of sustainability it became apparent that a change was required from the ‘conventional’ approach described earlier, towards an ‘integrated’ approach which considers multiple aspects and services in a coordinated way (Mitchell, 2006). The word integrated means desegregated and implies looking at the bigger picture, considering all relevant information or, in other words, viewing situations as a ‘whole’, made up of interconnected parts. In the field of water management the key difference between a ‘conventional’ and an ‘integrated’ approach is that the latter takes into consideration multiple competing objectives, contributing factors and the relationships between these variables.

This change from ‘conventional’ to ‘integrated’ is generally referred to as a ‘paradigm shift’. However, in the literature this new paradigm has been given many different names – including integrated water resource management (IWRM), integrated water management, integrated water cycle management, integrated urban water management, etc. In the literature these differing terms are usually accompanied by the authors’ opinions on what actually needs to be integrated, and some high level guidelines about how this should be done (Jaspers, 2003; Mitchell, 2006; O’Connor, 2010).

The opinions of experts appear to be, to a certain extent, based on local context and personal experience (Downs et al., 1991). Therefore this large variety of terms with differing definitions can be partially attributed to the fact that although the need for integrated approaches is universal, the exact factors that need to be integrated and the optimal process with which to consider them vary tremendously between situations. The context of a given situation has a large impact when selecting the appropriate concepts, such as: decision-making scale and boundary selection process, level of stakeholder input, institutional and legal arrangements, agricultural and economic considerations, technical and budgetary limitations, etc. (Vugteveen & Lenders, 2009). In some cases there is also contentious debate within a given context about the meaning and utility of terms. One notable example of this is the monocentric versus polycentric management debate common to river basins in developing countries (Lankford & Hepworth, 2010).

The history of integrated approaches

One way that the water policy field can be conceptually separated is into the three highly interrelated components of what, who and how. ‘What’ refers to objectives and standards such as sustainability and water security, ‘who’ refers to water governance and institutional arrangements, and ‘how’ refers to the processes through which water is managed. This paper deals primarily with the ‘how’ component, and seeks to develop a better understanding of what theories exist and in what ways they differ. Although some existing management styles differ substantially, the complex and interrelated nature of water issues in the modern age requires that all management styles include an integrated approach on some level (Biswas, 2004). In the interest of conveying the general history of the topic in the simplest possible way, the authors have at
various points in this paper used the term ‘integrated approaches’ to refer to all of the integration-related terms covered. The differences between these terms will be explored later in this paper.

The exact origins of integrated approaches in the field of water management appear to be contested in the literature; however, this is largely due to the fact that different aspects emerged at different times. For example, the idea of considering environmental impacts in decision making was realised decades ago, whereas social and liveability considerations within urban areas are relatively new and not widely practised (Mukhtarov, 2008).

The literature suggests that there is a commonly held belief that concepts of integration in the water management field did not exist before they were discussed in a series of global summits in 1977, 1992 and 2002. However, a brief scan of the literature quickly reveals that some aspects have been around much longer (Mukhtarov, 2008). Two authors make the case that some integrated concepts such as downstream water re-use, diverting excess water to groundwater recharge, participatory water tribunals and organising water management on the basis of river basins can be identified in Spain as far back as the Middle Ages (Rahaman & Varis, 2005; Vivas et al., 2009).

In modern history the first records of the use of integrated approaches in water management occurred in the United States in the early 1900s. Some of the first terms that were used to describe these concepts were ‘rational comprehensive planning’ and ‘multiple-purpose water construction’ (Mukhtarov, 2008). These terms were involved in the broader idea of ‘river basin management’ which was based on the idea that river basins were the ‘natural’ unit for water management (Warner et al., 2008). Some authors argue that the exact origins of integrated approaches to water management can be traced back to the USA Flood Controls Act of 1917 or the establishment of the Tennessee Valley Authority in 1933 (Gallego-Ayala, 2013). These ‘river basin management’ concepts were very much centred on the construction of dams on a river for multiple purposes (Warner et al., 2008).

In the 1950s, the term IWRM was first used by the United Nations (UN) (Mukhtarov, 2008). This was part of the broader concept of ‘integrated resource management’ which can be described as ‘the sharing and coordination of the values and inputs of a broad range of agencies, public and other interests when conceiving, designing and implementing policies, programs or projects’ (Mitchell, 1990).

In the 1970s and 1980s, the water management field started to shift towards having more of an emphasis on environmental considerations (Warner et al., 2008). In this period many terms were created around the concepts of ‘ecosystem based approaches’ such as ‘holistic river basin management’ (Downs et al., 1991).

At the 1977 UN Conference on Water, held in Plata Del Mar, for the first time a large proportion of the international community began to discuss the need for integrated approaches to water (Biswas, 2004). The idea did not become widespread until it began to gain momentum after the two UN Conferences held in 1992, where ideas were formalised into Chapter 18 of Agenda 21, recommending the adoption of integrated approaches for water management. In 2002, at the World Summit on Sustainable Development, recommendations were made that IWRM plans be made for all river basins around the world by 2005 and, in the years following, IWRM was largely adopted around the world as the way to achieve sustainability in the water sector.

Consolidating this process, the Global Water Partnership (GWP) suggested that the following definition for IWRM be adopted:

‘A process, which promotes the coordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems’ (Global Water Partnership, 2000).
The term IWRM and the interpretation above have become the most widely used terminology for integrated approaches within the water management field (Rahaman & Varis, 2005; Mukhtarov, 2008). However, despite this apparent international consensus, in the period following this process many other terms with similar definitions have appeared in the literature.

Even though the term IWRM and the concepts and practices behind it were accepted by a large proportion of the international community following the World Summit on Sustainable Development, there are a substantial number of experts who hold the view that IWRM is too rigid and that a one-size-fits-all top-down management approach is not suitable for every situation (Lankford, 2008). Some authors hold the view that IWRM often fails to incorporate significant issues, such as irrigation, by not adapting to local contexts through the role of polycentric governance and citizen participation (Lankford et al., 2007).

It was from this viewpoint that the ideology of adaptive water management (AWM) was spawned. Although there are some differing opinions on what form AWM should take, the literature is consistent on the point that management processes should be continually revised and updated in order to continually improve and tailor them to particular situations (Pahl-Wostl et al., 2007; Bruch, 2009; Lankford & Hepworth, 2010).

Unlike the AWM ideology which emerged as a conscious challenge to the generally accepted IWRM paradigm, some other terms do not explicitly challenge the IWRM paradigm and in many cases do not refer to IWRM at all. As no emphasis is placed on the difference between the IWRM concept and the concepts of these terms, it is not always clear to what extent terms differ from IWRM and from each other. As the distinctions between the majority of terms are not immediately obvious, it is logical that conceptual analysis should be employed to provide further insight into what differences exist between terms.

Before attempting to determine the potential impact of terminological issues on the water management field it is prudent to take a moment to consider the current state of the field itself. There are numerous problems that exist within global water management. One problem is a lack of knowledge-sharing or, as Biswas (2004) phrased it, ‘sitting in water-tight cages and preaching holistic approaches’. Another problem commonly discussed is the ‘absence of strong and legitimate institutions to promote water governance’ (Gupta et al., 2013). Some consider it a problem that politics intrudes on the ability of specialists to manage water-related problems (Blomquist & Schlager, 2006). Lankford (2008) argues that the typical water management approaches are often theory-facing rather than problem-facing and this leads to strategic level planning being insufficiently context aware. In summary, as Gupta et al. (2013) state, societies on all scales are struggling to deal with global water governance and its implications.

**Analysing the terminology of integration**

As mentioned in the previous section, there are many problems that exist in the water management field. There are a number of factors that contribute to and exacerbate these issues. It is the opinion of the authors of this study that the large variety of terms is a factor that slows progress within the field by aiding the creation of knowledge silos. One piece of evidence that points to this conclusion is the way literature reviews are conducted. An example of this can be seen in the literature review conducted by Gallego-Ayala (2013) in which the researcher searched for the terms IWRM and Integrated Water Management but not Integrated Urban Water Management, Total Water Management or other
terms. In the paper’s analysis section, concepts are discussed which are highly relevant to the urban sector such as water supply augmentation, the economic value of water, and climate change. The literature review in question therefore has not included a large proportion of the literature, and thus has reduced value for water policy makers.

In the light of this, the authors propose that the terminology used is a matter of some importance in the consideration of water policy. The authors Downs et al. (1991), Medema & Jeffrey (2005) and Vugteveen & Lenders (2009) agree that the terminological issues are of importance and their work will be discussed in this section.

Several preliminary reviews of different terms have previously been attempted. A study conducted in 1991, before IWRM became widely adopted, determined that there were at that time already between 21 and 36 different terms being used to describe ‘the paradigm of a unified approach to basin management’ and suggested ‘that there are advantages to be gained by using terms in a standard way’ (Downs et al., 1991); in its conclusion, the study discussed the perceived difference between two popular terms, ‘comprehensive basin management’ and ‘integrated basin management’, before ‘ provisionally recommend [ing]’ that ‘holistic river basin management’ be used in certain circumstances.

A study in 2005 sought to answer the question ‘IWRM and Adaptive Water Management: synergy or conflict?’ and concluded that both terms had similar drivers, that theoretically they complemented each other, and not enough was known about the practical application of either to answer the question (Medema & Jeffrey, 2005).

Another study in 2009 discussed the meanings of 10 competing terms and found that they could be grouped into two categories; holo-centric terms which are conceptually rooted in human issues, focusing on factors such as social considerations and stakeholder consultation, and eco-centric terms where eco-systems are considered the major structural and functional units (Vugteveen & Lenders, 2009).

The authors have not discovered a clear and up-to-date record in the literature on what terms exist, their relative popularity, and to what extent their meanings and associated concepts and practices differ. Also there has not been any serious discussion of potential impacts that the existence of these numerous terms may have had on knowledge sharing.

This paper sets out a preliminary review of a large set of integration-related terms. The objectives of this study are to identify the most popular integration-related terms, compare the popularity of terms, investigate their respective meanings and associated concepts, and to make an initial assessment of what potential impact term proliferation may be having on knowledge sharing.

Method

Identification of terms

The first stage involved surveying a sample of the available literature in order to identify and catalogue the various terms that include the aspect of integrated approaches in water management.

This process began with a reading programme that set out to select papers that involved a general connection to the use of integrated approaches in relation to water management. This collection of 80 papers was deliberately undertaken in a sporadic fashion, as the main aim was to achieve diversity and breadth within the field. The diversity that was sought included a variety of institutional types, including state, academic and industry sources, a broad representation of countries of origin and of a diverse range of disciplines such
as ecology, economics, water management, public and environmental policy, etc. The papers were drawn from a range of sources including online databases such as Scopus, and the online libraries of Elsevier and the American Society of Civil Engineering. The papers that were collected are predominantly academic but this set also included a variety of reports from public and private organisations.

The process for this involved the researchers screening the literature for repeated terms and assessing from stated definitions, and/or context, whether terms were being used to identify integrated approaches. In the majority of cases the terms appeared in the title, abstract or key terms, making identification easier. The most obvious inclusion criteria was the presence of the words ‘integrated’ and ‘management’ in phrases that were repeated throughout. In other cases where the trigger term ‘integrated’ was not present, a closer reading sometimes identified related themes, such as concepts related to ‘total’, ‘adaptive’ or ‘sustainable’ water management. In such cases further analysis was required to determine if the term did in fact include an integrated approach. The output of this process was a list of distinct terms.

Data collection

The second stage of the study involved collecting historical data on the use of terms from an online literature database. The use of terms was recorded against time and between subject areas.

Following the identification of distinct terms, the researchers were then able to use database search functions to quantify the frequency of use over time for individual terms. There are currently two online literature databases which are able to facilitate this process: Scopus and Web of Science. The Scopus database was selected on the basis that it has a larger total collection, due to the inclusion of low impact journals (Chade-gani et al., 2013). Scopus has search functions which display relevant information about search results. By utilising one of these functions, researchers were able to easily view the number of search results each year. The frequency of use of each term was recorded in 5-year periods and graphed over time.

The graphical representation of the frequency of use of terms over time enabled the researchers to draw correlations between the trends shown on the graphs and the broader global context, for example global summits and ideological movements such as the sustainable development agenda. In order to further understand the use of differing terms, the body of literature for each term was separated into subject areas. This was undertaken using a Scopus search function in the same way that the year of publication was determined.

Comparison of definitions

The third stage of this study involved collecting and interpreting the definitions given to terms.

This process took the form of collecting and then comparing the stated definitions of terms. The number of identified terms (31) was deemed too large to facilitate this process and therefore it was conducted for only the nine most used terms from Table 1. It was originally planned that for each of the selected terms, the two most cited academic papers featuring the term in their title would be collected, and have definitions extracted from them. However, it became necessary to adapt this plan mid way, as it was found that the most cited academic papers do not always include definitions of the terms that they are using. In such cases less cited papers were referred to. Definitions were then able to be compared within each term, and between each term. In keeping with previously conducted studies, an attempt was then made to analyse terms with regard to their conceptual content in order to ascertain what components are included within each of the terms.
Identification of terms

Terms were first identified from the initial readings and compiled into a list. The process identified 31 distinct terms that were seen to potentially include the use of integrated approaches; these are displayed in Appendix A1 (available online at http://www.iwaponline.com/wp/017/185.pdf). The count of the number of initial readings that included the respective term is shown in the column ‘Initial readings’. A search for the respective phrase was then conducted on the Scopus online database, and the total number of results and the year of the earliest result were recorded in the ‘Scopus database’ and ‘Earliest recorded use’ columns. The 10 overall most popular terms are displayed in Table 1. As predicted in the introduction, Integrated Water Resource Management has been the most frequently used term.

It became evident that Sustainable Water Management and Sustainable Water Use are terms that identify the goal of sustainability but do not indicate a method or approach. The literature is quite consistent in this matter (Liu et al., 2008; Makropoulos et al., 2008) and therefore it was decided that, as these terms do not include the concepts of integrated approaches, they should not be represented in the ‘frequency of use’ graphs.

With a few exceptions, such as Integrated Urban Water Management being over-represented in the initial readings, it can be said that there is a fair correlation between the counts in the initial readings and the relative number of results found during the Scopus database search. It should be noted that the earliest recorded use in the Scopus library is not necessarily the earliest actual use in the literature, as no online database contains the entirety of the literature on any topic.

Data collection

The total number of Scopus search results for each term was recorded in time periods, starting with pre-1979 and then in 5-year blocks from 1980 onwards. Figure 1 shows the results for the eight most used terms that include an integrated approach. The collected data can be seen in Appendix A2 (available online at http://www.iwaponline.com/wp/017/185.pdf).

Table 1. Frequency of use within initial readings and Scopus database, as well as earliest recorded use of the 10 most used terms.

<table>
<thead>
<tr>
<th>Terminology</th>
<th>Initial readings</th>
<th>Scopus database</th>
<th>Earliest recorded use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated water resource management</td>
<td>32</td>
<td>992</td>
<td>1966</td>
</tr>
<tr>
<td>Integrated water management</td>
<td>39</td>
<td>523</td>
<td>1970</td>
</tr>
<tr>
<td>Sustainable water management*</td>
<td>3</td>
<td>484</td>
<td>1984</td>
</tr>
<tr>
<td>Integrated watershed management</td>
<td>2</td>
<td>196</td>
<td>1984</td>
</tr>
<tr>
<td>Integrated river basin management</td>
<td>2</td>
<td>181</td>
<td>1986</td>
</tr>
<tr>
<td>Sustainable water use*</td>
<td>1</td>
<td>171</td>
<td>1997</td>
</tr>
<tr>
<td>Water sensitive urban design</td>
<td>1</td>
<td>124</td>
<td>1999</td>
</tr>
<tr>
<td>Integrated urban water management</td>
<td>7</td>
<td>89</td>
<td>1990</td>
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<tr>
<td>Total water management</td>
<td>1</td>
<td>67</td>
<td>1970</td>
</tr>
<tr>
<td>Adaptive water management</td>
<td>3</td>
<td>36</td>
<td>1995</td>
</tr>
</tbody>
</table>

* Determined as not indicating the use of integrated approaches.
Figure 1 clearly shows the rise in popularity of the term IWRM in the period 2000–2004. The graph also shows a steady increase in use for almost all terms. This is certainly partially due to an increasing interest in the field, but it also may be affected by the Scopus database being more likely to contain more recent papers, and a global increase in the total number of publications. It should also be noted that the period displayed as ‘2010–’ (meaning 2010 until August 2013) does not represent a full 5-year period and therefore the dips that can be seen on the right of the graph do not represent an actual decline. This same data is displayed in Figure 2 below as a percentage of total term use over the same time periods.

![Use of term over time](image1)

Fig. 1. Use of terms over time.

![Dominance of terms over time](image2)

Fig. 2. Dominance of terms over time.
Figure 2 makes certain parts of the overall story easier to interpret, for example the dominance of the term Total Water Management prior to 1980. It also shows that the terms Water Sensitive Urban Design and AWM are relatively new, and that Integrated Watershed Management, Integrated River Basin Management and Integrated Urban Water Management have all maintained a relatively consistent percentage of the total field. As could be seen in Figure 1, Figure 2 also illustrates once more the decisive shift from Integrated Water Management to IWRM between 2000 and 2004.

Comparison of definitions

Appendix B1 (available online at http://www.iwaponline.com/wp/017/185.pdf) displays two definitions for each of the eight most used terms that include the use of integrated approaches. Definitions have also been shown for Sustainable Water Management, a term that does not include the use of integrated approaches, and also for ‘integrated approach/assessment’, which was used by this paper as an overarching term in the introduction.

As stated earlier, after a careful reading of the provided definitions it can be confirmed that Sustainable Water Management differs from the other terms. Sustainable Water Management is a term used to describe the goal of sustainability. As a goal rather than a management style, it can be determined that this term does not include the use of integrated approaches. Once definitions were collected, an attempt was made to compare the terms against each other regarding their conceptual components.

The process involved in the creation of Table 2 was unavoidably subjective and based only on stated definitions rather than underlying concepts and practices. In the opinion of the researchers, all of the terms shown include the use of integrated approaches.

Figure 3 shows the use of terms within a number of subject areas. The actual data can be found in Appendix A3 (available online at http://www.iwaponline.com/wp/017/185.pdf). IWRM, Integrated Water Management and AWM display similar distributions across subject areas. Integrated River Basin Management and Integrated Watershed Management display a decreased proportion of use in engineering, and an increased proportion in earth and agricultural sciences. Finally, the terms Total Water Management, Water Sensitive Urban Design and Integrated Urban Water Management show an increased proportion of use in the business, engineering and mathematics areas, and a decreased proportion in the areas of earth and agricultural sciences.

Discussion

Integrated approaches, in different forms and identified by different names, have gradually become widespread in the field of water management over the past few decades. The use of many of the terms increased dramatically around the year 2000. This increase can be partially attributed to the 2002 World Summit on Sustainable Development, and subsequent actions taken by the UN and other international organisations, such as the Global Water Partnership, to promote the uptake of IWRM plans throughout the world.

The study has discovered that there are at least 26 different water management terms being used that include the concepts of integrated approaches. Interestingly it can be shown that terms are still being coined, with twelve new terms being created over the past 10 years, as can be seen in Table 1. Figure 2 indicates that prior to 1980 the most popular term was Total Water Management; since that period, the
Table 2. Concepts included in each term.

<table>
<thead>
<tr>
<th>Water resources/fields</th>
<th>Economic &amp; financial considerations</th>
<th>Environmental considerations</th>
<th>Social considerations</th>
<th>Strategic perspective (long-term) and demand for water supply and use</th>
<th>Management systems</th>
<th>Adaptive learning processes</th>
<th>Coordination between institutions</th>
<th>Urban areas</th>
<th>Always hydrological boundaries</th>
<th>Agriculture &amp; rural areas</th>
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<td>Integrated water resource management</td>
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<td>Integrated water management</td>
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<td>Integrated watershed management</td>
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<td>Integrated river basin management</td>
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<td>Water sensitive urban design</td>
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<td>Integrated urban water management</td>
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<td>Total water management</td>
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<td>Adaptive water management</td>
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terms Integrated Water Management and IWRM have dominated the research field, although the results indicate a recent shift towards the use of less well-known terms.

**Differences between terms**

After analysing the definitions of the 10 most popular terms it was determined that the meaning of all except Sustainable Water Management and Sustainable Water Use included the concepts of integrated approaches. Sustainable Water Management is a goal or aspiration rather than a management style (Liu *et al.*, 2008).

Of the remaining eight popular terms that do include the concepts of integrated approaches, there are fundamental differences between some of them. The authors of this study propose that the differences between the definitions of terms are largely caused by two factors. The first is variance in the spatial context both between and within countries, meaning that different situations require different management styles, and the second is personal experience, including the discipline that authors are versed in. As Biswas (2004) states: ‘water problems of the world are neither homogeneous, nor constant or consistent over time’ and clearly different circumstances call for different responses. These differences in context have partially contributed to the proliferation of terms. The most obvious distinction between terms is whether they relate to an urban or rural area; however, some distinction can also be made between the socio-economic status of countries and the management review process.

Water management concepts that need to be considered vary between rural and urban areas; therefore the differentiation between rural and urban is a logical distinction. For example, it is common for water managers working in rural/agricultural areas to take the view that decisions should be made along hydrological boundaries, as this is generally considered to be the ‘natural’ unit for water management, although that claim is thoroughly contested by some authors (Warner *et al.*, 2008). In rural areas it is also typical that land use planning, stakeholder consultation and water allocations take high priority (Jaspers, 2003). The terms that typically align with these priorities are IWRM, Integrated River Basin Management, Integrated Watershed Management and AWM. Davis (2005) argues that IWRM is often used within developing countries and is almost always carried out along hydrological
boundaries. Warner et al. (2008) state that IWRM is Integrated River Basin Management at the broadest scale. AWM was designed as a conscious objection to the one-size-fits-all approach of IWRM (Pahl-Wostl et al., 2007).

In contrast to this, an urban water manager is likely to be of the view that decisions should be made along urban planning or metropolitan zones, and centred on the three major sectors of water supply, sewage and stormwater (Mitchell, 2006). This leads to an emphasis on infrastructure solutions that provide benefits to more than one sector, such as sewage and stormwater recycling plants (Chanan & Woods, 2006). Some of the terms commonly associated with these priorities are Integrated Urban Water Management, Total Water Management, Whole-of-water Cycle Management and Integrated Water Cycle Management. In the opinion of the authors of this paper there is no clear distinction between the meanings of these terms. There are some cases in the literature where urban water managers in developed countries have used the history of IWRM as justification for urban-centred theories around integration (Wallington et al., 2010). This practice is questionable as there are distinct differences between IWRM practices and those used in urban areas.

Integrated Water Management as a term is often used in both a rural and urban context. There are many cases within the literature where authors appear to use certain terms interchangeably with Integrated Water Management. In these cases the other terms used typically align with the urban/rural distinction. Some examples of this are Geldof (2002), who uses Integrated Urban Water Management interchangeably with Integrated Water Management, and Rahaman & Varis (2005) with IWRM and Integrated Water Management.

The findings above provide justification for sorting terms into three categories: rural-centred, urban-centred and the umbrella term of Integrated Water Management. The subject area results in Figure 3 provide further support for these categories, with the proportions of engineering increasing in urban areas, and the proportions of earth sciences and agricultural sciences increasing in rural areas.

There are also many cases where the definitions of terms appear highly similar but differences can be noted in associated concepts and practices. Further analysis supports this finding that the terms’ definitions alone are not able to convey all of the associated concepts and practices, as well as the different ways ideas are applied across the world. One example of this is IWRM, the broad and vague definition of which does not carry all of the varying opinions about how it should be put into practice (Biswas, 2004). Integrated Watershed Management has a definition very similar to that of IWRM, however, in practice, there are differences. Integrated Watershed Management appears to be more often used in developed countries and often takes polycentric organisational forms (Blomquist & Schlager, 2006).

Within each term there are also many debates surrounding how these terms should be implemented on a practical level. One example of this is within AWM where there are differing opinions on whether water management should have a formal, regulatory approach or a more decentralised approach (Lankford & Hepworth, 2010).

The implications of term proliferation

The creation of different terms has the potential for leading to a belief that each term identifies a distinctly different field of study, creating pockets of knowledge that do not fully share or interact with each other. In the corporate world, this concept is referred to as the creation of ‘knowledge silos’ (Pemsel & Muller, 2012). The researchers found many examples where an author using a particular term explains
why that term/ideology is different and in some way a necessary advancement in understanding. In such cases the author often appears to have a tendency to refer to papers that use the same term.

There are of course other factors contributing to the lack of knowledge sharing in the water management field. There are knowledge gaps created by language and geographical and political barriers. There is also a knowledge-sharing problem between academia (that often publishes theoretical research but does not always have practical experience) and industry (that has practical experience but often does not consult the available research or disseminate findings in the scientific literature).

If knowledge silos are being created, this represents a significant risk to the continuing development of the water management field and may impede knowledge sharing, preventing researchers from developing a clear understanding of what research has previously been conducted and causing studies to be repeated unnecessarily rather than learning from previous research.

Perhaps the most compelling evidence that term proliferation hampers knowledge sharing and contributes to the creation of knowledge silos is the case mentioned in the introduction, which can now be considered in the context of the popularity of terms. It can now be demonstrated that, by only searching for IWRM and Integrated Water Management in the literature review, Gallego-Ayala (2013) could potentially access only 1515 out of the 3050 papers (less than 50 per cent) available on Scopus that relate to the concepts under consideration.

Conclusion

Knowledge silos have the potential to negatively impact water policy objectives. In order to reduce the impact of knowledge silos, it is the recommendation of this paper that researchers and water managers need to start actively considering term proliferation when searching and publishing literature. It is also recommended that the umbrella term. ‘Integrated Water Management’ be used in place of all the urban-centred terms or, as a minimum, that they are mentioned in the key words of journal papers. In the case of rural-centred terms, it has been found that there are some fundamental differences between terms and they should therefore not be conflated, although Integrated Water Management should still be mentioned in the key words. It is considered that these actions will improve knowledge sharing in the water management community.

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References


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Chapter 3: Water governance structures in Melbourne, Australia

3.1 Introduction

This chapter describes the water governance structures in place in Melbourne, how they have changed over time, and the impact of various structures on the implementation of IUWM. The role of this chapter in the current thesis is to establish the governance and political context for IUWM in Melbourne, and provide a brief introduction to: (a) the IUWM project case studies which are explored further in Chapters 6 and 7; and (b) the IUWM strategies conducted by the Office of Living Victoria (OLV), referred to here as “sub-regional plans”. Two of the IUWM strategies conducted by the OLV are explored further in Chapter 8. The scholarly significance of this work is predominantly in the detailed description of IUWM initiatives undertaken by the OLV between 2012 and 2014. Such a detailed and critical account of real-world IUWM initiatives is extremely rare within the body of knowledge.

The chapter is made up of a journal paper which has been published in a special “water governance” issue of Utilities Policy, an Elsevier journal. It was originally written as a conference paper for the Redrafting Water Governance conference held at the University of Lisbon in 2015.

The practical implications of this chapter are:

- IUWM implementation does not require any specific governance structure, as long as planning processes are well designed and implemented in a way that promotes effective collaboration
- IUWM implementation does not necessary lead to positive results, if it is not implemented effectively
- It is not yet known whether IUWM strategies/plans can be effectively created over a large geographical area, as there are many practical hurdles to overcome
- Unnecessary political interference can create difficulties for urban water management outcomes. Politically motivated reforms may fail, as they are generally motivated by ideology rather than evidence, and are likely to be pushed through quickly (before the next election)
Governance of Integrated Urban Water Management in Melbourne, Australia

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A B S T R A C T
The Integrated Urban Water Management (IUWM) paradigm, including concepts such as water reuse, and Sustainable Urban Drainage Systems, has become popular within Melbourne, and this has created new governance issues. This paper explores the relationship between changing governance structures and IUWM implementation. It is found that IUWM implementation has predominantly been accelerated by: a major drought, and implementing the Office of Living Victoria (OLV) as an overarching body. Efforts by the OLV have increased inter-agency collaboration, and institutionalised integrated planning. However, there is still no consensus on what the specifics of IUWM planning and infrastructure arrangements should actually look like.

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1. Introduction
1.1. International context

The management of water is of crucial importance to both humanity and the natural ecosystem. Traditional urban water management involves the delivery of segregated water supply, sewerage and drainage services to residences and industry via a network of buried pipes and open channels (Marlow et al., 2013). Historically as urban populations have grown, urban water managers have systematically upgraded and increased the size and scale of water infrastructure to meet specified service targets. These upgrades generally involved the construction of new dams, river diversions, groundwater extractions, and larger sewerage and drainage pipes and channels (Mukheibir et al., 2015).

As the global population has increased dramatically over the past century many areas of the world are beginning to, or have already, passed sustainable environmental limits (Gleick, 1998). These sustainable environmental limits affect both water quality and water quantity issues (Biswas, 2004). Major water quantity issues such as droughts, ground and surface water depletion, and flooding are all affected by regions passing the limits of what local environments are able to sustain (Bouwer, 2000).

Water quality issues are generally related to various forms of manmade pollution from inadequate sewerage systems, point source pollution from industry, and diffuse pollution from agriculture. These quality issues often exacerbate water quantity issues by making existing water unsuitable for human consumption through contamination of ground and surface water resources (Carpenter et al., 1998). Human induced water quantity and quality issues contribute to the destruction of the earth’s natural environment, and its ability to sustain human as well as plant and animal life (Vitousek et al., 1997).

All of these issues are now being multiplied in terms of effects, and also in terms of uncertainty, by climate change, population growth and migration, and unsustainable farming practices (Howden et al., 2007). The United Nations has predicted a global water deficit of 40% by 2030 (UN Water, 2015). Physical water challenges have created growing concern across the planet and increased attention from governments, industry and researchers (Heathcote, 2009). It has become well established that traditional water management approaches are not sufficient to deal with these emerging water challenges (Bell, 2012).

In response to these global challenges a series of major international summits were held in 1977, 1992 and 2002 (Mukhtarov, 2008). Out of these conferences emerged the wide-spread adoption of the Integrated Water Resources Management (IWRM) approach, which includes the key principles of integrated...
management, seeing water from economic, social and environmental perspectives, and the participation of communities and women (Global Water Partnership, 2012). IWRM has typically been considered at either the regional or river-basin scale (Warner et al., 2008).

1.2. Water governance for Integrated Urban Water Management

In parallel to the evolution of IWRM, water challenges have also been considered specifically from an urban perspective and related ideologies have emerged such as Integrated Urban Water Management (IUWM) and Water Sensitive Urban Design (WSUD) (Furlong et al., 2015).

IUWM can be described as a strategic long-term planning approach to urban water management which considers all water services, sources, stakeholders, and impacts in order to create the best possible community outcomes (Closas et al., 2012). Implementing IUWM requires the inclusion of a greater number of actors in decision making, integration with urban planning, understanding trade-offs between multiple competing objectives, and the coordination of multiple water sources including from decentralised reuse schemes (CSIRO, 2010).

The World Bank’s Water Partnership Program strongly supports the implementation of IUWM, stating that “An IUWM approach that... focuses on the integration of water supply, sanitation, and drainage with urban planning, and takes into account water resources... may provide an opportunity to avoid infrastructure lock-in in expensive traditional solutions” (Closas et al., 2012).

WSUD has similarities to IUWM in terms of its original definitions and in terms of its practices and messages can be considered as a subset of IUWM (Furlong et al., 2015). WSUD is a term widely used in Australia to describe an approach of incorporating Sustainable Urban Drainage Systems (SUDS), also known as green infrastructure, and reuse schemes into urban planning. This is done in order to improve liveability outcomes, through providing more plants and trees in streetscapes, and environmental outcomes, through protecting waterways from the damaging effects of urban stormwater runoff (Brown et al., 2009).

Growing physical water challenges make having appropriate water governance arrangements crucially important. The Global Water Partnership defines water governance as “the range of political, social, economic and administrative systems that are in place to regulate development and management of water resources and provisions of water services at different levels of society” (Rogers and Hall, 2003).

Implementing IUWM as a planning approach, and WSUD as an objective, makes the practice of urban water management even more complex, and this in turn makes the implementation of effective governance structures even more important. Delivering IUWM requires either designing new institutions, or improving the cooperation or co-ordination between existing institutions through governance structures (Da Silva et al., 2010).

1.3. Focus of this paper

This paper will focus on the correlation between water governance structures and the implementation of IUWM. In order to explore this relationship the narrative of water governance structures in Melbourne, Australia, a city that has begun to widely implement IUWM, will be used as a case study. A series of nested infrastructure projects, and servicing strategy development case studies, have been explored as part of a wider research program. These nested case studies will not be specifically discussed but will be woven into the narrative to highlight the impact that various governance structures have had on IUWM and WSUD outcomes. The history of Melbourne’s traditional water management functions, including water supply, wastewater and drainage service provision, up until around 2011, is covered in work in this area, such as Fam et al. (2014), Byrnes (2013), Ferguson et al. (2013), and Abbot (2011). The major international research program known as “SWITCH” has also produced a case study on Melbourne’s city centre, which highlighted the implementation of WSUD and water conservation efforts (Mitrotta, 2011).

However, these articles do not cover the significant governance changes which have occurred since with the establishment and then subsequent removal of the Office of Living Victoria (OLV) as an overarching water industry body. Therefore the period between 2011 and the present day is the main focus of this paper.

Previous academic work in this area by those such as Fam et al. (2014) and Ferguson et al. (2013) has used social science concepts of “transitions frameworks” and “multi-level perspectives” to discover how Melbourne was able to achieve its transition towards IUWM. These works imply a cumulative improvement in the water field away from the old, “bad” way of doing things towards the new, integrated, “good” way of doing things. Previous discussion is shaped in this way due to an idealised and simplistic view of what IUWM is. Literature related to planning in the water sector “often contains inspirational proposals and little detail on how planning is being undertaken in practice” (Malekspour et al., 2015).

IUWM, just like IWRM, can be considered as a “nirvana concept”. Nirvana concepts are “attractive yet [vague] concepts ... [which] typically: a) obscure the political nature of natural resources management; and b) are easily hijacked by groups seeking to legitimize their own agendas” (Molle, 2008).

Works from outside of the water management field, such as from the field of planning theory, have long put forward the view that planning is not rational, objective and scientific (Furlong et al., 2016a). In reality planning is subjective, political, and affected by personality conflicts (Lane, 2001). Lindblom (1959) famously described planning as “the science of muddling through”. It is hypothesised that the implementation of, and transition to IUWM, which involves the activities of large populations of planners, managers, and policy makers, with their own personalities and established views, is not as straightforward a story as is represented in existing literature. In order to deliberate on this hypothesis this paper will explore the actual mechanics of water management and governance since implementing IUWM in Melbourne. Through doing this, a more balanced, nuanced, complex, and realistic picture of IUWM will be painted, and a deeper understanding of the impacts of governance arrangements on IUWM will be gained.

2. Methodology

2.1. Wider research program

This paper forms part of a larger research program investigating IUWM infrastructure planning being undertaken by RMIT University in collaboration with Water Research Australia. As part of the wider research program, 36 leading water sector experts have been consulted on a range of aspects relating to water management, planning and governance. Additionally, seven infrastructure projects, and nine servicing strategy development case studies have been conducted to compare different approaches to water planning in Melbourne over time.

These case studies are concerned with specific examples of IUWM implementation between 2008 and 2015, and were selected through collaboration with Melbourne’s water utilities and the City of Melbourne. Case studies were analysed using the planning framework described in Furlong et al. (2016a) which includes the
following nine elements: Context, Integrated project management, Community and stakeholder engagement, Option identification and shortlisting, Technical evaluation, Option selection, Governance and regulation, Financing, and Outcomes and evaluation.

Each of these case studies is currently being finalised for publication on the Water Research Australia website. This database of knowledge is being used to write a series of academic papers. The first considers the planning scales and approval processes involved in these case studies (Furlong et al., 2016b). The current paper is the second, and draws on the case studies and the industry consultation findings to consider water governance in Melbourne and its relationship with IUWM. Two future papers by the authors will address: financial evaluation and risk management processes used in the case studies; and refining the concept of IUWM into a variety of specific methods.

2.2. Current paper

The methodology for the current paper is summarised in Fig. 1, and was designed to develop a narrative of facts, in combination with expert opinion, in order to consider the relationship between governance structure and IUWM. The work has been exploratory in nature, and original in content, although its methodology has similarities to existing papers such as Fam et al. (2014) and Ferguson et al. (2013), mentioned in the introduction.

In order to examine how water governance has changed in Melbourne over time it was necessary to divide the chronology into a number of phases. Existing papers on Melbourne, such as those mentioned above, have already segregated most of Melbourne’s history into phases. Four phases were synthesised from these papers, and we then added two more recent phases, to create a total of six phases which are considered in this paper. There is some overlap between these phases because some are defined by legislated arrangements while others are contextual e.g. drought.

Although extensive consultation within the water industry had already been undertaken, researchers considered that some further detailed information and expert opinion were required in relation to the actual workings of water governance in the more recent phases. A set of five experts, three who had already been consulted previously, and two who had not, were selected by researchers on the basis that they were directly involved in recent governance arrangements. These five content experts were engaged in another round of consultation.

The consultation style utilised by the authors changed and evolved over time depending on who was being interviewed and what stage in the overall research program the consultation was to occur. In the early stages of the research, the authors approached consultations in a relatively unstructured manner, asking experts to expand on their experiences in the water sector and what they believed to be the major problems and opportunities for IUWM in Melbourne. As the process went on, consultations became more structured, to identify, and then gather information on specific case studies, and then focus on water governance changes. Information from all meetings was recorded in meeting minutes and sent to experts for corroboration.

Information from consulted experts, the 16 nested case studies, as well as academic papers, and government and water sector reports were then synthesised to create a narrative of water governance structure changes within Melbourne. This was possible to do because the case studies consider strategies and projects from the year 2008 until 2015, and reveal how the various governance phases have affected the implementation of IUWM. Conceptual analysis was then undertaken to determine what the implications of this narrative are for the relationship between water governance structures and IUWM implementation.

Due to the extremely political nature of criticising current or previous government approaches to water governance, the experts involved in the second round of “targeted” consultation which delved into the mechanics of water governance issues during recent years have requested that they not be named or formally acknowledged.

The authors of this paper acknowledge that this piece is not a representation of “objective truth” for a number of reasons. Firstly there is no such thing as a neutral expert. Therefore experts from both the wider consultation and targeted consultation will have their own subjective opinions and views. Secondly the authors themselves may have approached this work with inbuilt biases. Thirdly opinions on planning processes and outcomes which have become politicised are difficult to validate, because there is a lack of documented evidence.

With all this being the case, the researchers have attempted to approach the task in such a way that if another researcher was to replicate the methodology they would be likely to arrive at the same results and conclusions. It is believed that the expert opinions expressed in this paper, both positive and critical, are generally representative of the wider water industry views which are expressed informally throughout the industry.

3. Phases of water governance and IUWM in Melbourne

In Australia, water is governed by state governments rather than federally. This is partially due to the large distances between states and partially due to the states being unable to agree on water issues at the time when they joined in federation to become a country (Abbott et al., 2011).

Water governance institutional responsibilities in Melbourne can be separated into five functional categories: policy, service provision, economic regulation, environmental regulation, and health regulation (Byrnes, 2013). Environmental regulation by the Environmental Protection Authority, and health regulation by the Department of Health, has remained consistent in Melbourne over time. Therefore the narrative given here will focus on policy and service provision, with mention of economic regulation made where appropriate.

Water governance structures in Melbourne have changed over time. For the purposes of this paper these changes have been delineated into six phases (see method). For each of the phases a description will be given of: the relationships and division of authority between key actors, associated benefits and problems, and discussion of impacts on IUWM. Simplified diagrams of governance structures have been provided to aid understanding.
The phases which will be explored here run from pre-1990 through to the present day and are listed as: pre-corporatisation, corporatisation/division, government intervention during drought, “golden age of recycled water”, establishment of an overarching body, and the current era.

3.1. Pre-corporatisation (Before 1991)

Between 1891 and 1991 the majority of water, wastewater and drainage service provision was undertaken by a large monolithic institution named the Melbourne and Metropolitan Board of Works (Fam et al., 2014).

Even though water, wastewater and drainage services were being conducted by one institution, the planning of these services was not integrated. Each service had its own policy, planning and implementation team, and these teams operated within “silos”, in the sense that they had little to do with each other (Dingle and Ramussen, 1991). These silos are reflected in the overarching Water Act 1989 under which the Board and its successor operates; the Act has separate divisions governing Water Supply, Sewerage and Waterway Management. It accounts for the fact that the expansion of the metropolitan sewerage system did not keep pace with that of the water supply system and remains so to this day (Auditor General Victoria, 2006). Compared to the present day, the MMBW operated with relative independence from the State Government with whom the relationship was often testy (Dingle and Ramussen, 1991). Water governance structures in Melbourne over this period are illustrated in Fig. 2.

![Fig. 2. Water governance in Melbourne pre 1991.](image)

According to personal reflections of one of the consulted experts MMBW had an inefficient corporate structure in the sense that it tended towards having the character of local government rather than a commercial enterprise. In the experts opinion MMBW was overstaffed, and in some years there was not enough work to keep all staff occupied. The expert remembered that one drawing or letter would often need to be signed-off on by many different signatures, and that the highly unionised work force made any change difficult.

This culture of inefficiency led the State Government to shift water planning and policy out of MMBW into a government Water Resources Department in 1985, and then MMBW being corporatized in 1991 (Abbott et al., 2011).


In 1991 the MMBW was corporatized and had its name changed to Melbourne Water Corporation (MWC). MWC was initially still very inefficient. It had a poor culture, too many managers, and a lack of direction. Downsizing began and continued throughout this whole period. In 1995 another round of reform began whereby MWC was split into four entities, three retailers (Yarra Valley Water, City West Water, and South East Water) engaging in reticulation and retailing of water and sewerage, and MWC retaining bulk water supply, most sewage treatment, major drainage and waterway protection functions (Abbott et al., 2011). The Department of Water Resources which was responsible for water policy was merged with other government departments to form the Department of Sustainability and Environment (DSE) (Byrnes, 2013). Regulation of water pricing became the jurisdiction of the newly created Office of Regulator General from 1995 (Abbott et al., 2011).

The separation of the three retail companies was done to facilitate “benchmarking competition” i.e. so regulators could compare the performance of the companies (Abbott et al., 2011).

However according to the consulted experts this idea of competition by comparison was never able to be conducted with any weight because of different circumstances and context within which each of the retailers operate. However downsizing continued and over time the retailers became what one expert described as “lean and mean”, with a focus on cost-efficiency and improved customer service. Water governance structures in Melbourne over this period are illustrated in Fig. 3.

![Fig. 3. Corporatisation and division.](image)

It has been argued by some that the disaggregation of water governance structures caused the de-coupling of decision making and implementation, resulting a number of years later in inefficient supply augmentation investments being made without adequate analysis (Crase et al., 2007).

The evidence appears to suggest that these water sector reforms did not begin the shift towards IUWM in Melbourne, and other than downsizing and streamlining of institutions there was no real drive for changing the way water management and planning was done until the millennium drought began having an impact on Melbourne’s water resources around the year 2000.

That being said, in 1996 a number of water conservation measures, and ideas for recycled water already existed, including plans for supplying non-potable recycled water to houses (Anderson, 1996). Some sewage effluent was used to irrigate farmland at Melbourne’s largest sewage treatment plant, although large scale recycling did not start til 2005 (Barker et al., 2011).

Melbourne’s major “Millennium drought” began in 1997 and continued to worsen until 2007 (Ferguson et al., 2013). This water resource crisis caused the Labor Party, who were in power of the State Government at the time, and their environment and water related department (DSE), to take a more active role in water management functions. This was done through the creation of five regional water strategies which were conducted in collaboration between all water authorities and government. As part of taking a more active role in water management the State Government replaced the Office of Regulator General in 2000 with the Essential Services Commission (ESC) (Abbott et al., 2011).

Through the creation of these strategies water authorities began to acquire a much broader mandate and set of considerations. Ideas which were discussed as part of these strategies included: water efficiency measures, public awareness campaigns, stakeholder engagement, climate change, river and groundwater systems sustainability, pricing and allocation mechanisms, and tourism. The first strategy in 2002 recommended the creation of a 20% water recycling by 2010 target (Water Resources Strategy Committee for the Melbourne Area, 2002). Another strategy in 2005 considered a variety of potential water supply augmentations including water recycling projects (DSE, 2005). Water governance structures in Melbourne over this period are illustrated in Fig. 4.

According to the consulted experts, over this period, water management in Melbourne became highly political with a high degree of influence exerted by the Labor State Government (through DSE) onto water authorities. The latter were told what they could and could not talk about publicly. Long term water supply and demand planning for the city was similarly limited by the inability to put prescribed measures on the table, even for the sake of discussion. These included the construction of new dams and seawater desalination because of the perceived damage to the Government’s environmental credentials, while rural-urban water trading and transfer of water from North of the Divide were considered too upsetting for the farming lobby.

In 2006, Melbourne’s storages experienced their lowest inflows on record; the severity of the situation was such that the Labor State Government over-ruled the recently completed, dutifully complying Melbourne Water Supply-Demand Strategy to immediately plan for Australia’s biggest desalination plant (150 GL/year capacity), and also a 70 km inter-basin pipeline to connect the Melbourne system to the Goulburn River. These investments added up to AUD$4.9 Billion in capital (DSE, 2007). The cost of the desalination plant when operating costs are included is expected to be AUD$18.3 billion over 27 years (Cook, 2014a). The combined capacity of these projects is equivalent to about 64 per cent of Melbourne’s water consumption (Productivity Commission, 2011).

According to the consulted experts, MWC undertook the modelling which informed the government decision to build the desalination plant, although it was the Labor State Government that made the call, and few in the water sector understood why the government decided on the 150 GL/year size. This size was equivalent to more than a third of Melbourne’s annual consumption. One consulted expert expressed that a very severe lack of transparency was present in water infrastructure decision making over this period.

A State Government election was held in 2010 in which the Labor Party lost to the Liberal party. Since the construction of the 70 km North-South pipeline and desalination plant neither of these have ever been used to supply water (Ker, 2010; Cook, 2014a). These projects resulted in widespread community outcry (Ferguson et al., 2013) which was largely drummed up by the incoming Liberal State Government, who was keen to discredit its predecessor. A belief was instilled in the Victorian community that recycled water and stormwater harvesting projects would have resulted in a better outcome for the community (Porter, 2013), although this claim is open to debate.

However despite this lack of transparency, it was the occurrence of the drought, and the strategies, expanding mandates, grants and targets that followed, which laid the groundwork for innovation and a transition towards IUWM within Melbourne’s water sector. When the period ended there was a greatly increased awareness of both water conservation and alternative water sources (Fam et al., 2014).


The term “golden age of recycled water” is commonly used within the Melbourne water industry to describe the period where it was easier to receive government funding and endorsement for reuse schemes, including stormwater harvesting schemes.

During the drought water storages dropped to the point where strict water restrictions were put in place. These restrictions limited outdoor water use, and impacted severely on private and public gardens, parks, sportsgrounds and street trees. This created liveability, health, and environmental concerns which were taken very seriously by the water sector. And so in the period that followed the end of the drought water managers felt that their mandate had truly expanded to being that of custodians of Melbourne’s environment, and liveability, in addition to the health of the population. This mindset, combined with the slowly establishing ideologies of IUWM and WSUD, became engrained in both the culture and the structure of Melbourne’s water utilities. Teams were set up in utilities with names like “Integrated Water Strategy”, “Water Recycling”, “Alternative Water”, and these ideologies, although criticised by some in relation to economics, eventually became accepted as the norm in the water industry (South East Water, 2010; Melbourne Water, 2009).

The Millennium Drought concerned not just one state of Australia, but affected most of the country. As a result, the federal government prepared the National Urban Water and Desalination Plan which provided 50% subsidies for water saving initiatives with a total budget of around AUD$700 million (Department of Environment, n.d.).

This AUD$700 million fund, in combination with the 20% water
reducing target for Melbourne, made it possible to implement IUWM projects which could not achieve full cost recovery. Management and regulatory support on all levels created a “policy window”. These projects included recycled water and stormwater harvesting projects. Ferguson et al. (2013) cites that in 2012 there were 108 stormwater harvesting schemes in operation in Melbourne, many of these operated by local government and private companies, and large swaths of residential developments with mandated recycled water dual pipe systems.

Three project case studies considered by this research, including two recycled water and one stormwater harvesting projects, received approval partially due to government support, targets, and grants which constituted the “policy window” which was open during this period of 2006–2011 (Furlong et al., 2016b). Water governance structures in Melbourne over this period are illustrated in Fig. 5.

Consulted industry experts expressed differing views in regards to whether these subsidised/mandated schemes represented good value for money. In the planning of these schemes water utilities had a tendency to consider federal government funding as “free” money, and therefore only sought to justify their 50% contribution rather than justifying the total cost. The same can be said of the 20% recycling target, since, as the utilities were obligated to meet this target, recycling schemes were not subjected to the standard level of strict financial scrutiny.

In 2011 the Productivity Commission, a government research and advisory body, recommended that “in general, the Australian, State and Territory Governments should cease providing subsidies for water, wastewater and stormwater infrastructure” (Productivity Commission, 2011).

Happening in parallel to the implementation of IUWM projects, was the implementation of WSUD legislation and funding arrangements. In 2006 as part of the Sustainable Neighbourhood provisions, Clause 56.07-4 was implemented which required all major new residential developments to include stormwater treatment. Also in 2006, MWC began its Living Rivers program which gives 50% subsidies to local government to help them implement stormwater management projects such as rain gardens (biofilters), swales and wetlands (Hussey and Kay, 2015). This program alone has contributed to the construction of 633 rain gardens, with many more being constructed as part of new developments funded purely by developers to meet Clause 56 provisions.

3.5. Establishment of an over-arching urban water governance body (2012–2014)

Due to the public unease over the huge expense of an unused desalination plant, throughout the years from 2012 to 2014, water management issues became highly politicised and both major parties developed new policy platforms focused on IUWM that were aimed at the public appeal. As a result of the long drought having engendered a strong public consciousness of the value of water, rainwater tanks, stormwater harvesting and wastewater recycling were rapidly gaining currency as the new green ideology. Dual pipes installations in new housing estates became major selling points. The incoming Liberal Party government made water reform a major topic in order to leverage off the perceived desalination plant “failure” by the previous government (Ferguson et al., 2013).

According to one industry expert “the first casualty” was the Melbourne Water Supply-Demand Strategy of 2011 with its 50-year outlook, begun under the old Government but finished under the new. The Strategy suggested intensive development of alternative water sources and put great efforts into financial justification for these projects. The Strategy was never allowed public release because the new Government was convinced by its advisors that a much more truly integrated water strategy could be formulated.

The Liberal Party State Government in 2012 implemented a reform which was intended to provide greater independence to their urban water policy division by moving it out of a government department into a statutory authority, known as the Office of Living Victoria (OLV) (Byrnes, 2013). This organisation was established to develop long term water planning frameworks, implement a range of productivity and efficiency reforms, and provide greater transparency in decision making. Its agenda included coordinating urban water planning, increasing industry capacity for IUWM and reforming regulations to clarify roles and responsibilities associated with alternative water sources (Ministerial Advisory Committee, 2012). Water governance structures in Melbourne over this period are illustrated in Fig. 6.

According to the consulted experts, IUWM in Melbourne pre-dated the establishment of the OLV. However as part of a political point scoring exercise, the incoming Liberal government used the
example of the desalination plant to associate the previous Labor government with the old paradigm of large, centralised water supply projects.

As stated earlier in this paper, the water sector was already moving towards IUWM, with integrated planning and alternative water source functions being formalised in utility processes. In addition, rainwater tanks had enjoyed a steep growth, stormwater harvesting projects were numerous and many dual pipe installations had come into fruition (Ferguson et al., 2013).

Other than the practical functioning of the OLV, a number of other non-water specific issues occurred including allegations of improper conduct with regard to tendering, staff employment and conflicts of interest (Baker and McKenzie, 2014a; Victorian Ombudsman, 2014) and a lack of transparency with the public (Baker and McKenzie, 2014b). As part of the State Government Fairer Water Bills Initiative leading up to an election, the OLV required other water companies to cut costs, while simultaneously spending millions on staff and consultants in processes that lacked transparency, accountability, and visible results (Baker and McKenzie, 2014c).

Following a highly critical Ombudsman Report in 2014, the OLV’s independent status was removed, and then at the end of 2014 the OLV was absorbed back into a government department (Cook, 2014b).

3.5.1. Functioning of the Office of Living Victoria

It is at this point in the record that existing academic literature falls silent, and therefore this section, until the end of Section 3.6, is predominantly informed by the two rounds of industry consultation previously described. What follows is an attempt at a balanced and thoughtful description of the benefits and also problems which occurred in relation to establishing the OLV as an overarching urban water industry body, which directed Melbourne’s water utilities into new activities. In an effort to reduce unnecessary repetition the authors have reframed from beginning each sentence with the phrase “consulted experts were of the opinion that”. It should be considered that any opinions expressed in these sections are the opinions of the consulted experts, not of the authors.

The functions of the OLV can be divided into: legislative reform including changes to bulk water and pricing agreements, and third party access to water sources and infrastructure; policy development including how IUWM should be done; and sub-regional water planning functions.

In relation to legislative reform the OLV approached problems with a “private sector zeal” which according to one expert “was perhaps slightly misguided.” As stated earlier in this paper, the reforms happened so fast that it was a “hard adjustment for some stakeholders.” OLV senior management believed they had to “crash through” bureaucratic intransigence and resistance to their reform agenda; that public service inertia and entrenched views and processes would stymie effective and timely change (Victorian Ombudsman, 2014).

The OLV embarked on an ambitious reform and policy agenda for the metropolitan water sector as detailed in its document, Melbourne’s Water Future covering almost every aspect of water-related servicing. The document is especially strong in advocating IUWM, extolling its many virtues while making no mention of potential drawbacks. Three scales of planning and implementation were identified: developing a metropolitan planning framework, sub-regional plans, and local plans. Most activity was focussed at the sub-regional scale and some activity at the level of local governments. It should be noted that prior to the OLV, Government departments had never been involved directly in detailed water planning below the metropolitan level, this being left to water companies.

The OLV began developing its sub-regional “whole-of-water-cycle” (WOWC) plans very early on in its operation. Melbourne was divided into five sub-regions: west, north, central, east and south-east and teams led by the OLV were set up to deliver on the first three in the list. The original ambitious time frame was lengthened repeatedly, growing from months to years as the complexity of the task soon became apparent.

3.5.2. Sub-regional plans

The OLV began the development of whole-of-water-cycle sub-regional plans without first developing an overarching methodology or framework. Because of this a number of questions were not adequately answered before the development of sub-regional plans began. These questions include:

1. What does it mean at a practical level to “integrate” the planning of water supply, sewerage, drainage and waterway health?
2. How can the boundaries of a single plan be logically defined?
3. What exactly is the existing problem that has to be solved by this new approach?
4. How would the plan differ in a greenfield area against a brownfield and what would it look like in a diverse subregion comprising greenfield, brownfield and rural swathes?
5. What exactly are the linkages across different scales of planning and should the approach be top-down or bottom-up?
6. And how can different servicing options be assessed against each other to arrive at the optimal option and what exactly is “optimal” anyway?

Problems arose in the lack of appropriate tools and methodological guidelines. Existing hydrologic and hydraulic tools for instance, were designed to model only one aspect of the water cycle. Attempts to account for the non-monetary benefits of IUWM proved problematic while the elusive concept of “liveability” became the subject of multiple studies (Melbourne Water, 2014). Rather than the straightforward process it was envisioned, subregional planning became an experimental laboratory of tools and guidelines evolving in conjunction with the actual plans themselves. As stated by the CEO Mike Waller “the reform path [was] incremental and to some degree experimental, when often the outcomes of one discrete project defined the scope of work for the next step” (Victorian Ombudsman, 2014).

The process was indeed strong in terms of stakeholder consultation with frequent meetings and workshops bringing together water companies, councils, government departments and consultants. Not all of these were appreciated by the attendees with one interviewee expressing frustration at the cost in time and effort and the lack of value. Another did not feel that it was appropriate to commence the planning process by bringing stakeholders together and asking them what they want, with the result being that small and large issues had to be given equal weight, as for instance, a council keen to improve park amenities against the water company having to manage frequent sewer overflows.

Precinct Structure Plans (PSP) – master plans for whole communities — were being developed and implemented for particular local areas at the same time as large scale modelling and analysis was being conducted. Once a PSP is completed it is far more difficult to implement IUWM and WSUD solutions. This means that once a

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1 It is important to note that the critiques included here are issues relating to governance, direction and process, not personal capability of the planners and managers involved. It is entirely unavoidable that there are process issues to iron out when implementing an entirely new thing such as a detailed and integrated water plan for one quarter of a major city.
decision was reached about what should be done in an area, then it is possible that it will be too late to implement the recommended arrangement. The OLV, which reported to the Water Minister, wanted the planning of these local areas to slow down, but the Planning Minister wanted them to speed up, providing an interesting example of competing objectives. The process for these subregional plans began in 2012 and, as of mid-2015, none of the first three subregional plans (west, central and east) has been published. However, a number of potentially useful tools have been developed including a set of technical Guidelines for Subregional Analysis, a template to undertake cost-benefit analyses and the valuing of some externalities based on a review of willingness to pay studies. On the other hand, the attempt to develop an integrated system modelling tool stalled.

3.5.3 Impact and lasting legacy of the OLV

The OLV was endowed with a Living Victoria fund of AUD$50M to give out grants to worthy IUWM projects (Victorian Ombudsman, 2014). Some infrastructure projects were financed through this fund, including the Albert Park Stormwater Harvesting Scheme and a number of small-scale stormwater and rainwater harvesting schemes. A substantial proportion of the funding scheme went to non-physical “projects” such as assessment tools, and strategy development (Walsh, 2014; Pearson, 2015). There was a lack of alignment between the purpose of the fund and the eligibility criteria used to assess applications, a lack of risk assessment, funding agreements were not always dated, and matters were not documented properly (Pearson, 2015).

Two of the project case studies considered by this research program, both major recycled water schemes, which actors were trying to implement during this period did not receive any funding from the OLV, and possibly, less support than was expected. In the case of one major 5 GL/year recycling project which was proposed by one of the water retailers, the project was rejected by the Essential Services Commission (State Government economic regulator) even though it was expected to be NPV positive. No large scale IUWM projects went ahead under the OLV period, as they had previously during the “golden age of recycled water”. This raises issues around conflicting messages from the government. The final two remaining project case studies (out of a total of seven) have not yet been implemented due more to project specific circumstances, than because of changing governance structures.

MWC’s Living Rivers program established in 2006 continued to function effectively before, during, and after the OLV period, steadily rolling out WSUD stormwater management projects.

According to the consulted experts, it is not yet possible to assess the lasting impact of the OLV, either positive or negative. Experts describe the OLV as a “disturbance in the eco-system”, in the sense that it disrupted established processes and therefore has given the water sector in Melbourne a chance to reset and evolve. “Establishing the OLV kick started the reform process and got some ideas thrown around.”

Some changes in Melbourne’s water sector are currently apparent. There is a tendency towards greater collaboration and openness between water utilities. This includes less strict controls on data, practices and information. In the past water utilities would consider options and develop a business case before approaching other utilities to acquire licences and approvals as required. Now utilities are likely to collaborate with each other from the outset and consider options together.

A lot of personal and institutional connections have been made between organisations. However in future “we may need more than personal relationships, as people move on from jobs.”

The OLV reform to bulk water entitlements held by the retailers may be considered the most important of its tangible achievements, yet, one of its least publicised. While it has laid the groundwork for individual retailer responsibility for their supply-demand balance and potential future trading, it is still too early to observe the practical impact of this reform. With over a year since the reform, there has been no change in the way that the four water metropolitan water companies operate. Over the long term however, these reforms encapsulate the potential for substantial industry re-alignment.

Perhaps more important than what has actually changed because of the OLV is what lessons have been learned, and there are many. It is now understood that it is important to establish a framework/methodology and clear scope and objective before large scale plans are begun. This experience has made it clear that more work is needed to determine how to do consultation efficiently and effectively, i.e. the “need to get the level of collaboration right for each party.” Another lesson is that “funding issues can cause everything else to fall apart. Budget silos are just as difficult to overcome as institutional ones.”

3.6 Current era — over-arching body absorbed back into government

Following the 2014 state election, in which the Liberal Party lost power back to the Labor Party, the OLV was absorbed into the Water and Catchments division of the Department of Environment, Land, Water and Planning (DELWP). This is probably because its brand was considered to be damaged. In fact, its website was taken down by the incoming Government the very next day after its election victory. Water governance structures in Melbourne over this period are illustrated in Fig. 7.

Since then, DELWP has been tasked with developing the Victorian Water Plan, a wide-ranging water policy document for the state covering issues including IUWM, long term water supply-demand planning, water security, network optimisation and bulk water. As yet, no details are available publicly.

It is not yet publically known what the current Labor State Government policy is going to be on water, it is expected that this will be released soon. It appears that the current government will take a more hands-off approach to water, by allowing planning activities that were being done by the OLV to be continued as part of DELWP. The current government appears to have the view that since the desalination plant is sitting ready for use, that there is no urgent need for action. The new water minister is still deciding what their position will be on recycled water and stormwater...
harvesting projects.

The water team within DELWP are presently seeking to retain all of the good work previously done by the OLV while getting rid of the reputational stigma attached to its brand, essentially “keeping the baby and throwing out the bathwater”. In regard to IUWM, there has been no pushback with this paradigm still considered the norm in all levels of planning for water related services. On the other hand, there is no consistent understanding of the concept with any planning considered to be IUWM as long as it involved some consideration of alternative water use.

In a number of the water utilities IUWM is now the preferred base case for new developments, but determining the specifics of this are very difficult. Some of the experts wonder if some kind of grant funding or targets are required to drive IUWM into the future.

4. Discussion

Melbourne has undergone considerable water governance reform, and the narrative of water governance and IUWM in Melbourne can be highly informative for academics and planners from other localities in Australia and around the world.

Water management issues are context dependent and unique, although parallels can be drawn between the challenges of localities with similar climatic and socio-economic circumstances. For example many of the issues discussed in relation to Melbourne, have also been discussed in relation to Barcelona, Spain, on the other side of the planet. In Barcelona the same political, social and governance complications have played out through decisions regarding desalination and water reuse. Similar to Melbourne, a large desalination plant was built in Barcelona in 2009, but has only operated at a low capacity (Domenec et al., 2013).

This paper has focused on the time period from 2011 onwards, and in particular the planning functions of the OLV, which have not been covered in existing academic literature. Implementing the OLV was in some senses a courageous experiment, creating an overarching water industry body that made full use of its authority and powers to intervene in the planning functions of existing utilities. To the authors’ knowledge this has never been done before, at least not within Australia. This paper is perhaps one of the first documents to rigorously consider the lessons from the implementation and subsequent removal of the OLV.

4.1 Relationship between governance structures, politics, and IUWM implementation

In this paper the authors sought to understand the relationship between governance structure and implementation of IUWM. In Melbourne the transition towards IUWM has occurred throughout different governance regimes, some mono-centric such as the OLV phase, some polycentric, such as the “golden age of recycled water”. Each has had different planning styles and impacts. From this it can be seen that there is a complex relationship between governance regimes and IUWM implementation. Perhaps periodic shifting between regime structures can drive ongoing innovation and reform.

Melbourne Water was originally split up into four utilities to drive efficiency through competition by comparison. Competition between these public utilities never stimulated any great fervour because of differing contexts. The story of Melbourne shows that water governance reform can happen in an environment of collective evolution and collaboration. Competition between water authorities is not necessarily required to implement innovative methods and solutions.

From the narrative provided it can be seen that the implementation of IUWM in terms of a planning approach and physical projects is influenced by both governance structure arrangements, and also contextual factors. IUWM and WSUD in Melbourne were both originally given momentum by the millennium drought and the environmental and social problems which came with it such as dying greenery in parks. Necessity can be the mother of invention, provided that there is sufficient funding, institutional and individual capacity, and government support to facilitate innovative responses.

Implementation of the OLV has effectively shaken-up established structures, processes and relationships, providing a number of useful lessons, creating a culture of collaboration between utilities, and passing a number of potentially positive reforms. In terms of non-physical aspects such as strategy development it can be argued that implementing the OLV has moved Melbourne further towards implementing IUWM.

However in terms of physical infrastructure outcomes it is evident that more large scale reuse schemes were planned during the “golden age of recycled water” which immediately preceded the installation of the OLV. Therefore if IUWM means “implementing reuse projects”, then grants and targets are more important than governance structures, and integrated planning.

Interestingly, Melbourne Water’s Living Rivers program has been consistently and effectively rolling out WSUD projects together with local councils from 2006 until the present, entirely independently of the broader water planning context. This raises questions around whether “integration” of services and plans is the be all and end all of IUWM.

Melbourne as a case study provides concrete evidence of the political nature of water management. The narrative shows that political interference can be either good or bad, and that applying these rational, objectives judgements to planning and infrastructure can be difficult due to the inter-connected influence of the media, public perceptions, and political cycles. Politics was a large driver for the implementation of IUWM in Melbourne. However the political push for IUWM in Melbourne was fuelled by political point scoring, and to some extent ideology, rather than rigorous science and economics.

From the information available to the authors it does not appear that either of the governing political parties, Labor or Liberal, had a consistent or principled viewpoint on water management issues. The Labor party is generally perceived to be more environmentally and socially aware, and the Liberal party to be more conservative and business focused. In regards to water management in Melbourne these typical roles were almost reversed, with Labor implementing desalination, and the Liberals championing IUWM. It is the opinion of the authors that each party simply reacted to crises as they occurred and did their best to discredit the other party.

4.2 What does IUWM really mean?

The majority of the existing literature on transitioning to IUWM and WSUD represents these concepts as some kind of “nirvana” where planning processes and recommendations, and also regulatory processes and decisions, will make objective and rational sense (Molle, 2008). As stated in the introduction, planning is by its very nature threaded with subjectivity, political aspects, and personality conflict (Furlong et al., 2016a).

Melbourne as a case study reveals that transitions towards planning being more “integrated”, do not necessary translate into best community outcomes, or even logical planning processes and recommendations. In addition to this it is clear that, as one consulted expert has said, “IUWM involves a lot more parties, a lot more effort, and a lot more time.”

At a theoretical level there are a number of methodologies for
how to implement IUWM, such as the CSIRO IUWM planning manual (CSIRO, 2010). In a real world environment such as Melbourne, with established as well as growth areas, industrial as well as environmentally sensitive areas, multiple utilities and councils, and conflicting government messages around objectives, it is possible that any methodology or approach would have serious issues being implemented.

IUWM projects that have been implemented due to government grants and targets do not generally achieve full cost recovery, and it has not been demonstrated that most, or even a significant number of these projects represent good value for money. This is why the Productivity Commission recommended that grants should not be awarded to future reuse projects (Productivity Commission, 2011).

Without the specifics of an approach, governance regime, planning methodology, or particular project, the idea that IUWM is “good”, is in some sense superfluous. It is only possible to consider the actual specifics on their own merit. One of the consulted experts expressed a thought-provoking quote in relation to what IUWM actually is:

“Perhaps IUWM is a solution looking for a problem.”

The authors see an aspect of truth in this perception. However the present discussion leads to the inference that IUWM, without the specifics of how it should be implemented, does not mean anything more than “good water management” and implementing solutions which are deemed to create best community outcomes in any given context. In some situations this may include water recycling, stormwater harvesting, and WSUD features. In other contexts none of these solutions will be appropriate. In some situations this may involve creating integrated city-wide 100 year plans, and in others it may involve 30 year plans which look at each water service separately, with one particular team allocated the task of investigating IUWM and WSUD projects. Which solution is better will depend on institutional and individual capacities, objectives, available resources and data, number of stakeholders and many other things.

With all this being the case, according Molle (2008), concepts like IUWM and IWRM still provide a benefit to governments and the water sector by establishing, at least ostensibly, some kind of “common ground” from which to begin discussions about reform. This may be one reason organisations like the Global Water Partnership, and World Bank, have found these loosely defined concepts valuable.

5. Conclusion

A lot can be learned from the Melbourne narrative. Innovation and reform can be instigated in a number of ways including: natural events such as droughts, installing an over-arching water industry body, targets, and government grants. All of these have their own pros and cons. There is a complex relationship between governance regime structures and IUWM. It is not possible to suggest that any particular regime structure is required for the implementation of IUWM. There may be some benefits which can be accrued through shuffling government departments so that environment, land, water and planning are combined into one entity, although it is not yet possible to draw this conclusion.

Polycentric and monocentric water management paradigms each come with their own benefits and problems. Monocentric paradigms can achieve reforms fast, although they may aggravate some institutions. Polycentric paradigms cause accountability issues when it comes to major augmentation decisions such as desalination plants and inter-basin pipelines. Within both paradigms, determining how to conduct stakeholder consultation is a serious issue. Further work can be done by comparing the narratives of multiple cities to further explore the relationships between water governance regimes and IUWM.

Perhaps the most important conclusion to draw from this research is that IUWM is not some kind of panacea solution to the water management crisis. It is a very loose concept that, when implemented in a real-life complex environment, will achieve entirely unpredictable outcomes. IUWM was implemented in Melbourne in the form of sub-regional strategies. It is not clear yet how much value will come out of this process. Perhaps the exercise may prove extremely valuable at some point in the future. However it is currently clear that the implementation of this planning initiative has been fraught with issues precisely because of its “integrated” nature.

There is no one-size-fits-all “integrated” water methodology, and there never will be. Water management, like all public policy planning activities, will always to some extent be a “science of muddling through”. However in regards to IUWM, as it was with IWRM, there may be some benefit from using these loosely defined terms to provide a conceptual starting point from which to begin discussions around water sector reform.

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Appendix A. Additional expert comments

Consulted experts have provided a number of other interesting perspectives including:

“Melbourne’s water sector has not yet answered the question of what an ‘integrated’ water plan actually is. Is it just a plan that includes stormwater?”

“Perhaps IUWM is a solution looking for a problem. Water planning was not broken, sewerage planning is not broken, whole crisis is in stormwater.”

“Some kind of fund, targets, overarching body, or government intervention may still be needed in the future to drive IUWM.”

“Perhaps other cities could look towards the formation of something like DELWP because it brings together all the relevant areas (environment, land, water and planning) which are required for IUWM.”

“Accountability is a big issue. Before DELWP and the OLW, accountability was spread around between so many institutions. Lack of accountability was the downfall of the OLW, but that’s why reforms happened fast, there wasn’t the level of consultation that perhaps there should have been in relation to reforms. “

“IUWM involves a lot more parties, a lot more effort, and a lot more time. Some stakeholders view it as a waste of time and effort. You have to get everyone to the same level of understanding and information in order to begin.”
"Perhaps IUWM plans should be about pointing people in the right direction."

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Chapter 4: Industry perspectives on IUWM

4.1 Introduction

This chapter describes the results of a survey conducted by the researcher which asked industry experts for their views in relation to the nature of IUWM. Using these survey results as evidence, the chapter outlines the original proposal that IUWM contains conceptual elements relating to an ideology, a set of objectives, and a set of methods.

This chapter is made up of a publication which was originally published as a conference paper in a conference organised by the Australian Water Association (AWA). After the conference the AWA selected this paper as the only paper from the conference which warranted publication on their online journal. This paper is therefore shorter, and contains fewer references than the other papers in this thesis. A decision was made to include this paper in the thesis on the basis that the contents of this paper are not incorporated into the other papers, and constitute an original contribution to the body of knowledge.

The practical implications of this chapter are:

- Industry experts mean very different things when they use the term IUWM. For some it means effective integration of waterways and stormwater management into urban areas, for others it is about reuse of water, and others it is simply collaboration between institutions. Therefore it is not possible to make a judgement around the value of IUWM as a concept, good or bad, without first defining what specific practices are being evaluated
- It is proposed that practitioners and researchers should invest their time into specifying various methods of implementing IUWM and comparing them, in order to identify which are creating positive outcomes and which are not
ABSTRACT
The authors have sought to test the hypothesis that industry perceptions of Integrated Urban Water Management (IUWM) include elements pertaining to an ideology, method and set of objectives. In order to assess this, a survey was conducted that received responses from 34 industry experts. Survey responses show a wide variety of perspectives on IUWM, ranging from specific processes to broad, all-encompassing and vague descriptions. According to the results the specific methods most commonly associated with IUWM are: stakeholder engagement; coordinated planning; holistic option assessment; and integrated modelling. The objectives most commonly associated with IUWM are: diversification of water sources; environmental improvements; reduced cost; and improved liveability outcomes.

INTRODUCTION
IUWM, also known as Integrated Water Management, has been popular in Australia’s water sector for approximately the last decade. The shift from traditional segregated and reactive approaches to integrated and proactive approaches was prompted by Australia’s Millennium Drought and has been adopted most whole-heartedly in Melbourne (Fam et al., 2014).

Adoption of the IUWM ideology has resulted in changed mental attitudes within Melbourne’s water sector, attempts at “integrated planning”, and the construction of alternative water source and WSUD infrastructure assets of various sizes (Ferguson et al., 2013).

There has been a long-held view that implementing IUWM will result in better community outcomes. The Office of Living Victoria (OLV) at one point claimed that IUWM would save Melbourne $6 billion, while also improving both environmental and social outcomes (Office of Living Victoria, 2013).

Our team at RMIT University has been investigating IUWM in Melbourne for the last three years. We began this research by studying the international evolution of integrated approaches to water management and compared differing traditions (Furlong et al., 2015).

After this we developed a planning framework (Furlong et al., 2016), which was used to assess eight Melbourne water reuse projects. We found that the projects that were implemented relied on targets and grants for funding and approval, rather than the planning approaches that are generally associated with IUWM (Furlong et al., in press).

We then considered the changes in water sector governance structures within Melbourne between 1990 and the present to see how these have affected the implementation of integrated planning, reuse and WSUD projects. We found that the most systematic, detailed and integrated planning approaches have not resulted in the construction of actual projects (Furlong et al., 2015 (2)).

These results prompted us to begin questioning some assumptions about the nature of IUWM. From this vantage point we developed the hypothesis that the industry perception of IUWM includes elements pertaining to an ideology, method and a set of objectives.
objectives. We are using the term ideology here to mean “a belief system that exists in a particular culture”.

In order to test this hypothesis and stratify IUWM’s conceptual components, the team at RMIT has conducted an industry survey that asked experts:

1. What does IUWM mean?
2. What specific steps/methods/actions does IUWM involve?
3. What are its objectives?
4. How relevant is IUWM as an ideology now, and in the future?

This paper will discuss the results of this survey, and then attempt to relate these results back to the hypothesis.

**METHOD**

The team at RMIT has, for three years now, undertaken wide-ranging literature reviews, face-to-face industry consultation with 40+ experts, assessment of eight infrastructure project case studies, and nine strategy case studies.

Critical reflection on these research outcomes led us to the research hypothesis. In order to test this hypothesis we conducted an industry survey that has received 34 responses. The survey was sent to the group of more than 40 experts whom we consulted previously, with the request that it also be circulated to some of their colleagues. Details of the respondents are shown in Figures 1 and 2.

The survey received responses from a variety of organisational types, the largest being from consultants, retailers, bulk suppliers and councils. Analysis so far has not attempted to compare the difference between states and organisational type, but this will be considered at a later time.

The survey asked for short answers from respondents. These answers were qualitatively analysed to draw out themes, and then again to see how many of the respondents mentioned each theme. These results have been provided in a table format (Table 1) to show the top responses to each question. Survey responses provided four substantive IUWM methods and four objectives.

We then considered the current state of these methods and objectives using previously collected data and findings. All of these information sources have been combined in order to use Melbourne as a holistic and broad case study on IUWM implementation. By comparing the current state of the objectives and methods we were able to determine how closely linked they are to each other in practice.

**SURVEY RESULTS**

The first question that was given to the experts asked them to describe what they thought IUWM was.

The results show that the majority of respondents are in agreement about IUWM involving consideration of the whole water cycle and coordinated planning. The next highest responses were that IUWM involves holistic option assessment, and that it improves community outcomes.

One notable disparity between responses was whether IUWM implies the installation of alternative water projects, or whether it does not.

In the second question experts were asked about the specific actions involved in IUWM.

The top responses were:

1. Stakeholder engagement and involvement;
2. Coordinated/collaborative planning;
3. Holistic option assessment;
4. Integrated modelling.

A wide variety of responses were given. Many of these actions are not specific to the water sector, are something that all planners should do, and pre-date the advent of IUWM as a concept. This shows how broad and varied industry perceptions of IUWM are, once specific methods are discussed rather than overall meaning.

Thirdly, experts were asked what they thought were the objectives of IUWM. Again the responses show a lack of consensus. However, these results are interesting for a number of reasons. The most common response was that the objective of IUWM is achieving a more integrated approach – in other words, that IUWM was an

<table>
<thead>
<tr>
<th>Theme</th>
<th>Mentioned by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consideration of the whole water cycle through a coordinated and collaborative planning regime</td>
<td>68%</td>
</tr>
<tr>
<td>Holistic option analysis (cost-benefit analysis or multi-criteria assessment)</td>
<td>32%</td>
</tr>
<tr>
<td>Improved community outcomes</td>
<td>29%</td>
</tr>
<tr>
<td>Environmental protection</td>
<td>21%</td>
</tr>
<tr>
<td>Alternative water sources/fit-for-purpose water use</td>
<td>15%</td>
</tr>
<tr>
<td>Stakeholder engagement and involvement</td>
<td>12%</td>
</tr>
<tr>
<td>Liveability, amenity, water-sensitive cities</td>
<td>9%</td>
</tr>
<tr>
<td>Long-term view including population and climate</td>
<td>9%</td>
</tr>
</tbody>
</table>
end in itself. This response is likely due to the mental association between IUWM and improved community outcomes shown in Table 1. Leaving aside “a more integrated approach”, and “best overall outcomes”, the top responses for the objectives of IUWM were:

1. Alternative water sources;
2. Environmental protection;
3. Reduced cost;
4. Liveability and greening.

Finally, experts were asked about the relevance of IUWM to the water sector, now and in the future.

Experts were also given the option to select “not relevant”; however, none of the experts selected this answer. Results show that experts generally believe IUWM to be “very relevant” now, moving to “extremely relevant” in the future.

USING MELBOURNE AS A CASE STUDY TO ASSESS THE CURRENT STATE OF IUWM

Now that the concept of IUWM has been separated into its commonly associated methods and objectives, it is possible to explore how closely linked they are to each other in practice. In order to give specific and practical examples, this will be explored in relation to planning efforts in Melbourne over the past decade.

This period has included a number of different eras: government intervention during drought, the “golden age of recycled water” following the end of the drought, the establishment of the Office of Living Victoria (OLV) as an oversight body, and the current era following this oversight body being absorbed back into government (Furlong et al., 2015 (2)).

CURRENT STATE OF THE IUWM METHODS

Stakeholder Engagement And Involvement

Engagement with stakeholder organisations and the wider community has been increasingly promoted as a tool for achieving improved community outcomes. The practice of stakeholder and community engagement is not specific to the water sector, and there are a number of resources that exist to help planners in undertaking engagement, such as the IAP2 framework.

Table 2. Top survey results for “What are the specific steps/methods/actions involved in IUWM?”.

<table>
<thead>
<tr>
<th>Theme</th>
<th>Mentioned by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stakeholder engagement and involvement</td>
<td>53%</td>
</tr>
<tr>
<td>Coordinated/collaborative planning (e.g. between utilities and with urban planning)</td>
<td>50%</td>
</tr>
<tr>
<td>Holistic option assessment (non-market cost-benefit analysis and multi-criteria assessments)</td>
<td>28%</td>
</tr>
<tr>
<td>Integrated modelling</td>
<td>28%</td>
</tr>
<tr>
<td>Cost and responsibility apportionment</td>
<td>25%</td>
</tr>
<tr>
<td>Strategic planning/policy development/leadership</td>
<td>22%</td>
</tr>
<tr>
<td>Wide-ranging option identification</td>
<td>19%</td>
</tr>
<tr>
<td>Objective/goal setting</td>
<td>16%</td>
</tr>
<tr>
<td>Post-project evaluation and learning from mistakes</td>
<td>16%</td>
</tr>
</tbody>
</table>

Table 3. Top survey results for “What are the objectives of IUWM?”.

<table>
<thead>
<tr>
<th>Theme</th>
<th>Mentioned by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achieving a more integrated approach</td>
<td>50%</td>
</tr>
<tr>
<td>Alternative water sources</td>
<td>35%</td>
</tr>
<tr>
<td>Best overall outcomes</td>
<td>26%</td>
</tr>
<tr>
<td>Environmental protection</td>
<td>26%</td>
</tr>
<tr>
<td>Reduced cost and social equity</td>
<td>18%</td>
</tr>
<tr>
<td>Liveability and greening</td>
<td>15%</td>
</tr>
<tr>
<td>Site/context specific</td>
<td>12%</td>
</tr>
<tr>
<td>Stakeholder collaboration</td>
<td>12%</td>
</tr>
<tr>
<td>Fit-for-purpose use</td>
<td>12%</td>
</tr>
</tbody>
</table>

Figure 3. Survey results for “What is the relevance of IUWM now and in the future?”.
In the water sector, practices for stakeholder and community engagement are considered to be well understood, and the typical premise of existing water sector reports is that “more is better” (Office of Living Victoria, 2013). However, extensive industry consultation conducted by RMIT has revealed another perspective.

During the mammoth effort involved in the development of the OLV’s ‘Whole-of-Water Cycle’ sub-regional plans, many meetings and workshops were held to bring together water utilities, councils, government departments and consultants.

A number of experts expressed dissatisfaction with the number and process used in the engagement. One expert expressed frustration at the cost in time and effort and the lack of produced value. Another did not feel that it was appropriate to commence planning processes by bringing stakeholders together and asking them what they want, saying that this resulted in small and large issues being given equal weight. For example, a council keen to improve park amenities was given equal weight to a water utility having to manage frequent sewer overflows (Furlong et al., 2015 (2)).

Some experts have proposed a change in perspective from the idea that “more engagement is better”, towards the view that engagement should be appropriately targeted and structured.

**Coordinated/Collaborative Planning**

It is almost universally acknowledged within the water sector that planning approaches should be coordinated and collaborative. This concept extends to coordination of:

- Water services, including water supply, sewerage and drainage;
- Different water utilities, and departments within utilities;
- Urban planning, together with councils and state government;
- Local, sub-regional and regional plans coordinated across scales.

In comparison to a decade ago, water planning in Melbourne has become far more collaborative in the sense that water utilities, councils and government now have substantially more contact with each other than they used to. Experts have expressed a view that this increased willingness to collaborate is useful, and some examples can be pointed to where positive outcomes have been achieved through collaborative planning, such as in growth areas in the Barwon Water region.

However, in regard to the coordination across planning scales and different water services there have been some serious difficulties. The development of the OLV’s sub-regional plans was hampered by an assortment of problems relating to linking planning efforts at different timing and spatial scales.

Precinct Structure Plans (PSP) – master plans for local communities – were being developed at the same time as large-scale modelling and analysis, making the linking of the two extremely difficult. Also, it was difficult to scope what issues should be considered at which scales. This has prompted one consulted expert to question: “Does every issue need to be managed at every scale?” (Furlong et al., 2015 (2)).

Integration of all water sources/services, at multiple timing and spatial scales, together with the changing political and intuitional landscape, proved to be an insurmountable challenge, with the sub-regional plans not having been released after three years of effort.

Therefore, efforts aimed at integrating the planning of all water services at a large scale have not yet been successful in Melbourne. Previous planning efforts in Melbourne have been achievable because they focus either on: (a) one water service at a large scale; or (b) multiple water services, but only at a suburb or growth area scale.

**Holistic Option Analysis**

Water industry experts have been discussing the need for holistic option assessment methods for a long time. These assessments generally take the form of either non-market Cost Benefit Analysis (CBA) or Multi-Criteria Assessment (MCA). Both of these relate to trying to capture the full spectrum of costs and benefits that arise from infrastructure options (WSAA, 2014).

For a number of years MCAs were popular. They were used in many planning processes that looked at the best water servicing strategies for growth areas up until 2012. These assessments were influenced by the personal views of water planners and consistently suggested that growth areas should be serviced by some form of alternative water such as recycled water, rainwater collection or stormwater harvesting, together with WSUD. However, there was always a lack of confidence in the results of these MCA assessments.

The water industry across Australia, including experts in Melbourne, Sydney and Perth, had begun making efforts to develop non-market CBA assessments that were seen to be more objective and defensible.

Therefore, when the OLV was created it made a high priority of developing a CBA methodology for use in selecting the preferred option in servicing strategies. Unfortunately, the OLV CBA assessment experienced the same hurdles that the water industry has been experiencing for years: no-one has yet successfully and consistently quantified the non-market benefits and costs of IUWM in a way that garners widespread agreement. This includes benefits such as eco-system protection, liveability and health.

Although many studies have been conducted into both consumer willingness to pay and how these benefits and costs should be tallied up, no system has been widely implemented and accepted. Even in relation to benefits created through the deferral of other infrastructure assets there has been disagreement.

Frequently the use of non-market CBA has resulted in one of two fates. The first is that benefits are not comprehensively included, and the BAU approach receives a higher Net
Present Value (NPV) than the IUWM options. Sometimes, in this case, planners then reject the BAU option because it is “not integrated”.

The second fate, which is applicable to large projects, is that the CBA shows an IUWM option to have the highest NPV, and the responsible organisation then creates a business case around this CBA assessment, only to have the CBA results rejected by the state government on the basis that either: (1) the benefits are inflated; (2) the risks are not effectively considered; or (3) beneficiaries are not willing to contribute.

As there is no agreed methodology, or means of creating one, it must be considered that the water sector, at least in Australia, is a long way from achieving holistic option assessment.

**Integrated Modelling**

Some modelling software has been created that is capable of considering water supply, recycled water, sewerage, drainage and stormwater treatment simultaneously. One notable example is Urban Developer, created by eWater, the developer of MUSIC. These new software tools are not currently in use by the water sector at any large scale, but are being used by some planners to answer specific questions. For example, they are used in early planning stages such as option identification, but not to do detailed modelling and designs.

As part of the creation of Melbourne’s Water Future, the OLV used an integrated model of Melbourne’s network, and it was this model that produced the claims that IUWM would save Melbourne $6 billion. This model has been described by some experts as a “black box”, the failings of which were hidden from the public gaze.

However, when the OLV moved on to the creation of the sub-regional plans, problems arose from the lack of appropriate software programs. The hydrologic and hydraulic tools that were used were designed to model only one aspect of the water cycle. Using separate tools doesn’t necessarily give poor information, although it becomes difficult to optimise models across the water cycle, particularly at linkages between models (Furlong et al., 2015 (2)).

It is difficult to judge if, and when, fully integrated and functional software will be developed and then adopted by the water sector, because of the complexity involved in integrating multiple water services at multiple spatial scales.

**CURRENT STATE OF THE IUWM OBJECTIVES**

**Alternative Water Sources**

Historically, Melbourne had only one water supply source, which was its dams. The protected catchments and dams system in Melbourne provides one of the cleanest and best municipal water supply sources in the world, and current Melburnians owe a great debt to the foresight of Melbourne’s founding fathers.

Up until the Millennium Drought these sources proved sufficient. During the drought, which lasted approximately from 1997 to 2007, Melbourne’s water storage levels continued to drop to the point where Melbourne’s water sector was operating in crisis mode. The state government intervened to implement both the largest desalination plant in Australia and the North-South Pipeline. The desalination plant is capable of supplying approximately one-third of Melbourne’s water needs.

In addition to this, Melbourne has implemented substantial recycled water activities. Melbourne achieved its 20% recycling target by 2010, predominantly through the use of recycled water for agriculture. Over 100 small-scale stormwater harvesting schemes also exist in Melbourne (Ferguson et al., 2013).

Melbourne has thus achieved a substantial diversity of water sources. But what proportion of this water source diversity can be attributed to stakeholder engagement, coordinated planning, holistic option assessment and integrated modelling? The North-
South Pipeline and desalination plant planning involved none of these methods, as they were knee-jerk reactions to the Millennial Drought. The major recycled water projects implemented out of Western Treatment Plant, Eastern Treatment Plant and other smaller sewage treatment plants such as Boneo also pre-date major efforts in the IUWM methods considered here, although it was imprecisely recognised that these schemes provided multiple benefits.

A case may be made that some of these recycled water decisions were coordinated as part of the Central Region Sustainable Water Strategy and other large-scale planning efforts. While this is true, these projects were able to be implemented primarily because of the Victorian Government’s 20% recycling target, and Department of Sustainability and Environment grants.

If one was to take a broad view of IUWM, then perhaps these targets and grants could be considered to be part of IUWM. However, IUWM is typically associated with cost sharing under a beneficiary pays model. Targets and grants are typically associated with the “traditional”, pre-IUWM paradigm.

Melbourne now has a substantial number of alternative water sources, but these have not been facilitated by the IUWM methods considered in this paper. They have been achieved through traditional, reactive, top-down planning approaches such as government targets, grants and interventions.

Environmental Protection
In recent decades many efforts have been made to protect Melbourne’s waterways and bays. Major efforts towards environmental protection in Melbourne’s water sector have involved regulatory instruments around pollution, usually required by the Environmental Protection Authority (EPA). EPA regulations and other government directives have resulted in the upgrading of sewage treatment plants, water recycling, ensuring water allocation for rivers, and the installation of raingardens and wetlands for the treatment of urban stormwater (Brown and Clarke, 2007).

In recent times, Melbourne’s planning agencies are taking serious steps to ensure the protection of upstream waterways in growth areas. This issue has been taken seriously in the planning of both the Sunbury and Northern growth areas.

There have also been massive improvements in Port Phillip Bay water quality because of Melbourne Water’s efforts to upgrade the Western Treatment Plant and increase water recycling, as well as the construction of over 200 wetlands and the stormwater offset program for new developments.

EPA regulations, and Melbourne Water actions, have evolved since 1965, mostly in response to: (1) a growing amount of community environmentalism; and (2) an increasing body of scientific knowledge from the Port Phillip Bay study, National Water Quality Guidelines and CSIRO work (Brown and Clarke, 2007).

The EPA, Melbourne Water and the environmental department of the Victorian Government have collaborated over a number of decades in planning to determine appropriate regulations and actions. Improvements to environmental protection in Melbourne have, therefore, involved significant communication between some organisations.

Reduced Cost
Industry experts have shown that they believe IUWM, when implemented successfully, should save the community money. Logically this makes sense, although there is little evidence of this being achieved at present.

It is difficult to assess the costs and benefits of the IUWM methods explored in this paper. This is because this task would require highly detailed and technical data from water utilities outlining what staff and expenses are involved in stakeholder engagement, coordinated planning etc.

Stakeholder engagement increases costs in the short term, but may theoretically lead to cost savings through the identification of synergies between organisations, and from influencing public opinion, for example through persuading the public that potable recycling is safe.

Coordinated planning also should, in theory, save money on a whole-of-community basis. For example, through coordinated planning a utility may realise that implementing recycled water may defer a sewage treatment plant or pipeline upgrade, and also delay the need for another desalination plant, resulting in a cost saving to the community. In practice there have been some issues with this, such as: (1) cost sharing of water supply benefits is difficult to achieve; and (2) in several cases it has later been determined that the upgrade is required regardless, because of the seasonality and uncertainty involved in IUWM schemes, as well as uncertainties in growth estimates.

Holistic option assessment, in the same way as coordinated planning, should in theory save the community money, but has so far failed to do so. Assessments are generally conducted by consultants, costing the public money. In the case of the OLV sub-regional plans, many different pieces of work were completed by private consultants, with few actual outcomes achieved as the plans were never released.

Integrated modelling is still emerging and has not had a substantial cost, or cost saving, associated with it. Attempting to quantify whether the IUWM methods have decreased or increased community costs would be a major research effort in itself and is beyond the scope of this paper. However, it can be stated that there is no empirical evidence of overall cost savings.

Another possible perspective on this issue is that once an effective non-market CBA is developed, and social and environmental benefits are included, the overall community cost savings associated with IUWM will become evident.

Liveability And Greening
As part of Melbourne Water’s Living Rivers program, more than 633 WSUD projects have been constructed in Melbourne, adding greenery to Melbourne streets. Over 100
small-scale stormwater harvesting schemes operate within Melbourne, providing added water security for park irrigation, and as such also contributing to the greening of Melbourne (Ferguson et al., 2013).

In some cases the planning of council schemes has involved a substantial amount of community consultation, such as four stormwater schemes implemented by the City of Melbourne.

The WSUD schemes that are carried out through the Living Rivers program have involved some degree of holistic option analysis as part of prioritising for each round of funding, and coordination between councils and Melbourne Water.

Although this statement may be controversial, another large contribution to the protection of liveability and greenery in Melbourne is the desalination plant, which will, at least for some time, prevent the need for water restrictions. But this water security benefit came with a large community cost, and so far no water has been ordered.

Therefore, stakeholder engagement, coordinated planning and holistic option analysis have at least partially contributed to the liveability and greening of Melbourne.

**DISCUSSION**

**Do IUWM Methods Lead To Its Objectives?**

Other than reducing costs, Melbourne has come a long way towards achieving its objectives: alternative water sources; environmental protection; and liveability/greening.

But what role have the IUWM methods (stakeholder engagement, coordinated planning, holistic option analysis and integrated modelling) had in achieving these objectives? This investigation presents a mixed picture.

Diversification of water sources has occurred predominantly through government interventions of: (1) implementing the desalination plant; (2) the 20% water recycling target; and (3) grants for harvesting schemes. Government intervention, targets and grants are not typically associated with IUWM and have not been mentioned in survey responses.

Environmental protection, liveability and greening have been achieved through: (1) EPA and other government regulations, which limit pollution and mandate WSUD; (2) Melbourne Water programs and other government grant/subsidy initiatives that help councils fund projects; and (3) the desalination plant.

EPA regulations and Melbourne Water receiving water quality improvement actions have been planned collaboratively, but not as part of an “integrated” water plan such as was attempted in the OLV sub-regional plans. Attempts at large-scale “integrated” plans, and high-detail non-market CBA, have not so far contributed to achieving the IUWM objectives.

The evidence appears to suggest that the valuable aspects of IUWM involve promoting communication between organisations and well-structured stakeholder engagement. One expert said: “Bringing everyone to the table is the first step”. Large-scale “integrated” plans, and high-detail non-market CBA, have not so far contributed to achieving the IUWM objectives.

**Reflections On The Meaning Of IUWM**

With the knowledge gained from this analysis it is possible to consider the survey responses, and the meaning of IUWM, in a new light.

The first point to note is that experts have a mental association between the concept of IUWM and the achievement of improved community outcomes. The implementation of IUWM has resulted in positive outcomes in some instances, but there is a lack of empirical evidence to suggest that IUWM has so far achieved a net positive community impact. This lends weight to the argument that, for some, IUWM is an ideology, or belief system.

Secondly, there is no agreement as to whether the concept of IUWM inherently includes alternative water sources such as recycled water and stormwater harvesting. Some experts mentioned it in their responses, and some did not. One expert expressed during an interview that “IUWM doesn’t mean alternative water!” The IUWM planning processes conducted so far have almost invariably
recommended the construction of such schemes, sometimes excluding the BAU option entirely, because it is “not integrated”.

Thirdly, the survey responses are in some cases very broad, general and/or all-encompassing. If IUWM means everything, then it means nothing. That is to say that, if IUWM means correctly doing governance, regulation, long-term planning, project planning, regulation etc., then IUWM does not mean anything other than “good water management”.

Fourthly, there is a high degree of consensus that IUWM involves the consideration of water supply, sewerage and drainage in an integrated fashion. However, no large-scale attempts at this integrated and coordinated planning approach have so far been successful. Biswas (2004) stated: “The definition of [Integrated Water Management] continues to be amorphous, and there is no agreement on fundamental issues like what aspects should be integrated, how, by whom, or even if such integration in a wider sense is possible.” Twelve years later, attempts have been made, but little has been resolved.

The final noteworthy point is that experts consider IUWM to be “extremely relevant” in the future, which begs the question, how can the industry have so much faith in IUWM, when it is a nebulous concept that means so many different things?

CONCLUSION
Views on the meaning, methods and objectives of IUWM have some similarities but also have some differences. One of the clearest differences is whether IUWM implies the implementation of alternative water source and/or WSUD projects or whether it implies neither. Another clear difference is whether the meaning of IUWM is so broad that its methods effectively encompass all water sector actions, or if it involves only some specific methods.

It seems that the original hypothesis that the industry perception of IUWM includes elements pertaining to an ideology, method and a set of objectives has proven to be correct. From the survey responses the authors have identified four methods and four objectives that are discrete enough to allow investigation.

Exploration of these methods and objectives has found that Melbourne has achieved improvements in the selected objectives, but only some aspects of these methods have contributed towards achieving these improvements. The value of IUWM appears to be in “bringing everyone to the table” – not necessarily conducting large-scale water plans with integrated modelling and highly detailed economic assessment of options.

The authors recommend that the water sector re-evaluate its expectations of IUWM, separating its meaning into an ideology, aspirational objectives, and a variety of methods that can be further considered in isolation.

This paper was presented at the 2016 YWP Conference in Sydney.

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Lachlan Guthrie is close to completing a PhD investigating Integrated Water Management strategic planning processes at RMIT University in Melbourne. Lachlan is also heavily involved in the WASH sector, working as the Risk Manager for Engineers Without Borders Australia and chairing the AWA WASH Specialist Network.

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Chapter 5: Selecting an appropriate planning framework

5.1 Introduction

This chapter documents the efforts that the researcher went through to create a planning framework for use in structuring the IUWM infrastructure project case studies which are included in Appendix B. It includes a literature review on the history of planning theory and a comparison of existing water planning frameworks. In relation to the overall thesis the importance of this chapter is that it describes the planning framework used to assess the case studies. Without the creation and use of such a framework, the consistent and comparable analysis of IUWM infrastructure project case studies would have been impossible. It also provides an original contribution to the body of knowledge on water management by conceptually linking the evolution of water management concepts to the evolution of planning theory.

This chapter includes a journal paper which has been published in a standard issue of Utilities Policy.

The practical implications of this chapter are:

- Decision making for water infrastructure is often represented as objective and rational, but they are actually shaped by complex social and political dimensions. It is therefore important for transparency, and also for continual improvement of decision making processes, to identify and document these external influences.
- Existing infrastructure planning frameworks typically represent the process as sequential, but in reality the process is iterative, going back and forth between planning stages.
- It is important to consider cost apportionment of options before recommending a final infrastructure option. If this is not done the recommendations are more likely to be disregarded.
- A novel water infrastructure planning framework is proposed that can be used to guide the planning of new infrastructure, or guide the assessment of past planning case studies.
Developing a water infrastructure planning framework for the complex modern planning environment

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Abstract

Prevailing water infrastructure planning frameworks tend to present planning processes as rational and objective, paying little attention to whose interests are served. In reality, the planning process is inherently subjective and shaped by social and political dimensions. In this paper we develop a water infrastructure planning framework that is mindful of this context, beginning with a review of the evolution of planning theory. Existing frameworks are compared in order to develop a draft framework, which was then refined through consultation with water industry experts. Compared to the prevailing frameworks, our approach: (1) makes explicit the iterative process between decision analysis and decision taking, (2) ensures that cost-sharing arrangements are in place before final recommendations are made, (3) considers the effects of public and media perceptions about project outcomes on future planning, and (4) makes explicit the impact of government and community preferences on the planning process. We recommend this framework for use in both planning and analysis.

1. Introduction

1.1. Changing context and drivers for the water sector

Water policy is understood as an emerging priority for governments (Heathcote, 2009). As countries all over the world approach, and often exceed, sustainable environmental limits, there have been increasing occurrences of water shortage (Bouwer, 2000). Water managers are required to consider climate change (Khouri, 2006), contamination of water supplies, population growth, and migration, all while suitable locations for new dams and river extraction points become increasing limited (Bouwer, 2000; Biswas, 2004). The United Nations has predicted that a business-as-usual approach to water resources will result in a global fresh water deficit of 40% by 2030 (UN Water, 2015).

The field of water utility management, which was traditionally an engineering-based, technical practice, is now far more complex (Bell, 2012), with many interrelated factors to consider (Vugteveen and Lenders, 2009). Water utilities are currently required to integrate an increasing array of water resource technologies, such as desalination, rainwater tanks, and water reuse, in combination with water efficiency measures. In addition to these technical functions, water managers have an expanding mandate to consider ecosystem protection and restoration, with endangered species present in peri-urban rivers (Morley and Karr, 2002) and “Ramsar” classification of sewage treatment plants for having internationally significant wetlands (Hamilton, 2007).

Other than technical and environmental considerations, values-based and less quantifiable social factors, such as liveability and social amenity, should also be considered. To effectively incorporate these factors into planning, stakeholders should be more actively consulted and water authorities should be involved in urban planning and building regulations (Morison and Brown, 2011). The traditional framework within which urban plans are made first to set broader urban development objectives, followed by water plans, is no longer seen as the best way to plan urban areas. Benefits can be accrued from creating “integrated” plans that consider water and broader urban planning considerations in combination.

Increasing scrutiny by the media and community members are also pulling water infrastructure issues into the political cycle (Ravesteijn and Kroesen, 2007), creating a more complicated relationship with government actors and funding sources. Two examples of the politicization of infrastructure planning are given in Section 1.3 below.
Water utility management in some areas of the developed world is currently moving towards sustainable “fit-for-purpose” water management in the form of decentralised stormwater and wastewater treatment and reuse (Institute of Sustainable Futures (2013); Office of Living Victoria (2014); Bell, 2012; Ferguson et al., 2013), as has been predicted by some academic researchers (Brown et al., 2009). However, as Bell (2015) points out, there is a simultaneous counter trend towards capital and energy-intensive desalination plants, as well as environmentally damaging inter-basin transfers. The direction that urban water management takes in a particular region or city will be greatly affected by social and political factors in the planning process.

1.2. Water utility management practices in transition

Changing context and drivers for the water sector are making it necessary for water management practices to adapt and evolve (Bell, 2015). A number of related water management paradigms are emerging around the world in response to the trends described above.

Although this transition is occurring sporadically across the globe, parallels can be drawn between the global sustainable development agenda and specific paradigms such as Integrated Water Resource Management (IWRM), Integrated Urban Water Management (IUWM), and Water Sensitive Urban Design (WSUD) (Furlong et al., 2015). Key principles of IWRM include integrated management practices, seeing water from economic, social and environmental perspectives, and the participation of communities and women in key processes (Global Water Partnership, 2012). IUWM can be described as a strategic long-term planning approach to urban water that considers and includes all potential water sources, services, stakeholders, and impacts in order to create the best possible community outcomes (Mukheibir et al., 2014). WSUD describes the approach of incorporating best-practice stormwater management, such as implementing biofilters and wetlands, into urban areas in order to improve liveability and environmental outcomes (Brown et al., 2009).

Major institutions have examined how water management practices can be improved in order to achieve sustainability. The SWITCH project, funded by the European Commission and involving 33 different organisations, investigated a wide array of topics related to managing water (Howe et al., 2011). The Global Water Partnership was instrumental in advocating for the creation of IWRM plans across the world (Global Water Partnership, 2014). The introduction of the Water Framework Directive in the European Union in 2000 was largely prompted by water pollution concerns but actually addressed many water challenges and encouraged a comprehensive approach to both water quantity and water quality (Science for Environment Policy, 2015). Another project, known as Prepared Enabling Change, is focused on preparing water utilities for the effects of climate change (Hulsman et al., 2010).

1.3. The need for an improved water infrastructure planning framework

One aspect of water management involves decisions around what water infrastructure should be built and where. Water infrastructure includes the physical structures that capture, hold, treat, and transport fresh/potable water, wastewater and stormwater and are generally managed and planned by water utilities, also known as water authorities or water service providers. Planners within water utilities conduct analysis to develop infrastructure recommendations that are then assessed and reviewed by management within the utility as well as external government regulators, as applicable. Elected politicians impact the infrastructure planning process by exerting either direct or indirect influence on utilities and regulators, sometimes in order to pursue partisan policies.

“Water infrastructure planning frameworks” are used to guide and augment project planning by specifying the process and steps for identifying infrastructure solutions. It is typical for planners to agree on an infrastructure planning framework at an early stage in the planning process. Frameworks are usually either set at an institution/department level or determined on a case-by-case basis.

“Infrastructure planning framework” is a general term used by the water and transport sectors (CSIRO, 2010; WSAA, 2014), but also in fields such as communications and electricity supply (Wilmoth, 2003). These frameworks include a number of fundamental steps such as goal setting, identification and evaluation of options, and implementation of decisions, which generally can be described as consistent with the rational planning tradition (Hudson et al., 1979).

It has long been recognized that although planning is often represented as rational and objective, in reality it is inherently subjective and affected by social and political dimensions, as well as prone to unavoidable conflicts (Lane, 2001; Minnery, 1985). Lindblom (1959) famously described planning as “the science of muddling through.” One only needs to look briefly into the decision-making processes involved in any major infrastructure project to discover just how subjective and political planning can be. Two obvious examples from Australia: the Australian broadband network, which was re-designed mid-rollout due to a change in government (Murphy, 2015; Safi, 2014), and the Melbourne desalination plant, which was used as a political point scoring exercise to the extent where one newspaper headline read as “the state election that neither side deserves to win” (Davison, 2014).

Although planning processes are ideally informed by science and evidence, it is problematic to consider planning decisions as entirely objective or rational, as all are made by humans and are therefore open to interpretation and opinion.

It has been noted that even 21st century paradigms such as IWRM and IUWM pay relatively little attention to social issues such as “whose interests are served, and whose voice is being heard,” having a general tendency to focus mainly on technical aspects of planning (Mukhtarov, 2008). Recent works by CSIRO (2010) and Rodrigo (2012) continue to represent water infrastructure planning as linear, rational, and expert driven. Considering that water infrastructure outcomes are affected by a variety of social and political factors, it is logical and desirable that water infrastructure planning, and the frameworks that guide it, should explicitly address and incorporate these factors.

1.4. Focus and structure of this paper

The focus of this paper is on understanding the reality of planning in the modern context, and creating a water infrastructure planning framework that is tailored to this environment. To be more specific, the research develops a list of the steps that should be conducted in a water infrastructure planning process, but not the particulars of what should be done in each of these steps.

One explanation for why researchers have chosen to not discuss specifics borrows language and concepts used in psychology by the developers of Neuro-Linguistic Programming (NLP). NLP practitioners provide clients with “process instructions” that are deliberately left “content free”. This is because if the “content” of the process is included, and it does not match what the client is looking for, then the client is likely to reject the process itself. In other words the more content details provided within a process framework, the greater the probability of rejection (Grinder and Bandler, 1981). This likely also applies to the field of water management, where if a practitioner observes that the content of a planning process is not relevant to their situation, they will likely disregard the overall structure and process. Put another way, the developed
framework is more of a heuristic device, that is to say a practical aid to problem solving, than it is a theoretical framework, which is a bounded, internally consistent conceptual schema used to interpret and evaluate data and theoretical concepts (Bullock and Tromley, 2000). This distinction is also expressed as the difference between Procedural and Substantive planning theories (Faludi, 1973).

Theoretical and substantive frameworks, such as the key principles of IWRM, can be described as “content”. Such content is relevant to infrastructure planning in terms of how infrastructure planning steps should proceed, but the existence of IWRM principles does not negate the need for a set of process instructions. The same can be said of legislative arrangements such as the EU Water Framework Directive. Policies that reflect IWRM principles, and WFD legislation, will still benefit from the use of a well-designed infrastructure planning process.

Whether described as process instructions, a model, a framework or a heuristic, the approach developed in this research was designed to be inclusive of the many contingencies found in actual planning practice rather than to sideline or ignore these uncertainties in order to build an idealized map of the planning process. Although not intended to be a fully developed methodology, this contribution intends to offer greater sufficiency than existing planning frameworks because it acknowledges a number of planning concepts that generally are not currently considered, or at least not considered systematically.

The structure of this paper is laid out as follows: (1) we review the evolution of urban and infrastructure planning concepts, (2) compare existing water infrastructure planning frameworks with findings from the review in order to identify conceptual gaps, and (3) develop and refine an innovative water planning framework that is sufficiently complex to deal with the myriad of issues faced by modern water planners.

2. Methodology

The methodology utilised in this research was inspired largely by the method that Lichfield (1975), a preeminent urban planning scholar, used to create his General Planning Process. This involved a review of the evolution of planning concepts, a comparison of existing planning frameworks, and industry consultation in order to develop and refine an innovative framework. The full methodology is shown in Fig. 1.

A literature review was conducted on the evolution of urban and infrastructure planning concepts. It was determined through this review that the evolution of planning theory is effectively covered by a number of preeminent authors, including Faludi (1973, 1997) and Lichfield (1975, 1996), who have written wide-scope "classic" treatments of the subject. In combination with some more recent papers to check modern perspectives on traditional analysis, a picture was painted of how the conceptual landscape of the planning field has evolved over the last century.

The next phase of the research involved analysis and comparison of modern water infrastructure planning frameworks. Planning frameworks are not necessarily explicitly defined, or easily identifiable, within planning documents. The frameworks considered here were collated from two years of comparative research into water infrastructure planning. A set of six frameworks was selected for detailed analysis; four were based on industry-standard documents from reputable sources, and two were based on academic research.

Conceptual analysis was conducted to determine what components were included in each framework in order to create a combined set without duplication. This combined set was used as the basis for creating a draft framework. Concepts that were deemed important by the literature review, yet not included in the modern water infrastructure planning frameworks, were added.

Examples are the inclusion of decision taking elements and the effects of project outcomes on future planning processes.

An extensive industry consultation process was conducted to improve and validate the draft framework. Australian water planning professionals from both the public and private sectors were consulted. Experts were identified and contacted through a combination of what is known as “snowball sampling”, where experts recommend additional experts, and maximal variation sampling, which involves consciously searching for experts from a variety of desirable backgrounds (Baumgartner and Pahl-Wostl, 2013). A total of 34 industry experts were identified from 19 organisations across four states of Australia. The organisational types from which the experts were selected are shown in Appendix A.

The draft planning framework was improved and refined through consultation with the industry experts to create a final version that was consistent with their recommendations. The industry consultation process involved 29 meetings in person and another three by phone. In each meeting industry experts were asked for their opinion on the draft framework. The format of the consultation meeting was semi-structured and experts were allowed to discuss whatever topics they saw fit in addition to commenting on the proposed framework. Comments were assessed in relation to each other and used to develop the final version of the framework, which was validated through a 2 h workshop with the Water Services Delivery team of Melbourne Water Corporation.

The practical utility of the proposed framework was assessed through a preliminary analysis of planning case studies. Case study samples were chosen from water infrastructure projects within Australia that had been planned within the last seven years and where information about the planning process was available to the researchers. It is difficult to objectively assess the effectiveness of the framework in relation to the case studies; however, we can draw some preliminary conclusions about using our framework in comparison to previously used frameworks.

3. Review on evolution of urban and infrastructure planning concepts

In order to understand the complexities of planning in the
modern context, it is useful to consider the findings accrued in the academic field of planning over its history.

Evidence of relatively sophisticated urban planning practices can be seen as far back into history as ancient Egypt (Pedersen et al., 2010) and ancient Greece (Minnery, 1985). Urban planning became known as an independent professional field and academic area around the turn of the 20th century (Minnery, 1985), emerging from a combination of architecture, engineering, and surveying (Faludi, 1973) with some influence from economics, geography, human ecology, and urban design (Friedmann, 1963).

Unlike urban planning, infrastructure planning does not have an independent theoretical or academic background and has evolved mainly through a trial-and-error process led by practitioners within public institutions (Elmer and Leigland, 2013). In an increasingly complex and dynamic sociotechnical process, infrastructure planning is generally done through a combination of federal, state and local governments; bureaucratic planning agencies; and water, road, communications, and energy utilities (Graham, 2000).

In the first half of the 20th century, both urban and infrastructure planning practices were predominantly technical and expert driven, involving centralised control and a formalised plan (Hudson et al., 1979; De Smit and Rade, 1980). This type of planning is generally referred to as ‘rational planning’, which typically involves the basic elements of goal setting, identification of policy alternatives, evaluation of means against ends, and implementation of decisions. This process is not always undertaken in precisely this order, and can include any number of feedback loops; however all of these steps must be included (Hudson et al., 1979).

The pursuit of rationalism can be traced back at least to ancient Greece when rationality and logic were seen as the highest attributes of humanity (Lawrence, 2000). These ideals have pervaded thought in western society ever since and became widespread in the urban planning and public policy fields between 1890 and 1950 (Mukhtarov, 2008; Heinzerling et al., 2005).

In the early 20th century, it was common to apply purely rational thinking to complex systems. For example, the US government consistently used expert driven, science and economics based methodologies to determine policy on issues such as air-pollution regulation, and the creation of new dams (Heinzerling et al., 2005). These processes involved putting a number of experts in a room to attempt to objectively calculate what is best for society. These types of government studies are typically referred to as ‘rational comprehensive planning’ because they focused on experts doing quantitative analysis on all relevant factors to determine the best options for solving complex problems.

In the second half of the 20th century “rational” approaches to planning became unpopular in urban planning and other areas of public policy, which moved on to a more socially oriented planning regime (Faludi, 1973). Infrastructure planning practices however did not follow suit, and have remained largely rational, centralised, expert-driven systems up until the present. In other words, from the 1950s onwards, urban planning and public policy went one direction and became more socially and politically aware, and infrastructure planning tended to remain in the old rational/technocratic paradigm.

This made sense until recently because infrastructure planning, as practiced throughout history, had not been particularly complex and generally involved independent, segregated planning for each service and reactive upgrading as required (Mukheibir et al., 2014; Closas et al., 2012). Therefore a purely rational approach to infrastructure seemed suitable during that period (De Smit and Rade, 1980). The only significant non-technical adjustment to infrastructure planning over the last century has been the inclusion of some level of community consultation.

From around 1950 onwards, problems associated with applying the rational planning tradition to urban planning and public policy emerged. Increasing societal complexity and instability contributed to increasing difficulty in applying rational planning to public policy problems (De Smit and Rade, 1980). Critiques of rational planning centred on the inaccuracy of outcome prediction, the subjective nature of planning, and the unavoidable conflict among personalities involved in planning. These critiques led to the conclusion that rational planning is not applicable to complex social systems, and that the planning field has incorrectly attempted to represent something that is inherently political and subjective as rational, objective, and scientific (Lane, 2001).

Charles Lindblom, famous “the science of muddling through”, asserted that in many cases it was impossible for planners to design an effective plan that in incorporates a detailed analysis of different options due to lack of time, intellectual capacity, and information, and that the fluctuating nature of society would make sticking to such a predetermined plan inappropriate (Lindblom, 1959).

Many authors now argue that urban and public policy planning requires a “sociocratic” approach (Faludi and Altes, 1997; Mignoli and Nijkamp, 2006; Lindblom, 1959). Lichfield (1975) described this shift as a general reorientation of urban planning away from architecture and engineering and toward economic, sociological, and political considerations. Table 1 contrasts the main the differences between rational/technocratic and the sociocratic planning styles.

Many different planning traditions have been proposed to solve the problems associated with rational planning. These more sociocratic traditions can be described under the names given by Hudson et al. (1979) as incremental, transactive, advocacy, and radical planning. Lane (2001) uses slightly different labels, but the common thread across these alternative planning traditions is the focus on flexibility, decentralisation and community consultation, and all are highly related to the notion of sociocratic planning shown in Table 1.

Strategic planning (SP) emerged in the 1960s as a method to help organisations achieve success (Mintzberg, 1994). Proponents argue that SP, if done correctly, is quite different from the historical practice of rational planning. It is argued that SP should not be conducted in an overly rational way because this diminishes an organisation's ability to innovate and adapt (Lenz and Lyles, 1985). One of the key ways that SP differs from the rational tradition is that, when performed correctly, it does not use a top-down approach, where the leaders of an organisation claim to have all the answers, but rather sees strategic planners as facilitators and coordinators that piece together strategies that are formed over time and across different parts of an organisation (Mintzberg, 1994).

Infrastructure planning frameworks should take into consideration the knowledge accrued in the field of planning over the past century. According to the considered literature, planning for complex systems should be done in a way that recognises that (1) politicians and the public influence planning, (2) planning processes are cyclical rather than linear, and (3) planning decisions are inherently subjective and political, rather than objective and scientific.

4. Development of an innovative water infrastructure planning framework

In the context of the more nuanced account of planning described above, it is possible to apply this understanding toward developing an improved water infrastructure planning framework. This transposition of urban and public policy planning theory onto water infrastructure planning is outlined in five subsections. First, a more comprehensive explanation of the meaning and use of planning frameworks is given using an example from urban planning. Next, six existing water infrastructure planning frameworks are compared against each other to identify key concepts as well as conceptual gaps,
for use in creating a draft planning framework. We then summarise the advice received from the water industry experts on how to improve the draft framework. In the final two subsections, the finished framework is proposed, and its utility is explained.

4.1. Planning frameworks

This section provides details on the meaning and use of planning frameworks. Within the broad academic fields of planning/urban planning, hundreds of papers and books are concerned with the creation of planning frameworks to assist planners in navigating the complex modern planning environment. One well-regarded explanation of a planning framework is known as the General Planning Process, which was developed through comparing previous frameworks and consultation with experts. The General Planning Process involves the following steps (Lichfield et al., 1975):

1. Preliminary recognition and definition of problems
2. Decision to act and definition of the planning task
3. Data collection analysis and forecasting
4. Determination of constraints and objectives
5. Formulation of operational criteria for design
6. Plan design
7. Testing of alternative plans
8. Plan evaluation
9. Decision-taking
10. Plan implementation
11. Review of planned developments through time

This process is an expansion of the rational planning steps and is applicable to major urban plans that have set objectives, deliverables, and timelines.

Two major points can be noted from Lichfield’s planning framework. First, in 1975, the concept of community consultation had not come to prominence yet and hence was not included; second, Lichfield identified a step referred to as “decision taking” to include regulation and approval, which were understood at the time as crucial steps because planners do not have ultimate authority to make or implement decisions (Lichfield et al., 1975).

In his later work, Lichfield (1996) includes community consultation and describes the groups that influence planning and the process by which they do so, shown in Table 2. The success of planning is also influenced by government policy that sets out the structure, commitments, and jurisdiction of infrastructure-related departments (Wilmoth, 2005). It is important to acknowledge that planners are not the only group that influence planning outcomes.

4.2. Comparison of existing water infrastructure planning frameworks

As a starting point for developing a new and innovative water infrastructure planning framework, it is prudent to compare the prevailing frameworks. This section explores planning frameworks that are specifically related to water planning.

Over a two-year period, the researchers conducted an in-depth and cumulative investigation into water infrastructure planning. This discovery process identified embedded and stand-alone, planning frameworks, both Australian and international, within industry reports, academic papers, and books. A set of six of these frameworks was selected for detailed analysis within this research on the basis of providing both industry-standard knowledge, as well as outlier perspective. Each of these lists between four and nine steps for water infrastructure planning, as summarised in Table 3.

Two of the frameworks are broad in scope, covering a range of water planning issues rather than being specifically infrastructure related. These are the World Bank framework and the framework developed by the Water Services Association of Australia (2014). The remaining four frameworks refer specifically to the planning of water infrastructure. Two of these, Jeffcoat (2009) and Sapkota (2013), are recorded in academic papers; the third, the CSIRO framework, is part of a published book by a major research institution; and the fourth is an industry report by the US EPA.

The contents of these six frameworks were compared with each other and against the findings of the planning review to identify consistencies and reveal gaps. These findings are shown in Table 3, with gaps marked as crosses.

The order of the steps, and the overall content of the process are generally consistent across the five systems; however the number of steps differs from four to nine. Interestingly none of the frameworks mention cost-sharing and financing, or regulation and approvals both of which were thoroughly covered in the works of Lichfield (1975). Also, none of the documentation makes reference to any planning theory or tradition, Lichfield’s general planning process, or any other author’s framework. In other words, none of the identified frameworks acknowledge the existence of other frameworks or make explicit comparison with competing theories.

Comparisons between existing frameworks were used to develop a draft framework that could then be refined through consultation with water industry experts.

Several water planning frameworks were not included in this comparison table. This includes the strategic planning process developed by the SWITCH project (SWITCH, 2010), which was seen to be too broad to be relevant to infrastructure planning, and other water planning frameworks such as Speed (2013), which relates to water allocation decision making but does not address the construction of new infrastructure projects.

4.3. Draft framework and improvement through industry consultation

Using Table 3 as a reference point, a set of seven planning components were determined and then combined with “context” and “outcomes” to make a draft planning framework with a total set of
nine components. This process was undertaken while being mindful of the concepts identified from the review of planning theory. The draft framework was refined through consultation with water industry experts. The purpose of the consultations was to receive industry feedback on the content and structure of the draft framework.

Industry experts were consulted on the number, order, terminology and also the concepts and meaning of each of the proposed planning components. There were four major and consistent themes that were brought up in many of the industry consultations.

First, risk assessment, and objective setting methods were often stressed, with many experts pointing out that these should be considered, and reconsidered, throughout the decision making process rather than in one specific phase. From these comments the researchers decided to include both risk analysis and objective setting within an “Integrated Project Management” overlay that intertwines all of the “decision making” elements.

Second, regulatory and approval issues were discussed in the context of projects that planners had recommended and advocated for but where government regulators had for various reasons decided against pursuing.

The third issue, raised in tandem with the second, concerned cost-sharing and financing arrangements. Many stories were told of infrastructure servicing strategies created at high cost, often by private consultants, that were never implemented because planners had not adequately considered who was going to pay for their proposals.

The fourth major comment was that, due to the non-linear nature of planning, it was impossible to accurately represent planning with a chronological list. For this reason, we opted for a process diagram that represents the non-chronological nature of the planning process and the iterative interactions among components as shown in Fig. 2 of the following section.

Additional comments on the planning framework were largely terminological, or relating to methods, or concepts that should be associated within each component. The terminology used for individual components evolved over time as industry experts were consulted individually. The total number of steps did not change between the draft and final version of the framework.

4.4. Proposed planning framework and component interaction

The key concepts of the proposed planning framework are explained in this section with a basic explanation of how they could be put into practice, as shown in Table 4. In our proposed process framework, each step is attached to a fundamental description of the concepts that should be considered within each step. Process

### Table 2

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<thead>
<tr>
<th>Groups that influence planning.</th>
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<tr>
<td>Politicians</td>
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<td>Planners</td>
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<td>Members of the community</td>
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Source: adapted from Lichfield (1996).

### Table 3

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<tr>
<td>Understanding conditions and defining overall approach</td>
<td>Engagement</td>
<td>Convene key stakeholder group</td>
<td>Define goals and objectives of the plan</td>
<td>Define approach</td>
<td>Understanding local conditions and current system</td>
<td>Problem definition</td>
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<tr>
<td>Convening and engaging key stakeholder group</td>
<td>Agree on objectives, measures and criteria</td>
<td>Agree on objectives, measures and criteria</td>
<td>X</td>
<td>X</td>
<td>Characterise</td>
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<td>Agree on objectives measures and criteria</td>
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<td>Understand the broader planning context</td>
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<td>Data collection</td>
<td>Assessment</td>
<td>Understand current system</td>
<td>Collect and analyse data to support plan development</td>
<td>Develop options</td>
<td>Establish specific objectives</td>
<td>Development of objectives and criteria</td>
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<td>Option identification</td>
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<td>Select models to perform analysis</td>
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<td>Development of scenarios</td>
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<td>Option assessment and selection</td>
<td>Assess system performance</td>
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<td>Conduct impact assessment on the plan including stakeholder involvement</td>
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<td>Financing and cost-sharing of options</td>
<td>X</td>
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<td>Regulation and approvals</td>
<td>X</td>
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<td>Implementation planning</td>
<td>Participatory planning</td>
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<td>Implementation and monitoring</td>
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<td></td>
<td>Monitor evaluate and review</td>
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Sources (left to right): authors’ interpretation, Closeas (2012), CSIRO (2010), Jeffcoat (2009), WSAA (2014), Sapkota (2013) and Rodrigo (2012),
steps are segregated with respect to decision analysis and decision taking elements. Option selection is undertaken through an iterative process between the decision analysts and decision takers.

As explained in the introduction, a more detailed explanation of the proposed planning components is not attempted here because implementing the framework will vary with context. Contextual factors include location, objectives, resources, available data, number of stakeholders, level of development, etc. We suggest it is not necessary to justify the nine proposed components because they are based on fundamental and universal concepts. The only aspects of the proposed framework that must be logically justified are the aspects that differ from prevailing water infrastructure planning frameworks.

The proposed framework differs from the purely rational/technocratic tradition common to traditional water infrastructure planning by delving into complexity in the following four ways.

First, in the tradition of Lichfield (1975) the researchers have separated "decision analysis", which leads to planning recommendations, from "decision taking", in which authorities review recommendations and give final approvals. Outcomes are generally produced through an iterative, back-and-forth process between the responsible parties. Inclusion ensures that planners consider those who will give final approval of their recommendations. This is important because water infrastructure planning recommendations are not always accepted by government regulators (Melbourne Water, 2013).

Second, this framework ensures that cost-sharing arrangements are considered before final recommendations are made. According to consulted experts, water infrastructure planning processes occasionally recommend infrastructure plans and only afterwards determine how the infrastructure will be funded.

Third, in accordance with Lichfield (1996), the infrastructure planning loop is closed by considering how the results of one plan or project will affect future planning. This is accomplished by representing the planning process as cyclical rather than linear, which is important because if a particular water project is perceived by government or the community as successful then future projects of the same type may be perceived in a positive light and therefore will receive more support. The reverse is also true for infrastructure projects that are perceived as failures. If a planning process is conducted in isolation from past and future plans and projects, then these potential legacy factors are not adequately considered.

The final way that the proposed framework differs from a purely rational planning tradition is by making explicit the potential influence of government and community preferences before and during the planning process. If, either through a structured or unstructured process, planners attempt to account for what the government or the local community want at the time, this should be explicitly documented. This step would encourage the water management field to take account of “whose interest is being served, and whose voice is being heard,” a problem identified by Mukhtarov (2008). At present, it is not uncommon for politicians to give private directives to planners, which creates problems in terms of a lack of transparency and accountability.

Fig. 2 depicts the water infrastructure planning framework, listing the planning steps and showing how they interact in a non-linear, cyclical fashion.

4.5. Utility of the proposed framework

4.5.1. The proposed framework has two functions

1) to assist researchers and planners in gathering, recording, and analysing information from previous planning processes, and

2) to provide a broad conceptual approach future planning processes.

The proposed framework is currently being used to record information on water infrastructure planning case studies from across Australia as part of a collaborative program between RMIT University and Water Research Australia with support from Melbourne Water Corporation. We have used this experience to make some preliminary conclusions. Thus far, the framework is proving to be a useful and necessary tool within the broader research program. Its functional purpose includes but is not limited to organizing information on case studies, guiding case study interviews based on the links between planning components, providing a data recording template, and allowing for easy comparison between case studies of different types and scales.

Fig. 2. Proposed water infrastructure planning framework.
Several case studies have underlined the importance of recognising that planners do not generally have ultimate authority to make final decisions, and the process through which “decision taking” occurs is therefore crucial. This confirms that the decision making process of regulation and financing play a major role in actual planning outcomes, and should thus be considered both in the planning framework for new infrastructure as well as the analysis of previous planning processes.

The fact that this framework is proving useful for analysing previous infrastructure planning processes lends weight to the fact that it has utility for future planning processes. Although specific planning methods will vary depending on circumstances and context, the framework provides a comprehensive list of general planning steps and the interactions among them in order to ensure that planners do not miss out on crucial elements. For example use of this framework may help ensure that planners consider cost-sharing before recommending a preferred option. It may also encourage planners to re-evaluate objectives and risks throughout the planning process rather than only at one particular time.

Although this framework was intended for application to water infrastructure planning, we believe it has broader functionality with the water sector. In fact, during the course of our research, we were contacted by government officials about adapting the framework to a wide variety of water planning issues, including catchment management. Theoretically the framework may be applicable to other infrastructure-intensive fields, such as transportation and electricity. Case studies from these fields would be a potentially fruitful area for future research.

5. Discussion and conclusion

A number of water infrastructure planning frameworks currently exist, but they include significant conceptual gaps. We suggest that these gaps in the prevailing water planning frameworks may be partially due to weak linkages between the academic fields of water management and urban planning/public policy. Indeed, we find that the water-infrastructure planning literature generally makes no reference to these other disciplines.

In addition, even specific water-infrastructure planning frameworks have a tendency to not reference other works. We found no examples of comparing or building on previous frameworks. We suggest that these conceptual gaps are partially due to the inconsistent labelling used. More consistent use of “water infrastructure planning framework”, as explained in the introduction, in the water utility management literature would allow greater cross fertilisation of ideas.

We addressed these issues through an analysis and comparison of the existing body of knowledge on planning theory, urban planning practice, and modern water infrastructure planning frameworks. Findings from our review were combined with an extensive and wide-spread industry consultation process in order to develop and improve an innovative framework to more accurately model an effective planning process, including the ordering of and interactions among components. Compared to the prevailing frameworks, our approach: (1) makes explicit the iterative process between decision analysis and decision taking, (2) ensures that cost-sharing arrangements are in place before final recommendations are made, (3) considers the effects of public and media perceptions about project outcomes on future planning, and (4) makes explicit the impact of government and community preferences on the planning process.

Ongoing research indicates the usefulness of the proposed framework, which commends its use by others engaged in water-infrastructure planning and analysis.

The major limitation of this research is that applied water infrastructure planning frameworks are generally found in public-sector reports rather than the academic literature, making them difficult to locate. Future research would benefit from the inclusion of a wider array of water infrastructure planning frameworks for comparison. However taking into account time and resource constraints, we are confident that our framework is well informed and adaptable to water-infrastructure planning in a variety of modern contexts.

Acknowledgements

The authors wish to acknowledge the financial support of RMIT University, Water Research Australia and Melbourne Water Corporation. In addition to this the authors would like to thank the

Appendix A

Organisational types consulted.

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References

SWITCH, 2010. SWITCH Approach to Strategic Planning for Integrated Urban Water Management (IUWM) (s.l.: s.n).
UN Water, 2015. Water for a Sustainable World. s.l.: UNESCO.
Chapter 6: Planning processes for IUWM projects

6.1 Introduction

This chapter provides preliminary discussion of the in-depth case studies included in Appendix B in relation to (a) planning scales, and (b) approval processes. It includes a literature review on IUWM in general and the planning processes associated with it. In particular it considers the case study results in relation to a published IUWM planning manual (CSIRO, 2010), and finds some conceptual discrepancies between theory and practice. The publication has scholarly significance for two reasons. It is one of the first discussions of planning scales and approval processes for IUWM projects, and includes a proposal for a division of responsibilities across scales. Secondly it provides real-life IUWM case studies which are extremely valuable for both scholars and practitioners working in the area of IUWM.

This chapter is made up of a journal paper which has been published in Water Policy journal.

The practical implications of this chapter are:

- IUWM projects are typically identified by utilities and municipalities independently, rather than as part of a regional or sub-regional collaborative planning process. Therefore they are not often not designed in alignment with larger scale policies
- Many IUWM projects are experiencing difficulties when it comes to achieving approval from internal senior management and external regulators. Therefore many recommended IUWM projects are not being constructed
- Major barriers to IUWM project approval include a lack of communication between regulators and practitioners, and a lack of consistent financial evaluation processes. Both of these issues are compounded by a lack of regional policy and collaborative planning
- A multi-tier model is proposed for how these issues can be addressed through a distribution of decision making responsibilities across regional, sub-regional and local scales. In this way policy can be determined at a regional scale and strategies and projects can be developed at smaller scales in accordance with regional policy
Abstract

In the Australian context integrated urban water management (IUWM) processes consistently recommend the implementation of recycled water and stormwater harvesting projects. These projects are typically decentralised and planned by a variety of organisational types. Major international research programmes have thus far focused on how IUWM should be operationalised as a single-tier, city scale planning system. This study investigates IUWM in relation to two under researched aspects: planning scales and approval processes, by investigating eight project case studies from Melbourne, Australia. Results reveal that IUWM projects are often planned at the sub-regional and local scales, without coordination from metro scale strategies, and that many of these projects are experiencing issues achieving final approvals. Major barriers to approval include a lack of communication between regulators and planners, and the absence of consistent financial evaluation methods. A multi-tier water planning system has been proposed to lessen these barriers through effective division of decision making responsibilities across scales, and setting of consistent frameworks, methods, and objectives at the metro scale. It is considered that this multi-tier planning system may help facilitate the implementation of decentralised IUWM projects.

Keywords: Integrated water management; Integrated urban water management; Water infrastructure planning; Water planning framework; Water planning scales

1. Introduction

1.1. Urban water management

The effective management of water is a critical factor for the ongoing viability of cities (Marlow et al., 2013). Traditionally urban water management has been performed along the lines of segregated water supply, wastewater, and drainage services (Khoury, 2006; Brown et al., 2009). These services are...
delivered via a network of buried pipes that connect residents to water sources, and treatment and disposal outlets (Marlow et al., 2013).

Water management in urban areas has gone through a number of phases throughout its history (Marlow et al., 2013). Urban water management in the modern era began with the creation of dams and the supply of water to cities. The need to provide sanitation and dispose of water led to the use of both separate and combined sewer and drainage systems (Brown et al., 2009). Around the time of the 1970s, in many countries, environmental considerations came into the spotlight, as governments began to realise that current practices were unsustainable (Mukhtarov, 2008). This related to the pollution of waterways, and social amenity considerations as well as unsustainable water usage patterns (Brown et al., 2009).

In many areas of the world, limits on water resources are now forcing water authorities and governments to look beyond traditional water sources towards alternative water sources. Globally there is a simultaneous trend towards (a) centralised large scale desalination plants, (b) centralised direct potable reuse schemes, and (c) smaller scale decentralised fit-for-purpose recycled sewage and stormwater schemes (Bell, 2015).

As urban water management practices evolve away from purely water supply, sewerage and drainage functions towards a wider set of environmental considerations, such as river and ocean ecology, and social considerations, such as liveability and recreation, there is an associated increase in planning complexity (Bell, 2012). The progression of urban water management principles and practices towards the mastery of this complexity is typically described using the rhetoric of a transition from traditional water management towards Integrated Water Management (Furlong et al., 2015).

### 1.2. Integrated urban water management

The idea that traditional water management and planning practices needed to change began being discussed widely after a series of global conferences in 1977, 1992 and 2002, which created the foundations from which integrated water management concepts emerged. At the end of the 2002 World Conference on Sustainable Development, the United Nations recommended that all countries develop integrated water resource management (IWRM) plans (Mukhtarov, 2008). These IWRM plans were designed to consider the overall water resource situation of countries in an integrated way. In relation to urban infrastructure, the integrated water paradigm is gradually becoming known amongst practitioners and academics as integrated urban water management (IUWM) (CSIRO, 2010; Closas et al., 2012; Furlong et al., 2015).

According to Biswas (2004), at that time there was no agreement on exactly what needs to be integrated, or by whom, and any list of these factors could be extended almost indefinitely. A number of concepts, however, are common throughout the literature, including the following (Mukheibir et al., 2014):

1. Proactive, long term planning.
2. Active consideration of water supply, wastewater, and drainage services, and the interactions between them.
3. Fit-for-purpose water use.
4. Collaboration between organisations and departments.
5. Inclusion of water considerations into urban planning processes.
6. Both centralised and decentralised planning and infrastructure.
1.3. The planning challenges associated with IUWM

Within the ‘traditional’ water management paradigm, urban water infrastructure planning has been done in much the same way for the centuries since the creation of the first water supply dams and sewer systems (Bell, 2012). Even as drivers changed over the decades, for example, when water authorities began to actively consider environmental concerns (Mukhtarov, 2008), water infrastructure planning processes have remained reactive and segregated (Mukheibir et al., 2014). However there is an ever-growing consensus in the water management field that reactive planning of segregated services is no longer the optimal way to conduct water infrastructure planning. IUWM proponents propose the adoption of a proactive and integrated planning approach involving assessing multiple water infrastructure options, across many criteria, over a long time span (Maheepala, 2010; Closas et al., 2012; Marlow & Tjandraatmadja, 2014).

At the conceptual level IUWM can mean different things to different people. At the physical infrastructure level there are a number of project types that are consistently selected by IUWM planning processes. Australia does not at present have any direct potable recycling schemes, i.e. recycled water to drinking water (ATSE, 2013). The types of infrastructure projects most commonly associated with IUWM in Australia are decentralised non-potable recycled wastewater and stormwater harvesting projects, which utilise previously unwanted water for fit-for-purpose uses (Barker et al., 2011; Institute of Sustainable Futures, 2013). These two types of projects represent the crux of the IUWM paradigm by cutting across the traditionally segregated services of water supply, wastewater, and drainage. The addition of these alternative water source projects to existing centralised infrastructure such as dams and desalination plants can be described as a gradual water infrastructure hybridisation process (Marlow & Tjandraatmadja, 2014), meaning that the existing centralised sources are supplemented by an increasing diversity of water sources over time.

Difficulties arise in the planning of these types of projects for a number of reasons. Firstly, they involve many different stakeholders, organisations, departments, and regulators (CSIRO, 2010; Mukheibir et al., 2014). Secondly, they present higher levels of risk and uncertainty to organisations than traditional servicing solutions because the governing organisations have less experience with them (Marlow & Tjandraatmadja, 2014), and because alternative water source costs and demands cannot always be accurately predicted (Institute of Sustainable Futures, 2013). Thirdly, even under idealised circumstances, these projects generally do not achieve full cost recovery, and are often done on the basis that they provide environmental and social benefits to residents which are difficult to value financially (Marsden Jacob Associates, 2013).

Planning for IUWM projects therefore requires a new planning regime which effectively includes proactive consideration of complex interrelated objectives, trade-offs between social, environmental and economic factors, and long term consideration of possible infrastructure portfolios (CSIRO, 2010).

In recent years there has also been increasing speculation in regard to the role that markets and competition play in urban water management and planning (LECG Limited Asia Pacific, 2011; Arup, 2014). Internationally water service competition and privatisation has been a contentious issue for decades (Bakker, 2008). The transition towards IUWM means that there will be a larger number of smaller water infrastructure projects. In Australia this has meant that many new on-site, i.e. building-scale, decentralised systems are owned and operated by private entities rather than public water utilities (Mukheibir et al., 2015).
1.4. Previous research into IUWM

The planning of urban water infrastructure has always been a function undertaken by water authorities, but has not historically been extensively considered by academic literature. Purely for the purposes of illustrating this point, a search of the Scopus database was conducted and yielded 88,821 results for ‘water management’, 4,679 results for ‘water planning’, and 20 results for ‘water infrastructure planning’ (search conducted 30/3/15).

Research into the practicalities of water infrastructure planning within the IUWM paradigm has largely been undertaken by major government and industry led initiatives, there are however some notable research projects conducted by academics. Ferguson et al. (2013) considered the institutional context required to facilitate the adoption of IUWM but did not delve into planning frameworks and processes. Dominguez et al. (2011) compared a number of different approaches to using strategic planning to deal with uncertainty in relation to the planning of water infrastructure over a 20–30 year time period, and included some basic steps through which infrastructure strategies should be developed.

The most significant contributions to the literature on IUWM planning have been undertaken by SWITCH, the World Bank, and the CSIRO.

The SWITCH research project ran between 2006 and 2011 and was funded by the European Commission with a budget exceeding €20 million. The main objective of the research was to determine how to achieve sustainability in urban water management. As part of this research a ‘strategic planning approach’ to water management was designed (SWITCH, 2010). This research focused on building a joint vision and the development of strategy (Howe et al., 2011), and did not specifically address infrastructure planning issues. One reason for this was that the SWITCH project suggested that long-term (30 year) strategic thinking should be predominantly related to abstract/societal systems rather than specific infrastructure considerations. Infrastructure was considered on an operational level, with a time scale of zero to 5 years (Jefferies & Duffy, 2011).

World Bank research conducted in 2012 utilised metro-scale case studies from the developing world to consider the process for the operationalisation of IUWM. Barriers to implementation, specific issues, and further research requirements were identified. A process was developed through which cities were expected to adopt IUWM, and a dialogue was begun on the issues of choosing between various infrastructure options (Closas et al., 2012).

Perhaps the most pertinent and practical research project completed to date on this topic is the IUWM Planning Manual. In 2010 the CSIRO, a major research organisation supported by the Australian Government, together with the US-based Water Environment Research Foundation, conducted an international study into infrastructure planning processes for IUWM. The study put forward a single tier, city-scale planning framework for how IUWM should be implemented, and recorded information on six metro-scale case studies (CSIRO, 2010).

1.5. Water governance and the politics of scale

Within the literature there have been long running discussions of water management at different spatial scales and it is argued that a scalar perspective is crucial for understanding water governance (Sneddon, 2003). Some topics of discussion include: whether decisions should be made at the river-basin scale rather than being divided by state and local government areas (Warner et al., 2008), if local scale water governance increases decision making power in communities (Norman & Bakker,
2009), at what spatial scale should water security be considered (Cook & Bakker, 2012), the idea of scale as a social construct and the relationship between authoritarian governance and scalar politics (Swyngedouw, 2000), the role of scales in scenario planning (Warwick et al., 2003), and discussing how stakeholder interests change across spatial and jurisdictional scales in relation to understanding competing interests (Lebel et al., 2005). From this it can be seen that scalar issues are considered in academic literature in the field of water management.

It is understood that the transition towards IUWM requires a shift from centralised infrastructure to diverse, flexible infrastructure solutions at multiple scales via a suite of approaches (CRC for Water Sensitive Cities, 2012; Mukheibir et al., 2015). However major research efforts into IUWM by those such as SWITCH, the World Bank and the CSIRO have not thus far addressed the scalar issues relating to how these distributed infrastructure projects should be identified, planned and approved.

In water industry practice however there has been a shift towards acknowledging that water infrastructure planning does, and should, occur across multiple scales with a division of responsibilities across scales. This is demonstrated by the difference between the Water Services Association of Australia (WSAA) planning manuals in 2005, which do not acknowledge planning scales or division of tasks between scales, and in 2014, which include both (Erlanger & Neal, 2005; WSAA, 2014).

1.6. This study

None of the identified major IUWM research programmes specifically address two important questions for IUWM planning which form the basis for this paper. The first question is that if IUWM projects are to be distributed throughout the water grid, in the form of decentralised recycled water, stormwater harvesting, rainwater harvesting and sewer mining schemes, then at what scale should potential projects be identified and planned, and by whom? The second question is if these projects are in fact going to be implemented by a variety of different organisations at different scales then who should be responsible for oversight, approval and regulation of these projects, and how should this be done?

An attempt will be made to begin to explore these questions by investigating IUWM in Melbourne, Australia, and the planning scales and approval processes of eight project case studies. Melbourne was selected as the location for this research due to the fact that it is considered to be a world leader in IUWM, and since 2009 has had a significant number of decentralised recycled sewage and stormwater harvesting reuse schemes planned (Jefferies & Duffy, 2011; Ferguson et al., 2013; Green, 2014).

2. Research methodology

The overall methodology for the current research was informed by the works of Thomas (2011) in relation to case study structure and analysis. The study has involved an investigation into the progression of IUWM in Melbourne, and eight nested case studies of IUWM project planning within this context. The data sources for this work have included consultation with 34 water industry experts and a variety of published and unpublished literature.
2.1. Assembling a group of industry contacts

For the purposes of this research, 34 water industry experts from Melbourne and across Australia have been consulted. The organisational types, organisations and numbers of experts consulted in total can be seen in Table 1.

Industry experts were identified and contacted through two sampling methods. The first, Snowball Sampling, means that industry experts were asked to recommend additional experts which is most suitable when sampling restricted populations where trust is required (Barbour, 2014). The second, Maximal Variation Sampling, means that a conscious effort was made to include a variety of experts (Flyvbjerg, 2011), in this case meaning from a spread of organisational types. It can be said that there is no such thing as a neutral expert (Haack, 2014), and while maximal variation sampling helps alleviate this issue by gaining a spread of opinions, potential biases remain a limitation of the present research and will be considered in the conclusion section of this document.

2.2. Consultation phases

Industry consultation occurred steadily throughout the research. These consultations can be delineated into three groups according to the time period in which the consultation occurred: prior to the design of the research method \((n = 13)\), during the data collection phase \((n = 17)\), and to verify the findings \((n = 4)\). In order to gain the maximum benefit from the knowledge of industry experts a semi-structured interview process was used. Meeting minutes were recorded from each interview and sent to the relevant interviewee for verification.

2.2.1. Preliminary work. Thirteen industry experts were consulted prior to the design of the research questions and were consulted in order to understand the planning processes used by their organisations and their views on historical and current water infrastructure planning and existing research. The

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information collected during this first round of consultation was used to inform the development of the research gap and method.

2.2.2. Case study selection and analysis. Through discussions with industry experts it was eventually agreed that eight nested project planning case studies should be investigated for this research. This number was selected on the basis that in order to answer the research questions it was absolutely necessary to investigate a spread of projects. A total of eight projects allowed the inclusion of public and private, small and large, utility and local government led, successfully implemented and also projects which did not achieve implementation. If a spread of projects was not included it would not be possible to draw potential logical generalisations to the broader population (Thomas, 2011), in this case IUWM projects in Melbourne.

Seventeen experts were consulted during this phase, in relation to selecting the most appropriate project case studies and also for collecting information on these. Selection was done through creating a long list of 14 case studies from which 8 were selected. Criteria through which eight were selected related to (a) availability of information, including factors such as documentation available and political sensitivity, (b) independent/succinct planning processes, and, to a lesser extent, (c) a spread of organisations, types of projects and project outcomes. The final selection was informed by a targeted workshop held at Melbourne Water Corporation with the Water Services Delivery team in September 2014. Two meetings were held in relation to each of the eight selected case studies, the first to establish background and gather documentation, and the second to confirm findings.

3. Water management context in Melbourne

Urban water infrastructure in Melbourne has developed since the gold rush in the 1850s (Rhodes, 2000), with the first water supply dam being built in 1857 and sewerage and drainage networks constructed over the following decades (Ferguson et al., 2013). Over the period between 1850 and 1984 major water supply augmentations were conducted in the form of new dams through which Melbourne’s water supply storage was increased dramatically. Towards the end of the century the focus of water management turned away from water supply towards catchment and waterway protection (Rhodes, 2000).

Officially Melbourne’s major ‘Millennium drought’ began in 1997 (Ferguson et al., 2013). Between 2000 and 2007 the drought continued to worsen. Over this period water supply became an increasing policy priority for government (Ferguson et al., 2013). By 2008 it was well understood within Melbourne Water that climate change would affect the ongoing sustainable yield limits of water resource systems (Tan & Rhodes, 2008).

Crucial decisions about water resources in Melbourne over the drought period were made as part of centralised metro-scale strategies with government involvement. Five strategies were conducted over the 1997–2007 drought. The occurrence of this major drought and the strategies for dealing with it began to lay the groundwork for innovation and a transition towards IUWM within Melbourne’s water sector.

The first metro-scale strategy, in 2002, determined that climate change was not a serious threat and that emphasis should be placed on water efficiency measures, although a 20% water recycling by 2010 target was also suggested (Water Resources Strategy Committee for the Melbourne Area, 2002). The second strategy, in 2004, was a policy framework for Victoria, in which there was a broadening of
focus to consider river and groundwater system health, as well as economic arguments around pricing and allocation mechanisms (Department of Sustainability and Environment (DSE), 2004). The third strategy, in 2005, was known as the Central Region Sustainable Water Strategy and focused more broadly than water supply, and added the consideration of rivers for tourism. As part of this strategy it was recommended that a reservoir separated from the Melbourne water grid should be reconnected and a number of water recycling opportunities were identified, including Boneo Recycled Water Scheme (DSE, 2005), which is one of the case study projects for this paper.

The fourth strategy, in 2006, conveyed no sense of urgency in regard to water security, other than a continued focus on water efficiency and the possible creation of an eastern water recycling scheme (Melbourne water utilities, 2006). However the fifth and final strategy, only 1 year later in 2007, painted an entirely different picture. Melbourne found itself quickly running out of water and operating in crisis mode. This final state government strategy included the recommendation that the biggest desalination plant in Australia (150 GL/year capacity) should be constructed, in addition to a 70 km pipeline to connect the Goulburn River to Melbourne. These investments amounted to a predicted total of AUD$4.9 × 10^9 in capital (DSE, 2007), and when operating costs are included the cost of the desalination plant is expected to be AUD$18.3 × 10^9 over 27 years (Cook, 2014a, 2014b). The combined capacity of these projects is equivalent to about 64% of Melbourne’s water consumption (Productivity Commission, 2011).

Since the rushed construction of the North South pipeline and desalination plant neither of these major infrastructure projects has ever been used to supply water to Melbourne (Ker, 2010; Cook, 2014a, 2014b). Water infrastructure planning processes and outcomes in Melbourne between 2000 and 2008 have resulted in widespread public outcry from the community (Ferguson et al., 2013). Many critics argue in hindsight that cost benefit and ‘real options’ analysis of a variety of alternative water sources such as additional recycled water and stormwater harvesting projects would have resulted in a better outcome for the community (Porter, 2013).

When the drought period ended there was a greatly increased awareness of liveability and environmental issues associated with water management (Fam et al., 2014). It is from this backdrop of drought, centralised water strategies which pushed the boundaries of what the water sector should consider, major augmentations which have never been used, and focus of water management issues in the media and the community that IUWM emerged so strongly in Melbourne.

From 2008 to 2012 the number of IUWM recycled water and stormwater harvesting schemes in Melbourne steadily increased. Ferguson (2013) cites that in 2012 there were 108 stormwater harvesting schemes in operation in Melbourne, many of these operated by local government and private companies, and large swathes of residential developments with mandated recycled water dual pipe systems. This period is described by consulted experts as ‘the golden age of recycled water’.

In May 2012, the state government created an independent statutory body, named the Office of Living Victoria (OLV), to facilitate the implementation of IUWM (Byrnes, 2013). The media has criticised this new institution for a number of things including: its tendering and human resources processes, and conflicts of interest (Baker & McKenzie, 2014a, 2014b), and also allegedly awarding some of its community grant funding to pay consultant invoices and office renovation (Baker & McKenzie, 2014c). After a state election this institution was dissolved in 2014 (Cook, 2014a, 2014b). Consideration of the actual planning processes and outcomes achieved by the OLV is worthy of a whole paper on its own.
By 2012 the government and the public at large had lost much of their interest in reuse schemes as it reached 5 years since the drought had ended. Due to this waning interest federal government grants dried up, the 20% recycling target was met and then forgotten, and the focus in the water sector turned towards reducing water bills, customer satisfaction, and stormwater management. This prompted experts to say ‘the golden age of recycled water is over’ in Melbourne.

Water planning in Melbourne has become a highly sensitive and political issue with numerous headlines in the press, and a hot topic for the last three elections. One headline read ‘The state election that neither side deserves to win’. This was based on the premise that both major parties had such a bad track record with water management (Davidson 2014), with one party building a desalination plant which cost more than it should have and has never been used, and the other party installing the OLV which the media has described as ‘the biggest cabal of mates looking after mates this state has seen’ (Baker & McKenzie, 2014a).

Aside from this controversy, the institutions generally involved in IUWM within Melbourne are Melbourne Water, as a bulk supplier and caretaker of major drainage networks and waterways, three retailers who are the interface with the community, a small number of state government agencies, and a large number of local government areas which are known as Local Councils. One of the case studies, Toolern Stormwater Harvesting Scheme, was planned on the fringe of Melbourne and therefore involved a semi-urban water utility, and a rural water and groundwater authority which deals primarily with farmers.

The bureaucratic agencies which are relevant to the case studies are the Essential Services Commission, a pricing regulator, the Department of Treasury and Finance, the Department of Health, and the Environmental Protection Authority (EPA) which all report to the State Government. The water and environment portfolios of the Victorian government have shuffled around between a number of arrangements including: the Department of Sustainability and Environment, the Department of Environment and Primary Industries, and now currently the Department of Environment, Land, Water and Planning.

Combinations of these agencies have been responsible for identifying, planning, funding, regulating, and approving Melbourne’s IUWM projects at a variety of scales. The following case studies illustrate these complex relationships and provide valuable learnings in relation to planning scales and approval processes for IUWM.

4. Project case studies

For the purposes of this research paper the scope of interest for the case studies is limited to the following details: (1) what are the key features of the project, (2) at what scale was the project identified and planned, and by who, and (3) what was the approval process for the project, and what has been the outcome. A summary of the case studies can be found in Table 2 at the end of the section.

For the purposes of this paper specific definitions have been adopted for some terms relating to planning scales. Centralised planning process is considered to be a coordinated process conducted by a collective of organisations looking at options for the entire Melbourne region. Strategic planning process is considered to be a coordinated process conducted at a high level of one organisation to determine which IUWM infrastructure projects should be implemented in their particular area. A specific need is
Table 2. Summary of case study planning information.

<table>
<thead>
<tr>
<th>Case study</th>
<th>Project lead</th>
<th>Identification scale and method</th>
<th>Critical approval hurdle</th>
<th>Planning result and reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Altona stage 2 RW project</td>
<td>Retailer</td>
<td>Specific issue at local scale</td>
<td>State Government, Pricing regulator, Department of Treasury and Finance</td>
<td>On hold – only stated reason is that project is not ‘time critical’</td>
</tr>
<tr>
<td>Boneo RW project</td>
<td>Retailer</td>
<td>Metro-scale strategy</td>
<td></td>
<td>Approved – assisted by a 20% recycling target for the Melbourne region</td>
</tr>
<tr>
<td>Coburg SWH project</td>
<td>Retailer</td>
<td>Strategic planning process at sub-regional scale</td>
<td>Internal board, Federal grant process and Local Council</td>
<td>Cancelled – original grant received but then cost increase due to stakeholder requests and geo-tech conditions made project unviable</td>
</tr>
<tr>
<td>Coldstream RW project</td>
<td>Private consortium</td>
<td>Customer request at local scale</td>
<td>Seeking external funding</td>
<td>On-going – Having difficulty sourcing external funding</td>
</tr>
<tr>
<td>Doncaster Hill RW project</td>
<td>Retailer</td>
<td>Strategic planning process at sub-regional scale</td>
<td>EPA and Local Council</td>
<td>On hold – community concerns caused Local Council to refuse planning permit</td>
</tr>
<tr>
<td>Fitzroy gardens SWH project</td>
<td>Local government</td>
<td>Strategic planning process at local scale</td>
<td>Local Council and Federal grant process</td>
<td>Approved – community support and federal grant</td>
</tr>
<tr>
<td>Kalkallo SWH project</td>
<td>Retailer</td>
<td>Strategic planning process at sub-regional scale</td>
<td>Internal board and Federal grant process</td>
<td>Approved – innovative solution and federal grant received</td>
</tr>
<tr>
<td>Toolern SWH project</td>
<td>Retailer</td>
<td>Specific issue at local scale</td>
<td>Federal grant process and SRW</td>
<td>On hold – grant received, could not reach agreement with water users, pilot trial in process, grant terminated</td>
</tr>
</tbody>
</table>

SWH = stormwater harvesting; RW = recycled water; SRW = Southern Rural Water.

defined as being identified either through a customer request, or a small scale identification of an issue affecting one area which is not part of a larger strategy process.

4.1. Altona recycled water project stage 2

**Key features:** Intended to supply up to 4.7 GL of recycled water per year from a sewage treatment plant to industrial customers via a 21 km pipe system at a cost of AUD$80M in capital.

**Planning scale:** Identified due to a specific demand at a local scale. The project has been planned and arranged by a water retailer in discussion with industrial customers without coordination from a metro or sub-regional strategy.

**Approval process:** The scheme is predicted to be net present value (NPV) positive but has been put on hold for 5 years by the State Government for the stated reason that the project is not ‘time critical’ i.e. there is no window of opportunity that will close if the project does not proceed at this time. The decision to put the project on hold was informed by advice from the Essential Services Commission (pricing regulator). There is some uncertainty in the water industry in regard to how this decision was reached and why. However the official decision has not precluded the project going ahead with other, potentially private, sources of funding.
4.2. Boneo recycled water scheme

**Key features:** Currently supplies 1.7 GL/year of recycled water from a small local sewage treatment plant via a 9 km pipeline to surrounding market gardens, golf courses and parks at a cost of AUD$16M in capital.

**Planning scale:** Identified as part of a centralised metro-scale strategy, known as the Central Region Sustainability Strategy (CRSWS), as mentioned in section 3 of this paper, then planned and implemented locally by the relevant water retailer.

**Approval process:** The Boneo project was required to meet the 20% recycling target set by the CRSWS centralised planning process and therefore the project did not experience noteworthy issues achieving approval from the Department of Treasury and Finance.

4.3. Coburg stormwater harvesting project

**Key features:** Intended to supply 213 ML/year of treated stormwater to new apartment buildings for toilet flushing and clothes washing, as well as public open space irrigation at a cost of AUD$13–16M in capital.

**Planning scale:** Identified through a semi-structured strategic planning process by a water retailer at the sub-regional scale which looked for opportunities to implement IUWM.

**Approval process:** Received a federal grant for half its estimated cost and a detailed design process was begun. During the detailed design some local stakeholder requirements around aesthetics and features added to project costs. Through a well-implemented engagement process these requirements were substantially reduced. However these costs and also additional costs from unexpected geological conditions in the area contributed to a significant cost increase which has resulted in the project becoming unviable and being cancelled by the water retailer in 2013.

4.4. Doncaster hill recycled water project

**Key features:** Intended to be a 400 kL/day sewer-mining scheme which would supply recycled water to new residential apartments.

**Planning scale:** Identified through a semi-structured strategic planning process by a water retailer, with assistance from a local council, at the sub-regional scale which looked for opportunities to implement IUWM.

**Approval process:** As a sewer-mining scheme the project required a nearby location for its treatment plant. A number of objections to this facility’s location were made by local residents. A planning permit from the local Council was required for construction of the treatment plant. Councillors voted against issuing a planning permit at a Council meeting in 2012. Resident objections to the project are still visible online and include: the risk that raw sewage will be spilled near houses (Unknown, 2012a, 2012b), why that location was the only one being considered (O’Brien, 2012), potential increases to water bills, and gas emissions from the plant (Unknown, 2012a, 2012b), that the plant was to be within 25 m of existing residences, and that the EPA had not given their approval by the time of the Council vote (Welsh, 2012). The Council vote was influenced by the strong community sentiment of distrust around what the impacts of the treatment facility would include. Some also believe that trust between the community and government planners may have been impacted by a previous government highway project in the area.
According to a representative of the council the main reasons for refusing the treatment plant planning permit were as follows (Daws, 2015):

1. Proximity to adjoining properties.
2. Visual amenity impacts.
3. Potential amenity issues emanating from noise and odour.
4. Loss of open space/parkland.
5. Impacts on native vegetation.

4.5. Kalkallo stormwater harvesting project

**Key features:** Intended to supply 360 ML/year of treated stormwater for direct potable use, and was the first of its kind in Australia at a cost of ~AUD$20M in capital.

**Planning scale:** Identified through a semi-structured strategic planning process by a water retailer at the sub-regional scale which looked for opportunities to implement IUWM.

**Approval process:** Received a federal grant for half of its expected cost, was approved by the retailer’s board and then constructed. However due to time limitations on the relevant government grant it has been built prior to development in the area, and so currently sits unused awaiting development. Once development in the area has commenced the project will initially supply water to a Class A non-potable recycled water system. While supplying recycled water, water quality monitoring will be undertaken to demonstrate that treated stormwater is of the standard required by the Department of Health for potable water supply. Community consultation will also be needed to determine if the community is happy to drink treated stormwater prior to supplying this water to the drinking water network.

4.6. Coldstream recycled water project

**Key features:** Intends to supply 1 GL/year of recycled water to high value produce farms, such as wine-grapes and strawberries, via a 15 km pipeline for a capital cost of approximately AUD$6M.

**Planning scale:** Identified and being planned by a private consortium of farmers in Victoria’s Yarra Valley Region, on the outskirts of Melbourne.

**Approval process:** This project is still in its planning phase. Farmers originally approached a retailer to own and operate this scheme. The retailer estimated a cost of AUD$15M, which the farmers considered to be an overestimate as well as ‘gold plated’ to urban standards, which are different to agricultural requirements in terms of pressure and reliability. Farmers are seeking to build an AUD $6M scheme, with AUD$2M worth of support from either state government, for local economy benefits, or Melbourne Water, for river health benefits. The private consortium is progressing with the planning of this project and has experienced considerable hurdles trying to achieve its objectives. Farmers are in discussion with a private water utilities company around taking on ownership of the scheme.

4.7. Fitzroy Gardens stormwater harvesting scheme

**Key features:** Currently supplies 69 ML/year of treated stormwater to irrigate one of Melbourne’s oldest parks at a capital cost of AUD$4M.
Planning scale: Identified through a strategic planning process by Melbourne City Council looking at how to provide water for local parks.

Approval process: The project received funding through a government grant in 2011 and was not subject to scrutiny by the Department of Treasury and Finance, so the final approval was given by the local Council.

4.8. Toolern stormwater harvesting scheme

Key features: Was conceived as a way to supplement the potable water supply to meet the demands of a new development located in a low rainfall area. It was designed to collect stormwater for agricultural uses, in exchange for taking a share of upstream water from a traditionally agricultural water source to be used for potable uses within the new residential development. The original exchange mechanism was a trade of all harvested urban stormwater for a 25% share of the irrigation entitlement in an upstream reservoir.

Planning scale: Identified through a local-scale servicing strategy undertaken by a semi-urban water utility.

Approval process: A federal grant was received and planners were optimistic that the project would go ahead. However the rural water and groundwater authority which represented the interests of the irrigators determined that they could not be confident of the predicted quantity reliability of the stormwater supply, and therefore were not willing to accept the risk of trading away their long-term rights to river water until the scheme could be proven. This decision was made despite water resources modelling results (MUSIC and REALM) which indicated the trade would have no adverse effects on irrigators. The project has been put on hold while a pilot scheme is implemented to test the reliability of the stormwater source. However due to this lack of certainty regarding scheme outcomes the federal government has determined that they cannot be confident in the potable water savings generated by the scheme and so in early 2015 it was decided to terminate the federal grant agreement.

5. Discussion

5.1. Planning scales for IUWM projects

Out of the eight projects, three were identified by a strategic planning process that took place at the sub-regional scale; one was identified by a strategic planning process that took place at the local scale; three were identified by specific demands at the local scale and one was identified through a metro-scale centralised planning process.

As would be expected from the decentralised nature of IUWM projects (Marlow & Tjandraatmadja, 2014), the case study projects were identified at multiple scales and through a variety of different mechanisms including the identification of specific issues at the local scale and customer requests. The only project out of the eight considered which was identified through a metro-scale strategy was the very oldest project, which was identified in 2005 and had its detailed design and approval in 2009.

These findings demonstrate that there is a conceptual gap in much of the existing literature on water infrastructure planning such as the CSIRO IUWM planning manual (CSIRO, 2010), work by the World Bank (Closas et al., 2012), and also the SWITCH strategic planning process (SWITCH, 2010). These
major research programmes consider IUWM at the metro scale, without taking into account multiple scales of identification, planning and decision making responsibilities.

5.2. Approval processes for IUWM projects

Three of the analysed projects have been approved and implemented despite all of these being NPV negative projects, three were put on hold despite one of these being NPV positive, and one has been cancelled. The final project, Coldstream Recycled Water Project, which is being led by a consortium of farmers is experiencing difficulty in finalising its planning and is seeking a private organisation to own and operate the scheme. The Coldstream case study provides an example of a function that private water utilities may provide in Melbourne in the future.

Final approvals for the case studies, here meaning the essential decision which determined whether the infrastructure was to be built, were issued from a wide variety of sources. They highlight both complexity, and in some cases uncertainty, around who is making decisions about whether infrastructure should be built, and how these decisions are being made. A general process for approvals is revealed by the case studies, with potential barriers being revealed by case studies at each phase.

A project must achieve support from senior management and the relevant board of directors. In the Coburg case study it was the board who decided to cancel the project. In order to achieve this support originally, in many of these cases an external government funding grant was required. Coldstream and Altona projects have been unable to receive any funding grants thus far, likely because as industry experts have claimed ‘the golden age of recycled water in Melbourne is over’, and there are far less government grants available.

Following on from this, many external stakeholders share the ability to veto spending on these projects such as the State Government, the Department of Sustainability and Environment, the Department of Treasury and Finance, and the Essential Services Commission. Altona, despite being determined to be an NPV positive project was put on hold by the State Government under advice from the Essential Services Commission.

In addition to financial regulation, projects must also be approved by the EPA and Local Councils, and in a democracy this in essence means the support of local residents is also required. The Doncaster case study reveals that if a water project requires a treatment facility in a residential area there may be some difficulty achieving this approval.

On top of all of these challenges is the need to receive agreement from any potential water users such as irrigators, or local residents, and to ensure that the treated water from any proposed scheme will in fact be used. This is evidenced by the Toolern case study in which irrigators were not convinced of the reliability from the scheme, and Kalkallo, as it is impossible at this stage to determine whether future residents will be willing to drink treated stormwater because the area is currently uninhabited.

These results serve to highlight the complex nature of planning in the modern world, which historically has been misrepresented in the light of being objective, linear and rational (Lindblom, 1959). These case studies reveal an important issue in IUWM which is that even if a planning process recommends a piece of infrastructure there is a significant possibility that it will not be approved by all relevant organisations. The results show a 38% approval rate. This is due to the fact that planners and regulators/approvers are usually distinct groups from different organisations with different goals.
and different priorities. This phenomenon is well understood by preeminent planning scholar Nathaniel Lichfield who in 1975 wrote a book using the terms ‘decision maker’ to describe planners, and ‘decision taker’ to describe approvers (Lichfield et al., 1975).

This represents another significant gap in major research programmes such as those of SWITCH, the World Bank, and the CSIRO in the sense that they do not address the fact that planners do not generally have ultimate authority to implement their own recommendations.

5.3. Barriers to IUWM project implementation

The five out of eight case studies which have thus far failed to be implemented highlight four major barriers to implementation of IUWM projects: stakeholder and community engagement issues, impacts of previous project outcomes, a lack of communication between regulators and planners, and the absence of consistent financial evaluation methods.

Stakeholder and community engagement to encourage public participation has long been considered to be a major component for the successful implementation of IUWM. There is discussion in the academic water management literature about the role of local scale water governance (Norman & Bakker, 2009), and how stakeholder interests change across spatial and jurisdictional scales (Lebel et al., 2005). The Global Water Partnership (GWP) promotes participation by all stakeholders (GWP, 2012). The CSIRO manual recommends community consultation at all stages of planning (CSIRO, 2010), and the SWITCH programme also places a focus on this aspect of IUWM (Howe et al., 2011).

Case studies from this paper provide real life examples of community and stakeholder engagement issues. In Toolern planners were unable to convince irrigators of the quantity reliability that the stormwater harvesting scheme would be able to achieve, despite having modelling results from two different hydrological software programmes as evidence.

In Doncaster efforts were not successful in convincing residents around the proposed treatment plant that it would not impact on them. Surrounding residents were asking questions about why there were no other sites being considered and raising concerns about the safety of the plant and that there may be a risk of spilling raw sewerage out onto the street, which for a sewer-mining scheme in a developed country cannot be considered to be a significant risk. These community concerns provide evidence that although significant efforts were taken by the water retailer to engage with the community, it is not always possible to convince everyone. In certain areas or circumstances, infrastructure planners may come across particularly concerned and vocal members of the public. Planning decisions are inevitably impacted by social and political circumstances, and there are only a limited number of avenues that infrastructure planners can pursue to engage with and convince residents.

Additionally in the Doncaster case residents were concerned about how the costs of the project would affect them, having felt the effects of recent water price increases caused by Melbourne’s desalination plant, and some residents may still have been angry about impacts of a previous traffic project in the area. This provides evidence of how previous project outcomes affect the implementation of future projects.

The case studies allude to the fact, and expert consultation has confirmed, that, in some cases, there is a noteworthy lack of communication and coordination between policy setters, planners, and regulators, and this problem is exacerbated by election cycles and the creation and dissolving of government institutions such as the recently dissolved OLV, which had a coordination role.

In the case of Altona, researchers have determined that the underlying reason for the project being put on hold has not been communicated effectively to planners. However it can be noted that the advice from the
pricing regulator to put an NPV positive project on hold implies a lack of consistent financial evaluation methods, particularly in relation to valuing externalities, such as long-term water supply benefits.

5.4. The way forward

So far this paper has demonstrated that IUWM is being implemented across different scales without the coordination of metro-scale strategies, and also that the barriers to implementation represent a lack of communication, coordination and consistency in decision making. It can be logically deduced that the two problems are linked. The authors propose that the fact that IUWM projects are identified and planned at sub-regional and local scales does not negate the need for metro-scale strategy development, consistency of message and method, as well as overarching coordination. Industry experts are in agreement that centralised strategies are also required to determine overall water supply and demand balances and inform sub-regional and local-scale strategies.

The authors propose that by separating responsibilities between scales, it is possible to have all scales of planning guided by strategy. A visualisation of this argument can be seen in Figure 1. This demonstrates how water infrastructure can be identified and planned at multiple scales with coordination from centralised strategies. The figure shows that higher scale strategies require more flexibility than lower

Fig. 1. Visualisation of water infrastructure planning responsibilities divided across scales.
scale strategies. This is because higher scale strategies are more likely to be dealing with overarching objectives, targets, principles and methods, as well as possibly having a longer time horizon. Local scale strategies may have more specific requirements to fulfil such as how a new development should be serviced, and this requires concrete, or certain, recommendations.

Within such a system it is possible for centralised strategies to identify policy directions and create evaluation templates which would then be able to assist planners at lower scales with project planning, valuing benefits, developing business cases and approval processes. It is logical that these centralised and consistent planning directions would assist in the implementation of IUWM projects.

The exact way that responsibilities should be divided may be very different depending on the context; however some general suggestions can be made based on the findings from the case studies, expert consultation, as well as logical inferences. A possible way to separate responsibilities is put forward in Table 3. The key thing to note from this separation is that water supply and demand balances, planning frameworks, evaluation methods, and guiding principles and objectives should be set at a higher planning scale, and then sub-regional or local projects should be planned at lower scales in accordance with these recommendations.

In relation to stakeholder and community engagement issues, the authors agree with previous research such as from SWITCH, the World Bank, and the CSIRO, that these issues need to be thoroughly considered at all phases of planning. Doing such community engagement as part of planning should also help to ameliorate any issues with community dissatisfaction around previously implemented projects.

6. Conclusions

IUWM is becoming a worldwide phenomenon, and is increasingly the focus of efforts and research within the water industry. This study has considered existing research into IUWM, conducted widespread industry consultation, and assessment of IUWM within Melbourne generally and eight project case studies in particular in order to explore at what scale IUWM projects are being planned, and how approval and regulatory processes are functioning.

Analysis of the IUWM case studies has shown a trend towards identification and planning of infrastructure at the sub-regional (38%) and local scale (50%). Results also illustrated that regulation and approval processes include a number of significant barriers to the adoption of decentralised infrastructure, with only a 38% infrastructure approval rate. The implications of both the planning scale results

Table 3. Proposal for separation of responsibilities across scales.

<table>
<thead>
<tr>
<th>Scale</th>
<th>Responsibilities</th>
</tr>
</thead>
</table>
| Metro/regional | - Determination of the overall water supply and demand balance  
                  - Frameworks/valuation techniques/guiding principles  
                  - Planning of metro-scale augmentations such as desal plants and dams                   |
| Sub-regional   | - Planning of sub-regional projects to meet demands identified at the metro-scale  
                  - Industrial, residential and agricultural IUWM projects identified through strategic planning processes |
| Local          | - Planning of local projects to meet demands identified at the metro-scale  
                  - Public open space watering schemes to ensure that parks are conserved  
                  - Industrial, residential and agricultural IUWM projects identified through specific customer requests |
and approval results are not well considered in major industry-led research programmes which have so far been conducted into IUWM. However politics of scale has long been considered in academic literature on water management, and therefore perhaps there should be more interaction between the two research sub-sets in the future.

The eight case studies revealed some barriers to IUWM project implementation including: stakeholder and community engagement issues, impacts of previous project outcomes, a lack of communication between regulators and planners, and the absence of consistent financial evaluation methods. Barriers relating to community consultation are well understood within the literature already, and the case studies have given examples of these issues playing out in a real life context.

Issues surrounding communication between regulators and planners, and also a lack of consistent evaluation methods are not well discussed in existing literature. A multi-tier water planning system has been proposed as a way to help lessen these barriers relating to communication and consistency through coordination from metro-scale water strategies. It is proposed that this system may help facilitate implementation of decentralised IUWM projects.

It is a limitation of this research that it has partially relied upon consultation with water industry experts. It can generally be noted that there is no such thing as a neutral expert, as all experts will have their own ideologies, experiences, loyalty etc. However by consulting with a broad range of experts from a spread of organisations, and by hearing consistent messages, it does not appear that it has been a major issue in this research.

It is considered that the findings from this study will assist future research, policy development, and infrastructure planning efforts by providing the reader with knowledge of the planning processes of one city which has experienced some transition from the traditional planning paradigm towards the IUWM planning paradigm, and some of the issues that have arisen from this transition.

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Chapter 7: Risk management, financial evaluation and funding for IUWM projects

7.1 Introduction
The previous chapter included preliminary discussion of the in-depth case studies included in Appendix B, but does not provide high levels of detail on conducted planning processes. This chapter provides greater detail in relation to the projects and for this reason a decision was made to make the case studies anonymous for the purposes of journal paper publication.

The current chapter focuses on the case studies in relation to risk management, financial evaluation and funding. For each of these elements the narratives are provided, and the results are discussed in order to determine implications for future IUWM projects. This paper is perhaps one of the most detailed accounts of IUWM project planning processes yet published, and hence has great scholarly significance.

This chapter is made up of a journal paper which has been published by the Journal of Environmental Management, an Elsevier journal.

The practical implications of this chapter are:

- IUWM projects involve a wide variety of different risks, including political, environmental, social, technological, legal and economic. Practitioners are generally able to effectively identify risks associated with IUWM projects, as all of the eventuating risks have been identified at some point. However, it is common for practitioners to first identify risks effectively, and then not consider these risks with appropriate significance during final decision making processes. For example, occasionally assumptions are made that all identified risks can be effectively managed, and therefore no substantive consideration of risks in final decision making is required.

- Financial evaluation has been conducted in different ways across the case studies. Time periods of analysis are different, externality assessment is different, and consideration of costs to external organisations is different, thus making direct comparison between the Net Present Value of case studies impossible.

- Almost all of the case studies required external, often national government, funding to be implemented. It appears likely that this source of funding will be less common in the near future, and so the continued implementation of IUWM projects is likely to require full funding from the water sector. In order to facilitate this, it is proposed that regional collaborative forums are required to prioritise and evaluate which IUWM project proposals justify funding.
This paper has considered risk management, financial evaluation and funding in seven Australian wastewater and stormwater reuse projects. From the investigated case studies it can be seen that responsible parties have generally been well equipped to identify potential risks. In relation to financial evaluation methods some serious discrepancies, such as time periods for analysis, and how stormwater benefits are valued, have been identified. Most of the projects have required external, often National Government, funding to proceed. As National funding is likely to become less common in the future, future reuse projects may need to be funded internally by the water industry. In order to enable this the authors propose that the industry requires (1) a standard project evaluation process, and (2) an infrastructure funders’ forum (or committee) with representation from both utilities and regulators, in order to compare and prioritise future reuse projects against each other.

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1. Introduction

Wastewater and stormwater reuse

Traditionally wastewater and stormwater have been seen by water utilities as negative commodities that should be disposed of as efficiently as possible (Asano and Levine, 1996; Grant et al., 2012). In the developed world this has generally meant transferring and discharging untreated stormwater, and secondary treated wastewater, into receiving waterways and oceans (Mitchell et al., 2002). In recent decades this traditional viewpoint has been gradually altered as the water utility sector has faced increasingly serious challenges from population growth, climate change and pollution, which are causing water shortages and ecosystem degradation (Vörösmarty et al., 2010; Vörösmarty et al., 2000; Alcamo et al., 2007; Grimm et al., 2008).

Wastewater and stormwater reuse are now widely considered to be a crucial element in achieving “Sustainable Urban Water Management” (Wong, 2006; Brown et al., 2009; Ferguson et al., 2013; Brown and Clarke, 2007), which is a broad term used to indicate sustainable outcomes in the urban water sector (Furlong et al., 2015). Water shortages have led to a shift away from seeing wastewater and stormwater as a burden towards viewing them as a water resource (Mitchell et al., 2002; Asano and Levine, 1996; Levine and Asano, 2004; Grant et al., 2012). Wastewater reuse has been consistently increasing across the planet over the past two decades (Chen et al., 2013). Stormwater reuse is less common although a large number of these schemes can be found in Australia (Ferguson et al., 2013). Reuse of wastewater and stormwater has the added benefit of reducing negative human impact on the environment, by reducing the amount of pollutants which are transferred into waterways and bays (James et al., 2015; Ferguson et al., 2013).

There are four different types of water reuse schemes. The first involves irrigating farmland and public open space with either secondary (Class B or C) or tertiary (Class A) treated wastewater effluent, or the equivalent quality of stormwater. Secondly there are dual pipe systems which supply tertiary treated (Class A) wastewater, or the equivalent quality of stormwater, to residential and commercial properties for non-potable uses such as garden watering, toilet flushing and clothes washing (Ferguson et al., 2013; Furlong et al., 2016a). Thirdly there are direct potable reuse...
schemes such as the ones operating in California, Texas, Namibia and Singapore (Gerrity et al., 2013). In some cities potable reuse water is rebranded in order to mitigate the community stigma of drinking recycled sewerage, such as “NEWater” in Singapore (Lee and Tan, 2016). The final type of reuse scheme involves treating wastewater or stormwater then releasing to waterways in a particular flow regime in order to have a positive environmental impact (Luthy et al., 2015; Ferguson et al., 2013).

Wastewater and stormwater reuse can simultaneously impact water supply, sewerage, drainage, and waterway management functions that are performed by water utilities, and therefore if these projects are to be effectively planned an Integrated Urban Water Management (IUWM) approach is required (Lazarova et al., 2003; Furlong et al., 2016a). The main principles of IUWM are: (1) the integrated planning of water supply, sewerage and drainage services, (2) collaboration between previously segregated organisations and departments, (3) proactive long-term planning, and (4) increased community awareness and participation in water management functions (Furlong et al., 2016a; Global Water Partnership, 2012; Furlong et al., 2015; Mukheibir et al., 2014).

Aside from requiring an IUWM approach, water reuse projects increase the complexity of urban water management functions in a number of other respects (Bell, 2012, 2015; Furlong et al., 2016b). In particular water reuse projects are difficult for water utilities to manage in terms of risk management, financial evaluation and funding (Institute of Sustainable Futures, 2013; Institute of Sustainable Futures, 2008; Marsden Jacob Associates, 2013; Turner et al., 2016). These issues are the focus of the reminder of this paper.

1.2. Risk management in the planning of reuse projects

Risk management is the process through which project managers identify, consider, and attempt to mitigate potential risks to projects. There are a number of terminological issues discussed in literature relating to risk, such as the difference between risks, hazards, and uncertainties (Trevizan et al., 2007). The word "risk" in this paper is used loosely, in line with common usage of the word, which is defined by the Macquarie dictionary as "the state of being open to the chance of injury or loss". For the purposes of this paper, "risk" is being defined to include any future occurrence which may have a negative impact on reuse projects, as it is argued that project managers should attempt to consider all of these in the planning of reuse projects.

Wastewater and stormwater reuse schemes increase complexity in risk management processes because they involve so many different types of risk (Toze, 2006a). Water quality is often not of potable standard, creating a community safety risk in case of accidental ingestion (Toze, 2006b). Reuse schemes create a specifically designed stream of water, for a specific purpose, and therefore there is a risk that after a scheme is built that customers will use less or none of the water, thus creating a financial risk for utilities (Marsden Jacob Associates, 2013). There is a risk of community rejection of the water, particularly in the case of potable recycling schemes (Dolnicar and Schäfer, 2009). Also there are environmental risks inherent in decisions to either reuse water, or discontinue reuse, as both have environmental consequences (Luthy et al., 2015). In many places water infrastructure decisions are also highly politicised, which creates political risks for practitioners and policy makers (Furlong et al., 2016c).

In order to assist project managers in identifying such a broad range of potential risks, some authors propose the use of the PESTLE (political, environmental, social, technological, legal and economic) risk framework (Turner et al., 2016; Institute of Sustainable Futures, 2013). Consideration of these various types of risks should ideally inform financial evaluation processes, and consequently affect funding outcomes, although as will be discussed in this paper this is not always the case.

1.3. Financial evaluation and funding of reuse projects

Compared to traditional water supplies the financial evaluation and funding of reuse schemes is also complex for a number of reasons. Recycled water schemes do not generally achieve full-cost-recovery, and require some form of subsidy from the wider utility customer base, state or national governments (Hernández-Sancho et al., 2015; Marsden Jacob Associates, 2013). This means that financial evaluations and associated decision making processes must attempt to justify these subsidies (Institute of Sustainable Futures, 2008).

In situations where projects do not pay for themselves, there are a number of possible funding avenues, and determining the most appropriate funding avenues is an important topic for discussion (Productivity Commission, 2011; Hernández-Sancho et al., 2015). Subsidies can be granted from water utilities, local, state or National governments, or funding of these projects can be charged to property developers (Lazarova et al., 2003).

In order to justify subsidies, it is necessary to identify and value a range of benefits (and potentially costs) from the reuse schemes which are often referred to as externalities (Institute of Sustainable Futures, 2008; Hernández-Sancho et al., 2015). Externalities are the costs/benefits from a good or service that accrue to entities other than the transaction parties, thus creating a divergence between private and public costs and benefits. One general example of divergence is immunisation programs, which provide benefits for all members of the community, not only those immunised. In the case of reuse projects the transaction parties are likely to be a water utility and the direct users of water; however the reuse project may have a positive impact on many other groups. In such situations governments often choose to either (a) subsidise private provision of the service, or (b) provide the service itself and recuperate a proportion of the total cost from the direct customer (Barton, 1999).

Commonly associated reuse benefits (positive externalities) include: (1) environmental benefits from reducing human impacts on waterways and bays, (2) liveability benefits from ensuring water supply for public open space and garden watering during times of drought, (3) regional economic benefits from drought proofing farming areas, and (4) potable headworks benefits from reducing strain on traditional water supplies (Marsden Jacob Associates, 2013; Institute of Sustainable Futures, 2013; Hernández-Sancho et al., 2015).

Thus deciding upon the most appropriate financial evaluation model is extremely important. At present there is a high level of inconsistency in regards to how the financial evaluation of reuse schemes is being conducted (Marsden Jacob Associates, 2013). The examples given in this paper will help to illustrate the inconsistencies between the financial evaluation models which are currently being used by water utilities. Calculating the level of indirect benefits (positive externalities) that a project contributes can be particularly difficult, especially when stakeholder and regulator agreement is required. This is complicated even further when considering how potential risks are expected to impact on predicted benefits.

As explained in the previous section, there is a large amount of risk involved in the planning of reuse schemes, and so they often do not perform as well as predicted, in terms of the financial performance, and also in terms of their provision of other benefits (Institute of Sustainable Futures, 2013; Furlong et al., 2016a; Mukheibir et al., 2014). Many of the risks mentioned in the previous section have an impact on the performance of schemes. Such
risks can lead to increases in capital or operating costs and lower than expected water use, leading to both reduced revenue and also a reduction in previously estimated positive externalities. However in general the financial evaluation models which are being utilised by water utilities do not generally include a consideration of how financial projections will be affected by potential risks [Turner et al., 2016].

1.4. Focus of this paper

The current paper focuses on the following research questions:

1. What are the major risks associated with wastewater and stormwater reuse projects, and to what extent are planners able to accurately identify risks?
2. How are financial evaluations of reuse projects currently being conducted by project leaders, and what externalities are typically considered?
3. How are reuse projects being funded?

In order to investigate these questions the researchers have selected one case study region within South-Eastern Australia, and selected seven wastewater and stormwater reuse case studies from within this region. The major relevant water industry institutions that operate within this region are: one bulk water, wastewater and stormwater service provider (Bulk Supplier), a number of smaller water utilities which connect bulk services to customers (Water Retailers), a large number of municipalities, known in Australia as Local Government Areas, and a number of government or semi-independent regulators such as the Essential Services Commission (pricing regulator).

The discussion of local contexts is widely acknowledged to be important for understanding water management processes (Hering et al., 2015), but have not been considered in this paper. The reasons for this are that: (1) the case studies for this research have all been drawn from one region within South-Eastern Australian, meaning that they have had similar institutional conditions making comparison easier, and (2) the context of these case studies has been thoroughly explored in parallel research (see acknowledgements) and has been deemed to have little bearing on the specific questions explored by this paper which relate specifically to process. Furthermore it should be noted that the case studies have been made anonymous for the purposes of this paper so as to avoid any potential negative publicity for case study projects and their associated organisations.

2. Method

In order to investigate a variety of topics (see acknowledgement for reference to wider research program) relating to IUWM and water reuse, researchers conducted a wide-ranging water industry consultation process with a total of 43 experts from 25 organisations as shown in Table 1 below.

<table>
<thead>
<tr>
<th>Organisational type</th>
<th>Number of experts consulted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retailer</td>
<td>16</td>
</tr>
<tr>
<td>Government body</td>
<td>6</td>
</tr>
<tr>
<td>Academic</td>
<td>3</td>
</tr>
<tr>
<td>Bulk supplier</td>
<td>8</td>
</tr>
<tr>
<td>Private</td>
<td>5</td>
</tr>
<tr>
<td>Municipality</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>43</td>
</tr>
</tbody>
</table>

Findings in relation to risk, financial assessment and funding were then considered in combination in order to discuss current practices and make recommendations for future efforts.

This research utilises seven reuse project planning case studies, which will be explained in the following sections. A summary of the information on these case studies is given in Table 2 below. The total list includes four stormwater reuse projects, one of which is currently in operation, and three wastewater reuse projects, one of which is operation.

3. Case studies

3.1. Case Study A (stormwater reuse)

3.1.1. Project description

Case study A is a stormwater reuse project that has been led by a municipality and is currently in operation. It has been designed to harvest an average of 69 ML/year from a local drain to irrigate an inner-city park, equating to 59% of the park’s total water demands.
Table 2
Summary information for IUWM project case studies.

<table>
<thead>
<tr>
<th>Case Study</th>
<th>Water source</th>
<th>End quality &amp; use</th>
<th>Project lead</th>
<th>Capacity ML/year</th>
<th>Capital cost*</th>
<th>Financial evaluation</th>
<th>Grant requested (%)</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Stormwater from local drain</td>
<td>Class B for irrigation</td>
<td>Municipality</td>
<td>69</td>
<td>&lt;$10 M</td>
<td>Basic NPV assessment</td>
<td>50%</td>
<td>Grant received &amp; project in operation</td>
<td></td>
</tr>
<tr>
<td>B Wastewater from major STP</td>
<td>Class A (desalted) for industry</td>
<td>Utility</td>
<td>4,700</td>
<td>&gt;$50 M</td>
<td>Cost benefit analysis with potable headworks benefit</td>
<td>0%</td>
<td>Put on hold by pricing regulator</td>
<td></td>
</tr>
<tr>
<td>C Wastewater from local STP</td>
<td>Class B for irrigation</td>
<td>Consortium of farmers</td>
<td>1000</td>
<td>~$10 M</td>
<td>Funding gap justification through nitrogen reduction</td>
<td>30%</td>
<td>On hold because of difficulty sourcing external funding</td>
<td></td>
</tr>
<tr>
<td>D Stormwater from constructed wetlands</td>
<td>Class A for irrigation</td>
<td>Utility</td>
<td>1,670</td>
<td>~$10 M</td>
<td>MCA &amp; cost comparison with other RW schemes</td>
<td>15%</td>
<td>Funding received but then retracted because unable to reach water exchange agreement. Pilot trial being conducted</td>
<td></td>
</tr>
<tr>
<td>E Stormwater from constructed wetlands</td>
<td>Water exchange</td>
<td>Utility</td>
<td>~1000</td>
<td>&lt;$20 M</td>
<td>Basic NPV assessment</td>
<td>50%</td>
<td>Grant received but then project cancelled due to cost increase</td>
<td></td>
</tr>
<tr>
<td>F Stormwater from local drain</td>
<td>Class A for residential</td>
<td>Utility</td>
<td>213</td>
<td>&lt;$20 M</td>
<td>Cost benefit analysis with stormwater treatment benefit</td>
<td>50%</td>
<td>Grant received, project built, but not operating due to delay in surrounding development</td>
<td></td>
</tr>
<tr>
<td>G Stormwater from constructed wetlands</td>
<td>Potable/Class A for residential</td>
<td>Utility</td>
<td>360</td>
<td>&lt;$20 M</td>
<td>Cost benefit analysis with stormwater treatment &amp; spending deferment benefit</td>
<td>50%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* In some cases capital cost is highly confidential, and so all values have been given here in a highly indicative fashion.

Stormwater is sourced from existing drains, stored in a 4 ML buffer storage, treated through a simple treatment train with sedimentation, a bio filter, and UV disinfection, and finally being irrigated through an existing irrigation system. It has been in operation for two years and has collected more stormwater than expected, but utilised less than expected, due to some teething issues.

3.1.2. Risk management

It appears that Case Study A has a low level of associated risk because of its low level of complexity. The treated water is used by the same organisation that produces it (the municipality), and so there is no risk of a water customer deciding not to use the water. The park requires a constant stream of water, and is heritage listed, meaning that the park is guaranteed to exist into the foreseeable future. These two factors in combination result in low demand side risks.

Supply risks have been partially considered through calculating the percentage of time which the supply will be reliable, which has been calculated at 59%. This figure should theoretically hold true as a long-term average. Treatment risks in such a simple treatment train are minimal, although two minor issues have occurred with are explained in Table 3 below.

The impact on project outcomes from eventuating risks has been that contaminated soils being onsite has resulted in increasing the project costs by up to 20%.

3.1.3. Financial evaluation

As part of the official planning of the scheme the only financial evaluation that was conducted was a simple payback calculation, which was done with an analysis period of 50 years. Because this approach was notably inconsistent with the other case studies, the researchers conducted their own approximate financial assessment comparing the stormwater harvesting scheme with the base case of purchasing all required water from the local Water Retailer. This calculation shows that the NPV of Case Study A varies drastically, from -$2 M to +$26 M, depending on the financial assumptions including: assessment period (from 20 to 50 years), increase to the price of potable water (2–6% per annum), and discount rate selected. It was concluded that the project could be expected to lose a maximum of $2.2 M in a worst case scenario. The approximate financial evaluation that the researchers conducted was examined by a panel of financial experts from the Water Research Australia (2016).

3.1.4. Funding

A National funding grant from the National Water and Desalination Plan to the municipality contributed 50% of the expected scheme costs ($2.1 M of the expected $4.2 M) to the project, meaning that the municipality has essentially guaranteed itself a positive financial outlook from the project (because the maximum loss is a similar value to the external grant).

3.2. Case Study B (wastewater reuse)

3.2.1. Project description

Case Study B is a wastewater reuse project that has been led by a Water Retailer. It was planned to supply 4.7 GL/year of recycled wastewater from a major Sewage Treatment Plant (STP), which is owned by the region’s bulk water, sewerage, and stormwater...
service provider (Bulk Supplier), to industrial customers. The intention was for the Water Retailer to purchase Class A reuse water from the Bulk Supplier, and then apply additional treatment processes to the water, particularly for the purposes of salt reduction. Capital works for this project were to include: membrane filtration and reverse osmosis treatment plant, 16 km transfer pipeline, 2.6 ML supply tank and 23 km distribution network. After an Essential Services Commission (pricing regulator) determination to defer the scheme, the project is currently on hold, and may be revisited in the future (5 years after the pricing regulator determination).

3.2.2. Risk management
The major risk that was identified in relation to this scheme was the potential future reductions in customer demands, particularly because the scheme was intended to supply a number of large industrial customers which can be affected by market conditions. An attempt was also made to investigate other potential users including residential areas. It was considered that if demand was to drop considerably in the first 10 years of the scheme, then alternative demands could be found. If demands dropped after this point it was considered that the financials of the scheme would worsen. Over the considered 35 year lifespan there is a substantial risk that some of the customers will reduce or cease supply. Due to this reason the Water Retailer conducted a sensitivity analysis to see what the impact to the projects financial bottom line would be if they lost customers at different time-steps. Feed water quality and operational issues were considered to be a minor risk. Risks for Case Study B can be seen in Table 4.

The impact on project outcomes from eventuating risks has been that the project has been placed on hold by the pricing regulator, for reasons explained below.

3.2.3. Financial evaluation
The Water Retailer conducted a thorough cost benefit analysis during the planning of this project. The results of financial evaluation found that the scheme is predicted to be NPV positive over a 35 year time period. The conducted financial assessment estimated a benefit (equating to approximately 15% of the total cost) from deferral of the next major potable headworks augmentation such as a new desalination plant. This is an example of attempting to account for something that is generally not included in financial assessments, i.e. an “externality”, see section 1.3.

This was done through calculating the cumulative water savings which would be saving up inside dams, and calculating how much this would defer the next augmentation. However the Water Retailer has no direct mechanism by which to recuperate these headworks benefits, which would in theory be doing a service to a number of neighbouring Water Retailers and the Bulk Supplier. In theory some of these savings would accrue to the Water Retailer in question through lower bills from the Bulk Supplier, but the majority of these savings would accrue to other parties. Therefore the Water Retailer was predominantly attempting to achieve a public good.

However the decision by the pricing regulator to defer the scheme may indicate that the regulator was either (a) sceptical of this headworks benefit assessment, or (b) aware that the risks, as mentioned in the previous section, particular in relation to reduced demands, may impact on the financial performance of the scheme, causing its revenue to be less than predicted.

3.2.4. Funding
No external grants were made available or sought for this project, which is in contrast to the majority of the other case studies investigated by this research program.

Financial impacts to other stakeholder organisations were considered. The included organisations are the Bulk Supplier and scheme customers, with benefit cost ratios of 1.00 and 1.17 respectively. This higher benefit cost ratio for scheme customers is caused due to the fact that they will be given a lower volumetric charge for water if the scheme is ever implemented (recycled water is charged at a lower price than potable water), and therefore stand to make a substantial saving on their water bills.

No net financial impact is predicted for the Bulk Supplier that owns and operates the sewage treatment plant from which the recycled water was to be sourced. This assumes that the agreed Class A water purchase price is enough to cover the Bulk Supplier’s treatment and operating expenses. The prices that the Bulk Supplier charges for recycled water are affected by a complex web of interactions with other users and also influence from politics. At many points in time they have sold this water at a financial loss. Therefore whether this price actually covers the Bulk Suppliers operating expenses is an issue which may warrant a revisit if Case Study B’s implementation is sought into the future.

3.3. Case Study C (wastewater reuse)

3.3.1. Project description
A consortium of farmers is currently seeking to implement a wastewater reuse scheme to supply 1000 ML of Class B Recycled Water every year from a Water Retailer’s local sewage treatment plant to their farms. The farmers originally approached their Water Retailer, hoping that the Retailer would own and operate the scheme for them. The capital cost which the Water Retailer estimated that the scheme would be was higher than what the farmers estimated, or could fund. The farmers have been investigating other options for a number of years since then. This case study provides an example of a purely private enterprise seeking to implement a reuse scheme.

3.3.2. Risk management
An official risk assessment has not been conducted as part of the planning of Case Study C as off yet. Researchers have, in discussion with stakeholders, noted some of the potential risks in the project, as shown in Table 5.

As the project is still in its early stages it is not possible to know

<table>
<thead>
<tr>
<th>Risk</th>
<th>Explanation</th>
<th>Risk identified?</th>
<th>Risk eventuated?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced demands</td>
<td>Serious risk that industrial customers may go out of business or move within the 35 year life of the scheme.</td>
<td>✓</td>
<td>–</td>
</tr>
<tr>
<td>Feed water quality/operational issues</td>
<td>This is considered to be a low risk for two reasons. Firstly the source water is Class A and it has been in operation for some years. Secondly this risk can be further managed through a Design Build Operate Maintain contract with contractors.</td>
<td>✓</td>
<td>–</td>
</tr>
<tr>
<td>Failure to achieve approval from government regulators</td>
<td>The project eventually failed to achieve approval from the Essential Services Commission.</td>
<td>×</td>
<td>✓</td>
</tr>
</tbody>
</table>
what the impact of any risks will be. So far the consortium of farmers has had significant trouble achieving external funding and finding an appropriate delivery mechanism. It is also possible that the scheme may prove to be more costly than what they have predicted.

### 3.3.3. Financial evaluation

Financial evaluation that has been conducted for this scheme, by the farmers and the parties that they have been negotiating with, has focused on how the required external funding can be justified. If Case Study C is implemented it will result in reduced nitrogen removal such as habitat, recreation facility and community benefits which are not delivered through this project. Due to this reason, in their consideration of whether to grant external funding, the Bulk Supplier determined that this stormwater benefit calculation was inappropriate, and so determined that the scheme does not warrant funding. The Bulk Supplier proposed as an alternative benefit calculation method, that the value for the Long Run Marginal Cost of nitrogen treatment at one of their large sewage treatment plants was used. This value measures the long term cost of operating a treatment plant, and does not actually consider the potential environmental benefit of removing effluent from the waterway in question.

Table 6 shows the amount of external funding that the project requires, in comparison to the two different methods of calculating the nitrogen abatement benefit that the scheme would provide. The first column shows the Long Run Marginal Cost of nitrogen treatment at a large sewage treatment plant within the study region, the second column shows the amount of funding required, and the third shows the amount of funding that it could be eligible for if it were reducing nitrogen from a stormwater source in a new residential development. Neither of these benefit calculations is entirely appropriate, nor entirely inappropriate, with a more accurate value likely to land somewhere in the middle. See Case Studies F and G, and discussion for further exploration of this issue.

This is another example of attempting to account for “externalities” (see section 1.3) in the planning of reuse projects.

### 3.3.4. Funding

The farmers have predicted the scheme to cost $6 M, and are able to fund $4 M through scheme customers (in this case themselves), so they sought to have the Bulk Supplier fund $2 M. As explained above the Bulk Supplier determined that stormwater benefits did not warrant funding of the scheme. Without funding the scheme may not be able to proceed.

However there are perhaps other, more appropriate, funding avenues through State Government departments that may better align with the goals of the project. This is because the project is providing a mechanism to improve the viability of businesses (with potential environmental benefits as a by-product). If the municipality that the scheme is situated in was purely regional then there would be access to regional economic development funding. However it is a fringe area which is half metropolitan and half regional, and because of this these regional funding sources are not available.

There is a possibility that the state government may provide funding to the scheme as part of the sale of the region’s Port. Because some of the value of the Port has been derived from farming exports, some of the money from this sale is expected to be supplied to agricultural infrastructure projects.

---

### Table 5

Risk assessment of Case Study C project.

<table>
<thead>
<tr>
<th>Risk</th>
<th>Explanation</th>
<th>Risk identified?</th>
<th>Risk eventuated?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potential future reduction in recycled water demands</td>
<td>If demands from farmers drop significantly then the financial viability of the scheme would be damaged. This can be partially managed through take-or-pay contracts. However any environmental improvements from the scheme would be reduced if the water utilised by the scheme is reduced.</td>
<td>✓</td>
<td>–</td>
</tr>
<tr>
<td>Difficulty achieving external funding of (of $2 M)</td>
<td>If external funding is not achieved then the scheme will not be viable. So far it has proven to be difficult, but may still be possible.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Difficulty finding an appropriate owner and operator of pump and pipeline capital cost increases above what is estimated</td>
<td>There are various options being considered for delivery mechanisms. If a suitable candidate is not discovered then the scheme is unlikely to be able to proceed. The Water Retailer believes that the farmers may have underestimated the scheme costs. If this happens there is a risk that the scheme will run out of funding midway.</td>
<td>✓</td>
<td>–</td>
</tr>
</tbody>
</table>

---

### Table 6

Difference in nitrogen benefit calculation.

<table>
<thead>
<tr>
<th>LRMC of treatment at STP</th>
<th>Amount of funding required</th>
<th>Current MW stormwater offset contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>$0.43/kg</td>
<td>$357/kg/year</td>
</tr>
<tr>
<td>Annual or one off payment</td>
<td>Annual (25 year)</td>
<td>One off</td>
</tr>
<tr>
<td>Load</td>
<td>$5600 kg/year</td>
<td>$5600 kg/year</td>
</tr>
<tr>
<td>Total funding justified</td>
<td>$38,155 (NPV)</td>
<td>$2,000,000</td>
</tr>
</tbody>
</table>
3.4. Case Study D (wastewater reuse)

3.4.1. Project description

Case Study D has been led by a Water Retailer. It is currently in operation and involves the use of recycled water from a local sewage treatment plant (owned the same utility) for irrigation of public open space, market gardens, golf courses and school ovals. The scheme was intended to have two stages, which were planned (and financially assessed) together as a combined package. Stage 1, a 1.67 GL/year scheme began operation in 2009. Stage 2 was never constructed due to lack of demand.

Actual volumetric usage of recycled water has been below 50% of capacity so far. Because take-or-pay contracts (customer is charged regardless of usage) were utilised the level of demand has not been a financial issue for the Water Retailer.

The absence of predicted demand for Stage 2, and subsequently its non-implantation, has had a negative effect on the financial bottom line of Case Study D, in comparison to what was predicted in the business case. This is because Stage 2 would have provided cheaper water than stage 1, and then been sold at the same price, as explained further below. However overall the scheme has been successful in providing water security to the region, and it is likely that the water usage will increase in the next dry period.

3.4.2. Risk management

Interestingly the only two risks which have turned out to be an issue, the non-implementation of stage 2, and changing government legislation were not identified as part of the risk assessment which was completed for the business case, which is shown in Table 7.

Overall the eventuating risks have had a negative impact on this project’s bottom line. The risk of Stage 2 not being implemented was not discussed in the risk assessment or anywhere else in the business case. In fact the risk assessment states that because take-or-pay contracts will be used then there is no risk to the Water Retailer’s revenue. Changes to Cultural Heritage Management Plan legislation could not have been foreseen by the Water Retailer. However it is probably logical to include changing government legislation as a risk in future projects.

3.4.3. Financial evaluation

The conducted financial evaluation estimated a shortfall of $2.6 M for the recycling option over a 25 year period, in comparison to sewage treatment plant works which were required regardless of any recycling option. This is shown in Table 8.

Following on from the financial evaluation, which determined the level of financial shortfall, the Water Retailer was required to demonstrate that the more expensive recycling option was justified. This was done through a multi-criteria assessment which considered socio-economic and financial factors.

More prominently featured in the business case was a comparison of production costs between Case Study D and other recycling schemes which showed it to have a lower production cost. The reason for this was that because the government had signed off on a 20% water recycling target for the region, all that was required was to show that Case Study D was cheaper than alternative existing recycling schemes.

3.4.4. Funding

Half of the $2.6 M predicted shortfall was sought, as a $1.3 M external grant from a State Government Water Recycling fund. State Government funding success was aided by council, school and community element associated with this recycled water scheme.

In order to demonstrate how only implementing Stage 1, and not implementing Stage 2, has affected the financial bottom line of the project, the researchers conducted an approximate calculation as shown below in Table 9. It shows an additional loss of approximately $2.2 M for implementing Stage 1 only (which is what has happened), in comparison to the Stage 1 and 2 combined scheme which was included in the business case.

Therefore an approximate total of $3.5 M ($1.3 M predicted, and $2.2 M not predicted) in losses can be expected to accrue over time to the Water Retailer, which then needs to be charged to the wider customer base.

3.5. Case Study E (stormwater reuse)

3.5.1. Project description

Case Study E was designed by a Water Retailer to harvest urban stormwater and then transfer this water to an agricultural water authority in exchange for a permanent share of upstream agricultural water entitlements. The scheme successfully won a 50% grant from National Government funding. However, the agricultural water authority later decided not to accept the scheme in its proposed form because they perceived a risk to supply security.

Conducted modelling results demonstrated that the exchange scheme would have no adverse impact on irrigators, but the agricultural water authority, and the irrigators it represented did not have sufficient confidence in the modelling results to permanently hand over a proportion of their water resource assets. A pilot trial is now being planned to support a potential future scheme with a 1 ML for 1 ML exchange mechanism, although due to the lack of certainty surrounding project outcomes the National Government

<table>
<thead>
<tr>
<th>Option</th>
<th>NPV (variation from base case)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base case (STP upgrade without reuse)</td>
<td>$-4.8 M*</td>
</tr>
<tr>
<td>Recycling option</td>
<td>$-2.6 M</td>
</tr>
</tbody>
</table>

### Table 8

<table>
<thead>
<tr>
<th>Option</th>
<th>NPV (at 6% rate, 25 year period, 2007$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base case (STP upgrade without reuse)</td>
<td>$-13 M</td>
</tr>
<tr>
<td>Recycling option</td>
<td>$-15.6 M</td>
</tr>
</tbody>
</table>

### Table 9

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1 (only)</td>
<td>$7.7 M</td>
<td>41,250 ML</td>
<td>$-410*</td>
<td>$-296</td>
<td>$-116*</td>
<td>$-4.8 M*</td>
</tr>
<tr>
<td>Stage 1 &amp; 2 Combined</td>
<td>$10.6 M</td>
<td>75,350 ML</td>
<td>$-330*</td>
<td>$-296</td>
<td>$-36</td>
<td>$-2.6 M</td>
</tr>
</tbody>
</table>
funding agreement was terminated by mutual agreement in early 2015.

3.5.2. Risk management

A selection of the risk assessment which has been included in the final Case Study E report is shown below in Table 10. This risk assessment demonstrates that the lead organisation had significant concerns that risks would cause the project not to proceed.

The eventuating risks have had the impact of the project not proceeding in its original form, although it may proceed in a different form in the future. The Water Retailer accurately assessed the potential risks associated with the scheme. Most of the identified risks have eventuated. The Water Retailer was not able to achieve agreement with the agricultural water authority over the permanent water entitlement transfer. This caused the National government to end the funding agreement. The Project Team has learnt from previous water industry experience with developers and determined that development forecasts are notoriously unreliable, as has also been the case in this example.

3.5.3. Financial evaluation

An NPV assessment of possible stormwater harvesting schemes was conducted to determine which was the most cost effective. Present values of benefits and costs (under Historical Climate conditions) for the potential project scenarios (at a 5% real discount rate and for a 20 year evaluation period) were calculated. The main conclusions able to be drawn from the Historical Climate assessment were that: the stormwater project provides a net financial benefit to the Water Retailer.

3.5.4. Funding

National Government funding was granted for Case Study E was capped at 50 per cent of eligible capital costs. Because agreement was not able to be reached between the Water Retailer and agricultural water authority over the exchange mechanism the National Government cancelled the funding agreement by mutual agreement in 2015. $410,000 of National funding and $600,000 of Water Retailer funding was spent on planning.

A pilot trial is currently being constructed to test the potential benefits of the scheme; there are no results available yet from this trial. The pilot trial was predominantly funded through a separate state government grant, which has been kept financially disconnected from the larger project.

3.6. Case Study F (stormwater reuse)

3.6.1. Project description

Case Study F was led by a Water Retailer. It was designed to harvest stormwater from two transfer drains for non-potable use within new apartment buildings. Flows were to be directed into an 8 ML underground concrete storage tank. This underground tank was designed to supply a new up to 1 ML/day Class A treatment plant and .5 ML above ground balancing storage tank. The project was expected to supply approximately 213 ML of recycled water each year via a 3rd pipe system to new apartment buildings, as well as irrigation of parks.

The project won a 50% funding grant from the National Government, although the project was later cancelled by the Water Retailer due to a cost increase from the original estimate of $13.28 M to a total of $16.5 M which was revealed through tendering. The major reason for the cost increase was unexpected geological conditions, as well as some stakeholder requirements.

3.6.2. Risk management

A selection of the risks associated with Case Study F is shown below in Table 11.

Overall the eventuating risks have resulted in the project being cancelled due to a cost increase. This cost increase was caused partially by stakeholder requirements and partially by unexpected geotechnical conditions. The Water Retailer project team has effectively identified the two out of three key risks which have eventuated. Risks around planning estimates and risks around receiving design support from stakeholders did turn out to be significant issues. Developments in the area are currently over two years behind schedule.

<table>
<thead>
<tr>
<th>Table 10</th>
<th>Risk assessment of Case Study E.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk</td>
<td>Explanation</td>
</tr>
<tr>
<td>Inability to reach water exchange agreement with agricultural water authority</td>
<td>This risk has eventuated and caused the project to be put on hold. A pilot scheme is in operation however the future of the larger scheme is questionable.</td>
</tr>
<tr>
<td>Funding issues including having the funding retracted</td>
<td>This risk has eventuated. When the urban Water Retailer was unable to reach agreement with the agricultural water authority National funding was withdrawn.</td>
</tr>
<tr>
<td>Hydrology modelling proves to be incorrect</td>
<td>Extensive water resource modelling was undertaken to support preparation of the business case. It is not yet known how accurate and conservative this analysis will prove to be.</td>
</tr>
<tr>
<td>Delays in development</td>
<td>Urban development in the area is proceeding consistently but has been slower than expected.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 11</th>
<th>Risk assessment of Case Study F.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk</td>
<td>Explanation</td>
</tr>
<tr>
<td>No users for recycled water (development delays)</td>
<td>It was identified that there was risk of development not proceeding or proceeding slower than expected. A number of strategies were in place to mitigate this risk such as regular engagement with developers.</td>
</tr>
<tr>
<td>Difficulty obtaining planning permit and design support from relevant stakeholders</td>
<td>Difficulty in obtaining a planning permit and design support from relevant stakeholders, such as local government was correctly identified as a risk. During the detailed design some stakeholder requirements added to project costs.</td>
</tr>
<tr>
<td>Cost increases from geotechnical conditions</td>
<td>A risk that was not predicted was cost increases from geotechnical conditions. This substantially added to the costs of the project causing it to be cancelled.</td>
</tr>
</tbody>
</table>
3.6.3. Financial evaluation

Once initial technical evaluation was conducted the Water Retailer determined that cost effectiveness of the project was marginal over its 25 year assessment period, and that they would need to receive an external grant to go ahead with the scheme.

Therefore as additional justification for the project the Water Retailer put forward the case of indirect financial benefits to the Bulk Supplier, in the form of nitrogen reduction, similar to Case Study C. Case Study F would have reduced nitrogen levels discharged to local waterway. In the planning of this scheme it was determined that the appropriate nitrogen benefit value was:

$$1110 \, \$/\text{kg/year} \times 658 \, \text{kg/year} = \$730,380 \, \text{(one off payment)}$$

It is potentially a cost saving to the Bulk Supplier because it could theoretically be done instead of another nitrogen reducing project elsewhere in the drainage system. There is a precedent for this due to the fact that the Bulk Supplier has been considering the construction of a wetland in the area predicted to cost up to $14 M. Implementing Case Study F would have lessened the requirement, or size, for such a wetland.

3.6.4. Funding

The estimated capital cost of the project was $13.28 M. Funding was sought from the National Urban Water and Desalination Plan for 50% of the capital cost which equated to $6.64 M.

During development of this case study the researchers noted that in some components of the business case the Water Retailer has only attempted to justify internal costs, by investigating whether there were enough project benefits (scheme revenue plus indirect benefits such as stormwater as discussed above) to justify internal expenditure ($6.64 M), rather than total expenditure ($13.28 M). In other words the Water Retailer considered National Government money as “free money”, which did not need to be justified. Without Government grant money, the benefits of the scheme were able to offset only about half of the projects total costs.

Over the years that this project was delayed, this estimated cost increased from $13.3 to $16.5. This new cost of the scheme gradually became more unfeasible for the Water Retailer. A variety of attempts were made to reduce costs and also find additional funding sources. However there was no conceivable way to get project costs down to a level whereby the Water Retailer would not incur a significant loss, and therefore the project was eventually officially cancelled by the Water Retailer’s Board.

3.7. Case Study G (stormwater reuse)

3.7.1. Project description

Case Study G has been led by a Water Retailer. It is an innovative project to deliver sustainable potable water supply to a new industrial/commercial complex on a Greenfield (previously undeveloped) site. The scheme intends to source stormwater from a 160ha commercial catchment through a wetland system and 65 ML storage basin. Water will then be transferred to an extensive 1 ML/day treatment plant. Water will be initially utilised within a newly created non-potable recycled water network. Monitoring and testing will be conducted for a number of years to provide evidence that produced water is safe for drinking, and then the treated water will begin to be injected directly into the local potable network.

Due to the poor economic conditions arising during the Global Financial Crisis, the commercial development which forms the source catchment has not yet been constructed. A time-restrictive funding arrangement has resulted in the plant being constructed anyway, before the surrounding development, leaving the plant temporarily without a water source or water user. The treatment plant now sits unused awaiting development. The first development in the area is about to commence, and so in the near future the plant is likely to begin operation.

3.7.2. Risk management

The major risks which were included in the planning of Case Study G can be seen in Table 12.

Overall the impacts of the risks have been that the project has been unused for an extended period of time. In terms of demand for the treated water, so far because of the lack of development there is currently no demand, having a significant negative impact of the financial bottom line of the project. Due to the commercial/industrial development, which is the feed water catchment, not having been constructed yet it is currently unknown whether the final feed water quality will match what was predicted. After 2—3 years of operation the Water Retailer will still need to prove the quality of supplied water to the Department of Health and also convince residents that it is safe to drink.

When the development is completed in the future, there is still a significant risk that the community will not want to drink the treated stormwater. In this region there is currently an excess of non-potable Class A quality recycled water, and so this would be a negative result.

3.7.3. Financial evaluation

Financial evaluation was conducted over a 25 year period and determined that 50% external funding was required. With the external funding the project was expected to be cost neutral for the Water Retailer. The Water Retailer justified the project by showing how the levelised cost of produced water is impacted by the inclusion of indirect financial benefits. Nitrogen reduction benefits were calculated similarly to Case Study F above. Some infrastructure augmentation deferral benefits were also included.

The project is expected to eventually reduce the nitrogen load discharged to downstream waterways. The nitrogen load reduction due to stormwater harvesting is expected to be 1461 kg per year.

<table>
<thead>
<tr>
<th>Risk</th>
<th>Explanation</th>
<th>Risk identified?</th>
<th>Risk eventuated?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed water quality risks from chemicals and pollutants</td>
<td>There was considered to be an operational and public safety risk from worse than expected feedwater quality. A variety of mitigation measures were put in place to manage this.</td>
<td>✓</td>
<td>–</td>
</tr>
<tr>
<td>No users for recycled water</td>
<td>A financial risk was identified in regards to less than expected demands for recycled water. This has eventuated because the development has been behind schedule.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Failure to gain necessary approvals</td>
<td>There is a risk that even after 2 years of monitoring it may not be possible to gain approval to use the treated stormwater for potable uses as intended.</td>
<td>✓</td>
<td>–</td>
</tr>
<tr>
<td>Failure to convince future residents that it is safe to drink treated stormwater</td>
<td>If approval of potable reuse is gained then there may still be an issue convincing the community that it is safe. Planners have discussed this issue but it was not considered in the official risk assessment.</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Table 12
Risk assessment of Case Study G.
Using the same value as Case Study F it was found that nitrogen reduction benefits from the scheme can be calculated as:

\[ 1,110 \times \frac{1461}{1000} = 1,621,710 \]

Therefore this project results in a nitrogen reduction equivalent to $1.6 M in total offset charges. Even though the project is expected to provide these benefits to the Bulk Supplier, the Water Retailer did not attempt to seek contribution for this benefit.

In the area of Case Study G new infrastructure assets will soon be required that include two water supply tanks and a major water pipeline. Case Study G does not eliminate the need for these assets; however it may (if everything goes according to plan) enable their construction to be deferred. Development forecasts indicated a deferral period of at least 3 years. Assuming an interest rate of 5% per annum and a total capital cost of $34 M, the Water Retailer is likely to save approximately $1.7 M in financing costs through deferral. This calculation includes the assumption that Case Study G will eventually supply drinking water.

If the Water Retailer received the National grant, and didn’t include any of the indirect benefits calculated above (~$3.3 M), the project was expected to pay for itself over approximately 20 years. However due to delays in development this estimate would need to be recalculated.

3.7.4. Funding

A National grant was received for 50% of the expected costs. In this case due to a minor cost increase of approximately $900,000 due mostly to the developer deciding against expectations to charge for the land under the treatment plant, it has resulted in the Water Retailer paying slightly over 50% of the total capital cost. Because of delays in the pace of surrounding development the overall financial bottom line of the project has become more negative for the Water Retailer, however to what extent has not been calculated.

4. Discussion

The case studies have revealed a variety of interesting issues in relation to risk management, financial evaluation and funding of Australia’s wastewater and stormwater reuse projects. Overall from this research it can clearly be seen that each reuse project is unique, with each project differing not only in terms of technical aspects, but also in terms of planning processes, critical risks, financial justifications and funding issues.

4.1. Risk management in the case studies

Risk management in the case studies has revealed insights into the relationship between complexity and risk, and which risks should be given greater weight in the future. The case studies show that the more complex and large a scheme is, the more risk it involves. Case Study A is an example of a lower complexity scheme. By having the one organisation both producing and using the water, for a well-understood end use, most of the demand side risks were avoided. Case Study D is relatively low complexity because it is relatively small, is operated by a Water Retailer that has experience in similar schemes, and was able to utilise take-or-pay contracts with customers to secure revenue streams.

In contrast many of the other schemes are far more complex in a variety of ways. Case Study B is large and intends to produce water for industrial users who may go out of business, or relocate facilities in the future. Case Study C scheme is complex because it is a private enterprise, and does not have a clear owner/operator mechanism. Case Study E is complex because it involves an innovative exchange mechanism between urban and agricultural water authorities. Case Study G is complex because it intends to treat stormwater to a potable standard which has not been done before in Australia.

The case studies reveal two particular risks which should be given additional weight in future planning processes. The first is development forecasts; these have been shown to be unreliable in Case Study E, Case Study F and Case Study G. The second is the risk that later stages of a project do not proceed, negatively affecting a
projects bottom line, as occurred in Case Study D. Reasons why later stages of a project would not proceed include land-use changes, changes to consumer preferences and demand patterns, changes to financial outlooks for utilities etc.

4.2. Financial evaluation in the case studies

Financial evaluation in the case studies has shed light on a number of topics including: (1) the time period used for financial assessments; (2) which externalities are considered; (3) how stormwater system benefits are valued; (4) how infrastructure deferral benefits are valued; (5) using maximum volumes in benefit calculations; and (6) consideration of external costs.

The time period used for financial assessments varied drastically as shown in Table 13. Two of the case studies, the ones undertaken by local government and private enterprise, did not include a detailed cost benefit analysis, with the local government planners informally adopting 50 years as an appropriate analysis period. The others, conducted by water utilities, had an evaluation period ranging from 20 years to 35 years. Changing the evaluation period can have a very serious impact on the financial evaluation outcome.

For reuse projects, in the majority of cases, a longer evaluation period resulted in a higher NPV, because the major expenses generally occur at the beginning of the project (design and construction), and then subsequently project revenues are consistent per year (based on water used/sold in accordance with water demands and scheme capacity). Therefore if evaluation period lengths are different between projects, without a justifiable reason for this variation in length (such as lifespan of equipment), then in some cases this is likely to mean that project NPVs cannot be directly compared.

Considered case studies attempted to deal with divergence between private and public costs and benefits (see Section 1.3) by calculating indirect benefits (positive externalities) and using these as project justifications. Three of the case studies, Case Study C, Case Study F and Case Study G, attempted to value benefits (positive externalities) to the wider stormwater system. Interestingly Case Study E did not attempt this even though it would likely have provided further justification of the project. As shown in Table 6, the monetary value of removing stormwater from waterways can be calculated in a variety of ways, differing by a factor of up to 1000 (from $40 k benefits to $40 M benefits in the case of Case Study C). Case studies F and G have selected a middle value for nitrogen removal, which, if the same nitrogen abatement value was adopted within the planning of Case Study C, would have provided enough justification for external funding, allowing the project to proceed. In reality different waterways have different environmental, social and economic values, and so this value should be set on a case by case basis, but through a consistent process, which does not currently exist.

Two of the case studies, Case Study B and Case Study G, attempted to include infrastructure augmentation deferral benefits: Case Study B in regards to potable headworks; and Case Study G in regards to local transfer and storage assets. This is another example of attempting to consider externalities in the financial evaluation process.

Case Study D, as shown in Fig. 1, demonstrates that for schemes that have demands influenced by weather patterns (i.e. most outdoor uses) it is inappropriate to use scheme maximum capacity when calculating indirect scheme benefits (positive externalities). For agricultural/irrigation schemes it can be seen that “take-or-pay” contracts (where users pay regardless of if they use) are important to ensure financial sustainability of schemes, but if the water is not being used, then indirect benefits, such as to the stormwater system, are not being generated.

Investigated case studies are also interesting in terms of “financial ring-fencing”, which is how internal costs are considered in comparison to external costs. Case Study F and Case Study G projects, which both sought to receive 50% subsidies, effectively considered National funding as “free money”, only seeking to justify internal Water Retailer funds. Also Case Study B had an assumption that the Bulk Supplier would not lose money when providing feedwater, which may require further investigation if the project is to proceed.

Overall the case studies have highlighted both difficulty and subjectivity involved in trying to value the indirect benefits (externalities) from reuse schemes. It is clear that if there is to be any consistency and validity to these assessments they must be made through a standard process and scrutinised by a highly informed, and at least semi-independent, assessment process. Furlong et al. (2016a) discusses this notion in relation to various spatial scales, and suggests that valuation techniques should be set ideally at either the metropolitan, regional or state government scale depending on the circumstances, and then applied consistently at the local scale.

4.3. Funding of case study projects

Funding processes in the case studies have shown that almost all of the case studies required external funding to proceed; with four of the seven requiring a 50% subsidy, one 30%, one 15% and one 0%. Most of these were funded from the National Government. Case Study C project attempted to gain funding from the Bulk Supplier and the state government and, as there was no established process for a private scheme to do so, this proved to be very difficult.

Case Study G’s outcomes suffered from a lack of time flexibility in the National Funding agreement. Planners of Case Study E learnt from this experience and so requested a time flexible agreement. In future external funding agreements, the more time-flexible an agreement can be, the better the community outcomes are likely to be.

The practice of giving National grants to fund local water infrastructure projects in a financially stable water sector only existed for a short time window during Australia’s millennium drought. In 2011 the Australian Government’s Productivity Commission recommended that the National government cease this practice (Productivity Commission, 2011). This raises questions about such wastewater and stormwater reuse schemes in the future, seeing as minimal National funding is likely to be available. This is not to say that no subsidies will be provided to reuse schemes, but simply that they are unlikely to come from National grants.

Interestingly the only project not considered to require an external government grant has been put on hold by the Essential Services Commission (pricing regulator). This provides additional evidence that a consistent and transparent evaluation process is required for future projects.

Due to the fact that the case studies indicate some level of subjectiveness in financial evaluation processes, and that risks can have an unpredictable impact on financial outcomes, it is often very difficult to have confidence about what overall financial impact reuse projects will eventually have on their lead organisations. In Case Study A however, because the grant essentially equals the greatest possible financial loss that the organisation can incur (because in this case water usage is guaranteed), in this one example the organisation is almost guaranteed to not have a financial loss from the project.
5. Conclusion and recommendations for future projects

It appears likely that National Government funding is becoming less common (Furlong et al., 2016c). Although there will always be some exceptions, in general it can be said that if more of these projects are to be implemented in the future there are a number of things that must happen.

The water industry will need to create an internal funding model to justify future project subsidies, which would then be paid for by charging the wider customer base. Cost-sharing in this way requires justifiable calculations of benefits and costs (both direct and indirect). Without such a process it may be difficult for the water industry to justify the construction of these projects. Indirect benefits such as reduced pollutants to waterways are difficult to objectively value (by a factor of 1000), and determining which water industry body they accrue to can be difficult.

Therefore a standard planning and evaluation process, including financial evaluation, risk management, and other processes must be agreed on at a city, regional, state (or potentially national) scale. Such a process would specify time periods, discount rate determinations, expected potable water price increases, identifies which costs, benefits and externalities should be considered, and set calculation procedures for this. This task would be extremely difficult and time consuming. Indeed most attempt it in the past, at least in the case study region, have had very little success (Furlong et al., 2016c). However the fact that it has proven to be difficult does not imply that it is impossible.

As the water industry is likely to be internally funding the costs of these projects, by charging their wider customer bases, the industry must also continue to improve on risk management processes. Currently the industry does quite well at predicting and attempting to mitigate against certain risks. However, there is room for improvement in the matter of considering risks in overall decision making and option selection processes. There was a tendency in some case studies to only consider risks at an abstract level which are then effectively ignored in final recommendations. It is also important that projects which are already assessed as NPV negative (such as almost all of the considered case studies) take an extra conservative view of risks to cushion against further negative financial impacts on the project owner.

One possible way of tackling this issue in the future is the use of risk assessment results as a “pass or fail” test. If a project has any major risks which cannot be effectively mitigated then it may be unwise to pursue that project further.

An issue which has not been directly addressed this paper is whether any benefit would be derived from conducting such wastewater and stormwater reuse schemes through public/private partnerships. Some experts suggest that the inclusion of private financing, can increase project costs in the short term, due to profits, but decrease costs in the long term due to private companies taking a more realistic view of risks in the planning process (Flyvbjerg et al., 2003), and reducing the tendency of public organisations taking an over-optimistic view of project costs (National Audit Office, 2013). From the case study narratives presented in this paper, particularly the only private case considered (Case Study C), the inclusion of private capital in these projects would likely add another level of complexity. Whether doing so would also cause risk assessment and management to be conducted more effectively is a question beyond the scope of this research, and warranting further investigation.

There is also a serious question about who should have the authority to determine if a project is worthy of funding subsidies. The authors of this paper hereby propose a new approval pathway for such projects: an infrastructure funders’ forum (or committee) which includes senior members of all relevant water authorities and utilities as well as government regulators (and potentially other stakeholders), at a regional scale. In this way it would be possible to ensure that projects are objectively compared against each other and prioritised on merit, by the foremost experts on the topic who have a good understanding of the whole system. Such a group would be well placed to make judgements around the value that projects provide to the wider system (externalities) and therefore whether subsidies are justified.

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The authors wish to acknowledge the financial support of RMIT University and Water Research Australia. We would also like to thank the 43 industry experts who were consulted throughout the research, and the organisations which gave information on the seven case studies. Their input was absolutely crucial in making the research a success. I would also like to thank the reviewers who contributed substantially to the improvement of this paper.

This paper forms part of a wider research program into IUWM. The wider research program includes the following research topics: (1) international evolution of integrated approaches to water management, (2) planning frameworks for the complex modern planning environment, (3) water governance for IUWM, (4) planning scales and approval processes for IUWM, (5) industry perceptions of IUWM, followed by the current paper (6) on risk management, financial evaluation and funding.

References


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Chapter 8: Melbourne’s IUWM strategies

8.1 Introduction
The current chapter discusses “IUWM strategies” (see Section 1.2 for definition) which are the main mechanisms by which future “IUWM projects” are being identified and selected. This chapter provides preliminary exploration of the major issues which need to be grappled with by such IUWM strategies. It is one of the first papers ever written which considers such a large set of IUWM strategies in an empirical and critical manner. Two of the IUWM strategy case studies, “Water Futures Central” and “Water Futures North”, were introduced in Chapter 3 as “sub-regional plans” conducted by the Office of Living Victoria.

This chapter is made up of a journal article which is in press for publication in Utilities Policy.

The practical implications of this chapter are:

- The practice of creating IUWM strategies/plans to determine the best overall options for water infrastructure is extremely difficult, and still evolving, in particular challenges are faced with:
  - Setting environmental objectives in a way that is consistent and justifiable, in the absence of clear regional policies
  - Setting liveability, greening and amenity objectives in a way that is clearly defined, and is directly linked to water infrastructure options. A clear example of this issue is the proposal that providing alternative water sources supports greening, in the absence of analysis about the likelihood of future water restrictions in the context of a newly constructed desalination plant
  - Comparing IUWM options with a defined “business as usual” (BAU) option, because this involves many assumptions about what would happen in the absence of an IUWM strategy/plan
  - Comparing energy usage across IUWM and BAU options
  - Cost benefit analysis methodologies

- Overall the IUWM plans/strategies failed to rigorously consider long term climate change impacts, and this issue requires additional consideration in future planning processes

- The considered processes assumed a single future population, water use and climatic scenario. In the face of great uncertainty, the practice of not considering options in relation to multiple possible future scenarios (scenario planning), is considered to be problematic. The absence of scenario planning makes it impossible to consider the resilience of options to future uncertainties. It is proposed that future IUWM plans/strategies should include scenario planning
Key concepts for Integrated Urban Water Management infrastructure planning: Lessons from Melbourne

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ABSTRACT

“Integrated Urban Water Management plans” consider all water services simultaneously to determine optimal infrastructure solutions. They create many benefits, including unlocking opportunities for water reuse. This paper conducts preliminary assessment of nine IUWM plan case studies from Melbourne. It finds inconsistencies between plans in relation to environmental and liveability objectives, and option identification methods, and also that many IUWM options perform worse than conventional water supplies in regards to energy. The most consequential finding is that the plans do not include scenario planning and therefore fail to consider infrastructure performance regarding resilience to future uncertainties around population and climate change.

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1. Introduction

1.1. Urban water management

Urban water management has traditionally involved the provision of water supply, sewerage and drainage services to customers through a network of buried pipes (Marlow et al., 2013). Across the world there are large variations in regards to how these water services are managed, particularly in relation to division of responsibilities between utilities, state and local governments (Baïetti et al., 2006). In some countries there are large numbers of vertically integrated water utilities, or municipalities, who control all water services but only over a small geographical area. In other countries there are horizontally integrated utilities, or state and national government departments, which cover a wide area but only one or two water services, and everything else in between (Marques and De Witte, 2011).

However regardless of the organisational and governance arrangement utilised, it has always been the standard practice of water utilities to consider long-term planning of each water service separately (Mukheibir et al., 2014; Anderson and Iyaduri, 2003). Generally particular departments are given responsibility for the planning, construction and maintenance of infrastructure for one water service (Furlong et al., 2016c). This traditional segregated model makes planning relatively simple by allowing planners to monitor supply and demand trends for each water service separately, and wait until appropriate times to implement infrastructure augmentations (Closas et al., 2012).

Public water managers face a variety of increasing challenges. Two of the most serious challenges are long-term climate change and population growth and migration trends (Howden et al., 2007). Population changes have led to increasing urbanization and pollution, and have contributed to ecological damage, urban flooding, and water scarcity (Grimm et al., 2008; Sharma et al., 2010; Vörösmarty et al., 2010).

For this reason using scenario planning to design water infrastructure to be resilient to a variety of possible future population and climate change contexts has been widely recognised as an important practice (Luis et al., 2016). Various planning methodologies have been developed to assist water utilities in using potential scenarios and adaptive/ flexible approaches for the planning of urban water infrastructure. Generally the aim is to make water systems “resilient”, meaning that they are able to effectively deal with a variety of possible futures (Haasnoot and Middelkoop, 2012; WSAA, 2016).

1.2. Water sector shift towards integrated approaches

As a response to challenges there has been a gradual paradigm shift globally towards the idea that water management should take an “integrated” approach. This shift has taken many forms, and
been known by many names (Furlong et al., 2015). Integrated Water Resources Management (IWRM), the most widely recognised term, is an approach that predominantly has a river basin scale water resources focus, and gained popularity on the tail of a number of high profile international conferences from 1977 to 2002 (Mukhtarov, 2008). Although IWRM is the most recognised term for integrated approaches within the water sector globally, it is typically used in relation to the planning of water resources and water allocations, which occurs at a large, generally river basin scale (Warner et al., 2008).

This paper relates more closely to the idea of Integrated Urban Water Management (IUWM), which has become popular more recently through the works of the World Bank, CSIRO, Global Water Partnership and the SWITCH project (Global Water Partnership, 2012; Closas et al., 2012; Howe et al., 2011; Furlong et al., 2016a). IUWM means different things to different people (Furlong et al., 2016d), and its definition can be very broad such as (Global Water Partnership, 2012):

“Integrated urban water management (IUWM) offers a set of principles that underpin better coordinated, responsive, and sustainable resource management practice. It is an approach that integrates water sources, water use sectors, water services, and water management scales. It (1) recognises alternative water sources, (2) differentiates the qualities and potential uses of water sources, (3) views water storage, distribution, treatment, recycling, and disposal as part of the same resource management cycle, (4) seeks to protect, conserve and exploit water at its source, (5) accounts for nonurban users that are dependent on the same water source, (6) aligns formal institutions (organisations, legislation, and policies) and informal practices (norms and conventions) that govern water in and for cities, (7) recognises the relationships among water resources, land use, and energy, (8) simultaneously pursues economic efficiency, social equity, and environmental sustainability, and (9) encourages participation by all stakeholders.”

For the purposes of this paper this broader definition can be scoped to include only: (1) coordinated planning of all water services (water supply, sewerage and drainage) (Mukhebir et al., 2014; Makropoulos et al., 2008; Dobbie and Brown, 2013), (2) consideration of decentralised wastewater and stormwater reuse opportunities (Mitchell, 2006; Ferguson et al., 2013; Sharma et al., 2010), and (3) explicit consideration of liveability and ecosystem protection (Brown et al., 2009; Ferguson et al., 2013; WSAA, 2014).

Liveability is a term that includes a wide array of concepts. In a broad sense “liveability” means everything that makes an urban area pleasant to live in, and is therefore related to what a particular community values. The water industry has been discussing its role in, and contribution to liveability for a number of years (WSAA, 2014). Essential services that water utilities provide, including water supply, sewerage and drainage, are necessary for attaining liveable cities. However there are also “non-essential services” which relate to liveability including: community connection, local identity, natural environments/biodiversity, urban form/amenity, leisure/recreation, and ecological footprints (Holmes, 2013). In relation to these non-essential services there is a lack of clarity around what exactly the water sector’s role is, and how this should be done.

The idea that the water utility sector should be involved in contributing to these non-essential services has been a continued focus for a number of Australian researchers, who have been promoting a concept known as “Water Sensitive Urban Design” (WSUD) (Brown and Clarke, 2007). WSUD is an ideology that promotes the installation of stormwater management devices such as rain gardens, wetlands and swales throughout urban areas, to simultaneously improve all of these non-essential liveability services (Wong, 2006).

1.3. “Integrated” water infrastructure planning in Melbourne

Water infrastructure planning is a subset of water management that specifically involves identifying, comparing, and selecting infrastructure options to achieve best community outcomes. In some parts of Australia, particularly in Melbourne, there have been massive institutional water utility and government policy changes which have mainstreamed the integrated planning of urban water infrastructure (Ministerial Advisory Committee, 2012; Furlong et al., 2015; Department of Environment, Land, Water and Planning, 2016).

The process of planning water supply, sewerage, drainage, liveability and ecosystem services simultaneously to determine optimal long-term infrastructure solutions can be described as the creation of “IUWM plans” (CSIRO, 2010). In Melbourne IUWM plans are conducted at a sub-regional or local scale, particularly focusing on growth areas on the city’s fringes (Furlong et al., 2016a). IUWM plans are generally commissioned by public water utilities and created by private consultancies (Furlong et al., 2016c). They are conducted as far in advance as possible, ideally well before construction activities have begun (Wilson et al., 2013).

Consideration of infrastructure for multiple services in a single planning process allows, among other things, the identification of water reuse options, through the consideration of water supply, sewage and stormwater supply and demand balances (Fam et al., 2014). Water reuse, including wastewater recycling and also stormwater treatment and harvesting, is often considered to be an “IUWM option/project” (Furlong et al., 2016a). A large component of all IUWM plans involves comparing unconventional IUWM options to a conventional, or “business as usual (BAU)” option, on a total community cost basis (Makropoulos et al., 2008).

A wide spread of IUWM options can be seen in Table 3, and more detailed examples of IUWM infrastructure can be found in Furlong et al. (2016a), which provides case studies on four of Melbourne’s stormwater harvesting projects, and three of Melbourne’s wastewater reuse projects. These projects include a range of scales, water uses, and project leaders.

Within Australia’s water sector many believe that IUWM plans are able to unlock better infrastructure options than what would be achieved through the traditional segregated planning approach (Anderson and Iyaduri, 2003). 82% of surveyed water industry experts believe that IUWM is going to be either “very” or “extremely” relevant to the future of the urban water sector (Furlong et al., 2016d). In Melbourne’s water industry reports it is common to find statements similar to the following (Yarra Valley Water and Melbourne Water, 2013):

“Compared to a traditional servicing approach, the adoption of [IUWM] solutions can deliver higher community value by optimising the benefits and costs of each investment.”

Another key function of IUWM plans is to establish relationships between stakeholders and help to build a joint vision. Without such a joint vision efforts towards improving water services can be fragmented, and even conflicting (Howe et al., 2011).

1.4. Process for creating Integrated Urban Water Management plans

All planning processes involve a number of key steps which can be referred to as a planning framework (see Fig. 1). Furlong et al. (2016b) compared a number of water infrastructure planning frameworks, including both traditional and IUWM planning, and found that they were all to some extent based on the rational
1.5. Knowledge gap and focus of this paper

IUWM infrastructure options are “relatively new and involve increased complexity [and] there are wide knowledge gaps in their planning, design, implementation, operation and management, which are impeding their uptake” (Sharma et al., 2010). The existing academic literature related to water infrastructure planning that does exist “often contains … little detail on how planning is being undertaken in practice” (Malekpour et al., 2015).

It is only through the critical analysis of past planning case studies that the urban water industry and academia can learn from experience and facilitate continual improvement. However there have been only a relatively small number of research projects that have investigated IUWM case studies. Some examples of efforts towards the assessment of IUWM case studies include Mitchell (2006) and Institute of Sustainable Futures (2013); which focused on IUWM project outcomes, and Furlong et al. (2016a), which focused on planning scales and approval processes for IUWM infrastructure projects.

Efforts in regards to comparing and improving processes for IUWM “plans” (as opposed to specific projects) have also been limited. Some efforts include Anderson and Iyaduri (2003), and the case studies within the CSIRO (2010) planning manual. These assessments are (1) at a very high level, and (2) fail to critically assess the processes used in their case studies.

There is currently a large knowledge gap in regards to the consistency of method, rigour and validity of IUWM plans up to this point.

This paper attempts to fill this knowledge gap by conducting preliminary analysis of 9 IUWM plans which have been conducted in Melbourne. Analysis is undertaken with the intention of diagnosing process and input discrepancies, and also omissions of important concepts. The authors use this knowledge to put forward preliminary recommendations in relation to each of the identified discrepancies and omissions, and then conclude by reflecting on the future of IUWM plans and the relevance to the international water academic and practitioner community.

The structure of this paper after this point is as follows: methods, summary of the case studies, discrepancies and oversights in the case studies separated into eight sub-topics, and a discussion and conclusions section.

2. Method

The overall method used for this research has included (1) identification of suitable case studies, (2) case study analysis, and (3) synthesis of findings.

Case studies were identified with assistance from the Integrated Planning department of Melbourne Water Corporation (MWC). This department has been involved in the creation of most of the major IUWM plans that have occurred in Melbourne, and so experts from this department were able to identify and select a set of IUWM plans which cover the variety of methods which have been utilised in Melbourne.

A total number of 9 case studies were determined to be appropriate in order to cover the spectrum of contexts and methods. The criteria for selection predominantly related to achieving a diversity of locations and scales, as well as focusing on recent efforts (completed 2014 or later).

Analysis of case studies involved a number of steps. Firstly project managers of strategies were identified with the help of MWC. Then all of the relevant documentation was collected from the project managers. After a thorough assessment of the documentation it was determined that structured interviews with the relevant project managers would not be necessary, as all of the points of interest were covered in the documentation.
Case study documentation was then analysed in detail in order to identify process and input discrepancies and omission of pertinent concepts in the overall IUWM plan approaches. Discrepancies were considered to be substantive differences in any methodological aspect. Omissions were considered to be failure to incorporate commonly accepted water management considerations that were discussed in the introduction.

After thorough scrutiny of the case studies, a list of findings was produced for each, and then these findings were grouped into categories to form the subtopics listed in the analysis section of this paper. After the subtopics were created the case studies were then re-assessed in relation to each, creating summary tables where possible.

The authors acknowledge that the investigation of case studies in order to identify discrepancies and omissions appears to imply a predetermined bias, and an intention to represent IUWM plans in a negative light. The authors have been involved in IUWM plans for many years, and therefore did have predetermined viewpoints. However the intention of the authors was not to discredit but rather to discover practical recommendations for the improvement of future IUWM plans. Furthermore IUWM plans involve a complex web of institutional interactions, and so academics and practitioners with previous experience in IUWM plans are the most qualified to identify and analyse them. Although such an arrangement is not ideal from an academic perspective, it appears to be the only arrangement through which such a study can be efficiently and effectively conducted.

As a final step, in order to ensure the accuracy of the analysis, this paper was reviewed by three separate additional experts from Melbourne Water Corporation: one from a research team, one from a stormwater management team, and one from stakeholder engagement team. Positive feedback was received and no major issues identified. A number of small corrections were made in relation to the outcomes of particular case studies.

3. Overview of the IUWM plan case studies

The current research has utilised 9 case studies, summary information for these is displayed in Table 1, and a spatial representation in shown in Fig. 2.

The considered IUWM plans have been conducted collaboratively between water utilities, State Government departments and statutory bodies, and in some case studies, the relevant local government areas (municipalities). They have each included a total number of stakeholders ranging from 3 up to 10. This variation is primarily, but not entirely, a result of area size: the larger the size, the more utilities, local government areas, regulators and other stakeholders are likely to be involved. However there was one important stakeholder group, private developers, which was involved in some case studies and not others.

Scales of the case studies ranged from a 6500 lot housing development, to an area which covers approximately one third of Melbourne, expecting to house 1,750,000 people by 2050.

Seven of the nine case studies focused only on growth (currently undeveloped “greenfield”), areas; one focused on a developed (experiencing densification, “brownfield”) area; and one on both growth and developed. Creating IUWM plans for growth areas has become a well-established practice in Melbourne. However the case study which focused only on developed areas suffered from a lack of past experience to draw on, resulting in an iterative and explorative process that did not specifically recommend a solution.

Four of the case studies had a specific interest in developing a plan for the management of excess wastewater and stormwater. This is because many growth areas of Melbourne are not adjacent to any ocean body, and therefore new developments will generate additional wastewater and stormwater which, to avoid detrimental impacts to local waterways, will need to be transferred long distances if it cannot be reused locally. Many growth areas are also a long distance from existing water supplies (which are located to the East of Melbourne), and so potable water transfer benefits were considered in some case studies.

Assessment processes used generally consisted of expert driven option identification and shortlisting followed by a combination of water balance, cost benefit analyses, and in some cases also multi criteria assessment. Multi criteria assessments were not prominently featured in the three IUWM plans that included them, and have been conducted as an ad hoc addition to check cost benefit analysis results. Such assessments are comparatively simple and have been used in the water sector for a long time, therefore they will not be considered further in this paper.

Conducted cost benefit analyses showed that “integrated” approaches (e.g. water reuse and/or additional stormwater management) involve a higher total community cost (even with benefits included), with some options in the order of AUD$600M more expensive than BAU. Some other case studies estimated IUWM options to have a net cost of only slightly (AUD$2M - $6M) more than BAU. Total community cost results from these cost benefit analyses attempt to include all benefits and costs in a way that is as objective as possible, although there is always subjectivity and potential for error within such assessments as discussed later in this paper.

Four of the case studies indicated a preferred option of wastewater reuse, stormwater harvesting, or both. Four did not explicitly indicate a preference, but highlighted the benefits of IUWM options. One study found all of its IUWM options to be unaffordable, recommending the BAU option. This was an important development because very few of Melbourne’s IUWM plans before this point have resulted in a recommendation for BAU.

4. Discrepancies and oversights in the case studies

After a thorough assessment of the case studies the authors grouped the findings from each case study together by theme. This produced a list of subtopics which will be discussed in this section. The first five subtopics relate to discrepancies which warrant consideration before attempting future IUWM plans:

1. Environmental objectives for waterways and bays
2. Liveability, greening and amenity objectives
3. Creating a business as usual option for comparison
4. IUWM option identification
5. Energy and greenhouse gas evaluations

The final three relate to more serious issues which raise questions about the validity of present IUWM plan practices:

6. Resilience, security and flexibility considerations
7. Cost benefit analysis methods and results
8. Climate data and climate change considerations

4.1. Environmental objectives for waterways and bays

As explained in the introduction, IUWM plans attempt to identify and select the best possible infrastructure options to satisfy water supply, sewerage, drainage, liveability and ecosystem protection considerations. This section considers how the IUWM plans determined what their ecosystem protection objectives were for waterways and bays. These objectives are generally used to determine the level of stormwater treatment that is required in the
Table 1
Summary of the servicing strategy case studies (*sizes reported differently).

<table>
<thead>
<tr>
<th>Project</th>
<th>Number of organisations</th>
<th>Size (2050 projection)</th>
<th>Area type</th>
<th>Major focus</th>
<th>Number of options considered</th>
<th>Option selection method</th>
<th>Result of investigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Botanic Ridge Growth Area Servicing Plan 2014</td>
<td>3</td>
<td>317 ha</td>
<td>Growth area</td>
<td>Drainage for waterlogged area</td>
<td>4</td>
<td>Cost benefit analysis</td>
<td>All IUWM options found to be unaffordable therefore BAU recommended.</td>
</tr>
<tr>
<td>Pakenham East Servicing Plan 2015</td>
<td>3</td>
<td>6500 lots</td>
<td>Growth area</td>
<td>Best overall option</td>
<td>5</td>
<td>Cost benefit analysis</td>
<td>Options recommended were dual pipe supplied either from (i) recycled water from a local STP, or (ii) stormwater harvesting backed up by recycled water. The net cost of RW was comparable to BAU, whilst the net cost of stormwater harvesting was more expensive than BAU but achieved the best environmental outcomes.</td>
</tr>
<tr>
<td>Casey Clyde Growth Area Servicing Plan 2013</td>
<td>5</td>
<td>51,700 lots</td>
<td>Growth area</td>
<td>Best overall option</td>
<td>10</td>
<td>Cost benefit analysis &amp; multi criteria assessment</td>
<td>BAU was found to be 13% cheaper than the lowest cost IUWM options. However on the basis of MCA results it was determined that a number of IUWM options were preferable to BAU. It was decided that further work is required to select a final option.</td>
</tr>
<tr>
<td>Water Future North: Growth Areas 2014</td>
<td>3</td>
<td>120,000 lots</td>
<td>Growth area</td>
<td>Avoiding the need for an expensive new sewer main and protection of currently undamaged waterways</td>
<td>5</td>
<td>Cost benefit analysis</td>
<td>The study didn’t explicitly identify a preferred option. All IWM options were more expensive than BAU. However, stormwater to potable was the lowest cost alternative option and achieved the best environmental outcomes.</td>
</tr>
<tr>
<td>Water Future Central 2015</td>
<td>10</td>
<td>2,000,000 people</td>
<td>Established area</td>
<td>Best overall option</td>
<td>9</td>
<td>Cost benefit analysis</td>
<td>The study didn’t explicitly identify a preferred option. The ‘traditional’ option was least cost, but was not preferred as it was contrary to existing policies of stakeholders. Of the ‘IWM’ options, precinct scale sewer mining was preferred.</td>
</tr>
<tr>
<td>Fishermans Bend Whole of Water Cycle Management Servicing Plan 2015</td>
<td>2</td>
<td>180,000 people</td>
<td>Growth area</td>
<td>Flooding, which will also increase over time due to sea level rise, and increased peak flows in the Yarra. Another focus was on the potential to defer an upgrade to the Punt Rd potable water main.</td>
<td>5</td>
<td>Cost benefit analysis</td>
<td>The proposed solution is precinct scale sewer mining to supply dual pipe. This was found to be only marginally more expensive than BAU.</td>
</tr>
<tr>
<td>Melton Growth Area Servicing Plan 2015</td>
<td>6</td>
<td>140,000 lots</td>
<td>Growth area</td>
<td>Infrastructure interface between rural and urban water utilities, and also excess wastewater and stormwater</td>
<td>8</td>
<td>Cost benefit analysis &amp; multi criteria assessment</td>
<td>The two preferred options were to supply either recycled water or harvested stormwater. Both are more expensive than BAU.</td>
</tr>
<tr>
<td>Sunbury Growth Area Servicing Plan 2015</td>
<td>6</td>
<td>21,000 lots</td>
<td>Growth area</td>
<td>Effective management of both excess wastewater and urban stormwater runoff generated from the new development</td>
<td>6</td>
<td>Cost benefit analysis &amp; multi criteria assessment</td>
<td>Although more expensive than BAU, the preferred option was stormwater harvesting for potable reuse and excess recycled water to land disposal and for environmental flows.</td>
</tr>
<tr>
<td>Western Regional Water Balance 2015</td>
<td>5</td>
<td>1,750,000 people</td>
<td>Growth and established area</td>
<td>Investigating both infrastructure and non-infrastructure based IWM initiatives</td>
<td>4</td>
<td>Water balance, pollutant balance and cost benefit analysis</td>
<td>The study has provided useful information but did not seek to identify a preferred option.</td>
</tr>
</tbody>
</table>

The studies highlight the usefulness of IUWM options, such as wastewater and stormwater reuse, in relation to achieving environmental objectives for waterways and bays. Technology for these IUWM options, and also associated management approaches, are relatively well understood, and considered to be achievable, although many require significant investment.

All but two of the IUWM plan case studies adopt substantial environmental protection objectives. However these long-term goals or visions for waterway and bay health have not been clearly defined in many of the studies. Consequently, the specific targets adopted for stormwater quality and flow improvements have been both inconsistent, and also poorly justified, in the studies.

The specific environmental targets adopted in the case studies can be seen in Table 2.

In all of the case studies stormwater quality targets have been defined. In seven of these, targets have been set to match Melbourne’s “Best Practice Environmental Management Guidelines (BPEMG)” of 80%, 45% and 45% for suspended solids, phosphorus and nitrogen. The BPEMG targets are mandated for all residential developments in growth areas under Victorian Government Planning Provisions (Potter and RossRakesh, 2007).

In the remaining two, East Pakenham and Casey Clyde, the targets have been set to exceed the BPEMG. This higher value is based on a more stringent and seldom utilised or acknowledged schedule of Victoria’s State Environmental Protection Policy legislation which states that Westernport Bay catchment, to
Table 2
Stormwater reduction targets adopted in the case studies.

<table>
<thead>
<tr>
<th>Project</th>
<th>Stormwater quality targets</th>
<th>Stormwater flow targets</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total suspended solids</td>
<td>Total phosphorus</td>
</tr>
<tr>
<td>1. Botanic Ridge Growth Area</td>
<td>80%</td>
<td>45%</td>
</tr>
<tr>
<td>2. East Pakenham Servicing Plan</td>
<td>93%</td>
<td>66%</td>
</tr>
<tr>
<td>3. Casey Clyde Growth Area</td>
<td>93%</td>
<td>66%</td>
</tr>
<tr>
<td>4. Water Future North: Growth Areas</td>
<td>80%</td>
<td>45%</td>
</tr>
<tr>
<td>5. Water Future Central</td>
<td>80%</td>
<td>45%</td>
</tr>
<tr>
<td>6. Fishermans Bend</td>
<td>80%</td>
<td>45%</td>
</tr>
<tr>
<td>7. Melton Growth Area</td>
<td>80%</td>
<td>45%</td>
</tr>
<tr>
<td>8. Sunbury Growth Area</td>
<td>80%</td>
<td>45%</td>
</tr>
<tr>
<td>9. Western Regional Water Balance</td>
<td>80%</td>
<td>45%</td>
</tr>
</tbody>
</table>
Melbourne’s east, requires higher stormwater treatment than Port Phillip Bay catchment which covers most of Melbourne (Office of Living Victoria (2013)).

In three of the case studies stormwater flow targets have been defined. This included average annual stormwater runoff reduction targets ranging from 60%, based on proposed government policies, to 90%, based on an academic study conducted by Duncan et al. (2014a,b).

These targets can be seen to be problematic for a number of reasons. Firstly the targets have not been altered for different catchments or sub-catchments. A blanket approach, of 60% or 90%, has been adopted regardless of the characteristics (e.g. ephemeral or perennial) or existing condition of local waterways. Secondly the 90% reduction target is based on a study that identified a 70–90% runoff reduction target, only for ephemeral waterways (Duncan et al., 2014a,b). Some case studies have adopted the upper bound of 90% without proper justification, or identification of where the lower bound of 70% might apply, and what the target should be for perennial waterways. This means that the recommended options, in some cases costing AUD$200 million more than BAU, may have a weakness in their cost justification.

It is recommended that before future IUWM plans are conducted, stormwater quality and flow targets be set for a variety of waterway categories (such as perennial/ephemeral, and high value/low value) in order to better justify any additional costs over BAU. One possible way this could be done would be to keep the BPEMG as a baseline requirement, but then set higher targets for catchments which are considered to be high priority communities and ecosystems. Additional costs could then be justified through being required to meet higher targets in priority catchments.

4.2. Liveability, greening and amenity objectives

Within the Australian water industry there has been a strong intellectual association between the concept of IUWM and urban liveability improvements (Hodge et al., 2014). Because of this association the IUWM plan case studies have attempted to argue that IUWM options improve liveability. The extensive list of liveability concepts considered in the case studies includes:

- Quality of Life/Wellbeing
- Water Availability
- Amenity
- Greening
- Irrigation of street trees and parks
- Reduced heat island effect
- Environment
- Public Open Space Condition and Accessibility
- Good Urban Design
- Affordability
- Increased soil moisture
- Reduced nuisance flooding

However liveability objectives have generally not been well defined, and have been considered inconsistently across the case studies. There appears to be a general confusion in the studies, present all the way through from high level vision statements to articulated strategic objectives, goals and measures.

The studies have focused on monetising benefits. However techniques for valuing liveability benefits are still emerging and not well understood. Therefore the authors believe that the studies could be improved by using a combination of both quantitative and qualitative measures (i.e. a greater focus on MCAs) during option selection.

Additionally, liveability was often assessed in a positive way, in terms of whether an option improves liveability, but options that reduce or limit liveability have not been allocated a negative score. For example, negative impacts from options on liveability via noise, odour or land take have mostly not been considered. In one of the case studies liveability dis-benefits were qualitatively considered in an MCA.

Overall the assessments are not sufficiently rigorous. There are generic presumptions regarding the benefits of IUWM projects without a sufficient articulation and demonstration of possible benefits or dis-benefits. Whether generic presumptions are better or worse than totalling ignoring liveability is a matter open to debate.

There has been a presumption that alternative water sources, including stormwater harvesting, will provide water security for “greening parks, gardens and sports fields” during times of drought and water restrictions. There are a number of key issues relating to this that have effectively been ignored.

Firstly the idea that IUWM projects improve liveability by providing water for “greening” has an inbuilt assumption that in the future the government will implement damaging garden and park watering restrictions. However the case studies involved no consideration of the water security outlook for Greater Melbourne, such as the likelihood of water restrictions being imposed in the context of a newly built desalination plant which can supply a third of Melbourne’s water (Furlong et al., 2016a). Therefore the assumption has not been articulated or justified.

Secondly, the considered IUWM options include stormwater harvesting, which is a climate-dependant source of water and may not provide a secure water supply for greening in a period of drought unless backed-up by a climate independent water source.

The case studies have attempted to propose liveability, greening and amenity benefits as a way of justifying additional costs associated with IUWM options. In many cases this approach is justified, although in practice a far more consistent and valid process is required in the future. This will be discussed further in the Cost Benefit Analysis section below.

4.3. Creating a “business as usual” option for comparison

An important component in all IUWM plans is a comparison between a BAU option, and a number of IUWM options, which involve varying degrees of wastewater reuse and stormwater treatment and harvesting. BAU option definitions varied across the case studies.

Case studies were consistent to the extent that they all adopted the same water demands for all options i.e. water efficiency assumptions were the same for BAU and IUWM options. However they differed in terms of whether or not to consider existing planning requirements as part of BAU, particularly in relation to uptake of rainwater tanks, meaning that some BAU options included them, in varying degrees of uptake, and some didn’t.

Wastewater disposal requirements were also not considered consistently, with some studies assuming increased wastewater discharges to waterways from inland wastewater treatment plants, and others not. In reality discharge volumes are limited by Environmental Protection Authority (EPA) discharge licenses (Barker et al., 2011). In all cases there was a lack of clear justification for decisions.

The BAU assumptions in the case studies also do not align with a metropolitan scale BAU servicing strategy, known as the Avoided System Cost study (Department of Environment, Land, Water & Planning, 2015a,b). These discrepancies include assumptions relating to water efficiency gains, the level of uptake of alternative water sources and water restrictions. This is no fault of the case study creators, who may not have had access to this information,
but it is a problem for consistency of assumptions, and they made need to be updated.

It is recommended that each city or region which wants to implement IUWM planning set BAU assumptions and BAU option development methods at the highest possible scale in order to ensure transparent and consistent planning results and recommendations.

4.4. IUWM project option identification processes

IUWM options were uniquely defined in each study, resulting in large differences in what has been investigated and also has meant that not all plausible options have been considered. IUWM options considered in the case studies can be seen in Table 3.

Non-potable reuse of wastewater from a treatment plant or sewer mine, via dual pipe system, was considered in all except one of the case studies. Building-scale wastewater treatment and reuse was considered in one. No studies considered indirect potable reuse (IPR) or direct potable reuse (DPR) of wastewater because current political climate is not accommodating to such solutions (Australian Academy of Technological Sciences and Engineering, 2013). In two of the growth area case studies there was no consideration of options to transfer wastewater to Melbourne’s centralised sewage treatment plants, which leaves a policy blind spot in regards to this possibility.

Precinct scale stormwater harvesting of some kind (potable and non-potable) was widely explored in order to achieve large stormwater runoff reductions. Potable reuse of stormwater was considered in three case studies. However, all but one did not consider uses and disposal locations outside of their designated regions. This meant that cross catchment transfer of stormwater flows was not considered, and therefore other possible end uses for harvested water may have been missed.

Options involving rainwater tanks plumbed internally at all buildings were considered in most case studies. However the approach to rainwater tanks has been treated differently. As stated earlier in this paper some studies consider rainwater tanks as part of the BAU option and others do not.

In the case studies options have been defined intentionally to achieve very different performance objectives/standards/levels of service. For example, this includes different objectives for waterway health or provision of water for “greening” or “amenity”. This has complicated the comparison and evaluation of options and reflected a state of confusion around what problem was being solved.

It is recommended that all future IUWM plans include the widest variety of IUWM options possible, particularly the inclusion of direct and indirect potable reuse of wastewater should be actively considered in all areas. Through a thorough understanding of how these potable reuse options weigh up against non-potable reuse options it may be possible to influence policy makers and the community, thus changing the current political climate which is opposed to potable recycling.

4.5. Energy consumption and greenhouse gas valuations

The case studies have considered energy consumption associated with IUWM and BAU options as an operational cost for treatment and transfer systems. However they have not considered net energy consumption and Greenhouse Gas (GHG) emissions.

High energy use at Melbourne’s desalination plant gives the appearance of an additional benefit derived from IUWM options (which substitute the need for ordering water from the desalination plant). However, according to the contractual arrangements, Melbourne’s desalination plant offsets all energy usage with renewable energy credits, with all costs being internalised into the appearance of an additional benefit from IUWM options in regard to net carbon footprint. In theory, there may be certain situations where IUWM options have a lower net energy or carbon footprint than BAU, but it has not been demonstrated in any of the studies.

Table 3
<table>
<thead>
<tr>
<th>Projects</th>
<th>Recycled water</th>
<th>Stormwater harvesting</th>
<th>Rainwater harvesting</th>
<th>Grey water</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Centralised or local treatment plant</td>
<td>Sewer mining</td>
<td>Building scale</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Urban/Rural irrigation</td>
<td>Large</td>
<td>Dual pipe</td>
<td>Potable Dual pipe</td>
</tr>
<tr>
<td>1. Botanic Ridge Growth Area</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>2. East Pakenham</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>3. Casey Clyde Growth Area</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>4. Water Future North: Growth Areas</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>5. Water Future Central</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>6. Fishermans Bend</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>7. Melton Growth Area</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>8. Sunbury Growth Area</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>9. Western Regional Water</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Balance</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
Additionally, the renewable energy generation from sewage treatment at certain centralised wastewater treatment plants have not been considered.

It is recommended that future studies do not make an assumption that IUWM options perform better than BAU in terms of energy consumption and greenhouse gas emissions. In many cases BAU supplies may use less net energy and create less net GHGs. Additionally “net GHG” changes should be valued within cost benefit analysis wherever possible.

4.6. Resilience, security and flexibility objectives

The population of Greater Melbourne is predicted to grow from 4 million people in 2011 to 7.8 Million in 2051 (Department of Environment, Land, Water and Planning, 2015a,b (2)). There is significant uncertainty in future population projections, and also changes to the city's geographical boundaries and urban planning restrictions (Gordon et al., 2009).

These factors will have a large influence on the future scenarios for water supply, sewerage and stormwater management in Melbourne. There is a strong argument that to plan for this uncertainty, IUWM plans should consider multiple population and growth scenarios. This would provide an understanding of whether IUWM options are more resilient or perform better than BAU under a variety of futures.

In all of the considered case studies however, only a single, static vision of the future in the year 2050 was considered. The studies therefore did not consider the performance of options under a variety of scenarios for population growth, climate change, or specific shocks. A small number of the case studies did test the sensitivity of results to assumptions around “Long Run Marginal Costs (LRMC)” which are designed to internalise some of these factors. LRMCs will be explained further in the following section.

As stated earlier there was a general presumption that IUWM options (including climate-dependant stormwater harvesting sources) provide greater resilience or security against climate variability or climate change than a BAU approach, without clearly articulating how or why. This appears to ignore the water security provided by existing and future desalination plants.

There were no clear objectives established or referred to in any of the case studies relating to providing “resilience” or “security”. As a result, the topic has largely been ignored in the studies and has not contributed to the assessment and comparison of options.

The issue requires consideration at the system/metropolitan scale, to inform how it can be considered in the assessment and comparison of local and regional scale options. It requires policy direction, such as the setting of an alternative water supply or potable substitution target to achieve a desired supply portfolio.

This would then enable a proper consideration of the benefits or dis-benefits of certain options. Although some experts would argue that Government-set targets are counterproductive because they remove the rigorous economic justification tests that would normally be applied.

In the opinion of the authors the use of a single static version of the future rather than a spread of possible future scenarios in most of the case studies is considered to be a serious flaw that needs attention.

4.7. Cost benefit analysis

Cost benefit analysis was conducted in the case studies in order to determine which potential infrastructure options provided the most value to the community. In order to do this it was necessary to determine both the costs and the benefits associated with options. The process for determining costs is relatively straightforward (i.e. estimation of capital and operating expenses), but the calculation of benefits is more complicated.

In these case studies benefits were calculated by determining: if this option is implemented, how much water utility expenditure can be saved in other areas? In order to do this Long Run Marginal Costs (LRMCs) for the water, sewerage and stormwater systems have been used. LRMC is a relatively complex concept, but its meaning can be simplified to the long term cost per volume for each water infrastructure system. LRMC determination involves identifying all major future infrastructure augmentations, for each water service i.e. water supply, sewerage and stormwater. LRMCs are used to ensure the ability of water utilities to achieve ongoing full cost recovery of water infrastructure by including future operations and maintenance costs, capital costs, opportunity costs, and the costs of economic and environmental externalities (Billi et al., 2007).

For example, the LRMC for sewerage in Melbourne is the total cost of maintaining Melbourne's sewerage system, divided by the total volume of the sewerage system, over a specified period. Once an LRMC for a water system is determined, it can be used to approximately calculate the costs that are avoided when a specified volume is added or removed. This means that if a water infrastructure option either adds potable water, or removes wastewater/stormwater from a system, it is possible to calculate the associated savings.

Fig. 3 shows the incremental change in net cost (i.e. benefits have been incorporated as a negative) between BAU and IUWM options calculated in the considered IUWM plans. In no considered IUWM plan was an IUWM option found to provide a total community cost saving, in comparison to BAU. However, in two case studies, East Pakenham and Casey Clyde, the least cost IUWM option had only a small incremental net cost ($2M and $6M

| Table 4 |
| Indicative energy use assumptions for BAU and IUWM water sources. |

<table>
<thead>
<tr>
<th>Water infrastructure type</th>
<th>Energy usage (kWh/kL)</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAU water options</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conventional potable water supply from dams</td>
<td>0.15</td>
<td>Advised by Melbourne Water and DELWP. Based on historical system energy consumption and supply.</td>
</tr>
<tr>
<td>Desalination</td>
<td>5.3</td>
<td>Advised by Melbourne Water and DELWP. Based on Melbourne Desalination Plant specifications.</td>
</tr>
<tr>
<td>Conventional/desalination combination</td>
<td>1.2</td>
<td>Based on 80% conventional supply and 20% desalination over the assessment period</td>
</tr>
<tr>
<td>IUWM options</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rainwater harvesting</td>
<td>1.9</td>
<td>From report for Living Victoria Ministerial Advisory Council</td>
</tr>
<tr>
<td>Stormwater harvesting</td>
<td>1.9</td>
<td>From report for Living Victoria Ministerial Advisory Council</td>
</tr>
<tr>
<td>Building scale wastewater treatment and reuse</td>
<td>6.0</td>
<td>Indicative only, highly dependent on technology and plant specifications</td>
</tr>
<tr>
<td>Precinct scale sewer mining</td>
<td>6.0</td>
<td>Advised by Melbourne Water and DELWP</td>
</tr>
<tr>
<td>Treatment and transfer of recycled water from Western Treatment Plant</td>
<td>7.5</td>
<td>Indicative, requires salt reduction and pumping from Western Treatment Plant</td>
</tr>
</tbody>
</table>
respectively) compared to the BAU option.

However cost benefit analysis results must be viewed with caution for a number of reasons. Some of these reasons indicate that benefits of IUWM options are understated, and others overstated. On the one hand, it is very difficult to effectively capture eco-system and liveability improvements in LRMCs, and no attempts have been made to quantify “system resilience benefits” which can be expected from climate independent water sources such as recycled water. On the other hand there is an absence of rigorous and wide-ranging risk assessment and management which many consider to be necessary because reuse projects often do not go according to plan (Institute of Sustainable Futures, 2013; Furlong et al., 2017). There is also a lack of serious consideration of climate change impacts on climate dependant sources such as stormwater harvesting. To add to this ambiguity, the financial assumptions underpinning the analysis, such as inputs for increases to the cost of potable water and financial discount rates, are inconsistent or unclear.

A number of the case studies demonstrated that CBA results are particularly sensitive to the LRMC inputted for water supply headworks, with the performance of options with alternative water sources improving substantially for scenarios using a high LRMC. CBA results can also be seen to be heavily influenced by LRMCs placed on wastewater and stormwater nutrient loads to waterways and Melbourne’s bay. In relation to the LRMC of potable water supply, this highlights the importance of not only determining accurate LRMC estimates, but also assessing the performance of options under different realistic futures, which as stated earlier, has not been attempted in the majority of the case studies.

In relation to monetising benefits to waterway health, the case studies have highlighted that if environmental regulations become more stringent over time (such as legislating 90% flow reductions), then IUWM approaches are likely to begin to outperform BAU in CBA results. This is particularly the case for stormwater harvesting and reuse schemes (potable and non-potable), and potentially also wastewater reuse schemes in areas not currently connected to the centralised wastewater system.

In general stormwater to potable IUWM options have fared well across the case studies. However, significant technical and policy work, including a more detailed assessment of potential climate change impacts, is required to progress the evaluation of these options.

Unique local factors have contributed to improving the competitiveness of IUWM options. A key example is that projects that have found precinct scale stormwater harvesting to be cost competitive have been able to utilise large existing storages, reducing a potentially significant cost.

In future financial evaluations it is recommended that IUWM plans attempt to (1) establish consistent data inputs, (2) consider results under a variety of possible future scenarios, and (3) take a broader view of potential risks and what impact these could have on actual financial outcomes.

4.8. Climate data and climate change considerations

It is extremely important that water infrastructure planners must take into account climate change as water infrastructure is designed to last an extended period, and climate change has the potential to impact all water services. Assessed case studies have problems in terms of climate data used in long-term analysis. Only one of the case studies has included long-term climate change implications within its modelling. Three have completely failed to acknowledge climate change impacts at all. The rest consider or note climate change impacts in some way (see Table 5).
A number of climate change impacts do not appear to have been considered at all in many of the case studies. Changes to (per user/household) demand, including increased volumes for garden watering, have not been considered. Changes to environmental flow requirements have also generally not been considered, even though Melbourne Water is clear that environmental flow allocations will need to increase (Melbourne Water, 2013). Increasing sea level rise and its impact on flooding have not been adequately considered, even though there are clear standards within the Victoria Planning Provisions, and Melbourne Water guidelines (Hurlimann et al., 2014).

A scenario planning approach, that considers multiple future scenarios, has not been applied across the studies. Rather, a single, static vision of the future in the year 2050 has typically been explored. The resilience (i.e. ability to cope) of future options to different climate futures has therefore not been explored.

Only three studies considered different climatic conditions, such as a drought period, in the assessment of individual projects. This is a serious issue, especially in the planning of climate-dependant stormwater harvesting schemes.

There are a number of possible reasons why climate variability and change have not been considered in the majority of the studies. One reason is that climate change adaptation was not a core element of Victorian State Government’s policy agenda at the time the studies were conducted (Gordon, 2015). Another reason is the absence of guidelines and procedures at the state or organisational level as to how climate change impacts should be considered.

Some steps are now being undertaken within Melbourne to incorporate potential future climate change scenarios into long term plans. However even these consider only annual and seasonal changes to water supply yields, and do not consider changes in frequency and intensity of rainfall events. Without this more detailed information, accurate forecasting of performance of stormwater harvesting schemes is not possible.

It is crucially important that future planning studies receive some form of guidance on how to take into account impacts of climate change in relation to all different water services.

### 5. Discussion and conclusion

Regardless of any critiques presented in this paper the practice of creating IUWM plans in Melbourne has provided a number of benefits. At a minimum it has (1) forced all involved parties to view the urban water system as a whole and consider interaction between services, (2) helped to develop trust and collaborative relationships between relevant organisations, (3) helped water planners identify otherwise invisible potential IUWM options such as opportunities for wastewater and stormwater reuse, and (4) in many cases has put forward recommended solutions which can be further scrutinized before implementation. Through revealing how much more IUWM options cost in comparison to BAU approaches stakeholders are enabled to critically reflect on whether the costs are justified.

Putting forward a recommended IUWM option does not necessarily mean that it will be implemented. Previous research has shown that IUWM infrastructure can have difficulty achieving implementation, because this usually requires approval from an array of stakeholders and regulators (Furlong et al., 2016a). However the creation of IUWM plans can assist with achieving approvals by allowing stakeholders to be part of the decision making process, and giving the process an element of transparency.

A summary of the findings from this paper can be seen in Table 6.

Case study analysis has revealed a variety of inconsistencies across Melbourne's IUWM plans. It appears that some form of guidelines or “Standard Operating Procedure” is required to guide technical assessments in terms of (1) environmental objectives, (2) liveability objectives, (3) BAU scenario development, (4) IUWM option identification, and (5) energy and GHG considerations. In particular the authors believe it is important that future studies include direct and indirect potable recycling of wastewater as an IUWM option in order to determine how it compares to other options.

Whether there should be a consistent and standardised approach to the creation of IUWM plans is a matter open to debate. In the opinion of the authors there are some aspects of IUWM planning that does need to be standardised in order to give the process credibility. In particular the setting of environmental and liveability objectives should be done in a consistent and justifiable manner, and these drastically affect the outcomes of the process. In regards to other aspects such as option identification and selection processes, it may be that different processes are required for different contexts, depending on resources available, size of the area under consideration and other variables.

If an attempt to standardise the IUWM planning process is attempted, it is very important that this work rigorously considers the concept of planning scales. Furlong et al. (2016a) lays out one proposal for a distribution of decision making responsibilities across local, sub-regional and regional scales. The authors propose that even if specific data inputs and values vary between local areas,
it should still be possible to set some consistent value formulation guidelines at the regional (or potentially state/national) scale. Another finding is that the current practices of considering desalination in IUWM plans are questionable in a number of ways. The assumption that IUWM options perform better than conventional water supplies in terms of energy use is not justified, and will vary between local contexts. Also, no case has been made that IUWM options provide benefits through reducing net energy consumption and GHG emissions in relation to conventional options. Presented evidence suggests that this is not often the case.

The most important findings from the case study analysis are that (1) studies fail to account for future uncertainty around climate, population and water demands, (2) financial analysis methods are inconsistent and do not internalise potential risks, and (3) technical analysis generally does not model in potential future climate scenarios or often even historical dry years. Failing to consider climate change and future uncertainties is particularly unfavorable in the plans that recommend stormwater harvesting schemes, because these are climate-dependent. Addressing these issues in future IUWM plans is essential if they are to be considered a valid and justifiable form of infrastructure planning.

This is particularly interesting because the Melbourne water industry placed a key focus on scenario planning in the past (Mukheibir and Mitchell, 2011). Scenario planning formed the methodological basis for Melbourne’s previous Water Supply and Demand Strategy in 2011, and earlier in 2006 (Melbourne’s water utilities, 2011). The serious oversights in the case study methodologies can be partially explained by the fact that for the three years following 2011 the Victorian State Government was controlled by a party which placed a low priority on climate change policy (Gordon, 2015). This provides a very interesting example of political interference in public water management functions.

It is unclear whether other parts of the world also implement processes similar to Melbourne’s IUWM plans since there is a significant gap in the academic literature. It is likely that many industry attempts at processes similar to Melbourne’s IUWM plans are neither published nor the topic of research and as such this is a key area for further study. The present analysis provides insights that would be useful to international policy makers and practitioners who are considering implementing a planning approach which bears any similarity to Melbourne’s IUWM plans.

Acknowledgments

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References


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### Table 6

<table>
<thead>
<tr>
<th>Sub-topic</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Environmental objectives for waterways and bays</td>
<td>Environmental objectives have been set inconsistently, and poorly justified, across the case studies.</td>
</tr>
<tr>
<td>2. Liveability, greening and amenity objectives</td>
<td>These objectives have been poorly defined across the case studies, and the links between IUWM projects and these objectives have not been rigorously and justifiably determined.</td>
</tr>
<tr>
<td>3. Creating a business as usual option for comparison</td>
<td>Some of the case studies included a proportion of rainwater harvesting, and other reuse, within the BAU option, and others did not.</td>
</tr>
<tr>
<td>4. IUWM option identification</td>
<td>Different IUWM options were considered across the case studies, although in many cases this is likely to be appropriate due to varying contexts. More importantly, the absence of consideration of direct or indirect potable reuse of wastewater is an issue which should be addressed.</td>
</tr>
<tr>
<td>5. Energy and greenhouse gas evaluations</td>
<td>Many case studies assumed that IUWM options provide benefits through reducing net energy consumption and GHG emissions in relation to conventional options. Presented evidence suggests that this is often not the case.</td>
</tr>
<tr>
<td>6. Resilience, security and flexibility considerations</td>
<td>The case studies only consider infrastructure in relation to a single assumed future population, water use, and climate condition scenario, meaning that no scenario analysis is conducted. This means that although it is argued that IUWM options increase resilience, it is not demonstrated.</td>
</tr>
<tr>
<td>7. Cost benefit analysis methods and results</td>
<td>Cost benefit analysis has been conducted inconsistently across the case studies. Additional policy guidance is required in relation to achieving consistent data inputs, consideration of benefits and risks, and consideration of multiple possible scenarios (as above).</td>
</tr>
<tr>
<td>8. Climate data and climate change considerations</td>
<td>Overall the case studies do not include sufficient consideration of potential long term climate change impacts. This is an important issue to address for future IUWM plans.</td>
</tr>
</tbody>
</table>


WSAA, 2014. The Role of the Urban Water Industry in Contributing to Liveability. s.l. WSAA.

WSAA, 2016. Climate Change Adaptation Guidelines. s.l. WSAA.

Chapter 9: Review and conclusion

9.1 Conclusions
This research program has investigated a variety of phenomena relating to IUWM and its implementation. Through industry consultation and case study analysis the research has conceptualised IUWM practice, identified gaps, and proposed initial recommendations towards improving future practices.

Chapters three and four have related to IUWM as a loosely defined planning approach which includes a variety of methods and objectives. Chapters six and seven have related to one aspect of IUWM which is the planning and implementation of wastewater and stormwater reuse projects. Chapter eight has related to another aspect of IUWM which is the formal planning processes which consider water infrastructure options, including reuse projects.

This conclusions section has been structured into seven sub-sections: one on overall conclusions on IUWM, followed by six which correspond to the targeted research questions listed in Chapter 1. The sections for the final two research questions have been merged due to similarity of conclusions.

9.1.1 Overall conclusions on the Integrated Urban Water Management concept
Within the previously existing literature on IUWM it has been common for scholars to discuss IUWM (or similar ideas) as if their implementation (both as a planning approach and at an individual project level) will necessarily result in improved overall outcomes, in comparison to traditional approaches and projects. For this reason, much of the previous research has been focused on impediments to the implementation of IUWM (Ferguson, et al., 2013; Mukheibir, et al., 2014; Dobbie & Brown, 2013). Much of this previous research does not involve post-implementation case study research into IUWM projects, as has been conducted in this thesis. Research which has investigated specific IUWM projects has typically painted a more balanced picture which shows that some IUWM projects result in positive outcomes, but also some projects either experience implementation problems or lack sufficient justification (Marsden Jacob Associates, 2013; Institute of Sustainable Futures, 2013).

The current research has provided further suggestion that, in reality, planning, decision making, and implementation for all public infrastructure is inherently imperfect, described by Lindblom (1959) as “the science of muddling through.” This has been demonstrated through the Melbourne narrative provided in Chapter 3, and also the IUWM project case studies included in Appendix B and discussed in Chapters 6 and 7. This narrative and case studies show a myriad of issues that have affected IUWM planning and implementation.

It is therefore not justified to make the assumption that the implementation of “IUWM”, either as an overarching ideology, at an individual project level, or as a strategic decision making process, in any particular time and location, will necessarily lead to improved community outcomes in comparison to traditional approaches.

IUWM is a loosely defined concept, with many associated methods and objectives, as shown by the industry survey results in Chapter 4. As concluded in this chapter, the researcher proposes that practitioners and scholars conceptually separate the meaning of IUWM into its various “IUWM objectives” and “IUWM methods”. In particular various specific methods of implementing IUWM
must be categorised, defined, and assessed individually in order to make judgements in regards to their value in particular contexts.

The broad objectives of IUWM, as revealed by the industry survey results, such as increasing water security, liveability, urban greening, reduced cost and environmental protection, are inherently desirable for any community. It is perhaps necessary to explicitly state that pointing out the conceptual holes in IUWM-related research and practice is in no way similar to saying these broad objectives are undesirable. The point being made here is that there any many methods that can be utilised in an attempt to achieve these objectives.

In order to illustrate this point, it could be said that this thesis discusses multiple approaches which could be considered to be aspects of implementing IUWM:

1. Providing Federal and State Government funding grants to water security and reuse projects
2. The Living Rivers program operated by Melbourne Water which provides 50% subsidies to municipalities that identify and plan their own stormwater management (WSUD) projects
3. Water utilities and municipalities attempting to find opportunities for reuse projects which achieve full cost recovery and therefore can be internally funded
4. Justification of projects by valuing indirect benefits such as water security, and stormwater system benefits
5. The Office of Living Victoria approach of separating the city in several large areas and conducting detailed IUWM strategies for each
6. Other methods which have not been focused on in this thesis which include a variety of urban planning controls and partnerships with developers and municipalities.

Each of these methods has its own benefits and limits, and each is likely to be appropriate for some particular circumstances, provided they are implemented in a well-designed manner. The use of all of these has the potential to help achieve the broad IUWM objectives in certain circumstances, as part of a mix of other measures. Further research is required to compare these approaches and develop systems and processes for their implementation, within Melbourne and elsewhere.

9.1.2 Terminological issues
This research program provides a conceptual map to assist scholars and practitioners with navigating the 26+ different terms which indicate concepts similar to IUWM. Chapter 2 provides a detailed investigation into the various terms used to identify integrated approaches in the water management field. The results and discussion included in this chapter can therefore provide value to scholars who are struggling to understand the relationship between various terms. If researchers are aware of term proliferation then they can adjust their terminology, key words, and literature search phrases accordingly. Therefore this research has the potential to ameliorate the knowledge silo effect, and increase knowledge sharing.

9.1.3 Relationship between water governance structures and IUWM implementation
Chapter 3 outlines the water governance structures in Melbourne and how they have changed over time. It is determined in this chapter that there is no simple relationship between governance structures and IUWM implementation, as IUWM is loosely defined, and has continued to evolve within Melbourne over time. This chapter argues that in particular IUWM has been progressed by the Millennium Drought and the installation of the Office of Living Victoria (OLV) as an overarching body. However this does not indicate that the installation of an overarching water industry body, to
create a mono-centric governance arrangement, helps to progress the implementation of IUWM or achieve IUWM objectives. But rather it indicates that any man-made or natural drivers of change can potentially lead to reform and innovation. Chapter 3 concludes that no particular governance structure is required for the implementation of IUWM, so long as the planning processes are well-designed and conducted carefully.

It should be noted that although the terminology of “governance” is not applied throughout the other body chapters, the notion of governance is implicit throughout the entire thesis. For example any discussion of which agencies are responsible for what, or how should projects be planned and regulated, or the need for collaborative regional policy development and planning, is a discussion of governance. In hind-sight it may have been beneficial to adopt the terminology of governance throughout the remainder of the thesis; however the nature of the thesis by publication does not allow retrospective changes to terminology.

9.1.4 Industry perceptions of IUWM’s meaning and methods

Industry perceptions are addressed in Chapter 4 using an industry survey. The results from this survey give initial indications regarding how industry experts view the meaning, methods and relevance of IUWM. In general the results show limited consensus in regards to what IUWM means or specifically involves, but strong consensus that the IUWM concept is of high relevance to the water industry. From these survey results it can be concluded that, at least within the Melbourne region, IUWM is a very loosely defined term, and means different things to different experts.

9.1.5 A planning framework for IUWM project planning and case study analysis

Within Chapter 5 the researcher compared a number of existing water infrastructure planning frameworks and assessed them in relation to findings from a literature review into the history of planning theory. The investigation concluded that no existing framework was ideal for planning IUWM projects or assessing past IUWM project case studies. The most notable absences from previous frameworks were found to be governance, regulation and financing aspects (which include approval processes). An original planning framework was designed which included these absent concepts. This framework was then used to analyse the seven in-depth IUWM project planning case studies included in Appendix B. It was determined during the case study process that (a) the proposed planning framework was effective in guiding the case study investigations, and (b) in all cases governance, regulation, and/or financing, was critical to understanding the narratives of the case study projects.

This framework has practical utility for industry or academic experts who are undertaking either planning of new projects, or assessment of previous projects. This is evidenced by the fact that the framework is currently being used by another PhD candidate at RMIT (Lachlan Guthrie) to undertake additional IUWM case studies.

9.1.6 Planning scales and approval processes for IUWM projects

Seven in-depth IUWM project planning case studies were conducted using the original planning framework proposed in Chapter 5, and have been included in Appendix B. These case studies describe the entire planning process for each of these projects. In Chapter 6 the researcher utilised these IUWM project planning case studies to consider what scale IUWM projects are being planned at, and what was involved in their approval processes (which are part of governance, regulation and financing aspects in the planning framework).
Limited research currently exists which considers either (a) the scale at which IUWM projects are being planned, or (b) if and how projects are being approved. The most comprehensive piece of literature on IUWM planning conducted to date, the CSIRO IUWM planning manual (CSIRO, 2010), is written as though IUWM decision making is made at the metropolitan/city scale, and does not emphasise that many IUWM projects will not receive approval.

Chapter 6 indicates that many IUWM planning processes are actually undertaken by water utilities and local councils operating independently at the sub-regional and local scales, without coordination from city scale strategic processes. It is also indicated that many, potentially most, IUWM projects fail to receive approval for implementation. It is proposed that a well-designed division of IUWM planning responsibilities across city, sub-regional, and local scales, has the potential to improve the planning and justification for IUWM projects, and therefore result in a larger proportion of IUWM projects being approved.

It is proposed (as discussed at the end of Chapter 7) that Melbourne’s urban water management outcomes would benefit from the creation of some form of water industry forum or committee, with representation from all water utilities and regulators, to function as a peer-review system for IUWM projects, in order to enable Melbourne’s water industry to collectively determine which projects give the most benefit to the wider system and therefore which should be given priority access to available funding. This forum is proposed to be made up of senior staff from water utilities, and function as a peer-review process. The researcher proposes that such a forum may be better equipped to make decisions around IUWM project funding than existing approval mechanisms such as government finance departments, through a more thorough understanding of water systems, and the benefits provided through IUWM projects. Such a forum or committee would be able to compare IUWM projects against each other, and determine which should receive a higher priority for funding. Such a mechanism could be used to distribute finances collected through water bills, or from future Federal and State government grant processes.

9.1.7 Specific planning processes for IUWM projects and strategies

It is largely the specific decision making and planning processes used in IUWM strategies and project planning that determine the practical impact of IUWM. Specific processes that are being used for planning IUWM projects and strategies are not covered in detail in previous research. This research program has made some initial steps to fill this knowledge gap.

The IUWM project case studies included in Appendix B, and the IUWM strategy case studies discussed in Chapter 8, demonstrate that there is no consistency between the planning processes that are being used. Each of the in-depth case studies in Appendix B includes a section on risk management, financial evaluation and funding. These sections were summarised in Chapter 7 to provide an indication about how these processes are being conducted in Melbourne’s IUWM projects. From the investigated case studies it can be seen that IUWM practitioners have generally been well equipped to identify potential risks, but have often not considered risks with appropriate significance in decision making processes. This is evidenced by the fact that projects which have risks which cannot be mitigated are often being recommended for implementation. Some serious financial evaluation discrepancies, such as time periods for analysis, and how stormwater benefits are valued, have been identified. Most of the projects have required external funding to proceed. In the case of risk management, financial evaluation and funding, the water industry would benefit...
from the use of consistent planning processes to ensure that projects can be fairly compared against each other.

Chapter 8 includes descriptive case studies on nine of Melbourne’s IUWM strategies. These case studies do not give in-depth narratives of how these strategies are being conducted, but do discuss how liveability, resilience and climate change impacts are being considered. The results and discussion included provide initial exploration of these issues. The most important finding is that the IUWM strategies do not include scenario planning and therefore fail to consider infrastructure performance regarding resilience to future uncertainties around population and climate change.

As IUWM projects and strategies are both relatively new practices, it is likely that the planning processes for both will continue to evolve and improve naturally over time. However additional research is warranted into both topics.

9.2 Practical implications and recommendations

From the knowledge generated over the course of thesis development, the researcher has condensed findings into a number of practical implications and recommendations as will be detailed below:

1. All researchers and practitioners should take care to carefully define IUWM and similar terms if they are to use them, as they mean very different things to different people, and it is impossible to evaluate the implementation of IUWM without clearly scoping what practices are included. A typology of IUWM practices would provide great value to researchers and practitioners in this field, and allow the evaluation of IUWM practices.

2. Political intervention to reform urban water management practices is sometimes necessary, but great care should be taken to ensure that it is motivated by an existing failure which cannot be remedied internally by the water sector, rather than political motivations. Additionally, if political intervention is to be conducted, it is important to ensure that an expert with public water management experience is put in charge, rather than private sector and content-free management professionals, which is less likely to result in successful reform.

3. Water infrastructure planning frameworks and processes should:
   a. Acknowledge and record when political and community preferences influence planning outcomes.
   b. Consider cost-apportionment implications of each potential infrastructure option, before putting forward a recommendation.
   c. Be considered to include an iterative process between planning recommendations (by planners) and planning approvals (by internal management and external regulators). This iterative loop should be considered throughout planning processes as an integral component, and thus business cases should be developed with this loop in mind.

4. Identified risks should be considered seriously during final decision making processes for IUWM projects. They do eventuate, quite often, and therefore it is not justifiable to assume that risks can be successfully dealt with through effective design and project management. For projects that are considered to be high risk, it may be appropriate to pause construction until a time when risks are considered to be adequately controlled. This recommendation is
in contrast to much of the other research into IUWM and related concepts, which suggests that a risk-averse nature stifles innovation. Which perspective is correct is a subjective decision about how much public money should be spent on pilot projects (experiments).

5. Regional and/or sub-regional collaborative policy and strategy development is required in order to ensure that:
   a. IUWM projects that are developed are in alignment with regional objectives
   b. IUWM strategies/plans provide justifiable consideration of environmental, liveability, greening, amenity, water security, resilience, climate change and energy considerations
   c. Scenario planning is included in the consideration of IUWM projects, both during independent analysis, or as part of IUWM strategies/plans
   d. Funding is priorities for the best possible projects
   e. Cost-sharing is made possible
   f. Develop consistent and justifiable financial evaluation frameworks
   g. Communication between practitioners and regulators is facilitated

6. All of these implications/recommendations are designed specifically for Melbourne, although it is likely that many of them would be relevant for other cities/countries with similar climatic and socio-economic contexts.

9.3 Key contributions

The overarching aim of this research, as outlined in Chapter 1, was to deepen and increase the empirical understanding of IUWM and its implementation within Melbourne. It is proposed by the researcher that the current research program deepens and increases the empirical understanding of IUWM and its implementation in two key ways. In comparison to previous research into IUWM the current research program provides:

1. A clearer and more systematic approach to understanding IUWM
2. Additional case studies which add to the existing body of knowledge on IUWM

This research program has provided a clearer and more systematic approach to understanding IUWM, in comparison to previous research, in two senses. Firstly, throughout this thesis, the researcher has developed and implemented the consistent language of “IUWM”, “IUWM strategy” and “IUWM project”. Without this clear distinction it can be extremely difficult for scholars to understand the relationship between: (i) IUWM in a general sense, such as the way it is discussed in Ferguson et al. (2013); (ii) IUWM as a strategic decision making process, such as the way it is discussed in CSIRO (2010); and (iii) IUWM in the sense of infrastructure projects, such as the way it is discussed in Mitchell (2006). Secondly, in Chapter 5, the researcher has developed a comprehensive planning framework which can be used to consistently plan IUWM projects, and analyse past projects. In comparison to past frameworks, such as the IUWM planning manual (CSIRO, 2010), the proposed framework includes additional elements, which have proved to be crucial for understanding the IUWM project case studies included in Appendix B. Previous IUWM project case study research, such as Institute of Sustainable Futures (2013) and Mitchell (2006), although they are highly valuable, have not utilised such a consistent planning framework, and therefore in this sense provide a less complete case study narrative than the narratives provided in Appendix B.
This research program has provided additional case studies on IUWM in three senses. Firstly, in Chapter 3, the whole of Melbourne is utilised as a case study, chronologically extending the works of Fam et al. (2014) and Ferguson et al. (2013), while also enriching the narrative with expert opinion. Secondly, IUWM project case studies included in Appendix B, and discussed in Chapters 6 and 7, provide additional examples of IUWM projects, which add to those discussed in Institute of Sustainable Futures (2013) and Mitchell (2006). Thirdly, the IUWM strategy case studies in Chapter 8 provide some of the first IUWM strategy case studies ever to be published in an academic work.

9.4 Limitations of the research and critical reflections

The current research program has provided original and important contributions to the body of knowledge on IUWM. However there are a wide variety of limitations to the current research, and also potential criticisms, which require acknowledgement in order to accurately represent the academic research that has been conducted.

Firstly, particularly in Chapters 6, 7 and 8, the research has made use of a small number of IUWM project and strategy case studies, and has not conducted research into the larger set of IUWM projects and strategies that exist within Melbourne and elsewhere. Therefore the findings in these chapters cannot necessarily be generalised to the larger set. Also considering that the researcher has not identified any research programs, with similar levels of detail, focusing on IUWM in other cities or countries, it is not possible to know how IUWM in Melbourne relates to the rest of the world.

On the other hand, through focusing purely on the Melbourne region, and selecting a small number of case studies, it was possible to ensure that the narratives and case studies included in this research were sufficiently detailed in order to allow the identification of process gaps and consideration of complex issues. Dealing with such qualitative and complex phenomena would likely have been impossible if a far larger set of case studies, or multiple cities, were selected for the research.

Secondly, in the case study reports, and publications dealing with the case studies, the researcher was often restricted in regards to what could be included due to confidentiality and reputational issues. In regards to many of the case studies, the organisations involved provided substantial amounts of information initially, but then later restricted what they would allow to be published in case study reports. In particular in a number of instances the financial data that was initially included in case study reports had to be removed.

Third, the researcher has predominantly employed the methodological approach of “pragmatism” (Feilzer, 2010). In this way every step of the research method was considered in relation to practicalities, i.e. whether such a research method is likely to be effective, rather than precedents, i.e. what previous academic research it can be based upon. From a traditional academic perspective this has the potential to be perceived as a flaw in the current research program, and it is therefore a potential limitation to the wide-spread uptake of the research findings.

Fourth, particularly in Chapter 3, the industry consultation that has been conducted has focused on narratives and perspectives of a small number of experts. Due to the political sensitivity of the discussion points it was difficult to find large numbers of experts willing to discuss certain issues. This made it very difficult to utilise qualitative and social science research tools such as triangulation of perspectives. Therefore the narratives provided in this chapter are arguably subjective and at risk
of presenting biased information. However it is believed by the research team that the task was approached in such a way that if another researcher was to replicate the methodology they would likely arrive at a similar conclusion. Therefore although this aspect of the research is partially subjective, it is at least believed to be repeatable.

Fifth, it is not possible to conclude that the proposed planning framework is appropriate for the planning of future IUWM infrastructure projects and strategies. This is because it has only been trialled through the analysis of past projects. Additional work would be required to demonstrate it has usefulness for future projects, and this is outside the scope of this thesis.

Sixth, the nature of a thesis by publication reduces the ability to retrospectively change terminology as thinking further develops and refines. As such, there have been some cases where the researcher would have liked to change terminology as the thesis progressed but has not been able to. Furthermore, as a human, the researchers also occasionally had a tendency to subconsciously swap between terminologies without clear justification. For this reason, the author has endeavoured to use all possible terms simultaneously where possible (e.g. IUWM strategies/plans because Chapter 3 says strategies and Chapter 8 says plans). On a more consequential note, as explained in 9.1.3, if the researcher could start over again, the terminology of governance would be used explicitly, rather than implicitly, throughout the body chapters of this thesis.

Seventh, through focusing only on Melbourne, it has not been possible to demonstrate that the findings are relevant to other cities and countries. It is likely that the findings of this thesis would be applicable to cities with similar climatic and socio-economic contexts. However to effectively demonstrate and prove that they are relevant to other locations would be a time-consuming exercise, and is outside the scope of this thesis, as outlined in section 1.2.

Finally, due to the sample size and population of the industry survey included in Chapter 4, the results of this survey cannot necessarily be generalised to regions outside of Melbourne. It is highly possible that such a survey would receive different answers if it was conducted in another city or country, including a high proportion of water industry experts being completely unfamiliar with the term IUWM. To provide more definitive data on this topic the survey would need to be repeated with a larger sample size and broader demographic.

9.5 Further work required

The current research program has provided preliminary exploration of IUWM and its implementation within Melbourne. The researcher has focused on answering seven research questions. Over the period of the research the researcher has noted a number of other topics which would build on the findings of this investigation, and be valuable contributions to the body of knowledge on urban water management. These include:

1. Documentation and analysis of additional specific real-life cases of IUWM implementation
2. Definition of new models/frameworks/methods/manuals for IUWM implementation such as the one proposed by CSIRO (2010)
3. Categorisation and comparison of existing case studies and models in order to determine which are most likely to create positive outcomes in which contexts
4. Research into economic assessment of IUWM projects, particularly using repeatable tools such as “long-run marginal costs”
5. Research into how complex topics such as climate change, “resilience” and “liveability” are being considered within urban water planning processes globally

6. Further characterisation of different water governance structures, e.g. mono-centric versus poly-centric, and the benefits and costs associated with each

7. Further work to document, categories and compare all planning processes (e.g. project/risk management, engagement, technical evaluation, option identification, option selection, regulation and funding) used in planning of IUWM strategies and projects

As urban water challenges, particularly relating to climate change and population factors, are becoming increasingly concerning, it is more important than ever for researchers and practitioners to continue to investigate and develop water management systems for the benefit of humanity and the environment.
References (Introduction and Conclusion chapters only)

Please note: references for each body chapter are provided at the end of the appropriate chapter. References for the Introduction and Conclusion chapters are provided here.


[Accessed 3 January 2017].


Institute of Sustainable Futures, 2013. *Building industry capability to make recycled water investment decisions*. Sydney: s.n.


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Appendix A – Consultation details
<table>
<thead>
<tr>
<th>Organisation</th>
<th>Number of staff consulted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barwon Water</td>
<td>2</td>
</tr>
<tr>
<td>City of Ballarat</td>
<td>1</td>
</tr>
<tr>
<td>City of Melbourne</td>
<td>2</td>
</tr>
<tr>
<td>City West Water</td>
<td>3</td>
</tr>
<tr>
<td>Creative Victoria</td>
<td>1</td>
</tr>
<tr>
<td>DELWP</td>
<td>2</td>
</tr>
<tr>
<td>G&amp;M Consultants</td>
<td>1</td>
</tr>
<tr>
<td>Goulburn Valley Water</td>
<td>1</td>
</tr>
<tr>
<td>Institute of Sustainable Futures</td>
<td>2</td>
</tr>
<tr>
<td>Melbourne City Council</td>
<td>2</td>
</tr>
<tr>
<td>Melbourne Water</td>
<td>4</td>
</tr>
<tr>
<td>Metropolitan Planning Authority</td>
<td>1</td>
</tr>
<tr>
<td>Monash CRC</td>
<td>1</td>
</tr>
<tr>
<td>Office of Living Victoria</td>
<td>2</td>
</tr>
<tr>
<td>Private</td>
<td>2</td>
</tr>
<tr>
<td>RMCG</td>
<td>1</td>
</tr>
<tr>
<td>SA Water</td>
<td>1</td>
</tr>
<tr>
<td>South East Water</td>
<td>5</td>
</tr>
<tr>
<td>Sydney Water</td>
<td>1</td>
</tr>
<tr>
<td>Water Corporation</td>
<td>2</td>
</tr>
<tr>
<td>Western Water</td>
<td>2</td>
</tr>
<tr>
<td>Wiser Analysis</td>
<td>1</td>
</tr>
<tr>
<td>Yarra Valley Water</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>43</strong></td>
</tr>
</tbody>
</table>
Appendix B – IUWM project case study reports

B.1 Fitzroy Gardens Stormwater Harvesting Project case study report
B.2 Altona Recycled Water Project Stage 2 case study report
B.3 Coldstream Recycled Water Project case study report
B.4 Boneo Recycled Water Project case study report
B.5 Toolern Stormwater Harvesting Project case study report
B.6 Coburg Stormwater Harvesting Project case study report
B.7 Kalkallo Stormwater Harvesting Project case study report
Appendix B1 – Fitzroy Gardens Stormwater Harvesting Project

<table>
<thead>
<tr>
<th>Lead organisation</th>
<th>City of Melbourne</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Fitzroy Gardens</td>
</tr>
<tr>
<td>Water source</td>
<td>Stormwater from urban catchment</td>
</tr>
<tr>
<td>Treated water quality</td>
<td>Quality is between class A and B</td>
</tr>
<tr>
<td>End use</td>
<td>Public open space irrigation</td>
</tr>
<tr>
<td>Predicted volume (average)</td>
<td>69ML/year</td>
</tr>
<tr>
<td>Actual volume (average so far)</td>
<td>39ML/year</td>
</tr>
<tr>
<td>Total Capex</td>
<td>$~5M (2012$)</td>
</tr>
<tr>
<td>Predicted production cost</td>
<td>$1.86/kL (50 year payback) or $4.06/kL (20 year payback) (2012$)</td>
</tr>
<tr>
<td>Customer charge</td>
<td>Water used by City of Melbourne</td>
</tr>
<tr>
<td>Interesting aspects of this case study</td>
<td>Risk management, financial evaluation and financing</td>
</tr>
</tbody>
</table>

Table 1 – Case study information

Authors: Casey Furlong, Lachlan Guthrie, Saman De Silva
RMIT University
APPENDIX B1 – FITZROY GARDENS STORMWATER HARVESTING PROJECT

EXECUTIVE SUMMARY

The City of Melbourne has implemented five separate stormwater harvesting schemes to supply water to parks within their jurisdiction. One of those parks is Fitzroy Gardens, which has received a 50% subsidy through the National Urban Water and Desalination Plan. Demand calculations show that the Fitzroy Gardens require 117ML of water per year for irrigation. The stormwater harvesting scheme has been designed to produce 59% of this demand, equating to 69ML/year on average. Water is sourced from existing drains, stored in a 4ML buffer storage, before a simple treatment train with sedimentation, a bio filter, and UV disinfection, before being irrigated through an existing irrigation system.

The scheme is currently in operation and so far has collected more stormwater than expected, but utilised less than expected, due to teething issues.

Findings

1. Project management is as important as initial concept design

The Fitzroy Gardens project has taught the City of Melbourne a number of lessons around implementing this type of scheme. Firstly, having a consistent project manager throughout the whole planning process is preferable for ensuring the delivery of the original objectives. Secondly, it has shown the value of an experienced multi-disciplinary team, because this provides different insights into issues and encourages innovation. For example, at certain points contractors put forward alternatives to the tendered design. Some of these were to the benefit to the project and some were not, particularly from a performance and operational perspective. Access to a variety of different expertise was required to confidently assess these alternatives.

2. Calculations and designs should be checked at multiple stages to avoid errors

During the design phase the City of Melbourne learnt the importance of ensuring that calculations are correct before starting designs, and also double checking designs, preferably through an independent source. The processing ability of the biofiltration bed was overestimated in the concept design. As a result, the size of the biofiltration bed had to be increased from 120m$^2$ to 240m$^2$ in the final design to accommodate the volume of harvested water, causing delays and increasing costs. An independent assessment of the proposed design can be valuable in cross checking the details.

3. Planning stormwater harvesting schemes is a complicated task which requires additional cost and time contingencies to facilitate planning for uncertainties

When planning a scheme such as this it is important to avoid placing tanks under buildings, understand the soil characteristics, think about access, and keep an eye on the pits. Placing tanks under buildings exposes the land and/or building manager to the risk of blame shifting between the different construction contracts if there is future movement or settlement. Soil conditions and contamination should be investigated early in the design process as it can influence the feasibility and cost of the project. Cost effective management of contaminated soil is possible, but it takes time and persistence to achieve. Safe access for cleaning or inspection of underground structures must be considered as part of the concept design, otherwise it can be a hidden cost until the detailed design phase. Engineers love pits. Pits frequently multiplied as the project developed, adding to the cost and complexity of the project.

4. External funding is helpful for the implementation of projects, and multiple projects can be bundled into one funding submission, although there are significant reporting requirements

For institutions with similar characteristics to the City of Melbourne receiving external funding can be important in order to implement schemes such as Fitzroy Gardens. External funding was helpful to fast track the implementation of this project. However securing funding can take a lot of time and effort. Funding agreements often require regular reporting and evaluation. Time must be set aside during project planning to apply, report and evaluate projects for funding partners. In the case of Fitzroy Gardens the funding submission was done collectively with two other schemes as a bundled package. Bundling several projects together into one larger project was more cost efficient than completing them separately because the consultants could be contracted to work on all three projects.
IMPROVING PLANNING PROCESSES FOR IUWM INFRASTRUCTURE

at once. Considering the environmental benefits of the three projects collectively was also more attractive to potential funding partners.

5. Financial assessment results change dramatically when assumptions are altered

Approximate calculations have been done as part of this case study which were not included in the funding submission. These calculations indicate that the net present value (NPV) calculation for the Fitzroy Gardens scheme is substantially influenced by the assumptions made around: assessment time period, increasing cost of water, and discount rate. Results range from a $25M saving, to a $2M loss as these assumptions are altered, as shown below. As the scheme has received a $2.5M Federal grant, it is expected that the scheme is guaranteed to save money for the City of Melbourne.

<table>
<thead>
<tr>
<th>Water price increase above CPI</th>
<th>Discount rate 2%</th>
<th>Discount rate 4%</th>
<th>Discount rate 6%</th>
</tr>
</thead>
<tbody>
<tr>
<td>2%</td>
<td>$4,520,000</td>
<td>$1,055,000</td>
<td>-$749,000</td>
</tr>
<tr>
<td>4%</td>
<td>$11,680,000</td>
<td>$4,701,000</td>
<td>$1,236,000</td>
</tr>
<tr>
<td>6%</td>
<td>$25,800,000</td>
<td>$11,540,000</td>
<td>$4,763,000</td>
</tr>
</tbody>
</table>

NPV assessment (20 year outlook)

<table>
<thead>
<tr>
<th>Water price increase above CPI</th>
<th>Discount rate 2%</th>
<th>Discount rate 4%</th>
<th>Discount rate 6%</th>
</tr>
</thead>
<tbody>
<tr>
<td>2%</td>
<td>-$1,155,000</td>
<td>-$1,772,000</td>
<td>-$2,215,000</td>
</tr>
<tr>
<td>4%</td>
<td>-$205,400</td>
<td>-$1,058,000</td>
<td>-$1,671,000</td>
</tr>
<tr>
<td>6%</td>
<td>$1,016,000</td>
<td>-$147,200</td>
<td>-$982,000</td>
</tr>
</tbody>
</table>

6. Less complex alternative water systems involve less risk

In comparison to other case studies considered by this research, the Fitzroy Gardens scheme enjoys a substantial benefit from a reduction in complexity and a reduction in the substantive risks. The source water is to be collected free of charge, treated through a simple low-cost treatment train, does not need to be on-sold to a third party and will never exceed demand. Therefore there are almost no substantial financial risks which need to be considered. If the reliability of the scheme produces less water than expected, because of the Federal grant money, there is still a financial margin built in before the scheme will begin to lose the City of Melbourne money.
The number of “integrated” water projects and strategies across Australia is steadily growing; however there are gaps in knowledge surrounding the most effective way to manage their planning and decision-making processes. As water projects and strategies become increasingly integrated, in terms of interactions between different water services, functions, and organisations, the planning processes for these become more important and complex. This is due to higher numbers of stakeholders, competing objectives, implicit non-market values and possible infrastructure options and combinations that are available.

RMIT University is working with Water Research Australia and Melbourne Water to investigate ways to improve the planning processes for Integrated Urban Water Management (IUWM) infrastructure at the strategy creation and physical project level. This study has divided the overall planning process into a generic list of planning components referred to here as a “planning framework” shown on the following page, collected information on a variety of real-world case studies, analysed and compared the differing approaches that have been used, and created guidelines to assist future planning efforts.

In this research a conceptual distinction has been made between; planning for “IUWM projects”, here meaning planning for discrete physical infrastructure assets which may or may not have been advised by a strategy, and planning for “IUWM strategies”, here meaning mid to long term strategies which are used to inform infrastructure portfolios for specified geographical areas.

The research objectives are to (1) understand the current and historical water infrastructure planning context, (2) catalogue and compare differing planning processes to determine which techniques are more effective, and (3) provide a platform from which future water infrastructure planning processes can be conducted in an informed manner.

This case study report is one of 16. These case studies were selected together with water industry experts and are shown in Table 3.

<table>
<thead>
<tr>
<th>Organisation</th>
<th>IUWM strategies</th>
<th>IUWM infrastructure projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barwon Water</td>
<td>Towards a Botanic Colac</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Review of IWCM options for Fyansford</td>
<td></td>
</tr>
<tr>
<td>City of Melbourne</td>
<td>Total Watermark</td>
<td>Fitzroy gardens SWH project</td>
</tr>
<tr>
<td>City West Water</td>
<td>Footscray IWM Investigation</td>
<td>Altona Recycled Water Project Stage 2</td>
</tr>
<tr>
<td>Private</td>
<td></td>
<td>Coldstream RW project</td>
</tr>
<tr>
<td>SA Water</td>
<td>SA Water’s Long Term Plan for Eyre Region</td>
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<td>South East Water</td>
<td>Water Initiatives for 2050</td>
<td>Boneo Recycled Water Project</td>
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<td>Water Corporation</td>
<td>Water Forever South West</td>
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<td>Western Water</td>
<td>Recycled Water Strategy</td>
<td>Toolern SWH project</td>
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<tr>
<td>Yarra Valley Water</td>
<td>Northern Growth Area IWCM Plan</td>
<td>Coburg SWH project</td>
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<tr>
<td></td>
<td></td>
<td>Kalkallo SWH project</td>
</tr>
</tbody>
</table>
IMPROVING PLANNING PROCESSES FOR IUWM INFRASTRUCTURE

HOW TO READ THIS CASE STUDY

The researchers have developed an infrastructure planning framework to assist in the analysis of the case studies as shown below in Figure 1. A journal paper on this process has been published in Utilities Policy journal (Furlong, et al., 2016). For each of the case studies the researchers have recorded information on each of the planning components contained in blue boxes.

![Figure 1 – Infrastructure planning framework developed to assist in case study analysis](image)

Each case study begins with an introduction, followed by the details on planning, and then concludes with the findings which the researchers have extracted from the case study. Definitions and scopes of the planning components are shown below in Table 4. Contents of case studies have been approved by the lead organisations, although the findings are the opinions of the authors.

<table>
<thead>
<tr>
<th>Planning Component</th>
<th>Meaning and included concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Context</td>
<td>Anything which precedes the planning process, including political, environmental, and economic contexts, and preceding plans and strategies</td>
</tr>
<tr>
<td>Integrated project management</td>
<td>Project team functioning, management and reporting, and risk management</td>
</tr>
<tr>
<td>Community &amp; stakeholder engagement</td>
<td>Engagement with external stakeholder organisations and the broader community</td>
</tr>
<tr>
<td>Option identification and shortlisting</td>
<td>Identification of initial options and shortlisting prior to detailed analysis</td>
</tr>
<tr>
<td>Technical evaluation</td>
<td>Collection and analysis of technical information, including modelling and design, to provide data to inform the option selection stage</td>
</tr>
<tr>
<td>Option selection</td>
<td>Assessment, ranking, and/or scoring of options to determine the preferred option and planning recommendations</td>
</tr>
<tr>
<td>Governance and regulation</td>
<td>Analysis, review, and approval of planning recommendations by internal management and relevant external regulators</td>
</tr>
<tr>
<td>Financing</td>
<td>Financing arrangements (internal funding, cost sharing and/or grants)</td>
</tr>
<tr>
<td>Outcomes</td>
<td>Anything which comes after the determination of planning recommendations</td>
</tr>
</tbody>
</table>
INTRODUCTION

In recent years, climate change, drought, and associated water restrictions have highlighted the risks to Melbourne’s treasured inner city parks. These issues have prompted the City of Melbourne to implement a number of actions to ensure that parks in their jurisdiction are sustainable and ensuring that the trees, plants and turf in the garden are able to provide environmental and social benefits into the future. Some actions have included installation of warm season grasses, installation of drip lines, annual renewal and additional mulching of drought sensitive trees, investigation of synthetic surfaces for sports fields, and installation of rainwater tanks on council buildings. However the most significant of these measures has been the construction of five stormwater harvesting projects located in Fitzroy Gardens, Birrarung Marr, Alexandra Gardens, Darling St and Royal Park.

Apart from Darling St and Royal Park, these projects form the basis of the Eastern Melbourne Parks and Gardens Stormwater Harvesting Scheme which has received $4.88 million funding from the Australian Government’s Water for the Future initiative through the National Urban Water and Desalination Plan. These stormwater harvesting projects substitute the need for potable water supplies, mitigate pollution to the Yarra River, reduce the urban heat island effect and also provide some relief of nuisance flooding. In addition to these benefits the projects provide benefits to humans through making the park environment more green and amenable.

This case study will predominantly focus on the Fitzroy Gardens Stormwater Harvesting Scheme, while making reference to the larger set of schemes when appropriate for understanding the broader context. Fitzroy Gardens has an area of 26 hectares and is located on the eastern edge of Melbourne’s CBD. Having been identified as a nature reserve in 1848, the garden features are now heritage listed, and the park is well-known for its elm-lined avenues and variety of tourist attractions.

Analysis has shown that to maintain the health and amenity of Fitzroy Gardens approximately 117ML of water is required per year. The stormwater harvesting scheme has been designed to produce 59% of this demand, equating to 69ML/year on average, while also: providing pollution reduction benefits to the Yarra River and Port Phillip Bay, and contributing to the amenity of the gardens. Furthermore due to the prominent location of the project it has a significant potential to play a role in educating the community about water conservation, sustainability, and conveying a positive environmental message. The stormwater harvesting system was constructed during a scheduled council depot site redevelopment which provided an opportunity to construct the scheme with reduced cost. The Fitzroy Gardens Stormwater Harvesting Scheme is currently in operation.
The catchment that surrounds both Gardens is 67 ha in area, which spans from Spring Street/Macarthur Street on the western boundary to the residential area east of Clarendon Street, and Albert Street on the North boundary. The south of the catchment is bounded by Wellington Parade and Victoria Parade runs along the majority of the northern boundary. The catchment generally slopes from north to south with an average slope of 3.5%. The area includes residential (17%), commercial and government buildings (32%), park (49%) and roadway (2%). The overall impervious fraction of the catchment is estimated to be 47%.

The stormwater harvesting site at Fitzroy Gardens is located in a natural low point for the surrounding 67 hectare catchment. The system works by capturing stormwater from the existing underground drainage pipe which is located along the boundary of the park beside Wellington Parade. Water is then treated through a gross pollutant trap which removes litter and leaves, sedimentation chamber which removes suspended particles, and stored in a 4ML tank, before being sent to a biofiltration bed for nitrogen and phosphorous removal.

The bio filtration bed is planted with native Australian ephemeral wetland plants which are pruned once a year when the filter media is changed to promote uptake of nutrients. Treated water is stored in a 1ML tank while awaiting use through a previously existing irrigation system, with any excess treated water returning to the stormwater drains. Before water is irrigated it is passed over Ultra Violet (UV) light tubes to kill any remaining bacteria.

One of the major features of the Fitzroy Gardens is its Fern Gully and “The Rill” which flows along it. The Rill is a creek-like water feature that follows the natural drainage line through the park and includes a number of ponds. These features increase the amenity of the park and also engagement with visitors and the community. Because of water restrictions, the City of Melbourne was only able to make The Rill flow intermittently in the years before the stormwater harvesting scheme. Reinstating the water flow through The Rill was outlined in the Fitzroy Gardens Master Plan as an important way to restore the celebration and connection with water in the gardens.

The stormwater harvesting project has made this possible. As well as being a beautiful feature in the landscape, The Rill contributes to the function of the stormwater harvesting system. Treated water from the storage tank is pumped up to the top of the Rill, where it flows through it into its various ponds along the way. At the bottom of the Rill, water is returned to the underground storage tanks via the bio filtration bed, preventing it from becoming stagnant.
APPENDIX B1 – FITZROY GARDENS STORMWATER HARVESTING PROJECT

CONTEXT

Project Background

Melbourne is a city well known for its beautiful parks and gardens, which attract more than 12 million visitors each year. The municipality contains approximately 560 hectares of open space including 55,000 trees and nearly 480 hectares of internationally acclaimed parklands. City of Melbourne is responsible for the management of these important green spaces, a responsibility that has been challenged by the combined impact of climate change, drought and water restrictions.

As a result of these water supply challenges the City of Melbourne has constructed stormwater harvesting schemes for the Fitzroy Gardens, Alexandra Gardens, Birrarung Marr, Darling St, and Royal Park.

Relevant existing water infrastructure

The scheme was able to tap into an existing drainage network that flowed along the edges of the Fitzroy Gardens. The irrigation system within the park, and also The Rill, already existed. Therefore the Fitzroy Gardens Stormwater Harvesting Scheme simply needed to capture water from the existing drain and treat it for injection into the irrigation network as well as supply water to The Rill feature. As the existing system was under pressure, and needed to be uncontaminated by treated stormwater, the challenge was to manage the programming and pressures of the interface between the treated stormwater and the potable water system.

Environmental, social and economic

Between 1997 and 2007 Melbourne suffered from the Millennium drought. This created long-term pressure on Melbourne’s centralised water supply and eventuated in the implementation of Stage 3A water restrictions which have had significant consequences on the health of Melbourne’s recreational facilities such as parks, gardens and playing fields. Impacts on Melbourne’s parks have brought an increased focus to the issues of water conservation and alternative water supplies.

As a result of a variety of water management measures put in place, in 2007 use of potable water for maintenance of City’s public open spaces and trees was reduced by 62 per cent (from an agreed baseline year). Such a level of reduction, while demonstrating a commitment to comply with water restrictions, has proved unable to provide for the full irrigation requirements of the City’s landscapes.
Since the completion of the desalination plant, water security has been less of an issue for the City of Melbourne, although flooding is still of concern. Alternative water sources help to ensure water security and maintain Melbourne’s parklands to a high level of amenity and horticultural standard. If alternative water sources can be produced more cheaply than desalination water, while using less electricity, and also mitigating flooding, then this is a win-win for the City of Melbourne.

**Organisational and political**

As the council for Victoria’s capital city’s most central and established area the City of Melbourne felt that it had a leadership role to play in demonstrating best practice in sustainability. In 2009 the City of Melbourne released its Total Watermark, City as a Catchment strategy, which outlines its commitment to taking an active lead in saving water, reducing wastewater and improving stormwater quality.

The adoption and expansion of stormwater harvesting and reuse facilities is supported in various City of Melbourne policies and studies. Stormwater harvesting was identified in the Climate Change Adaptation Report (2008) as the highest priority adaptation action that can be undertaken by the City of Melbourne.

**INTEGRATED PROJECT MANAGEMENT**

**Project team functioning and oversight**

The Fitzroy Gardens scheme is substantially different to the other case studies in the sense that it has been planned and implemented by a local council rather than a water utility. It is also a smaller scale, and has not been planned to on-sell water to another user, as all water will be utilised by the City of Melbourne itself. Because of this reduced complexity and number of stakeholders the scheme has been planned, designed and constructed predominantly by a City of Melbourne project manager with oversight by their direct manager, with approvals from council where necessary. The City of Melbourne CEO has authority to approve spending up to $2M, after that Councillor approval is required.

A large number of consultants have been involved in the planning of the Fitzroy Gardens scheme and these are shown in Table 5.

![Diagram of project team function and oversight]

**Figure 4 – Project team function and oversight**

<table>
<thead>
<tr>
<th>Consultants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Councillors</td>
</tr>
<tr>
<td>CoM management</td>
</tr>
<tr>
<td>Project manager</td>
</tr>
</tbody>
</table>

**Table 5 – Consultants involved in project design and construction**
Existing national and international research suggests that planners are often overly optimistic when planning public infrastructure projects and the research has highlighted risk assessment methodologies as a crucial element in infrastructure planning. Typical project management and construction risks are not central to the themes of the current research, and so a focus will be placed on risks specifically associated with alternative water source projects.

In comparison to the other case studies it appears that the Fitzroy gardens case study has less associated risk because of its reduced complexity. Firstly, the treated water will be used by the council itself, and so there is no risk of a water user deciding not to use the water. Secondly, Fitzroy Gardens requires a constant stream of water, and is heritage listed, so will never be removed. These two factors in combination essentially remove any demand-side risks.

City of Melbourne has the authority to issue the planning permit, and also owns the land of the Fitzroy Gardens depot, effectively reducing the planning risk. The planning department could have blocked the project, but then councillors would have the ability to override this. There was also no controversial treatment process, meaning that health regulators did not need to get actively involved. Stormwater schemes fall under a grey area, because they don’t have established health regulatory processes.

Therefore the only risks that need to be considered are supply risks and treatment risks. Supply risks are considered through calculating the percentage of time which the supply will be reliable, which has been calculated at 59%. This figure should theoretically hold true as a long-term average. Treatment risks in such a simple treatment train are minimal, although two minor issues have occurred, which are explained in the table below.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Explanation/consideration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than expected supply</td>
<td>Although there are no substantial demand-side risks there is still a supply risk which needed to be considered. The main risk is if rainfall drops substantially. Although this could have some impact on the amount of water produced by the scheme, the impact would be incremental, and the modelling has been done taking into account dry year data.</td>
</tr>
<tr>
<td>Catchment pollution incident</td>
<td>City of Melbourne does not have control over the operations within the catchment which include roads. There is a potential risk of a chemical, or other spill incident. An ammonia spill has occurred in the past. A Diesel spill could also be an issue. This is why CoM monitor pH and EC of water, which are affected by these chemicals.</td>
</tr>
</tbody>
</table>
Other than these risks, some minor treatment risks have eventuated during construction and commissioning.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Solution/outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>An algae crust formed on top of the filter medium in the biofiltration bed as a result of the regular flooding. Although algae contribute to the biological processes that naturally clean the stormwater, in this case it was preventing the water from filtering through the substrate and blocking the system.</td>
<td>The top layer of the filter media, a fine sandy soil, was removed and mixed with large pea gravel and replaced. The larger size gravel pieces allow the water to move through the filter medium more easily. Although the algae still forms around the gravel granules, it no longer forms a crust that prevents filtration.</td>
</tr>
<tr>
<td>When water was first diverted into the system, high levels of salinity were measured, making it unsuitable for irrigation.</td>
<td>Both tanks were emptied and allowed to refill naturally, basically flushing the system. In addition, gypsum was added to the biofilter to offset the effect of any remaining sodium. These measures have been effective, suggesting that the saline water was a one-off event, likely caused by a saline solution being flushed down the drain.</td>
</tr>
<tr>
<td>Soil contamination worse than expected</td>
<td>Overall cost increase of 20% to remove additional contamination.</td>
</tr>
</tbody>
</table>

**STAKEHOLDER AND COMMUNITY ENGAGEMENT**

**Engagement process**

Considering the high value placed on Fitzroy Gardens by the community, meaningful interaction with stakeholders was seen by the City of Melbourne as a key part of project planning.

A Community Engagement Plan identified internal and external stakeholders and assessed their interests and engagement needs. The plan identified appropriate communication methods and channels for these audiences and assigned responsibility to individuals on the project team.

Community consultation with the public took place as part of the development of the Fitzroy Gardens Master Plan and showed strong community support for sustainable water management in the space. Three project information signs were placed around the project site. A media event was held when construction began, with the Lord Mayor Robert Doyle and Senator Don Farrell appearing on the evening news, communicating the importance of the project to a wide audience.

Other than this, the City of Melbourne sent out letters to residents and contacted community groups. A number of positive responses were received from residents by mail. Meetings with “Friends of the Elms” and the “East Melbourne Residents Group” showed a positive response from these groups as well.

Presentations about the scheme were given to government departments from Australia and overseas at a range of industry conferences and events, as well as some presentations to university students. The State Government Department of Planning and Community Development produced a video together with the City of Melbourne on the Total Watermark Strategy which included information on the Fitzroy Gardens scheme. Finally, site visits/tours were conducted with a range of industry figures and groups from local and international organisations.
Stakeholder incentives

In comparison to the other case studies, Fitzroy Gardens has fewer stakeholders because it is predominantly an in-house operation. In this case not only are there fewer stakeholders, but these stakeholders also have less influence over the outcome of the scheme, as the City of Melbourne has authority over the land and planning permits. Grant funders have a responsibility to ensure that grant money is used wisely on behalf of Australian tax payers. City of Melbourne, along with residents, visitors, and community groups, have an incentive to ensure that CoM parks are properly maintained so that they continue to provide social and environmental benefits to the area.

OPTION IDENTIFICATION AND SHORTLISTING

The Fitzroy Gardens, Birrarung Marr, and Alexandra Gardens stormwater harvesting schemes were planned together as a package named the Eastern Melbourne Parks and Gardens Stormwater Harvesting Scheme.

The concepts for the three systems arose out of a series of investigations undertaken by various consultants on behalf of the City of Melbourne since 2007. These schemes were selected from a broader list of 42 reuse schemes which were under consideration by CoM at the time. These three systems were included in the City of Melbourne pitch for funding because they were regarded to be the most readily achievable and beneficial in the short term, in comparison to other potential stormwater harvesting schemes which CoM had identified. The schemes also had to be near each other, and add up to over $4M in total to be eligible for funding. Alexandra Gardens was also a Lord Mayor request.

During 2009, Cardno consultancy was engaged to review and develop functional designs for each of the three concepts to give City of Melbourne and the Water for the Future fund confidence that the projects could be successfully delivered.

City of Melbourne discussed with Melbourne Water, City West Water and South East Water the impact of the proposed design and connection on their assets. Each of the water authorities involved have provided letters of support and will be involved in the ongoing development of the design.
IMPROVING PLANNING PROCESSES FOR IUWM INFRASTRUCTURE

TECHNICAL EVALUATION

Technical evaluations conducted as part of the planning of Fitzroy Gardens Stormwater Harvesting Scheme were similar to that of the Birrarung Marr and Alexandra Gardens. For all of these schemes this process has involved demand estimates, supply estimates, calculation of treatment requirements, cost estimation and also geo-tech and soil analysis.

In comparison to the other case studies less emphasis has been placed on the development of triple bottom line or sustainability assessments, calculation of environmental benefits, and risk assessment. This is due to the fact that this project has a smaller total cost, and has been subject to less scrutiny by financial regulators such as the ESC and DTF, so that it does not have to follow their business case templates. Although the City of Melbourne has conducted some assessments as part of developing the projects “merit criteria” which will be included in the Option Selection section of this case study.

**Demand estimates**
- A water plan for Fitzroy Gardens was developed in 2008 to show the exact size and layout of different vegetated areas and their primary uses. This was completed in-house and used as a base for estimating irrigation requirements and priorities.

**Supply estimates**
- Climate data sourced from the Bureau of Meteorology Melbourne Regional Office was used to model the likely rainfall supply. The modelling methodologies XP SWMM, MUSIC and tailored spreadsheets were employed.
- Water quality sampling was conducted throughout the drainage networks.
- eWater MUSIC modelling software was utilised to check reliability and run-off figures for each catchment area, and to determine the sizing of the bioretention basins and water quality performance.
- Both wet years and dry years were used in modelling, although not climate change scenarios.

**Treatment calculation**
- Rainfall data and stormwater pollution levels were used to calculate the effectiveness of the proposed treatment system and to determine the most appropriate size for the biofiltration bed.

**Cost estimates**
- Capital expenditure for the options were estimated by project managers together with consultants.

**Geo-tech and soil analysis**
- A geotechnical survey was commissioned in 2009 as part of the initial investigations of the site. Based on the soil conditions and groundwater levels, the report made recommendations that shaped the ultimate design of the stormwater harvesting system, visitor centre and depot.
- A soil contamination assessment was undertaken in 2010 to: determine the extent of the contamination, outline a management approach and gain approval from the EPA to proceed with proposed works.
OPTION SELECTION (PROJECT JUSTIFICATION)

In some of the case studies utilised in this research, various decision support systems were used to select final infrastructure options. In the case of Fitzroy Gardens it was determined from an early stage in planning that the preferred option was a stormwater harvesting scheme, and the location of this scheme. Treatment train design was not contentious, and the sizing of the storage tank was agreed at an early stage of planning. Therefore this section will focus not on option selection, but rather project justification, which was mostly done as part of the funding grant submission to the National Urban Water and Desalination Plan. This section will explore project costs and benefits, as well as the “merit criteria” outlined in the funding submission.

Table 8 – Project costs

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geotechnical survey</td>
<td>$10,000.00</td>
</tr>
<tr>
<td>Soil contamination</td>
<td>$250,000.00</td>
</tr>
<tr>
<td>Design and documentation</td>
<td>$314,000.00</td>
</tr>
<tr>
<td>Diversion</td>
<td>$284,000.00</td>
</tr>
<tr>
<td>Tanks</td>
<td>$2,631,000.00</td>
</tr>
<tr>
<td>Treatment</td>
<td>$100,000.00</td>
</tr>
<tr>
<td>Irrigation connections</td>
<td>$610,000.00</td>
</tr>
<tr>
<td>Total capital expected</td>
<td>$4,199,000.00</td>
</tr>
</tbody>
</table>

The project exceeded budget by about 20%, mainly due to the costs associated with managing soil contamination on the site. Some of this soil needed to be moved offsite, which was a major and expensive process.

Maintenance cost figures have been re-evaluated a number of times with projections ranging from $18,000 to $28,000 per year (in 2012 dollars). This includes removing litter from the gross pollutant trap, replacing plants and filter media, and replacement of the pump and gross pollutant trap (every 10 years). As construction of the scheme has only recently been completed, maintenance costs can still only be estimated at this stage.

With this information it is possible to create an approximate NPV assessment of the stormwater harvesting scheme in comparison to the base case of purchasing all required water from the potable water grid.
The assumptions included in this approximate assessment are as follows:

- Potable water is charged at approximately $3/kL to begin with
- Stormwater harvesting scheme Opex at $28,000 per year

<table>
<thead>
<tr>
<th>Water price increase above CPI</th>
<th>Discount rate</th>
<th>NPV assessment (50 year outlook)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2%</td>
<td>$ 4,520,000</td>
</tr>
<tr>
<td></td>
<td>4%</td>
<td>$ 1,055,000</td>
</tr>
<tr>
<td></td>
<td>6%</td>
<td>-$ 749,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Water price increase above CPI</th>
<th>Discount rate</th>
<th>NPV assessment (20 year outlook)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2%</td>
<td>-$ 1,155,000</td>
</tr>
<tr>
<td></td>
<td>4%</td>
<td>-$ 1,772,000</td>
</tr>
<tr>
<td></td>
<td>6%</td>
<td>-$ 2,215,000</td>
</tr>
</tbody>
</table>

This calculation shows that the NPV of the Fitzroy Gardens project varies drastically depending on the financial assumptions including: assessment period, increase to the price of potable water, and discount rate. Looking at the predicted losses calculated from a 20 year financial assessment it can be seen that the City of Melbourne is expected to lose a maximum of $2.2M. The Federal funding grant from the National Water and Desalination Plan the City of Melbourne can be expected to contribute $2.5M to the project, meaning that the City of Melbourne has guaranteed itself a positive financial outlook from the project.

In order to justify this external funding contribution, the City of Melbourne also considered the levelised cost of the scheme, environmental benefits, and community benefits.

**Additional justification 1 - Levelised cost comparison**

It has been indicated that levelised costs would be used as the key cost-effectiveness measure of water supplied for the evaluation of grant applications. For the purposes of this application, the levelised cost has been calculated using the following equation:

\[
\frac{\text{Capital Expenditure} + (\text{Design Life (years)} \times \text{Annual Operating Expenditure})}{\text{Design Life (years)} \times \text{Annual Potable water savings (kL)}} = \$1.86/kL \text{ (50 year payback) OR } \$4.06 \text{ (20 year payback)}
\]

The levelised cost of the Fitzroy Gardens project is also heavily influenced by the pay back period. The cost of potable water is already above $1.86/kL and is quickly increasing. Therefore the cost of treated stormwater is lower than the cost of potable water for the lifetime of the project, if a 50 year financial assessment period is used. However, in a 20 year assessment, the cost of the water is $4.06/kL, which is more expensive than the current mains water price.
Additional justification 2 - Environmental benefits

The project will deliver a range of environmental and social benefits, including:

- Saving of potable water;
- Water security for key city parks and gardens;
- Flood mitigation benefits;
- Reduction of nutrient load in stormwater;
- Enhanced amenity of the urban environment and creation of habitat for fauna;
- Raise community awareness of the benefit of stormwater harvesting; and
- Industry education through incorporation of leading-edge park management techniques into systems, and ongoing commitment to sharing knowledge and lessons learned.

The Fitzroy Gardens project has been estimated to deliver a combined stormwater quality improvement of 12,100kg/yr of TSS, 18kg/y of TP and 155kg/y of TN. The proposed systems exceed best practice stormwater quality treatment. These stormwater improvements contribute to nutrient reduction goals under City of Melbourne’s Total Watermark Strategy.

Additional justification 3 – Community benefits

Fitzroy Gardens contributes significantly to the character and liveability of Melbourne and is highly valued for the cultural, economic and social benefits it brings to the city. The main benefit of the scheme to the community is that it secures the health and vitality of this heritage landscape into the future by providing a reliable alternative water source for irrigation.

It is important to recognise that the parkland irrigation has not been ‘business as usual’ within the City of Melbourne for some time. The impact of water restrictions has had a profound effect on the practice of irrigation and the amount of water applied, particularly given the lack of non-potable water sources as an alternative. A key driver of this project is to ensure that sufficient ‘fit for purpose’ water is available to irrigate parkland to a high horticultural standard, befitting the character and amenity of these important urban landscapes.

This project also represents an opportunity to highlight the benefits of stormwater harvesting to the broader community. The latest record of visitor numbers undertaken in 2000-01 indicates that Fitzroy Gardens receives 2.8 million visitors per year. There is no question that the quality of these spaces is a very important attractor to visitors, particularly given that many local visitors will have been subject to the same Stage 3A water restrictions as Melbourne’s parks. There is a high level of community support for water management initiatives within Melbourne and it is important that this is matched by transparency and information sharing.

By incorporating a visitor information centre into the redevelopment of the site, the project will also play a role in increasing public awareness about the opportunities for sustainable water management in the urban environment. Through the development of online content and site tours, local, national and international peers will be able to learn about stormwater harvesting and reuse.

Each of the systems will incorporate signage and other interpretive elements to effectively communicate the process to visitors. The City of Melbourne is committed to providing interpretive information in public spaces to share details with visitors on the heritage, culture and horticultural details of the parks. This commitment will be extended to incorporate messages around sustainability, seeking to inspire visitors to look at how the principles behind the design can be incorporated into their own gardens.

The Fitzroy and Treasury Gardens system in particular will demonstrate that it is possible for precious heritage landscapes to adapt to the pressures of climate change, provided sound water management and park planning techniques are employed.
GOVERNANCE AND REGULATION

Heritage regulation

Two main factors influenced the overall planning approval for this project: the heritage overlay on Fitzroy Gardens and the discovery of contaminated soil on the depot site.

Gaining approval in this context was an extensive process that took over 18 months to complete and involved external consultants. Under the Victorian Planning System, a permit is required to carry out works where a heritage overlay applies. To gain approval for the entire depot site redevelopment, City of Melbourne completed a Statement of Heritage Impact, and negotiated with Heritage Victoria to reach agreement on the final site design. The main heritage limitations on the design of the site were:

- A 5 metre buffer from construction applied to all existing heritage-listed buildings on site, limiting the size and location of the tank
- The construction could not impact on heritage features, including the root systems of existing elm trees. The extent of root systems was mapped during the design phase to ensure that the excavation would not damage any root systems.
- The visual impact of the completed project had to respect the surrounding heritage landscape, including vegetation.

Environmental regulation

Due to contaminated soil on site, a works approval was needed from the Environment Protection Authority (EPA) for the project. Regulations specify that contaminated soil must not be removed from the site. For other projects, such as the construction of Birrarung Marr parkland, contaminated soil has been incorporated into the design by creating undulating hills in the landscape. This was not possible at Fitzroy Gardens because the heritage restrictions do not permit such a visible change to the existing form. Instead, the contaminated soil had to be stored on site during construction, and then re-buried around the tank. This required careful planning and supervision during construction.

Health regulation

The Fitzroy Gardens scheme water is used for non-potable irrigation at night, although there is no restriction on day time watering. Additionally the Environmental Protection Agency and the Department of Health do not have set guidelines for the health regulation of stormwater. Therefore health regulation has not played a major role in the planning of this scheme, because official approval was not required.

Financial regulation

Due to the size of this scheme, the Essential Services Commission and the Department of Treasury have not been involved in its financial regulation. Therefore the financial regulation has been managed internally by the City of Melbourne Council and also by the Federal grant funders.

FINANCING

Financing for the Fitzroy Gardens scheme has been bundled with the Birrarung Marr and Alexandra Gardens schemes because these projects were pitched to the National Urban Water and Desalination Plan as a package. The expected project costs for the systems were $4,232,000 for the Fitzroy Gardens; $3,530,000 for Birrarung Marr; and $1,996,000 for Alexandra Gardens, totalling $9,758,000. Annual ongoing maintenance costs for all three systems have been estimated at $63,000 per year. This estimate was calculated by City of Melbourne and the cost of each component has been prorated to include all costs such as profit margins, administration fees etc.

City of Melbourne has received Federal funding to the amount of $4,879,000, or 50% of the total capital costs.
APPENDIX B1 – FITZROY GARDENS STORMWATER HARVESTING PROJECT

OUTCOMES

Construction was completed at the beginning of 2014. Testing and commissioning lasted for a period of 6 months before landscaping was begun. By the end of 2015 the project was fully completed and in operation. So far:

- Maintenance costs have been in line with expectations
- Source water collected has been above expectations
- Irrigation water supplied has been below expectations (39ML/year rather than 69ML/year) because of teething issues. This is expected to rise to 69ML/year in the coming years.

The City of Melbourne considers the project a success, both in terms of technical performance and also aesthetics of the surrounding area.

FINDINGS

1. Project management is as important as initial concept design

The Fitzroy Gardens project has taught the City of Melbourne a number of lessons around implementing this type of scheme. Firstly, having a consistent project manager throughout the whole planning process is preferable for ensuring the delivery of the original objectives. Secondly, it has shown the value of an experienced multi-disciplinary team, because this provides a range of insights into issues and encourages innovation. For example, at certain points contractors put forward alternatives to the tendered design. Some of these were to the benefit to the project and some were not, particularly from a performance and operational perspective. Access to a variety of different expertise was required to confidently assess these alternatives.

2. Calculations and designs should be checked at multiple stages to avoid errors

During the design phase the City of Melbourne learnt the importance of ensuring that calculations are correct before starting designs, and also double checking designs, preferably through an independent source. The processing ability of the biofiltration bed was overestimated in the concept design. As a result, the size of the biofiltration bed had to be increased from 120m$^2$ to 240m$^2$ in the final design to accommodate the volume of harvested water, causing delays and increasing costs. An independent assessment of the proposed design can be valuable in cross checking the details.

3. Planning stormwater harvesting schemes is a complicated task which requires additional cost and time contingencies to facilitate planning for uncertainties

When planning a scheme such as this it is important to avoid placing tanks under buildings, understand the soil characteristics, think about access, and keep an eye on the pits. Placing tanks under buildings exposes the land and/or building manager to the risk of blame shifting between the different construction contracts if there is future movement or settlement. Soil conditions and contamination should be investigated early in the design process as it can influence the feasibility and cost of the project. Cost effective management of contaminated soil is possible, but it takes time and persistence to achieve. Safe access for cleaning or inspection of underground structures must be considered as part of the concept design, otherwise it can be a hidden cost until the detailed design phase. Engineers love pits. Pits frequently multiplied as the project developed, adding to the cost and complexity of the project.

4. External funding is helpful for the implementation of projects, and multiple projects can be bundled into one funding submission, although there are significant reporting requirements

For institutions with similar characteristics to the City of Melbourne, receiving external funding can be important to implement schemes such as Fitzroy Gardens. External funding was helpful to fast track the implementation of this project. However receiving funding can take a lot of time and effort. Funding agreements often require regular reporting and evaluation. Time must be set aside as part of the project planning to apply, report and evaluate projects for funding partners. In the case of Fitzroy Gardens the funding submission was made collectively with two other schemes as a bundled package. Bundling several projects together into one larger project was more cost efficient than completing them separately because the consultants could be contracted to work on all three projects.
at once. By considering the environmental benefits of the three projects collectively, it also became more attractive to potential funding partners.

5. Financial assessment results change dramatically when assumptions are altered

Approximate calculations made as part of this case study were not included in the funding submission. These calculations indicate that the NPV calculation for the Fitzroy Gardens scheme is substantially influenced by the assumptions made around: assessment time period, increasing cost of water, and discount rate. Results range from a $25M saving, to a $2M loss as these assumptions are altered, as shown below. As the scheme has received a $2.5M Federal grant, it is expected that the scheme is guaranteed to save money for the City of Melbourne.

<table>
<thead>
<tr>
<th>Water price increase above CPI</th>
<th>Discount rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2%</td>
</tr>
<tr>
<td>2%</td>
<td>$ 4,520,000</td>
</tr>
<tr>
<td>4%</td>
<td>$ 11,680,000</td>
</tr>
<tr>
<td>6%</td>
<td>$ 25,800,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Water price increase above CPI</th>
<th>Discount rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2%</td>
</tr>
<tr>
<td>2%</td>
<td>-$ 1,155,000</td>
</tr>
<tr>
<td>4%</td>
<td>-$ 205,400</td>
</tr>
<tr>
<td>6%</td>
<td>$ 1,016,000</td>
</tr>
</tbody>
</table>

6. Less complex alternative water systems involve less risk

In comparison to other case studies considered by this research, the Fitzroy Gardens scheme enjoys a substantial benefit from a reduction in complexity and a reduction in the substantive risks. The source water is to be collected free of charge, treated through a simple low-cost treatment train, does not need to be on-sold to a third party and will never exceed demand. Therefore there are almost no substantial financial risks which need to be considered. If the reliability of the scheme produces less water than expected, because of the Federal grant money, there is still a financial margin built in before the scheme will begin to lose the City of Melbourne money.

REFERENCES

Anon., n.d. Living encyclopaedia Fitzroy Gardens Stormwater Harvesting System case study DRAFT, s.l.: s.n.

Biofilta, n.d. Fitzroy Gardens Stormwater Harvesting, s.l.: s.n.


P., R., Multiple occasions. Meeting to discuss Fitzroy Gardens project [Interview] Multiple occasions.

SKM, 2009. Fitzroy Gardens Aquifer Storage and Recovery, s.l.: s.n.
Appendix B2 – Altona Recycled Water Stage 2

<table>
<thead>
<tr>
<th>Lead organisation</th>
<th>City West Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Melbourne’s inner west</td>
</tr>
<tr>
<td>Water source</td>
<td>Recycled Water from Western Treatment Plant</td>
</tr>
<tr>
<td>Treated water quality</td>
<td>Class A + RO</td>
</tr>
<tr>
<td>End use</td>
<td>Industrial use</td>
</tr>
<tr>
<td>Predicted volume (for stage one)</td>
<td>4.7GL/year</td>
</tr>
<tr>
<td>Actual volume (average so far)</td>
<td>N/A (not constructed)</td>
</tr>
<tr>
<td>Total Capex</td>
<td>Confidential as may be tendered in future</td>
</tr>
<tr>
<td>Predicted production cost</td>
<td>$~2000/ML (2013$)</td>
</tr>
<tr>
<td>Customer charge</td>
<td>$~2500/ML (2013$)</td>
</tr>
<tr>
<td>Interesting aspects of this case study</td>
<td>Risk management, option selection and financing</td>
</tr>
</tbody>
</table>

Table 1 – Case study information

Authors: Casey Furlong, Lachlan Guthrie, Saman De Silva
RMIT University
EXECUTIVE SUMMARY

Over the past decade City West Water has been developing and implementing a number of alternative water source schemes. As part of this process Altona was identified as an area with a high potential demand for alternative water sources estimated at 7.2GL/year for the entire area. Altona Recycled Water Stage 1 was constructed in 2011 and currently supplies 2.5GL/year to industry, council and golf courses.

Altona Stage 2 has been planned to supply an additional 4.7GL/year to industrial customers in the area. Capital works for this project include: membrane filtration and reverse osmosis treatment plant, 16km transfer pipeline, 2.6ML supply tank and 23km distribution network. Following Essential Service Commission’s determination to defer the scheme, it has currently been put on hold by CWW.

Findings

1. Altona is theoretically net present value (NPV) positive if a value for potable headworks augmentation deferral benefits is included

According to the financial assessment Altona Stage 2 represents a rare opportunity to implement a recycled water potable water substitution scheme which is predicted to be NPV positive. The majority of alternative water source schemes rely heavily on government grants and/or subsidy by an authority’s wider customer base. Although, the financial assessment includes an approximate benefit (~20% of total Capex) from deferral of the next major potable headworks augmentation, in this case CWW has no mechanism by which to accrue these headworks benefits, which are received by the entire Melbourne region.

2. For Melbourne’s particular situation there are relatively simple methods which can be used to calculate potable headworks augmentation deferral benefits

One reason for the NPV positive evaluation result is the inclusion of a value for deferring future infrastructure augmentation expenses. The simple and logical method used has involved multiplying potable water substituted by 35 years, and assuming this volume is accumulating within the very large Thomson dam, and mitigating the need to upgrade Melbourne’s desalination plant. This is a progressive step towards the inclusion of externalities in decision making. It may be appropriate to apply a similarly simple and replicable method to all potable water substation schemes being planned in Melbourne. The method and value used for this benefit should be determined at a regional or industry scale.

3. Financial evaluation methods should be set at a regional level and then implemented consistently

When taking a broader view, and looking at all of Melbourne’s IUWM schemes, it becomes apparent that different projects are justified through different financial evaluation methods. It is the opinion of the researchers that in the future if IUWM planning is to be consistent and justifiable, then financial evaluation methods, such as valuing externalities, should be set at regional level through collaboration between all of Melbourne’s water authorities and regulators. If financial evaluation methods were set at a regional level, then this would remove the possibility of disputes between water authorities and regulators around which IUWM infrastructure should be built.

4. Risk assessment is extremely important when planning alternative water source projects

Findings from previous research have shown that alternative water source schemes often do not perform as predicted. Actual demands are sometimes lower and more variable than expected and unexpected technical, or even political factors can conspire to affect the financial outcomes of alternative water source schemes. It can therefore be stated that the risks for these types of schemes always need to be considered earnestly and thoroughly. In the case of the Altona Stage 2 scheme there is a significant potential risk of customer demands dropping at least partially during some period of the scheme’s lifetime. Planners have attempted to mitigate this risk as much as possible through contracting and seeking alternative users if this risk becomes a reality, and also conducting sensitivity analysis. It should also be noted that industrial users have a far more consistent demand for recycled water than seasonal and climate dependant irrigators.
5. A project that is initially NPV positive is less sensitive to uncertainties than a project which is already known to be NPV negative during business case development

A logical assumption to make would be that demands will not be steady over the 35 year period regardless of any risk mitigation attempts. However the project is predicted to be NPV positive. This creates a realistic probability of the project breaking even, regardless of uncertainties, which is a substantially better financial outcome than many other alternative water source schemes. Although this positive NPV assumes that the potable headworks benefit calculation is justifiable.

6. Communication between regulators and planners needs to be clear

Financial regulation for the Altona Stage 2 scheme has been conducted through a somewhat opaque process involving a regulatory process which is not often utilised and with the operations of the evaluation being conducted by a private economics consultant, Pricewaterhouse Coopers (Essential Services Commision, 2013). The published ESC Water Plan review was lacking in detail. In this context communicating regulatory decisions, and the reasoning behind them, is particularly important and absolutely crucial for effective infrastructure planning.
The number of "integrated" water projects and strategies across Australia is steadily growing; however there are gaps in knowledge surrounding the most effective way to manage their planning and decision making processes. As water projects and strategies become increasingly integrated, in terms of interactions between different water services, functions, and organisations, the planning processes for these become increasingly important and complex. This is due to the increasing numbers of stakeholders, competing objectives, implicit non-market values and possible infrastructure options and combinations that are available.

RMIT University is working with Water Research Australia and Melbourne Water to investigate ways to improve the planning processes for Integrated Urban Water Management (IUWM) infrastructure at the strategy creation and physical project level. This study has divided the overall planning process into a generic list of planning components referred to here as a “planning framework” shown on the following page, collected information on a variety of real-world case studies, analysed and compared the differing approaches that have been used, and created guidelines to assist future planning efforts.

In this research a conceptual distinction has been made between; planning for "IUWM projects”, here meaning planning for discrete physical infrastructure assets which may or may not have been advised by a strategy, and planning for "IUWM strategies”, here meaning mid to long term strategies which are used to inform infrastructure portfolios for specified geographical areas.

The research objectives are to (1) understand the current and historical water infrastructure planning context, (2) catalogue and compare differing planning processes to determine which techniques are more effective, and (3) provide a platform from which future water infrastructure planning processes can be conducted in an informed manner.

This case study report is one of 16. These case studies were selected together with water industry experts and are shown in Table 2.

<table>
<thead>
<tr>
<th>Organisation</th>
<th>IUWM strategies</th>
<th>IUWM infrastructure projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barwon Water</td>
<td>Towards a Botanic Colac</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Review of IWCM options for Fyansford</td>
<td></td>
</tr>
<tr>
<td>City of Melbourne</td>
<td>Total Watermark</td>
<td>Fitzroy gardens SWH project</td>
</tr>
<tr>
<td>City West Water</td>
<td>Footscray IWM Investigation</td>
<td>Altona Recycled Water Project Stage 2</td>
</tr>
<tr>
<td>Private</td>
<td></td>
<td>Coldstream RW project</td>
</tr>
<tr>
<td>SA Water</td>
<td>SA Water’s Long Term Plan for Eyre Region</td>
<td></td>
</tr>
<tr>
<td>South East Water</td>
<td>Water Initiatives for 2050</td>
<td>Boneo Recycled Water Project</td>
</tr>
<tr>
<td>Water Corporation</td>
<td>Water Forever South West</td>
<td></td>
</tr>
<tr>
<td>Western Water</td>
<td>Recycled Water Strategy</td>
<td>Toolern SWH project</td>
</tr>
<tr>
<td>Yarra Valley Water</td>
<td>Northern Growth Area IWCM Plan</td>
<td>Coburg SWH project</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kalkallo SWH project</td>
</tr>
</tbody>
</table>
HOW TO READ THIS CASE STUDY

The researchers have developed an infrastructure planning framework to assist in the analysis of the case studies as shown below in Figure 1. A journal paper on this process has been published in Utilities Policy journal (Furlong, et al., 2016). For each of the case studies the researchers have recorded information on each of the planning components contained in blue boxes.

Each case study begins with an introduction, followed by the details on planning, and concludes with the findings which the researchers have extracted from the case study. Definitions and scopes of the planning components are shown below in Table 3. Contents of case studies have been approved by the lead organisations, although the findings are the opinions of the authors.

Table 3 - Meaning and included concepts of planning components

<table>
<thead>
<tr>
<th>Planning Component</th>
<th>Meaning and included concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Context</td>
<td>Anything which precedes the planning process, including political, environmental, and economic contexts, and preceding plans and strategies</td>
</tr>
<tr>
<td>Integrated project management</td>
<td>Project team functioning, management and reporting, and risk management</td>
</tr>
<tr>
<td>Community &amp; stakeholder engagement</td>
<td>Engagement with external stakeholder organisations and the broader community</td>
</tr>
<tr>
<td>Option identification and shortlisting</td>
<td>Identification of initial options and shortlisting prior to detailed analysis</td>
</tr>
<tr>
<td>Technical evaluation</td>
<td>Collection and analysis of technical information, including modelling and design, to provide data to inform the option selection stage</td>
</tr>
<tr>
<td>Option selection</td>
<td>Assessment, ranking, and/or scoring of options to determine the preferred option and planning recommendations</td>
</tr>
<tr>
<td>Governance and regulation</td>
<td>Analysis, review, and approval of planning recommendations by internal management and relevant external regulators</td>
</tr>
<tr>
<td>Financing</td>
<td>Financing arrangements (internal funding, cost sharing and/or grants)</td>
</tr>
<tr>
<td>Outcomes</td>
<td>Anything which comes after the determination of planning recommendations</td>
</tr>
</tbody>
</table>
INTRODUCTION

The planning of this project can be said to have started as far back as 2004 when investigations into alternative water source options in Altona began. In 2006 a formal alternative water source strategy was conducted for the region by consultants.

After the announcement regarding the creation of Altona Recycled Water Project Stage 1, some industrial customers in the Altona area expressed interest in using recycled water for their commercial processes. City West Water then spent a number of years investigating possibilities for meeting this industrial demand with an Altona Recycled Water Stage 2 scheme.

Another consultant was engaged in 2010 to complete the final options analysis for Stage 2 and recommend the preferred servicing option for industrial customers in Altona. In 2011 a strategic assessment report was written by members of the project team, which gained support from the board to proceed to business case development.

Through the strategies that were conducted CWW determined that the optimum solution was to deliver recycled water from Melbourne Water’s Western Treatment Plant (WTP) to the Altona Industrial Precinct. Capital works for this project include: membrane filtration and reverse osmosis treatment plant, 16km pipeline, 2.6ML supply tank and distribution network. Altona Stage 2 could save approximately 4,770 ML of potable water each year if it is implemented.

The proposed scheme includes construction of a salt reduction plant to ensure the water quality is fit for the intended industrial purposes and pipelines to transfer the recycled water from WTP to the Altona Industrial precinct.

The functional design for Altona Stage 2 was conducted later in 2011 by another consultancy and the Business Case was approved by the CWW Board in 2013. The Business Case was then submitted to the Essential Services Commission (ESC) as part of the CWW Water Plan 2013 – 2018. The ESC decided not to include the Altona Stage 2 project in the Water Plan, meaning that the project should be deferred for consideration in the next water plan. Although the scheme was predicted by financial analysis to be Net Present Value positive, it has been put on hold due to the ESC considering the scheme, among other things, to not be time critical. More information on this decision is given in the Outcomes section of this report.

There is some possibility of the scheme still going ahead in the future, for example if CWW was to decide to undertake the project outside of the water plan.
Project Background

The Altona area of Melbourne is home to a number of major industrial water users including Qenos, Mobil, Toyota and Australian Vinyls. Since 2004 City West Water has been investigating opportunities to provide fit for purpose recycled water to these industrial customers for uses which do not require drinking water.

Investigations by City West Water in 2006 revealed a total recycled water demand in the area of Altona of more than 7,200 ML/year and several studies have been completed to determine the appropriate sources, production and supply systems for providing an alternative water supply.

Water infrastructure

The Altona Stage 1 scheme was commissioned in March 2011 and recycled water is currently being supplied to one industrial customer, two golf courses and some public open space managed by Hobsons Bay City Council.

Since the production capacity and product water at the Altona Treatment Plant is fully allocated, CWW investigated options for alternative water supplies for providing recycled water to the remaining customers within the Altona Industrial Precinct. This resulted in CWW beginning the investigation and planning of the Altona Stage 2.

Melbourne Water’s Western Treatment Plant is located ~16km away and currently has enough recycled water capacity to supply the Altona region with the remaining alternative water supply demands.
The first alternative water source strategy for Altona was completed during the “millennium drought” which lasted between 1997 and 2007. During this time the water resources situation in Melbourne steadily worsened to the point where authorities were operating in crisis mode. Public water supplies across Melbourne were running low and groundwater aquifers were being depleted. For these reasons recycled water schemes were very popular for an extended period following the drought. This period is referred to by some as “the golden age of recycled water”. As explained in the Organisational and Political section below, this context changed significantly by the time Altona Stage 2 was submitted to the ESC.

Organisational and political

Integrated Urban Water Management has been slowly imbedded within the culture of City West Water over the past decade and sustainable water management has been embedded in CWW’s Statement of Obligations and Corporate Plan.

This commitment was encouraged and strengthened by the creation of the Living Melbourne, Living Victoria Implementation Plan and the Office of Living Victoria. The state government had stated a strategic priority of increasing the use of alternative water supplies as well as delivering multiple benefits to the community, environment and system resilience (Ministerial Advisory Council, 2011).

However there is also a counter trend away from recycled water schemes. The construction of Melbourne’s Wonthaggi desalination plant, north-south pipeline, and increased time having passed since the drought have contributed to a decreasing emphasis on recycled water within the public interest and also Victoria’s water sector and government. If Altona Stage 2 had been planned and implemented during the “golden age”, then it is likely it would have experienced less difficulty being approved.

At this time a commitment to meeting a recycled water target no longer exists and it has been stated by experts that “the golden age of recycled water” is over. Early in 2015 the Office of Living Victoria was dissolved leaving some uncertainty around the future of IUWM in Melbourne.
IMPROVING PLANNING PROCESSES FOR IUWM INFRASTRUCTURE

INTEGRATED PROJECT MANAGEMENT

Planning scale

Altona Stage 2 was identified through a local-scale planning process which investigated recycled water demands. The project was then planned and arranged by CWW, the water retailer, in discussion with industrial customers without coordination from a regional or sub-regional strategy. At certain points the planning of Altona stage 1 and 2 were considered as part of the State Government’s 20% recycling target initiative, although the Altona stage 2 project was predominantly considered outside of, and after, this process.

Project team functioning and oversight

Project team functioning and oversight for the Altona Stage 2 project is typical of water sector infrastructure projects. However one major difference is the consistent meetings held between CWW and MW counterparts over a long time period. Monthly meetings were held between CWW and MW planners for the duration of the planning of the scheme. In addition to this, meetings were held between CWW and MW at the steering committee level over the same period. The main purpose of the interaction between CWW and MW was that CWW required land at Western Treatment Plant to build a salt reduction plant, and also an agreement to supply the source water. CWW secured agreement from MW for both items.

Figure 4 – Project team function and oversight

Throughout this process it has been important that relationships were built between CWW and MW staff, allowing them to put faces to names and have a regular point of contact, and facilitation for meetings.
Risk management

Existing national and international research has suggested that planners are often overly optimistic when planning public infrastructure projects and the research has highlighted risk management methods as a crucial element in infrastructure planning.

Typical project management and construction risks are not central to the themes of the current research, and so a focus will be placed on risks specifically associated with alternative water source projects.

<table>
<thead>
<tr>
<th>Table 4 – Major risks considered in planning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Risk</strong></td>
</tr>
<tr>
<td>Potential future reduction in recycled water demands due to industrial users going out of business or moving</td>
</tr>
<tr>
<td>Feed water quality/operational issues</td>
</tr>
</tbody>
</table>

Feed water quality and operational issues are considered to be minor. However the more substantial risk of customers reducing or ceasing their demands cannot be entirely mitigated. It is impossible to determine an accurate probability and severity of this risk. Logically it can be considered that over the 35 year lifespan some of the customers will reduce or cease supply. Due to this reason CWW made sure to do a thorough sensitivity analysis to see what the impact to the projects financial bottom line would be if they lost customers at different time-steps.

As this particular case study has not been implemented, it is not yet possible to know if, and to what extent, the risks will eventuate.

STAKEHOLDER AND COMMUNITY ENGAGEMENT

Engagement process

For the purposes of an industrial recycled water scheme no specific consultation with the wider community is explicitly required by EPA guidelines. However earlier community consultation has revealed a general community support for water recycling. A customer survey undertaken by Strahan Research for CWW in June 2011 found that 87.4% of residential customers and 91.2% of business customers see recycled water projects as important to solving Melbourne’s water shortage issues.

Scheme customers were engaged directly to determine the water volumes and quality required for their operations and their attitudes towards switching water sources.
Stakeholder incentives

City West Water

CWW has an incentive to act in line with both government and organisation policy, which is supportive of alternative water source schemes. CWW also has a financial incentive to implement a scheme which is NPV positive. However CWW will not be worse off only if a ‘beneficiary pays’ agreement can be reached – where CWW is paid for the benefits they give the greater region. Additionally there is a reputational incentive to act innovatively and be responsive to customer needs.

Scheme customers

There are three major incentives for scheme customers to sign up to water from Altona Stage 2. Firstly, it’s cheaper than potable water, which is their current water source. Customers are estimated to save a total of $27M over the 35 year life of the project. Secondly, the water quality is specifically designed to their requirements. Thirdly, customers still have the flexibility to shut down or move their businesses. However CWW undertook to have long-term plan discussions on the future of major customers to ensure they had confidence to go ahead with the scheme.

CWW broader customer base

CWW’s broader customer base will have to pay for any project costs which are not covered by revenue from the scheme. The scheme is predicted to be NPV positive over a 35 year period, and so the wider customer base may experience a saving. However previous research has shown that public infrastructure in general, and recycled water schemes in particular, do not always perform as predicted, therefore there is a small financial risk involved for the CWW customer base.

Melbourne Water Corporation

Melbourne Water has an obligation to look after the interests of the wider population of Melbourne. Implementation of Altona Stage 2 will likely help to defer the next major water infrastructure augmentation, and therefore has the potential to provide a benefit to Melbourne Water customers. In this scheme MW is also the bulk water supplier and so has an incentive to cover their own production costs.
Local government (Wyndham and Hobson’s Bay Councils)

Proposed project infrastructure spans two Local Government Areas, namely Hobson’s Bay, which includes a majority of the Altona Industrial Precinct, and Wyndham, which includes the WTP and surrounding land. Local government has not played a major role in the planning of the scheme, although Hobson’s Bay Council is likely to receive a benefit from Altona Stage 2 in the form of increased economic activity.

Regulators

Regulation for this project can be divided along the lines of financial, health and environmental regulation and will be covered in the Governance and Regulation section later in this case study report.

OPTION IDENTIFICATION AND SHORTLISTING

The preferred option of Altona Stage 2 was selected through a number of stages of option refinement. In 2006 a range of alternative sources of non-potable water were identified including: rainwater; surface water from swamps and creeks; groundwater and aquifer storage recovery; seawater, and recycled water from the WTP. These water sources were considered in combinations of various servicing strategies. These strategies were developed into a list of 30 options. By ranking each of the options on their environmental, social, energy use, water quality and water security merits, they were refined into a short list of 8 options.

Figure 6 – Option shortlisting process

Following on from the selection of 8 options a decision making framework was developed and an additional multi-criteria analysis was undertaken. This MCA framework was developed by the consultant in conjunction with CWW and focussed on water supply, operability, environmental impacts, social/community impacts, and energy use. The MCA was combined with cost benefit analysis to select four options for concept design and detailed evaluation.

These four options can be seen in Table 5. The base case of continued supply of potable water was not considered as an option because it does not meet any of the predetermined strategic objectives; however a cost comparison with this option is included in the Financing section of this case study.
CWW has found this process of option identification and shortlisting has been both necessary and useful. Because of these processes CWW has documentation of how and why options were selected. CWW recommends future planning processes involve similarly rigorous levels of shortlisting.

Table 5 – Shortlisted options for further analysis

<table>
<thead>
<tr>
<th>Options considered</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base case</td>
<td>Business as usual potable supply to industrial customers</td>
</tr>
<tr>
<td>Centralised scheme using sewer mining</td>
<td>Involves sourcing untreated wastewater directly from sewers and treating to Class A standards at an entirely new treatment plant. Under this option 6,250 ML/yr would be mined from the upper lengths of the Western Trunk Sewer to produce approximately 5,000ML of fit-for-purpose water which would be reticulated to industrial users.</td>
</tr>
<tr>
<td>Centralised scheme with supply from Western Treatment Plant (WTP)</td>
<td>Implementation of a Class A recycled water salt reduction scheme to supply approximately 5,000 ML/yr to the Altona Industrial Precinct. The option involves the treatment of Class A recycled water from the WTP to produce high quality recycled. This option will involve the construction of a transfer pipeline from the WTP to Altona as well as a 21 km recycled water distribution network to supply the treated water to the end users.</td>
</tr>
</tbody>
</table>
| Localised scheme using stormwater, groundwater and sewer mining | Involves the establishment of four separate treatment facilities and distribution networks within the local areas to serve groups or clusters of customers. The total feedwater supply and recycled water distribution network would be approximately 22 km in length. Up to 5,000 ML/yr of treated water will be supplied to the industrial users in four areas of the industrial precinct from the following:
  - 1 stormwater treatment plant (1.4 ML/d treated water)
  - 2 groundwater treatment plants (4.8 + 1.1ML/d treated water)
  - 1 sewer mining treatment plant (6.4 ML/d treated water), sourcing raw sewage from the Western Trunk Sewer |
| Localised scheme using stormwater and sewer mining       | Localised scheme where the customers are serviced from one sewer mining plant and one stormwater treatment plant located at the Altona Recycled Water Plant Stage 1 site. The total feedwater supply and recycled water distribution network would be about 20 km in length. Up to 5,000 ML/yr of treated water will be supplied to the industrial users from the two treatment plants:
  - 5.2 ML/d stormwater treatment plant
  - 8.4 ML/d sewer mining treatment plant |
CWW have already completed the planning and implementation of two other recycled water salt reduction treatment plants. Therefore although Altona Stage 2 is a relatively large scheme, it is also relatively standard, and the only types of technical evaluation which are required are the basic elements which are necessary to complete the option selection process. For this project this includes demand, cost and revenue estimates, triple bottom line assessment, and qualitative assessment of risk.

**Demand estimates**
- Demand estimates were calculated through direct engagement with customers and assessment of current water demands.
- The potential for lost demand through industrial users closing down or moving has been considered in the risk assessment and sensitivity analysis.

**Cost estimates**
- Capital expenditure for the options were initially calculated by design engineers, confirmed by specialist cost estimator in November 2011 and then reviewed in line with recently received tenders for a similar project.
- These figures can be found in the following section, Option Selection.

**Revenue estimates**
- Revenue estimates for the options were calculated by multiplying prices by estimated demands. Revenue has been included in the Option Selection section where the method through which the preferred option was selected is discussed.
- For the preferred option sensitivity analysis was conducted to consider what would happen to revenue if prices vary from predictions or the largest customer ceases supply.

**Triple bottom line assessment**
- CWW adopted an MCA approach which is a semi-quantitative analysis using assessment criteria and which is consistent with the DTF’s IEPG and DSE’s Draft Guidelines for Planning and Reporting Recycled Water Programs.
- The criteria and weightings were determined by the Executive Management Team, with the scoring applied in a facilitated workshop, with CWW officers from the Water Innovation, Conservation & Environment, Planning, Water Quality, Standards and Design, Operations and Regulation Sections.

**Qualitative, comparative risk assessment**
- CWW and the consultant conducted a comparative risk identification process. The assessment was focussed on the actual construction and operation risks, as opposed to corporate and financial risks.

The method by which the technical information was used to select the preferred option is detailed in the Option Selection section.
OPTION SELECTION

In order to determine the preferred option, one more MCA process was conducted which utilised the technical evaluation data in the following steps. The results are shown in Table 6.

Step 1: An assessment of the degree to which the option aligns with strategic responses determined to be a) more effective use of available water; and b) improved access to a greater range of low cost water sources.

Step 2: A preliminary financial assessment

Step 3: A multi-criteria triple bottom line assessment using the weightings of 40% for environment 20% for socio-economic and 40% for financial factors.

Step 4: A qualitative, comparative risk assessment

Figure 7 – Selection of the preferred option
Table 6 – Option selection results (Included costs represent initial estimates. Updated cost figures for the preferred option are included in the financing section of this case study)

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Centralised Sewer Mining</th>
<th>Centralised from WTP</th>
<th>Localised stormwater, groundwater &amp; sewer mining</th>
<th>Localised stormwater and sewer mining</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. INTERVENTIONS - Does the option satisfy the strategic intervention?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More effective reuse of available water</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Improved access to a greater diversity of water sources</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Ensure water is used for the most appropriate purposes</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>2. FINANCIAL ASSESSMENT (IN RELATION TO RECYCLING OPTION)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital cost ($M)</td>
<td>113%</td>
<td>100%</td>
<td>302%</td>
<td>401%</td>
</tr>
<tr>
<td>Operating cost ($M/yr)</td>
<td>114%</td>
<td>100%</td>
<td>134%</td>
<td>136%</td>
</tr>
<tr>
<td>Net present cost (@5.1%)</td>
<td>114%</td>
<td>100%</td>
<td>252%</td>
<td>323%</td>
</tr>
<tr>
<td>Levelised break-even ($/kL)</td>
<td>2.43</td>
<td>2.14</td>
<td>5.4</td>
<td>6.92</td>
</tr>
<tr>
<td>Annualised break-even ($/kL)</td>
<td>1.08</td>
<td>0.96</td>
<td>2.4</td>
<td>3.07</td>
</tr>
<tr>
<td>3. TRIPLE BOTTOM LINE SCORE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weighted TBL Score</td>
<td>-0.7</td>
<td>0.4</td>
<td>-0.43</td>
<td>-0.59</td>
</tr>
<tr>
<td>4. RISK ASSESSMENT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of unmitigated high risks</td>
<td>3</td>
<td>5</td>
<td>6</td>
<td>5</td>
</tr>
</tbody>
</table>
The final round of option assessment showed that out of the alternative water source options centralised recycling from WTP was the most financially efficient scheme and the one with the highest Triple Bottom Line score.

After the preferred scheme was identified then CWW did detailed financial analysis of the scheme. CWW has found this component to be the most difficult part of the planning process because it is easy to gain agreement on processes; however actual inputs to benefit calculations are arguable.

CWW planners received assistance in developing the justification for the scheme through “Investment Management Standard workshops” by an independent DTF-accredited facilitator – undertaken by CWW in May 2010 and subsequently revisited in October 2012. CWW found these sessions to be useful for getting senior management on board, and recommends they may be of use in future planning processes.

The results of financial evaluation on this preferred option can be found in Table 7. This shows that the scheme is predicted to be NPV positive over a 35 year lifespan.

Table 7- Financial analysis over 35 years

<table>
<thead>
<tr>
<th>Item</th>
<th>NPV ($ to represent $20M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total project costs (Capex and Opex)</td>
<td>- $$$$$$$</td>
</tr>
<tr>
<td>Avoided potable water costs</td>
<td>$$$$$</td>
</tr>
<tr>
<td>Avoided augmentation costs*</td>
<td>$*</td>
</tr>
<tr>
<td>Avoided desal variable costs</td>
<td>$</td>
</tr>
<tr>
<td>Other CWW project bulk RW cost savings</td>
<td>$</td>
</tr>
<tr>
<td>Revenue (85% of potable price)</td>
<td>$$$$$$$</td>
</tr>
<tr>
<td>Potable revenue reduction</td>
<td>-$$$$$$$$$</td>
</tr>
<tr>
<td>Total project net position</td>
<td>$</td>
</tr>
</tbody>
</table>

* The financial assessment includes benefit from deferral of the next major potable headworks augmentation. In this case CWW has no mechanism by which to recover these headworks benefits, but would in theory be doing a service to the entire Melbourne region.

East-west potable water transfer benefits may also be created by the scheme in terms of deferred augmentation and reduced pumping costs, these have not been included so far, but work is being done to consider this aspect in the future.

Therefore as Altona Stage 2 was found to be (1) the highest scoring option in the TBL assessment, (2) the cheapest option, and (3) predicted to save money in comparison to the base case. In addition this project was consistent with government policies, business strategic orientation, Statement of Obligations progressing towards a resilient system, water security/drought proofing, climate change adaptability, customer needsREQUESTS, wider customer base support for this type of sustainable water management initiatives etc. This was enough to justify the project to the CWW Board.

**GOVERNANCE AND REGULATION**

**Health and environmental regulation**

Involvement with the health regulator, Department of Health (DoH), was limited due to the fact that feed water to the CWW-owned recycled water treatment plant has already been approved by DoH as being Class A standard.
In terms of environmental regulation, which is managed by the Environmental Protection Agency (EPA), CWW is likely required to write an Environmental Improvement Plan and possibly to seek a Works Approval for construction. However these requirements are both standard and are not predicted to be an issue for the implementation of Altona Stage 2.

Financial regulation

Financial regulation for this scheme has been conducted through a somewhat opaque process involving three different regulators to some extent. The Department of Treasury and Finance is responsible for approving major investments, the Department of Sustainability and Environment (has been recently renamed) which is overseen by the Office of the Minister for Water, and the Essential Services Commission sets the tariffs which water authorities may charge residents through the approval of a 5 year water plan.

Altona Stage 2 was included in CWW’s Water plan for 2013-18 and submitted to the ESC. CWW has received a response from ESC stipulating that Altona Stage 2 should not be included in the current water plan and should therefore be put on hold. The eventual outcome for the Altona Stage 2 project is not yet clear. The reasoning behind the decision to put the project on hold appears to be the recommendation from PwC consultants (Essential Services Commission, 2013). The documentation available to researchers is vague, and additional information would be helpful in order to understand the ESC decision.

FINANCING

The financing of Altona Stage 2 is typical of any CWW infrastructure project. Capital is sourced from a combination of existing funds and borrowings and the project is expected to pay for itself over its lifetime. No specific additional grants have been made available or sought for this project, which is in contrast to the majority of the other case studies investigated by this research program.

Financial impacts to other organisations have been considered in an economic assessment. The included organisations are CWW, MW and scheme customers, with organisation-specific benefit cost ratios of 1.06, 1.00 and 1.17 respectively. Therefore, according to planning predictions, scheme customers stand to make a substantial profit from the scheme, and for CWW the scheme is expected to be slightly NPV positive, compared to business as usual.

For MW the net financial impact is predicted to be zero, with a benefit cost ratio of 1. However this assumes that the agreed feedwater price is enough to cover MW’s operating expenses. The prices that MW charges for its RW from WTP are affected by a complex web of interactions with other users and also influence from politics. At many points in time MW has sold recycled water at a loss. Therefore whether this price actually covers MW’s operating expenses is an issue which may require a revisit if CWW continues to seek the scheme’s implementation into the future.

OUTCOMES

As stated earlier the scheme has been put on hold by the ESC at least for the duration of this Water Plan 2013 – 18. The decision was influenced by a Price Waterhouse Coopers review which found that “based on information received … PwC did not consider the justifications for the project were compelling… City West Water has not demonstrated the project to be economically efficient and there was lack of analysis demonstrating that the timing of the investment is prudent” (Essential Services Commision, 2013).

However the official decision has not precluded the project going ahead with other, potentially private, sources of funding. So far efforts in this area have been unsuccessful.
FINDINGS

1. Altona is theoretically NPV positive if a value for potable headworks augmentation deferral benefits is included

According to the financial assessment Altona Stage 2 represents a rare opportunity to implement a recycled water potable water substitution scheme which is predicted to be NPV positive. The majority of alternative water source schemes rely heavily on government grants and/or subsidy by an authority’s wider customer case. Although, the financial assessment includes an approximately benefit (~20% of total Capex) from deferral of the next major potable headworks augmentation, in this case CWW has no mechanism by which to accrue these headworks benefits, which are received by the entire Melbourne region.

2. For Melbourne’s particular situation there are relatively simple methods which can be used to calculate potable headworks augmentation deferral benefits

One reason for the NPV positive evaluation result is the inclusion of a value for deferring future infrastructure augmentation expenses. The simple and logical method used has involved multiplying potable water substituted by 35 years, and assuming this volume is accumulating within the very large Thomson dam, and mitigating the need to upgrade Melbourne’s desalination plant. This is a progressive step towards the inclusion of externalities in decision making. It may be appropriate to apply a similarly simple and replicable method to all potable water substitution schemes being planned in Melbourne. The method and value used for this benefit should be determined at a regional or industry scale.

3. Financial evaluation methods should be set at a regional level and then implemented consistently

When taking a broader view, and looking at all of Melbourne’s IUWM schemes, it becomes apparent that different projects are justified through different financial evaluation methods. It is the opinion of the researchers that in the future if IUWM planning is to be consistent and justifiable, then financial evaluation methods, such as valuing externalities, should be set at regional level through collaboration between all of Melbourne’s water authorities and regulators. If financial evaluation methods were set at a regional level, then this would remove the possibility of disputes between water authorities and regulators around which IUWM infrastructure should be built.

4. Risk assessment is extremely important when planning alternative water source projects

Findings from previous research have shown that alternative water source schemes often do not perform as predicted. Actual demands are sometimes lower than expected and more variable than expected and unexpected technical, or even political factors can affect the financial outcomes of alternative water source schemes. It can therefore be stated that the risks for these types of schemes always need to be considered earnestly and thoroughly. In the case of the Altona Stage 2 scheme there is a significant potential risk of customer demands dropping at least partially during some period of the scheme’s lifetime. Planners have attempted to mitigate this risk as much as possible through contracting and seeking alternative users if this risk becomes a reality, and also conducting sensitivity analysis. It should also be noted that industrial users have a far more consistent demand for recycled water than seasonal and climate dependant irrigators.

5. A project that is initially NPV positive is less sensitive to uncertainties than a project which is already known to be NPV negative during business case development

A logical assumption to make would be that demands will not be steady over the 35 year period regardless of any risk mitigation attempts. However the project is predicted to be NPV positive. This creates a realistic probability of the project breaking even regardless of uncertainties, which is a substantially better financial outcome than many other alternative water source schemes. This positive NPV, however, assumes that the potable headworks benefit calculation is justifiable.
6. Communication between regulators and planners needs to be clear

Financial regulation for the Altona Stage 2 scheme has been conducted through a somewhat opaque process involving a regulatory process which is not often utilised, and with the operations of the evaluation being conducted by a private economics consultant, Pricewaterhouse Coopers (Essential Services Commission, 2013). The published ESC Water Plan review was lacking in detail. In this context communicating regulatory decisions and the reasoning behind them is particularly important and absolutely crucial for effective infrastructure planning.

REFERENCES


City West Water, 2011. Altona Recycled Water Project (Stage II) Strategic Assessment & Options Analysis, s.l.: s.n.


City West Water, 2013. Altona Recycled Water Project Stage 2 Business Case, s.l.: s.n.


## Appendix B3 – Coldstream Recycled Water Project

### Lead organisation
- **CROPS**

### Location
- **Yarra Valley**

### Water source
- **Lilydale STP**

### Treated water quality
- **Class B**

### End use
- **Irrigation**

### Predicted volume
- **1GL/year**

### Actual volume (average so far)
- **Still being planned**

### Total Capex (recycling scheme)
- **$~6M (2014$)**

### Predicted production cost
- **$~1000/ML (2014$)**

### Customer charge
- **$600/ML (2014$)**

### Interesting aspects of this case study
- **Project ownership, financial evaluation and financing**

<table>
<thead>
<tr>
<th><strong>Table 1 – Case study information</strong></th>
</tr>
</thead>
</table>

*Authors: Casey Furlong, Lachlan Guthrie, Saman De Silva*  
*RMIT University*
EXECUTIVE SUMMARY

A consortium of farmers from the Yarra Valley region, known as CROPS, are seeking to implement a scheme to supply 1000ML of Class B Recycled Water every year from Yarra Valley Water's Lilydale sewerage treatment plant to their farms. CROPS originally approached YVW to own and operate the scheme. YVW estimated that the capital cost of the scheme would be higher than what CROPS could fund. CROPS have been investigating other options for a number of years since then.

CROPS hired a consultant to represent them, and planned a scheme which they estimate will cost approximately $6M. According to their estimates, users are able to fund $4M of this, leaving a $2M requirement for external funding. CROPS have been in communication with the State Government and Melbourne Water in an attempt to achieve this funding through local economy and river health benefits.

Efforts to achieve funding from these sources have not so far been successful, and so the scheme may not be able to proceed. However there is now a chance the project will receive funding from the current Labour Government, which has proposed a $500M agriculture infrastructure and jobs fund, to be funded by the sale of the Port of Melbourne for $6 – 9 billion. The Victorian Farming Federation has shortlisted Coldstream for Capex and planning finance support. If the Coldstream project wins a share of this funding the project will be able to go ahead.

Findings

1. Privately operated recycled water schemes may become more common in the future

There is increasing speculation around what role private companies should play in water service provision. Victoria currently has one private company (TOPAQ) involved in the supply of recycled water, and such companies can also be found in South Australia, New South Wales and overseas.

2. Water utilities are more qualified to run recycled water schemes than private entities, and so all public options should be considered before private options

Public water authorities in general, and YVW in particular, have a vast amount of experience in planning and operating recycled water projects. In comparison, planning and operating recycled water schemes does not generally fit within the job description of wine-producers. Therefore it could be considered that CROPS attempting to plan Coldstream Recycled Water Project privately is not the ideal scenario, particularly in terms of long term continuity of ownership. In this case this was not possible due to the fact that CROPS believe they are able to implement the scheme at approximately half the capital cost that YVW estimated.

3. There is currently no clear and consistent regulatory process to guide the planning of private recycled water schemes in Victoria

In Victoria the EPA has a lot of experience in regulating recycled water schemes in terms of environmental aspects, but there is no regulatory body to scrutinise private recycled water schemes for financial viability. In NSW there is an agency called IPART, a pricing regulator similar in function to Victoria's Essential Services Commission. IPART is required to assess proposed private recycled water projects for financial viability and decide whether or not they should proceed. This is because if the scheme is built and then found to be unsustainable, then this has not only a private impact but also a public impact. In the absence of a standard regulatory process, water utilities such as YVW must determine the financial sustainability of private recycled water schemes on a case by case basis.

4. There is currently no clear and consistent funding application process for private recycled water schemes in Victoria

There should be clear mechanisms through which funding support can be applied for and a transparent and consistent process through which this funding support is approved or denied. In the case of Coldstream this was further complicated by the installing and then removal of the Office of Living Victoria. Melbourne Water has undertaken to do an environmental benefits assessment to determine if they should contribute funding. However there was no existing standard process for this. State government representatives also considered contributing funding to the scheme for its
5. Different methods of valuing waterway benefits from recycled water schemes can vary by a factor of 1000

Depending on the benefit calculation method used, the Coldstream project may produce between $40k and $40M worth of waterway benefits. This highlights (1) the care planners should take when selecting the appropriate method, and (2) that there has not been consistency across the evaluation of recycled water schemes over time. The water sector should continue to catalogue and compare different valuation methods to refine this in the future, however it may not ever be possible to determine a waterway benefits calculation that will be acceptable to all stakeholders.

6. The world is not static; the community/government desire for recycled water schemes varies drastically over time

The popularity of recycled water schemes cycles with climate variation. If the Coldstream project had been planned in the “golden age of recycled water”, during or directly after the drought, there may have been more support available for the scheme. Because the scheme was planned long after the end of the drought, there was far less incentive for water utilities and the state government to provide financial support. On the other hand, midway through the planning of Coldstream it became clear that funding may be able to be sourced from the Victorian Andrew’s Government’s sale of the Port of Melbourne, which could not have been predicted by CROPS at the beginning of the process. This goes to show that the world is not static, and the context for planning recycled water schemes is always changing.

7. The Coldstream project represents a rare opportunity to safeguard a farming region against drought, and therefore some State Government funding is justified

The project is not able to achieve full cost recovery. However according to the estimates it is more cost-effective than many other alternative water source schemes and will provide an array of benefits which will perhaps only be noticed once the next drought arrives. Farms all over Australia are suffering from drought. This project represents a rare opportunity to safeguard Australian industry against drought and climate change. Therefore in the authors’ opinion some level of state or federal government funding is justified.
The number of "integrated" water projects and strategies across Australia is steadily growing; however there are gaps in knowledge surrounding the most effective way to manage their planning and decision-making processes. As water projects and strategies become increasingly integrated, in terms of interactions between different water services, functions, and organisations, the planning processes for these become increasingly important and complex. This is due to increasing numbers of stakeholders, competing objectives, implicit non-market values and possible infrastructure options and combinations that are available.

RMIT University is working with Water Research Australia and Melbourne Water to investigate ways to improve the planning processes for Integrated Urban Water Management (IUWM) infrastructure at the strategy creation and physical project level. This study has divided the overall planning process into a generic list of planning components referred to here as a “planning framework” shown on the following page, collected information on a variety of real-world case studies, analysed and compared the differing approaches that have been used, and created guidelines to assist future planning efforts.

In this research a conceptual distinction has been made between; planning for “IUWM projects”, here meaning planning for discrete physical infrastructure assets which may or may not have been advised by a strategy, and planning for “IUWM strategies”, here meaning mid to long term strategies which are used to inform infrastructure portfolios for specified geographical areas.

The research objectives are to (1) understand the current and historical water infrastructure planning context, (2) catalogue and compare differing planning processes to determine which techniques are more effective, and (3) provide a platform from which future water infrastructure planning processes can be conducted in an informed manner.

This case study report is one of 16. These case studies were selected together with water industry experts and are shown in Table 2.

<table>
<thead>
<tr>
<th>Organisation</th>
<th>IUWM strategies</th>
<th>IUWM infrastructure projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barwon Water</td>
<td>Towards a Botanic Colac</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Review of IWCM options for Fyansford</td>
<td></td>
</tr>
<tr>
<td>City of Melbourne</td>
<td>Total Watermark</td>
<td>Fitzroy gardens SWH project</td>
</tr>
<tr>
<td>City West Water</td>
<td>Footscray IWM Investigation</td>
<td>Altona Recycled Water Project Stage 2</td>
</tr>
<tr>
<td>Private</td>
<td></td>
<td>Coldstream RW project</td>
</tr>
<tr>
<td>SA Water</td>
<td>SA Water’s Long Term Plan for Eyre Region</td>
<td></td>
</tr>
<tr>
<td>South East Water</td>
<td>Water Initiatives for 2050</td>
<td>Boneo Recycled Water Project</td>
</tr>
<tr>
<td>Water Corporation</td>
<td>Water Forever South West</td>
<td></td>
</tr>
<tr>
<td>Western Water</td>
<td>Recycled Water Strategy</td>
<td>Toolern SWH project</td>
</tr>
<tr>
<td>Yarra Valley Water</td>
<td>Northern Growth Area IWCM Plan</td>
<td>Coburg SWH project</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kalkallo SWH project</td>
</tr>
</tbody>
</table>
The researchers have developed an infrastructure planning framework to assist in the analysis of the case studies as shown below in Figure 1. A journal paper on this process has been published in Utilities Policy journal (Furlong, et al., 2016). For each of the case studies the researchers have recorded information on each of the planning components contained in blue boxes.

**Figure 1 – Infrastructure planning framework developed to assist in case study analysis**

Each case study begins with an introduction, followed by the details on planning, and then concludes with the findings which the researchers have extracted from the case study. Definitions and scopes of the planning components are shown below in Table 3. Contents of case studies have been approved by the lead organisations, although the findings are the opinions of the authors.

**Table 3 - Meaning and included concepts of planning components**

<table>
<thead>
<tr>
<th>Planning Component</th>
<th>Meaning and included concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Context</td>
<td>Anything which precedes the planning process, including political, environmental, and economic contexts, and preceding plans and strategies</td>
</tr>
<tr>
<td>Integrated project management</td>
<td>Project team functioning, management and reporting, and risk management</td>
</tr>
<tr>
<td>Community &amp; stakeholder engagement</td>
<td>Engagement with external stakeholder organisations and the broader community</td>
</tr>
<tr>
<td>Option identification and shortlisting</td>
<td>Identification of initial options and shortlisting prior to detailed analysis</td>
</tr>
<tr>
<td>Technical evaluation</td>
<td>Collection and analysis of technical information, including modelling and design, to provide data to inform the option selection stage</td>
</tr>
<tr>
<td>Option selection</td>
<td>Assessment, ranking, and/or scoring of options to determine the preferred option and planning recommendations</td>
</tr>
<tr>
<td>Governance and regulation</td>
<td>Analysis, review, and approval of planning recommendations by internal management and relevant external regulators</td>
</tr>
<tr>
<td>Financing</td>
<td>Financing arrangements (internal funding, cost sharing and/or grants)</td>
</tr>
<tr>
<td>Outcomes</td>
<td>Anything which comes after the determination of planning recommendations</td>
</tr>
</tbody>
</table>
INTRODUCTION

Many farmers in Australia are subject to inconsistent rainfall patterns and steadily increasing climate change impacts. Farmers are therefore concerned about their water resources situations and seek alternative climate resilient water sources where available.

The Yarra Valley in Victoria contains more than 20 farms that produce high value horticulture including winegrapes, soft fruit and orchard fruit, in Melbourne’s Green Wedge Zone. The current water supply system is not secure enough to under-write long term farming production contracts, as it relies on catchment dams, winter-fill diversion licences, and potable supply and is currently experiencing low rainfall three years out of ten, resulting in uncertain yields and quality.

These farmers are seeking an alternative water source to drought-proof their production and give them confidence to sign long term supply contracts. They have created a consortium which has been named Coldstream Recycled water Pipeline Pty Ltd (CROPS) and hired a consultancy to help represent their interests.

Initially CROPS approached Yarra Valley Water (YVW) to request that YVW construct, own and operate a recycled water scheme to supply water to their farms from Lilydale Sewage Treatment Plant. YVW estimated a total cost to CROPS of around $12 -20M, depending on the size of the scheme. CROPS were unable to find funding for this amount. The project size and design was then revised by CROPS to something which they believe will cost approximately $6M including design and contingency. However YVW does not agree that it can be achieved for such a low cost.

Figure 2 – Scheme layout

Initial designs include a supply of 1GL/year of Class B recycled water at a constant supply of 3ML/day into farm dams supplied through a new 15km pipeline from Lilydale Sewerage Treatment Plant (STP). Continuous supply was selected to maximise supply and minimise capital and pumping costs over on-demand pressurised supply. It is planned that some growers of strawberry and vegetables may construct small-scale polishing plants on their properties to refine supplied recycled water to Class A. These polishing plants would to be paid for by individual farmers.
There is a plan to add on to this recycled water network over time, in stages to reduce risk and ensure viability as follows:

- **Stage 1:** 15km pipeline supplying 1000ML to 20 growers. Bulk Supply Agreement confirmed with YVW
- **Stage 2:** Expand demand from stage 1 pipeline
- **Stage 3:** Expand to West and South - with extra supply from YVW STP at Brushy Creek
- **Stage 4:** Expand to north of the Yarra River

However YVW and CROPS do not currently have a supply agreement for these later stages.

CROPS estimate that Stage 1 will cost $6M. Farmers are only able to fund $4M for the scheme and so have spent the last two years in discussion with Melbourne Water, YVW and various government agencies trying to convince them to contribute $2M towards the scheme on the basis of waterway health and regional economic benefits. The results of this process up until the beginning of 2016 are covered in the Outcomes section of this report.

**CONTEXT**

**Project Background**

Planning for the Coldstream project originally started in 2008. Since this time the long term champion has been Yarra Ranges Council (YRC), who have been interested in the project predominantly due to economic development drivers. YRC is officially a metropolitan council, meaning it is within Melbourne’s boundaries, but is partially rural due to the green wedge around Melbourne.

In 2010 a business case for the Coldstream project was developed, with funding from YRC, Melbourne Water, Yarra Valley Water, and DSDBI. This was arranged by an economic development officer within YRC, who has a long history of working for the Department of Primary Industries in the area of agriculture. This initial planning process was also supported by the Environmental Protection Authority (EPA).

A willingness to pay study was conducted, based on other similar schemes, and produced a scattergram showing the willingness to pay of around $300/ML. Later site specific work then revealed a willingness to pay of around $600/ML. A business case was made assuming that YVW would construct the plant as a means of reducing effluent discharge to Olinda Creek. This was assumed by CROPS because as far as they were aware it is the case in other places around Melbourne such as Western Water and South East Water.
YVW did not take over the planning of the Coldstream project as they had no incentive. This original business case was based on the YVW initial estimate of approximately $12M in total capital required for the scheme. Farmers sought a grant of $7-9M because otherwise the project would be unaffordable for them. This initial business case did not proceed as the State Government declined the grant on the basis of it being too expensive and that there was not enough proof of interest.

Over time, the farms in the Yarra Valley have become more corporatised and organised and the potential long term impacts of climate variability became more recognised. Yarra Valley farmers are now trying to secure export contracts which require 3-5 years of consistent production. In order for farmers to have the confidence to sign up to these contracts a secure water source is essential. An example of one of these long term supply contracts is alcohol purchases by the Norwegian and Canadian governments, who have a monopoly on alcohol importation and distribution in their countries.

In April 2013 three people approached a consultant about becoming involved in the planning and advocacy of this project. These three people included two growers and the economic development manager at YRC.

The time period from 2013 – 2015 has been spent exploring delivery options, building engagement with local growers, setting up Coldstream Recycled water Pipeline Pty Ltd (CROPS), engaging with multiple agencies trying to find point of leverage for receiving $2M in funding support, and building political interest.

**Water infrastructure**

Yarra Valley in Victoria is a mostly rural farming region in Melbourne’s Green Wedge Zone. Produce from the area includes winegrapes, fresh fruit and vegetables. Farms within the Yarra Valley predominantly source their water from catchment dams, winter-fill diversion licences, and in some cases also potable supply. Lilydale sewerage treatment plant is located slightly to the south of the CROPS farms.

![Figure 4 – Lilydale Sewerage Treatment Plant](image)

**Environmental, social and economic**

During the Millennium drought in Australia (approximately 1997 – 2007), and in the years immediately following the drought there was a high level of public support for recycled water. During this time the water resources situation in Melbourne steadily worsened to the point where authorities were operating in crisis mode. Public water supplies across Melbourne were running low and groundwater aquifers were being depleted. For these reasons recycled water schemes were very popular for an extended period following the drought. This period is referred to by some as “the golden age of
recycled water”. As explained in the Organisational and political section below, this context changed significantly by the time Coldstream came under consideration by Melbourne Water, and the State Government.

**Organisational and political**

As a privately led enterprise, the Coldstream project is distinctly different to other case studies investigated as part of this research. CROPS, the entity which is advocating for this project is a consortium of farmers acting in accordance with their long term business interests. This also potentially creates different political interactions than would occur between public water authorities and politicians. The Coldstream project has largely been championed by the Yarra Ranges Council and is supported by Christine Fyffe the local member of State Parliament.

However because the scheme’s planning has extended after the end of the “golden age of recycled water” into 2016, there is far less support of all kinds available to proponents of water recycling schemes.

**INTEGRATED PROJECT MANAGEMENT**

**Planning scale**

Coldstream recycled water project has been identified and being planned by a private consortium of farmers in Victoria’s Yarra Valley Region, on the outskirts of Melbourne, entirely separately from any larger-scale planning process. YVW, and at a certain point the OLV, had some involvement with the project, but the project was not considered as part of any larger plan or strategy. The Yarra Ranges Council has also been involved with certain elements, but the project has been largely run as an independent and private enterprise.

**Project team functioning and oversight**

The project team functioning and oversight for the Coldstream project is drastically different to the other case studies included in this research program. The consultant is representing CROPS and assisting with advocacy and communication with YVW, MW and various government agencies to secure funding support and further develop the business case.

![Figure 5 – Project team functioning during 2014/15 business case development](image-url)
After extensive planning had already occurred the consultant took the lead in the planning of the Coldstream project. In this capacity they liaised with the other project partners. The consultant was given a key account manager from MW, and at YVW. In the eyes of the consultant and CROPS, MW and YVW provided strategic endorsement but limited practical support in the early stages of project planning, whereas the EPA was considered quite helpful.

From their perspective, YVW put an appropriate amount of time and effort, as well as some money, into preliminary cost and engineering assessments for the scheme, but were simply unable to deliver what CROPS were hoping for.

As part of development of a more detailed business case YVW has been given specific responsibility for setting easements and assisting with development of the Environmental Improvement Plan with the EPA. Melbourne Water has accepted the lead role in developing the environmental benefits module, and YRC leads the work on planning permits and related issues.

The consultant, as a representative of CROPS, is involved in coordinating and managing the development of different aspects of the business case. Table 4 shows a full list of responsibilities.
### Table 4 – Responsibilities of partners

<table>
<thead>
<tr>
<th>Project</th>
<th>Demand</th>
<th>Supply</th>
<th>Route</th>
<th>Control</th>
<th>Construct</th>
<th>Planning</th>
<th>Viability</th>
<th>Commerce</th>
<th>Regional</th>
<th>WWCM</th>
<th>Environ</th>
<th>EIP</th>
<th>Health</th>
</tr>
</thead>
<tbody>
<tr>
<td>CROPS</td>
<td>✔✔✔</td>
<td>✔✔✔</td>
<td>✔✔✔</td>
<td>✔✔✔</td>
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</tr>
<tr>
<td>Melbourne Water</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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<tr>
<td>Yarra Valley Water</td>
<td>✔</td>
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<td>Yarra Ranges Council</td>
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<tr>
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<tr>
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</table>
Risk management

Existing national and international research has suggested that planners are often overly optimistic when planning public infrastructure projects and the research has highlighted risk assessment methodologies as a crucial element in infrastructure planning.

Typical project management and construction risks are not central to the themes of the current research, and so a focus will be placed on risks specifically associated with alternative water source projects.

An official risk assessment has not been conducted as part of the planning of Coldstream as yet. Researchers have, in discussion with the consultant, YVW and MW, noted some of the potential risks in the project and how they can be addressed.

Table 5 – Potential scheme risks

<table>
<thead>
<tr>
<th>Risk</th>
<th>Consideration/Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potential future reduction in recycled water demands</td>
<td>If demands from farmers drop significantly then the financial viability of the scheme would be damaged. This can be managed effectively through take or pay contracts, assuming that the land will not be rezoned to residential or commercial. However any environmental improvements from the scheme would be reduced if the water utilised by the scheme is reduced.</td>
</tr>
<tr>
<td>Risks to surrounding environment from recycled water contaminating groundwater</td>
<td>This risk is considered by the EPA as part of assessing the relevant Environmental Improvement Plan, and is expected to be managed effectively through appropriate controls.</td>
</tr>
<tr>
<td>Risk of project being blocked by EPA</td>
<td>Recycled water is used on a large number of farms throughout Victoria, therefore this is not considered to be a significant risk.</td>
</tr>
<tr>
<td>External funding of $2M is not achievable</td>
<td>If external funding is not achieved then potentially the scheme will not be viable. This is a significant risk.</td>
</tr>
<tr>
<td>Difficulty finding an appropriate delivery mechanism i.e. owner and operator of pump and pipeline</td>
<td>There are various options being considered for delivery mechanisms. If a suitable candidate is not discovered then the scheme is unlikely to be able to proceed.</td>
</tr>
<tr>
<td>Capital cost increases above what is estimated</td>
<td>YVW does not believe that CROPS will be able to implement the scheme for $6M. There is a risk that YVW is correct. However this may be able to be managed through careful tendering and contracting processes so that this risk is transferred to the construction contractors.</td>
</tr>
</tbody>
</table>

Thorough risk assessments will need to be completed in planning evaluations at a later date.
STAKEHOLDER AND COMMUNITY ENGAGEMENT

Engagement process

In other case studies considered in this research program, planning activities are conducted almost solely by the project team and the lead organisation. In contrast, the Coldstream project is being planned collaboratively with a range of stakeholders. Therefore this makes “stakeholders” part of the project team, and the engagement process embedded in the other planning elements. No community consultation was conducted in the planning of this project however in this case the direct users (farmers) effectively constitute a significant proportion of the affected community.

Figure 6 – Stakeholder influence vs. impact map.
*Agency has recently been dissolved

Stakeholder incentives

CROPS

CROPS have a financial incentive to proceed with the scheme so that farmers have water and production security into the future. Recycled water supply would likely also increase the value of the farming land.

Yarra Valley Water

YVW has a responsibility to maximise recycling, but also to minimise community cost. River health is not traditionally within the jurisdiction of YVW; however the organisation has recently stated that it has an expanded mandate to consider all impacts on the community.

Melbourne Water

MW has an incentive to maximise waterway health in the most cost effective manner. In this sense MW must truly understand the river health impacts of implementing the scheme, both positive and potentially negative.
Yarra Ranges Council

The Council has been the long term champion of the project. Its key interest in the project has been regional economic development.

Environmental Protection Authority

EPA is responsible for authorising the use of the recycled water under a regional Environmental Improvement Plan to minimise risks to waterways and groundwater. The incentive of the EPA is solely to prevent damage to the environment.

Department of Health

DoH is responsible for leadership on decisions regarding use of the recycled water for fresh produce and standards for any Class A plant required. As a health regulator DoH has an incentive to ensure that the scheme causes no direct or indirect health risks to humans.

Southern Rural Water

SRW licenses groundwater diversions and is concerned about any potential risk to groundwater supplies.

Office of Living Victoria

The OLV was dissolved in late 2014. However prior to this it was involved to some extent in assisting the planning of the scheme. This stakeholder’s incentive was previously to coordinate government policy regarding whole of water cycle management for the region.

Department of Environment and Primary Industries

Government agencies have reshuffled recently. DEPI used to house the minister for water and engages with government policy on water management.

Department of State Development, Business and Innovation

Government agencies have reshuffled recently. DSDBI, when it existed, had an incentive to promote business development across Victoria.

OPTION IDENTIFICATION AND SHORTLISTING

Project options considered for Coldstream Recycled Water Project fall into three categories: water source options, sizing options and delivery options. In each of these categories no formal option assessment process was conducted. These options were considered informally and qualitatively by CROPS over a number of years.

<table>
<thead>
<tr>
<th>Water source options</th>
<th>Informal assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diversions from the Yarra</td>
<td>Not sustainable, especially in low rainfall</td>
</tr>
<tr>
<td>Groundwater</td>
<td>Too salty and poor yield</td>
</tr>
<tr>
<td>Potable supply</td>
<td>Too costly and not fit-for-purpose</td>
</tr>
<tr>
<td>Recycled water</td>
<td>The best option in terms of cost and availability. Lilydale STP is the obvious best option for the sourcing of Recycled water</td>
</tr>
<tr>
<td>Delivery options</td>
<td>Informal assessment</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Ownership and operation by YVW</td>
<td>First option considered but comes with pressure to set high asset specifications and delay construction. Not commercially viable for growers</td>
</tr>
<tr>
<td>Growers own and operate</td>
<td>Challenging to find growers with the time, interest and capacity to set up and run a pipeline supply company</td>
</tr>
<tr>
<td>Third Party Infrastructure Manager</td>
<td>Most groups want to buy an on-going operation and not carry construction and establishment risks. The group met a number of possible partners, some of which currently own and operate recycled water schemes.</td>
</tr>
</tbody>
</table>

Considering that YVW did not want to own and operate the scheme, CROPS have opted for recycled water from Lilydale STP using a delivery mechanism which is a hybrid between growers operating themselves and a third party becoming involved. It is proposed that growers drive the construction to carry the risk with the possibility of a hand over to a third party at a later stage. One such third party originally wanted to get involved after the scheme was in operation as this involves a low risk, however now they are even considering becoming involved earlier.

**TECHNICAL EVALUATION**

Technical evaluation of the Coldstream project has been conducted by a number of different agents as explained under the various headings below. Actual figures can be found in the following section, Option Selection.

### Demand and revenue estimates
- Demand estimates were calculated through direct farmer to farmer engagement
- Original willingness to pay study resulted in around $300/ML, however more recently it is considered that willingness and ability to pay sits at $600/ML
- Revenue estimates for the options were calculated by multiplying assumed prices by estimated demands

### Cost estimates
- Capital expenditure for the options were initially calculated by YVW to be in the area of $12 - 20M
- CROPS estimates this figure to be $6M including contingency

### Waterway health benefit
- 5.6mg/litre of Nitrogen in recycled water multiplied by 1000ML/year removed from Olinda Creek.
- Modelling to determine environmental benefits received from the project in terms of flow and nutrient reductions to Olinda Creek
OPTION SELECTION (PROJECT JUSTIFICATION)

In some of the case studies utilised in this research, various decision support systems were used to select final infrastructure options. In the case of Coldstream it was determined from an early stage in planning that the preferred option was a recycled water scheme, and the location of this scheme, as discussed in the Option Identification and Shortlisting section. Therefore this section will focus not on option selection, but rather on project justification through financial evaluation.

Project justification

Financial modelling shows that at $600/ML direct user charges the scheme is able to fund $4M in total over the life of the scheme. This leaves a need for $2M of external funding which requires justification. It is considered that external funding for this gap by Melbourne Water can be justified by the following benefits.

*Indirect Financial Benefit 1 – Nitrogen Reduction*

If the Coldstream project is implemented it will result in reduced nitrogen levels being discharged to Olinda Creek. In Melbourne, developers must meet minimum requirements for nutrient removal in stormwater captured on their development. If developers are unable or unwilling to meet this nutrient removal requirement then they are required to pay Melbourne Water a financial contribution for development of stormwater treatment offsets in another location. As discussed in Appendix B6 Coburg Stormwater Harvesting Project case study, this contribution was recently set at $1,110 per kg of nitrogen.

In this case the nitrogen load removed from Olinda Creek due to the Coldstream project is estimated to be 5600 kg per year.

\[
(5.6 \text{ mg/L} \times 1000 \text{ ML/year} \times 1,000,000) / 1,000,000 = 5600 \text{ kg/year}
\]

This results in a nitrogen reduction equivalent to $6,216,000 in offset charges.

\[
1,110 \text{ $/kg} \times 5600 \text{ kg} = 6,216,000
\]

This value is a potential cost saving to Melbourne Water because it could theoretically be achieved in place of another nitrogen reducing project elsewhere in the drainage system. This is also a way of putting a dollar value on the environmental benefits produced through the scheme.

However, unlike the Coburg case study example, Melbourne Water is not specifically considering the creation of a wetland in the Lilydale STP, or Olinda Creek areas. Therefore a dollar for dollar transfer is not likely to be appropriate.

CROPS are seeking $2M in funding. If Melbourne Water was to contribute this then it would equate to a cost of approximately $300/kg of nitrogen reduction.

\[
$2,000,000 / 5600 \text{ kg} = 357 \text{ $/kg}
\]

*Indirect Financial Benefit 2 – Reduction of diversions from vulnerable Yarra River tributaries*

Current water sources for Yarra Valley farms include catchment dams which intercept flows to small, vulnerable tributaries of the Yarra, winter-fill dams with licensed diversions from tributaries of the Yarra, and potable supplies – which are used by strawberry growers as a supplementary supply.

The proposed scheme will displace the use of these current surface-water diversions. It will also replace demands for potable supplies.

However according to Melbourne Water there may be some environmental damage caused by removing the recycled water from Olinda Creek, so it may not be reasonable to assume a net environmental benefit to rivers.
Indirect Financial Benefit 3 – Economic stimulation of the area

The Coldstream project will also promote regional economic development benefits in the Yarra Valley region. These benefits include increased:

- Purchase of farm supplies from regional suppliers
- Employment of staff who spend their earnings within the local economy
- Processing of primary products, for example wine production and vegetable packing
- Promotion of wider regional activities such as tourism and recreation that are linked to the success of the irrigated sector

Modelling is required to quantify these wider benefits. This will be undertaken in collaboration with the Economic Development staff in Yarra Ranges Council and regional staff from DSDBI. This gives the project access to tools such as REMPlan that allow input/output modelling of the knock-on economic effects of an increase in primary production on the regional economy.

The economic benefits will also provide a more robust, resilient and sustainable regional community.

Funding is intended to be sought from DSDBI for these benefits.

Other justifications

The proposal is strongly aligned with the priority focus of Melbourne’s Water Future, which provides “a vision of a smart, resilient water system for a liveable, sustainable and productive Victoria”. The pipeline proposal meets the following priorities:

- Initiative 3.1.4: A community engaged in whole-of-water cycle management: Partner with communities
- Initiative 3.3.5: Sensible use of water in business: Increase peri-urban farms’ use of non-drinking water
- Initiative 3.4.1: Resilient water systems: Support and facilitate investment in projects that enhance water system resilience
- Initiative 3.5.4: Improved waterways and bays
- Initiative 3.5.5: Make better use of treated wastewater: Protect our catchments and plan for the long term management of our waterways:
- Initiative 3.7.1: Accelerated innovation and world recognition of expertise: Establish Melbourne as a global leader in water cycle management

These initiatives were promoted by the Office of Living Victoria through its regional metropolitan plans. However since the dissolving of the OLV, acting in accordance with their centrepiece strategy may no longer be seen by government as a priority.

GOVERNANCE AND REGULATION

Delivery mechanisms for the scheme are discussed in the Option Identification and Shortlisting section, and the Outcomes section. Financial regulation is not applied to private water companies in Victoria, as opposed to NSW, where schemes are required to prove they are commercially viable to an independent pricing regulator.

Health regulation

Only Class A water is regulated by the Department of Health. Class B recycled water is regulated by the EPA as part of required Environmental Improvement Plan. If any Class A polishing plants are planned in the future these will need to be approved by the DoH.

Environmental regulation

Environmental regulation is done almost entirely through the Environmental Improvement Plan regulated by the EPA. It has been stated by farmers that the EPA was quite helpful during the
planning process but was indecisive about the approval of recycled water for storage in farm dams. It has been determined that each individual farm will need its own EIP licence.

FINANCING

A submission was made to Living Victoria Fund for 200k to fund the business case to validate the proposed approach. This submission was with the Office of Living Victoria for 7 months before eventually being denied.

If council was purely regional then there would be access to regional development Victoria funding. The YRC region is a fringe area which is half metro and half regional, and therefore regional funding sources are not available. If located in a regional area CROPS are confident they could achieve a 50% subsidy for their scheme, making it viable.

At present the scheme is expected to cost $6M to construct including contingency and planning. CROPS, through funding from local growers are able to invest $4M to reflect private commercial benefits, leaving a $2M gap. All growers are to sign long-term contracts to cover capital and operating costs. Financial modelling confirms adequate return to investors at fair price to growers. At $4M capital then annual charges at $600/ML are affordable, however without external funding a $6M capita cost then volume charges of $1,000/ML is not affordable.

Efforts to source outside funding are continuing. The consultant are in discussion with Melbourne Water, Yarra Valley Water and various government departments in an attempt to find the $2M in external funding required to make the project financially viable. MW has said the only way they can fund is if they have avoided costs elsewhere, which is difficult to prove.

There is still a possibility of the scheme achieving external funding. This is discussed in the Case Study Update in the following section.

OUTCOMES

The planning of the Coldstream project is ongoing.

CROPS is refining the design of the project to provide a more tightly defined design and cost, and will then seek two design and construct quotes, which will be followed by an independent audit.

Yarra Ranges Council is becoming more actively involved, and taking the lead on cultural heritage, flora and fauna impacts.

Further investigation is being done into possible delivery options. One option being considered is a joint funding arrangement with a private recycled water supply company. This third party will be included in the design and construct quotes, project management for procurement and construction oversight, establishment of customer contracts and billing, operational management, and discussions on longer term ownership.

However the scheme is experiencing considerable hurdles. It is being found that it is too difficult for the farmers to manage the scheme themselves so a third party is required. But the scheme is not big enough to be commercially viable for a third party.

Case Study Update (early 2016)

An internal Melbourne Water assessment has been conducted into the Coldstream project which involved consultation with the Environmental Flows, Rural Land, Water Quality, and Diversions teams. After careful scrutiny, Melbourne Water has decided that the Coldstream project does have benefits, but does not positively impact its business activities enough to warrant a funding contribution.

This decision is partially based on the choice to quantify nitrogen removal using the Long Run Marginal Cost (LRMC) for WTP treatment, rather than the Stormwater Offset Contribution. The stormwater offset contribution considers criteria of multiple benefits on top of nitrogen removal such as habitat, recreation facility and community benefits which are not delivered, according to MW’s
definition, by this project. In their consideration MW chose between these two options and determined the LRMC was the most appropriate.

In order to put this in perspective we have considered these two options together with the method used in the Coburg case study, and also the amount of funding required.

<table>
<thead>
<tr>
<th>Table 7 – Difference in nitrogen benefit calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LRMC of treatment at WTP</strong></td>
</tr>
<tr>
<td>Cost</td>
</tr>
<tr>
<td>Annual or one off</td>
</tr>
<tr>
<td>Load</td>
</tr>
<tr>
<td>Total funding justified</td>
</tr>
</tbody>
</table>

Melbourne Water has decided that the LRMC is the correct metric to use, as the scheme is primarily reducing nitrogen and not providing a stormwater asset. Therefore MW funding has not been recommended. Without funding the scheme may not go ahead. However from Melbourne Water’s perspective there are other, more appropriate, funding avenues through State Government departments that may better align with the goals of the project. This is because the project is providing a mechanism to improve the viability of businesses (with potential environmental benefits as a by-product).

There is still one possible avenue which can be taken towards the implementation of the scheme. The current Victorian State (Andrews) Government is attempting to sell the Port of Melbourne for $6 – 9 billion. A significant proportion of the value of the port has been derived from farming, mostly dairy and grain, and also the sale of the port could potentially affect farmers. Therefore the Andrews Government has proposed a $500M agriculture infrastructure and jobs fund, and the Victorian Farming Federation has shortlisted Coldstream for Capex and planning finance support. If the Coldstream project wins a share of this funding the project will be able to go ahead.

**FINDINGS**

1. **Privately operated recycled water schemes may become more common in the future**

   There is increasing speculation around what role private companies should play in water service provision. Victoria currently has one private company (TOPAQ) involved in the supply of recycled water, and such companies can also be found in South Australia, New South Wales and overseas.

2. **Water utilities are more qualified to run recycled water schemes than private entities, and so all public options should be considered before private options**

   Public water authorities in general, and YVW in particular, have a vast amount of experience in planning and operating recycled water projects. In comparison, planning and operating recycled water schemes does not generally fit within the job description of wine producers. Therefore it could be considered that CROPS attempting to plan Coldstream Recycled Water Project privately is not the ideal scenario, particularly in terms of long term continuity of ownership. In this case it was not possible due to the fact that CROPS believe they are able to implement the scheme at approximately half the capital cost that YVW estimated.

3. **There is currently no clear and consistent regulatory process to guide the planning of private recycled water schemes in Victoria**

   In Victoria the EPA has a lot of experience in regulating recycled water schemes in terms of environmental aspects, but there is no regulatory body to scrutinise private recycled water schemes for financial viability. In NSW there is an agency called IPART, a pricing regulator similar in function to
Victoria’s Essential Services Commission. IPART is required to assess proposed private recycled water projects for financial viability and decide whether or not they should proceed. This is because, if the scheme is built and then found to be unsustainable, then this has not only a private impact but also a public impact. In the absence of a standard regulatory process, water utilities such as YVW must determine the financial sustainability of private recycled water schemes on a case by case basis.

4. There is currently no clear and consistent funding application process for private recycled water schemes in Victoria

There should be clear mechanisms through which funding support can be applied for and a transparent and consistent process through which this funding support is approved or denied. In the case of Coldstream this was further complicated by installing and then removal of the Office of Living Victoria. Melbourne Water has undertaken to do an environmental benefits assessment to determine if they should contribute funding. However there was no existing standard process for this. State government representatives also considered contributing funding to the scheme for its economic benefits, but there does not appear to have been a standard process for this consideration either. There is no clear policy on whether funding subsidies should, or should not, be offered to recycled water schemes in the future.

5. Different methods of valuing waterway benefits from recycled water schemes can vary by a factor of 1000

Depending on the benefit calculation method used, the Coldstream project may produce between $40k and $40M worth of waterway benefits. This highlights (1) the care planners should take when selecting the appropriate method, and (2) that there has not been consistency across the evaluation of recycled water schemes over time. The water sector should continue to catalogue and compare different valuation methods to refine this in the future, however it may not ever be possible to determine a waterway benefits calculation that will be acceptable to all stakeholders.

6. The world is not static; the community/government desire for recycled water schemes varies drastically over time

The popularity of recycled water schemes cycles with climate variation. If the Coldstream project had been planned in the “golden age of recycled water”, during or directly after the drought, there may have been more support available for the scheme. Because the scheme was planned long after the end of the drought, there was far less incentive for water utilities and the state government to provide financial support. On the other hand, midway through the planning of Coldstream it became clear that funding may be able to be sourced from the Victorian Andrews Government’s sale of the Port of Melbourne, which could not have been predicted by CROPS at the beginning of the process. This goes to show that the world is not static, and the context for planning recycled water schemes is always changing.

7. The Coldstream project represents a rare opportunity to safeguard a farming region against drought, and therefore some State Government funding is justified

The project is not able to achieve full cost recovery. However according to the estimates it is more cost-effective than many other alternative water source schemes and will provide an array of benefits which will perhaps only be noticed once the next drought arrives. Farms all over Australia are suffering from drought. This project represents an opportunity to safeguard a regional industry against drought and climate change. Therefore in the authors’ opinion some level of state or federal government funding is justified.
REFERENCES


T., M., Multiple occasions. *Meetings to discuss Coldstream project [Interview] Multiple occasions.*
## Appendix B4 – Boneo Irrigation Scheme

<table>
<thead>
<tr>
<th><strong>Lead organisation</strong></th>
<th>South East Water</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Location</strong></td>
<td>Mornington Peninsula</td>
</tr>
<tr>
<td><strong>Water source</strong></td>
<td>Boneo STP</td>
</tr>
<tr>
<td><strong>Treated water quality</strong></td>
<td>Class A</td>
</tr>
<tr>
<td><strong>End use</strong></td>
<td>Irrigation</td>
</tr>
<tr>
<td><strong>Predicted volume</strong></td>
<td>1.67GL/year</td>
</tr>
<tr>
<td><strong>Predicted volume</strong></td>
<td>1.67GL/year</td>
</tr>
<tr>
<td><strong>Actual volume</strong></td>
<td>0.66GL/year</td>
</tr>
<tr>
<td><strong>Actual volume</strong></td>
<td>0.66GL/year</td>
</tr>
<tr>
<td><strong>Predicted cost</strong></td>
<td>$36/ML (2007$)*</td>
</tr>
<tr>
<td><strong>Customer charge</strong></td>
<td>$270/ML (2007$)</td>
</tr>
<tr>
<td><strong>Interesting aspects of this</strong></td>
<td>Risk management, financial evaluation and regulation</td>
</tr>
</tbody>
</table>

Table 1 – Case study information

*Authors: Casey Furlong, Lachlan Guthrie, Saman De Silva
RMIT University*
EXECUTIVE SUMMARY

The Boneo Irrigation Scheme involves the use of recycled water from a minor sewage treatment plant for irrigation of public open space, market gardens, golf courses and school ovals. Stage 1, a 1.67GL/year scheme began operation in 2009. Stage 2, which would have involved sourcing additional recycled water from Melbourne Water’s South East Outfall, was never constructed due to lack of demand. There have been no serious technical, health and safety, or environmental problems associated with the scheme. Actual volumetric usage of recycled water has been below 50% of what was expected, presumably because of the end of the millennium drought. Because take or pay contracts were utilised the drop in demand has not been a financial issue for South East Water. The non-implementation of Stage 2 has had a negative effect on the financial bottom line of the Boneo scheme, but the scheme has been successful in providing water security to the region, and it is likely that the water usage will increase in the next dry period.

Findings

1. Future risk assessments and financial evaluations should consider project stages independently as well as in combination to understand implications of later stages not proceeding

Financial analysis of the Boneo scheme was done looking at Stage 1 and 2 as a combined project. The fact that Stage 2 has not gone ahead has had a negative impact on the project’s financial bottom line. The risk assessment did not consider the possibility of Stage 2 not going ahead. In the future, for projects that involve multiple stages, it may be prudent to include independent assessments of early stages, and include all significant factors which would lead to this outcome in the risk assessment.

2. Planning processes should not be considered in isolation but rather as an integrated network of decisions

The Central Region Sustainable Water Strategy (CRSWS) strategy mandated an upgrade to tertiary treatment and an earlier strategy set a 20% water recycling target. Due to these previous decisions the Boneo scheme became possible. The major factors affecting the implementation of the scheme were therefore determined during previous planning processes. This illustrates the point that infrastructure plans should not be considered in isolation but rather as part of an integrated network of decisions.

3. Maximum volume capacity of recycled water irrigation schemes should not be used to calculate benefits because actual usage can be significantly lower

Actual usage of recycled water from the Boneo scheme has averaged at .66GL/year since operation began. This is well below half of the maximum available of 1.67GL/year. Boneo and many other recycled water schemes show that water authorities should err of the side of caution when calculating the benefits of recycled water irrigation schemes.

4. Take-or-pay contracts are an essential element of recycled water irrigation schemes

Take-or-pay contracts which were used with water customers ensure that customers pay whether they use the recycled water or not, and this has been a crucial cornerstone of the project. If this type of contract had not been used the financial impact of a drop in demand would be significant.

5. Extra care is required if a tertiary treatment is added to an STP at the same time as a capacity upgrade

If an STP capacity upgrade is to be conducted at the same time as the addition of a tertiary treatment system planners need to be aware that the secondary effluent may have initial variations in quality, and the tertiary treatment system should be able to accommodate this. A longer time period should be allocated to commissioning before committing to customer supply.

6. Differing methodologies for undertaking financial assessment of schemes can lead to confusion when comparing different schemes


At first glance it is difficult to understand why a scheme with a Nett Present Cost of $36/ML being sold at $270/ML could have a negative NPV. The financial assessment of the Boneo scheme, in particular how the Nett Present Cost per ML was calculated, was done in a different way than the other case studies. Procedures followed were stipulated by the Department of Treasury and Finance and the costs used in the calculation were not the total cost, but rather the difference between the base case option and the recycling option. For this reason care needs to be taken when comparing the NPC$/ML of Boneo with the other case study levelised costs per volume.
The number of "integrated" water projects and strategies across Australia is steadily growing; however there are gaps in knowledge surrounding the most effective way to manage their planning and decision making processes. As water projects and strategies become increasing integrated, in terms of interactions between different water services, functions, and organisations, the planning processes for these become increasingly important and complex. This is due to increasing numbers of stakeholders, competing objectives, implicit non-market values and possible infrastructure options and combinations that are available.

RMIT University is working with Water Research Australia and Melbourne Water to investigate ways to improve the planning processes for Integrated Urban Water Management (IUWM) infrastructure at the strategy creation and physical project level. This study has divided the overall planning process into a generic list of planning components referred to here as a “planning framework” shown on the following page, collected information on a variety of real-world case studies, analysed and compared the differing approaches that have been used, and created guidelines to assist future planning efforts.

In this research a conceptual distinction has been made between; planning for “IUWM projects”, here meaning planning for discrete physical infrastructure assets which may or may not have been advised by a strategy, and planning for “IUWM strategies”, here meaning mid to long term strategies which are used to inform infrastructure portfolios for specified geographical areas.

The research objectives are to (1) understand the current and historical water infrastructure planning context, (2) catalogue and compare differing planning processes to determine which techniques are more effective, and (3) provide a platform from which future water infrastructure planning processes can be conducted in an informed manner.

This case study report is one of 16. These case studies were selected together with water industry experts and are shown in Table 2.

<table>
<thead>
<tr>
<th>Organisation</th>
<th>IUWM strategies</th>
<th>IUWM infrastructure projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barwon Water</td>
<td>Towards a Botanic Colac</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Review of IWCM options for Fyansford</td>
<td></td>
</tr>
<tr>
<td>City of Melbourne</td>
<td>Total Watermark</td>
<td>Fitzroy gardens SWH project</td>
</tr>
<tr>
<td>City West Water</td>
<td>Footscray IWM Investigation</td>
<td>Altona Recycled Water Project Stage 2</td>
</tr>
<tr>
<td>Private</td>
<td></td>
<td>Coldstream RW project</td>
</tr>
<tr>
<td>SA Water</td>
<td>SA Water’s Long Term Plan for Eyre Region</td>
<td></td>
</tr>
<tr>
<td>South East Water</td>
<td>Water Initiatives for 2050</td>
<td>Boneo Recycled Water Project</td>
</tr>
<tr>
<td>Water Corporation</td>
<td>Water Forever South West</td>
<td></td>
</tr>
<tr>
<td>Western Water</td>
<td>Recycled Water Strategy</td>
<td>Toolern SWH project</td>
</tr>
<tr>
<td>Yarra Valley Water</td>
<td>Northern Growth Area IWCM Plan</td>
<td>Coburg SWH project</td>
</tr>
</tbody>
</table>

This table shows a summary of the case studies utilised in the research program.
**HOW TO READ THIS CASE STUDY**

The researchers have developed an infrastructure planning framework to assist in the analysis of the case studies as shown below in Figure 1. A journal paper on this process has been published in Utilities Policy journal (Furlong, et al., 2016). For each of the case studies the researchers have recorded information on each of the planning components contained in blue boxes.

![Infrastructure planning framework developed to assist in case study analysis](image)

Each case study begins with an introduction, followed by the details on planning, and then concludes with the findings which the researchers have extracted from the case study. Definitions and scopes of the planning components are shown below in Table 3. Contents of case studies have been approved by the lead organisations, although the findings are the opinions of the authors.

**Table 3 - Meaning and included concepts of planning components**

<table>
<thead>
<tr>
<th>Planning Component</th>
<th>Meaning and included concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Context</td>
<td>Anything which precedes the planning process, including political, environmental, and economic contexts, and preceding plans and strategies</td>
</tr>
<tr>
<td>Integrated project management</td>
<td>Project team functioning, management and reporting, and risk management</td>
</tr>
<tr>
<td>Community &amp; stakeholder engagement</td>
<td>Engagement with external stakeholder organisations and the broader community</td>
</tr>
<tr>
<td>Option identification and shortlisting</td>
<td>Identification of initial options and shortlisting prior to detailed analysis</td>
</tr>
<tr>
<td>Technical evaluation</td>
<td>Collection and analysis of technical information, including modelling and design, to provide data to inform the option selection stage</td>
</tr>
<tr>
<td>Option selection</td>
<td>Assessment, ranking, and/or scoring of options in order to determine the preferred option and planning recommendations</td>
</tr>
<tr>
<td>Governance and regulation</td>
<td>Analysis, review, and approval of planning recommendations by internal management and relevant external regulators</td>
</tr>
<tr>
<td>Financing</td>
<td>Financing arrangements (internal funding, cost sharing and/or grants)</td>
</tr>
<tr>
<td>Outcomes</td>
<td>Anything which comes after the determination of planning recommendations</td>
</tr>
</tbody>
</table>
APPENDIX B4 – BONEO IRRIGATION SCHEME

INTRODUCTION

Irrigators in the Boneo region on the Mornington Peninsula needed a new source of water for irrigation. The Nepean Groundwater Aquifer, which was the traditional source of irrigation water in the region, has been fully allocated for some time. Southern Rural Water (SRW), the groundwater regulator, placed a moratorium on the issuing of new groundwater licences in 2003. This prevented irrigators from expanding their operations and has cast doubt on the security of existing groundwater entitlements.

The Boneo Irrigation Scheme involves the use of recycled water from a minor sewage treatment plant for irrigation of public open space, market gardens, golf courses and school ovals. It was first conceived in the early 2000s, and came under serious consideration in 2006 as part of the Central Region Sustainable Water Strategy (CRSWS) because at this point it was decided that the Boneo Sewerage Treatment Plant should increase its effluent quality to Class A.

Major motives for the project included improving water security for public open space and farmers, and also environmental protection. Implementation of the scheme also provided a cost-effective way for South East Water to meet their contribution towards the State Governments 20% water recycling target by 2010 target.

Figure 2 – Scheme layout for Stage 1 and 2

Stage 1, a 1.67GL/year scheme began operation in 2009. Capital works for Stage 1 included:

- a plant capacity upgrade,
- tertiary treatment (Class A) upgrade,
- 9km pipeline,
- 14 ML/day pump station and
- 2ML storage at Boneo STP

The plant capacity upgrade and tertiary treatment upgrade were already required independent of the reuse scheme. Stage 2 was intended to involve sourcing additional recycled water from Melbourne Water’s South East Outfall. Capital works for this would have included a pump station to extract flow from the SEO and additional disinfection, and an additional pipeline to service new customers.

Actual usage for Stage 1 has been lower than expected and Stage 2 was never implemented due to lack of demand. However the use of take-or-pay contracts, which require customers to pay for the recycled water they have signed up for whether they use it or not, has ensured that the negative impact on South East Water’s financial bottom line has not been major.
BACKGROUND

A 2002 State Government water strategy set out a target of 20% water recycling by 2010 for Melbourne (Water Resources Strategy Committee for the Melbourne Area, 2002). Three years later the CRSWS process was conducted in 2005 by the State Government in collaboration with all water authorities across greater Melbourne, Geelong, Ballarat, Sunbury, Bacchus Marsh and parts of West Gippsland. The CRSWS determined that both Eastern Treatment Plant (ETP) and Boneo Sewerage Treatment Plant were required to upgrade to produce Class A effluent (DSE, 2005). Irrigators in the Boneo region were also requiring an additional source of water as groundwater supplies were under pressure and SRW had decided not to issue any new groundwater licences.

All of this created an opportunity to implement a recycled water irrigation scheme supplied by Boneo STP with a Stage 2 scheme supplied by water from ETP, a scheme that was also essential if SEW was to meet its contribution to the 20% water recycling target.

Figure 3 – Boneo irrigation scheme drivers
Water infrastructure

The Boneo scheme was planned and approved during the “millennium drought” which lasted from 1998 until 2007. During this time the water resources situation in Melbourne steadily worsened to the point where authorities were operating in crisis mode. Public water supplies across Melbourne were running low and the local groundwater aquifer was being depleted. For these reasons recycled water schemes were very popular and Boneo was one of the cheapest potential schemes in the South East Water area.

Boneo Sewage Treatment Plant (STP) discharges effluent into the South East Outfall (SEO) downstream of ETP, Melbourne’s second largest STP. The SEO discharges into Boags rocks outside of Port Phillip Bay. In 2007, action 3.20 of the Central Region Sustainable Water Strategy, required Melbourne Water (MW) to proceed with an ETP upgrade to tertiary filtration and disinfection by 2012 to meet Environment Protection Authority (EPA) works approval requirements. Therefore all downstream STPs, including Boneo, were also required to upgrade. This created an opportunity for cost-effective Class A recycling in Boneo.

Environmental, social and economic

Due to the extreme drought local councils were unable to water public open space (POS) and ovals and therefore the flora, including grass and trees, in parks were dying. The community was very upset about this, and the usage of parks for recreation was reduced, creating probable mental and physical health and wellbeing impacts. In addition to this there are potential economic impacts such as loss of tourism and business, and falling house prices.

Organisational and political

During the drought the government at all levels was supportive of recycled water schemes. Within the South East Water organisation Integrated Water Management practices were still relatively new and their IWM strategy was not begun until 2009. Therefore the Boneo scheme was planned independently of a broader IWM strategy and evaluated on its own merits according to standardised business as usual infrastructure processes.
Planning scale

As mentioned earlier Boneo was identified as part of a centralised metro-scale water strategy in collaboration with the State Government and all other water authorities in the proximity of the Melbourne region, known as the Central Region Sustainability Strategy (CRSWS). It was then planned and implemented independently by South East Water, the local water retailer.

Figure 4 – Project team functioning and oversight

Project team functioning and oversight

Actual workings of the project team for the Boneo scheme were business as usual processes completed by the SEW recycling team with oversight from the management chain. No special internal or external steering committees were set up for this project.

A customer reference group with representatives from the market gardens, local council and school was set up, and information was sent to SEW management and board as a Noting Paper, and then later on as a Business Case.

Designs were done internally, “in-house”, through a utilities services alliance which gave contractors a SEW wage and security card.

Risk management

A long list of typical risks has been considered as part of the planning of the Boneo scheme. The majority of these risks are common to all major construction works and so have not been included here. Interestingly the only three risks which have turned out to be an issue: feed water quality issues, the non-implementation of stage 2, and changing government legislation, were not identified as part of the risk assessment which was completed for the business case.
**APPENDIX B4 – BONEO IRRIGATION SCHEME**

**Table 4 – Major risks**

<table>
<thead>
<tr>
<th>Risk</th>
<th>Mitigation strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed water quality, output from secondary treatment</td>
<td>Attempted to transfer all risk to contractor, however there were issues experienced. There were disputes about maintenance and the plant shut down multiple times over the first summer</td>
</tr>
<tr>
<td>Stage 2 not going ahead</td>
<td>Not considered in business case. This risk has been identified as part of investigating this case study.</td>
</tr>
<tr>
<td>Changing government legislation</td>
<td>During the planning of Boneo the Cultural Heritage Management Plan (CHMP) government legislation changed adding approximately $250k to the project cost.</td>
</tr>
</tbody>
</table>

Feed water quality was mentioned in the body of the business case however it was assumed that all risk was being mitigated through contracts and so the issue did not need to be included in the risk assessment. In practice it eventuated that there were moderate commissioning delays caused by higher than expected organic loads and inorganic concentrations in the secondary effluent which resulted in multiple plant shutdowns. Feed water quality problems have been solved over time.

The issue of stage 2 not being implemented has turned out to be a major issue which affects the financial bottom line of the project. This risk was not discussed in the risk assessment or anywhere else in the business case. In fact the section of the risk assessment which mentions Stage 2 states that because take-or-pay contracts will be used then there is no risk to South East Water’s revenue.

Changes to CHMP legislation could not have been foreseen by SEW planners. However it is probably logical to include changing government legislation as a risk in future projects.
**STAKEHOLDER AND COMMUNITY ENGAGEMENT**

**Engagement process**

Due to the non-controversial nature of the scheme only a minor amount of community engagement took place, predominantly through council newsletters. The majority of engagement was directly with scheme customers, which included the local council and school.

Scheme customers were engaged through programmed meetings, a web portal, and ongoing communication. Financial regulators, in this case the Department of Treasury and Finance and the Department of Sustainability and Environment were proactively engaged to convey the justification for the project through a PowerPoint presentation and discussion, as well as quarterly communications.

![Figure 5 – Stakeholder influence vs. impact map](image)

**Stakeholders**

**South East Water**

The main incentive for SEW to implement the project is that it helps the organisation achieve its contribution to the 20% water recycling target in the cheapest possible way.

In addition to this, SEW has an incentive to improve its reputation with government and the community. In terms of government, it is beneficial to appear to be acting in line with policy, and in terms of the wider community it is beneficial for SEW to be seen as innovative, sensitive to customer needs, and a caretaker of market gardens and public open space.

**Scheme customers**

Customers for the Boneo scheme include schools, the Mornington Peninsula Shire Council, two golf courses and multiple market gardens (small scale producers of fruit, vegetables and flowers). Some customers previously drew on groundwater resources and others from the potable supply. Groundwater resources in the Boneo region were becoming stressed, and recycled water is typically sold at a cheaper rate than potable drinking water and not subject to water restrictions. Incentives for
customers therefore relate directly to water security and being able to continue irrigation throughout drought circumstances and aquifer depletion.

### Table 5 – List of Boneo scheme customers

<table>
<thead>
<tr>
<th>Customer</th>
<th>Use</th>
<th>Annual capacity (ML)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Council/Schools</td>
<td>Open Space</td>
<td>120</td>
</tr>
<tr>
<td>Customer 1</td>
<td>Market Garden</td>
<td>100</td>
</tr>
<tr>
<td>Customer 2</td>
<td>Market Garden</td>
<td>60</td>
</tr>
<tr>
<td>Customer 3</td>
<td>Market Garden</td>
<td>100</td>
</tr>
<tr>
<td>Customer 4</td>
<td>Market Garden</td>
<td>200</td>
</tr>
<tr>
<td>Customer 5</td>
<td>Market Garden</td>
<td>240</td>
</tr>
<tr>
<td>Customer 6</td>
<td>Market Garden</td>
<td>500</td>
</tr>
<tr>
<td>Customer 7</td>
<td>Market Garden</td>
<td>100</td>
</tr>
<tr>
<td>Customer 8</td>
<td>Golf Course</td>
<td>100</td>
</tr>
<tr>
<td>Customer 9</td>
<td>Golf Course</td>
<td>150</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>1670</strong></td>
</tr>
</tbody>
</table>

### Regulators

Regulators act as proxies for the government of the day. Regulation for this project can be divided along the lines of financial, health and environmental regulation and will be covered in the Governance and Regulation section later in this report.

### Mornington Peninsula Shire Council and residents

There was no specific engagement of local council and residents beyond the council newsletters and the fact that the council was one of the 10 customers. Local residents receive a benefit from water security for their region, however their opinions were not specifically sought, and these benefits were not calculated or paid for.

### SEW broader customer base

SEW’s broader customer base will have to pay for any project costs which are not covered by revenue from the scheme and government subsidy, a gap predicted to be $1.3 million.

The major costs associated with the scheme relate to the upgrade of the sewage treatment plant which was mandated independently of the reuse scheme as will be explored in the Financing section of this case study.
OPTION IDENTIFICATION AND SHORTLISTING

Recycling options in the SEW region had been under consideration since 2004. Over the period between 2004 and 2007 a variety of alternative schemes were considered, two examples of which are included in Table 6 below. The other options considered involved undertaking the same scheme in 2012 rather than 2009, and different treatment trains.

Table 6 – Alternative options considered and basis for exclusion

<table>
<thead>
<tr>
<th>Options considered</th>
<th>Basis for exclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undertaking recycling in 2012</td>
<td>- Higher cost&lt;br&gt; - Does not help meet 2010 recycling target&lt;br&gt; - Delays benefit to customers</td>
</tr>
<tr>
<td>Supply to Sorrento and Portsea</td>
<td>- Higher cost per volume due to longer distance and less demand</td>
</tr>
<tr>
<td>South east community recycling scheme</td>
<td>- Similar volume for far higher cost</td>
</tr>
<tr>
<td>Class A treatment technology alternatives</td>
<td>- A number of treatment trains were considered. Ultra Filtration, UV and chorine was selected based on cost and safety</td>
</tr>
</tbody>
</table>

Due to the reasons included in Table 6 above all options other than (a) the base case, and (b) the recycling option, were excluded from further analysis. SE community recycling scheme could possibly have been selected instead/in-addition, if SEW were able to get State funding assistance through the Tourism Minister at the time.

TECHNICAL EVALUATION

Because the technologies involved are well understood, the only types of technical evaluation which were conducted were demand, cost and revenue estimates.

**Demand estimates**
- Demand estimates were calculated through direct engagement with customers and assessment of current water use. SEW’s revenue stream is protected by take or pay contracts which mean there is less risk involved.

**Cost estimates**
- Capital expenditure for the implemented option was estimated through standard estimation procedure.

**Revenue estimates**
- Revenue estimates were calculated by multiplying assumed prices by allocated demands. Take or pay contracts ensure revenue from Stage 1, although sensitivity analysis and risk assessment did not consider the impact of Stage 2 not being implemented.
APPENDIX B4 – BONEO IRRIGATION SCHEME

Demand estimates were displayed earlier in Table 5. Table 7 shows the cost estimates for the Boneo scheme which were produced as part of the business case development.

Table 7 – Cost estimates for recycling option

<table>
<thead>
<tr>
<th>Description</th>
<th>Establishment costs $M (2007)</th>
<th>Replacement costs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Contingency (included)</td>
</tr>
<tr>
<td><strong>Stage 1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class A upgrade</td>
<td>8.34</td>
<td>0.76</td>
</tr>
<tr>
<td>Distribution pump station</td>
<td>1.4</td>
<td>0.2</td>
</tr>
<tr>
<td>Distribution pipelines</td>
<td>4.71</td>
<td>0.73</td>
</tr>
<tr>
<td>Distribution system storage</td>
<td>1.32</td>
<td>0.2</td>
</tr>
<tr>
<td>Customer meters and services</td>
<td>0.25</td>
<td>0.04</td>
</tr>
<tr>
<td><strong>Sub-total</strong></td>
<td>16.02</td>
<td>1.93</td>
</tr>
<tr>
<td><strong>Stage 2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distribution pipelines</td>
<td>2.4</td>
<td>0.37</td>
</tr>
<tr>
<td>Customer meters and services</td>
<td>0.1</td>
<td>0.01</td>
</tr>
<tr>
<td>SEO pump station</td>
<td>0.2</td>
<td>0.03</td>
</tr>
<tr>
<td>SEO offtake chlorination</td>
<td>0.1</td>
<td>0.01</td>
</tr>
<tr>
<td><strong>Sub-total</strong></td>
<td>2.8</td>
<td>0.42</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>18.82</td>
<td>2.32</td>
</tr>
</tbody>
</table>

Revenue assumptions were calculated in accordance with ESC principles and are shown below in Table 8.

Table 8 – Revenue assumptions for recycling option

<table>
<thead>
<tr>
<th>Charge type</th>
<th>Price ($2007)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price of recycled water</td>
<td>270/ML</td>
</tr>
<tr>
<td>Connection fee (average)</td>
<td>5000/connection</td>
</tr>
<tr>
<td>Annual service charge per customer</td>
<td>300/customer</td>
</tr>
</tbody>
</table>

These technical details, along with qualitative judgement, were all that was required to select the preferred option in the following section.
OPTION SELECTION (PROJECT JUSTIFICATION)

The conducted financial evaluation estimates a shortfall of $2.6M for the recycling option. Half of which is sought from a state subsidy for recycled, as will be discussed in the financing section.

Table 9 – Financial evaluation results for Stage 1 and 2 combined

<table>
<thead>
<tr>
<th>Option</th>
<th>NPV (at 6% rate, 2007$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base case</td>
<td>-$13 M</td>
</tr>
<tr>
<td>Recycling option</td>
<td>-$15.6 M</td>
</tr>
</tbody>
</table>

Researchers were initially confused as to why a scheme with a Nett Present Cost of $36/ML (Table 12) being sold at $270/ML (Table 8) could have a negative impact in terms of NPV (Table 9). South East Water has explained that the NPC value used was done through a DTF financial assessment methodology which has utilised only the difference between the base case and the recycling option rather than the whole Capex and Opex. For this reason it should not be used as a direct comparison to levelised costs shown in other case studies.

Following on from the financial evaluation, SEW was required to demonstrate that the more expensive recycling option was justified. This was done through a simple multi-criteria assessment which considered socio-economic and financial factors.

Socio-economic impacts considered:

- Impact on households
- Impacts on business/industry
- Impacts on the labour market
- Impacts on urban environment
- Impacts on natural environment
- Impacts on the state
- Impacts on government

Financial impacts considered:

- NPV of options

Qualitative assessment of these impacts was conducted using the Department of Treasury and Finance business case guidelines which give scores of between -4 and 4 for all socio-economic and financial impacts.
Appendix B4 – Boneo Irrigation Scheme

Table 10 – Multi-criteria assessment scores for socio-economic impacts

<table>
<thead>
<tr>
<th>Impact</th>
<th>Weighting</th>
<th>Base case</th>
<th>Recycling option</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Raw score</td>
<td>Weighted score</td>
<td>Raw score</td>
</tr>
<tr>
<td>Expected economic NPV to local area and State</td>
<td>0%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Growth of new business customers for recycled water</td>
<td>10%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Recycling volumes contributing to the 20% by 2010 Government target</td>
<td>10%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Provision and economic activity in local area</td>
<td>10%</td>
<td>2</td>
<td>0.2</td>
</tr>
<tr>
<td>Value to customer</td>
<td>15%</td>
<td>1</td>
<td>0.15</td>
</tr>
<tr>
<td>Aesthetic and recreational improvement of amenities in local area</td>
<td>10%</td>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td>Improvement of marine habitat</td>
<td>15%</td>
<td>1</td>
<td>0.15</td>
</tr>
<tr>
<td>Sustainability of Nepean aquifers</td>
<td>15%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Consistency with Government’s Policy (20% Recycling by 2010 &amp; CRSWS targets)</td>
<td>15%</td>
<td>2</td>
<td>0.3</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>7.00</td>
<td>0.90</td>
</tr>
</tbody>
</table>

The results of the multi-criteria assessment can be seen in Table 11, using a weighting of 75% for socio-economic impacts, and 25% for financial impacts in accordance with DTF guidelines.

Table 11 – Results of Multi-criteria assessment

<table>
<thead>
<tr>
<th>Type of impact</th>
<th>Impact Measurement</th>
<th>Weight</th>
<th>Status Quo</th>
<th>Base Case</th>
<th>Recycling option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial</td>
<td>Expected financial NPV</td>
<td>25%</td>
<td>0</td>
<td>-13m</td>
<td>-15.6m</td>
</tr>
<tr>
<td></td>
<td>Score</td>
<td></td>
<td>-1</td>
<td>-1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Weighted score</td>
<td>0</td>
<td>-0.25</td>
<td>-0.25</td>
<td></td>
</tr>
<tr>
<td>Socio-economic</td>
<td>Aggregate score</td>
<td>75%</td>
<td>0</td>
<td>0.9</td>
<td>2.9</td>
</tr>
<tr>
<td></td>
<td>Weighted score</td>
<td>0</td>
<td>0.68</td>
<td>2.18</td>
<td></td>
</tr>
<tr>
<td>Total score</td>
<td>100%</td>
<td>0</td>
<td>0.43</td>
<td>1.93</td>
<td></td>
</tr>
<tr>
<td>Rank order of options</td>
<td></td>
<td>3</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
Although a multi criteria assessment was conducted, this was not featured heavily in the presentation given to DTF and DSE. More prominently featured in the presentation to regulators was the comparison of production costs between Boneo and SEW's other recycling schemes shown in Table 12.

Table 12 – Comparison of production costs with SEW’s other schemes

<table>
<thead>
<tr>
<th>Recycling scheme</th>
<th>$\text{Capex}/\text{ML}</th>
<th>$\text{Capex + Opex}/\text{ML}</th>
<th>$\text{NPC}/\text{ML}</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cranbourne east</td>
<td>1149</td>
<td>1749</td>
<td>740</td>
<td>4</td>
</tr>
<tr>
<td>Cranbourne west</td>
<td>1341</td>
<td>1940</td>
<td>564</td>
<td>5</td>
</tr>
<tr>
<td>Hastings pressurisation</td>
<td>56</td>
<td>306</td>
<td>43</td>
<td>1</td>
</tr>
<tr>
<td>Mornington schemes</td>
<td>209</td>
<td>614</td>
<td>287</td>
<td>3</td>
</tr>
<tr>
<td>Boneo recycling scheme</td>
<td>153</td>
<td>278</td>
<td>36</td>
<td>2</td>
</tr>
</tbody>
</table>

Tables 11 and 12 in combination provided all of the justification required to get the Boneo scheme approved by both the SEW board and also regulators. The process through which this occurred will be covered in the following section.

GOVERNANCE AND REGULATION

Financial regulation and approval of the scheme

Financial regulation by the Department of Treasury and Finance (DTF) and the Department of Sustainability and Environment (DSE), as arms for the government, predominantly sought to assess whether the developed business case had been well thought through. The overarching justification for recycled water was not scrutinised because the 20% recycling target was a government initiative. Therefore the Boneo scheme was not required to be either NPV positive, or to justify its costs, but rather only be shown to be cheaper than other recycling options.

The interesting thing about the engagement with financial regulators in this scheme is that SEW gave a PowerPoint presentation to DTF and allowed them to ask questions and have a discussion. In other words, the regulation process involved active engagement.

Health regulation

Involvement with the health regulator, Department of Health (DoH), including the recycled water quality management plan, was largely a typical and smooth process. Some issues were experienced by planners of Boneo in relation to DoH changing some standards relatively late in the planning process. It has been suggested that in future it would be a good idea to get DoH specifications contractually confirmed earlier in the planning process.

Environmental regulation

In terms of environmental regulation, which is managed by the Environmental Protection Agency (EPA), this scheme was very standard, and so only standard operating procedures were conducted.
FINANCING

Funding sources for this project can be divided into three categories:

1. SEW customer base losses mandated by CRSWS ($13M 2007$)
2. SEW customer base losses not mandated by CRSWS but required to meet the 20% recycling target ($1.3M 2007$)
3. DSE Water Recycling fund ($1.3M 2007$)

External funding here therefore represents 8.33% of total estimated losses which need to be financed, and has therefore not played a significant role in the planning of the Boneo project.

Funding success was aided by council, school and community elements associated with this recycled water scheme. If it was all a private business scheme it may not have received part or full funding support.

OUTCOMES

Stage 1 of the scheme has been successfully implemented. Demands from the scheme so far are shown in the Figure below. The actual usage average per year is 662.3ML.

Stage 2 was not implemented because of a combination of increasing cost and decreasing demand. There had been a lot of confidence that stage 2 would go ahead based on supply needs. This was subject to MW upgrade of ETP to class A and a separate SE Water business case approval for stage 2. The following conditions influenced timing of business case:

- MW upgrade was only ready by end of 2013 - a huge time lag
- Demand requirements for Stage 2 decreased and costs increased

Researchers have estimated that, by Stage 2 not going ahead, the NPV of the Boneo recycling scheme may have become substantially more negative. Table 13 below is indicative and should not be used to calculate the change in NPV, or the increase in supply cost. However it can be used to illustrate the significance of Stage 2 not going ahead, as the combined scheme produces water at a substantially lower cost than Stage 1 alone.

<table>
<thead>
<tr>
<th>Year</th>
<th>Actual</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009/10</td>
<td>420.66</td>
<td>1670</td>
</tr>
<tr>
<td>2010/11</td>
<td>326.31</td>
<td>1670</td>
</tr>
<tr>
<td>2011/12</td>
<td>737.99</td>
<td>1670</td>
</tr>
<tr>
<td>2012/13</td>
<td>1085.5</td>
<td>1670</td>
</tr>
<tr>
<td>2013/14</td>
<td>741</td>
<td>1670</td>
</tr>
</tbody>
</table>

Figure 6 – Recycled water use from Stage 1
Table 13 – Comparison of costs for Stage 1, 2 and combined (approximate values, Capex has had the cost of the Class A upgrade subtracted because it would have happened anyway)

<table>
<thead>
<tr>
<th></th>
<th>Stage 1</th>
<th>Stage 2</th>
<th>Combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capex (2007$)</td>
<td>$7,680,000.00*</td>
<td>$2,900,000.00</td>
<td>$10,580,000.00</td>
</tr>
<tr>
<td>ML (25 years)</td>
<td>41,750</td>
<td>33,660</td>
<td>75,410</td>
</tr>
<tr>
<td>Capex/ML (2007$)</td>
<td>$183.95</td>
<td>$86.16</td>
<td>$140.30</td>
</tr>
</tbody>
</table>

The Country Fire Authority (CFA) received $15K worth of assistance from the Boneo scheme with a tank filling point constructed on the distribution system by SEW, and free water from council’s recycled water allocation. This made the CFA decide to use recycled water for training purposes, and this has been one link in a chain of events which has led to both CFA and the Metropolitan Fire Brigade using recycled water for fire fighting, which is a significant outcome.

Despite Stage 2 not being implemented it can be considered that the Boneo Irrigation Scheme has been successful in providing a secure supply of water to irrigators in the region, improved environmental outcomes, and relieved stress on the groundwater aquifer. It is likely that the demand for recycled water in the region will increase during the next dry period.

FINDINGS

1. Future risk assessments and financial evaluations should consider project stages independently as well as in combination to understand implications of later stages not proceeding

Financial analysis of the Boneo scheme was done looking at Stage 1 and 2 as a combined project. The fact that Stage 2 has not gone ahead has had a negative impact on the project’s financial bottom line. The risk assessment did not consider the possibility of Stage 2 not going ahead. In the future, for projects that involve multiple stages, it may be prudent to include independent assessments of early stages, and include all significant factors which would lead to this outcome in the risk assessment.

2. Planning processes should not be considered in isolation but rather as an integrated network of decisions

The CRSWS strategy mandated an upgrade to tertiary treatment and an earlier strategy set a 20% water recycling target. Due to these previous decisions the Boneo scheme became possible. The major factors affecting the implementation of the scheme were therefore determined during previous planning processes. This illustrates the point that infrastructure plans should not be considered in isolation but rather as part of an integrated network of decisions.

3. Maximum volume capacity of recycled water irrigation schemes should not be used to calculate benefits because actual usage can be significantly lower

Actual usage of recycled water from the Boneo scheme has averaged at .66GL/year since operation began. This is well below half of the maximum available of 1.67GL/year. Boneo and many other recycled water schemes show that water authorities should err of the side of caution when calculating the benefits of recycled water irrigation schemes.

4. Take-or-pay contracts are an essential element of recycled water irrigation schemes

Take-or-pay contracts which were used with water customers ensure that customers pay whether they use the recycled water or not, and this has been a crucial cornerstone of the project. If this type of contract had not been used the financial impact of a drop in demand would be significant.
5. Extra care is required if a tertiary treatment is added to an STP at the same time as a capacity upgrade

If an STP capacity upgrade is to be conducted at the same time as the addition of a tertiary treatment system planners need to be aware that the secondary effluent may have initial variations in quality, and the tertiary treatment system should be able to accommodate this. A longer time period should be allocated to commissioning before committing to customer supply.

6. Differing methodologies for undertaking financial assessment of schemes can lead to confusion when comparing different schemes

At first glance it is difficult to understand why a scheme with a Nett Present Cost of $36/ML being sold at $270/ML could have a negative NPV. The financial assessment of the Boneo scheme, in particular how the Nett Present Cost per ML was calculated, was done in a different way than the other case studies. Procedures followed were stipulated by the Department of Treasury and Finance and the costs used in the calculation were not the total cost, but rather the difference between the base case option and the recycling option. For this reason care needs to be taken when comparing the NPC$/ML of Boneo with the other case study levelised costs per volume.

REFERENCES


Appendix B5 – Toolern Stormwater Harvesting Project

<table>
<thead>
<tr>
<th>Lead organisation</th>
<th>Western Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>South East of Melton</td>
</tr>
<tr>
<td>Water source</td>
<td>Stormwater from urban catchment</td>
</tr>
<tr>
<td>Treated water quality</td>
<td>N/A</td>
</tr>
<tr>
<td>End use</td>
<td>Treated stormwater to be given to irrigators in exchange for reservoir water in upstream storage</td>
</tr>
<tr>
<td>Predicted volume (average)</td>
<td>Design varied multiple times</td>
</tr>
<tr>
<td>Actual volume (average so far)</td>
<td>N/A (not constructed)</td>
</tr>
<tr>
<td>Total Capex</td>
<td>Design varied multiple times</td>
</tr>
<tr>
<td>Predicted production cost</td>
<td>Design varied multiple times</td>
</tr>
<tr>
<td>Customer charge</td>
<td>N/A (water exchange)</td>
</tr>
<tr>
<td>Interesting aspects of this case study</td>
<td>Risk management, stakeholder engagement and financial evaluation</td>
</tr>
</tbody>
</table>

Table 1 – Case study information

Authors: Casey Furlong, Lachlan Guthrie, Saman De Silva
RMIT University
EXECUTIVE SUMMARY

Toolern Urban Growth Area, on the south eastern edge of Melton, is expected to experience significant growth, but does not have a reliable source of water other than transfer from the Melbourne system. The Toolern Stormwater Harvesting Project was designed by Western Water to harvest urban stormwater and then transfer this water to Southern Rural Water’s irrigators in exchange for a share of upstream water entitlements within Merrimu Reservoir.

The scheme successfully won a 50% subsidy from Federal funding support. However, a slowdown in development meant the scheme could not be rolled out within the funding timeframes. This delay was coupled with WW and SRW’s inability to reach agreement on the entitlement transfer arrangement for the ultimate scheme in its proposed form because they perceived a risk to reliability. This occurred despite modelling results demonstrating that the exchange scheme would have no adverse impact on irrigators’ entitlements. A pilot trial is now being implemented to support a potential future scheme with a 1ML for 1ML exchange mechanism, although due to the lack of certainty surrounding project outcomes the Federal funding agreement was terminated by mutual agreement in early 2015.

Findings

1. Collaboration between urban and agricultural water utilities can be difficult due to conflicting objectives and may require State Government involvement and assurances

Western Water, as a semi-urban water utility, and Southern Rural Water, as an agricultural water utility have different customers and objectives. If the Toolern scheme was entirely climate-independent, risk-free, well-understood or a proven concept, then it may have been possible to reach agreement with SRW over the water entitlement exchange mechanism. However as this was not the case SRW had an incentive to be risk averse to protect their customers. Perhaps a State Government intervention and guarantee that irrigators would be no worse off could function as an insurance mechanism in future similar situations. It seems likely that the result, of losing the Federal Grant and the full scheme not proceeding, has not been beneficial for either Western Water or Southern Rural Water.

2. It can be difficult to prove the benefits of an innovative scheme through modelling alone

Modelling suggested that the Toolern Scheme with a 25% of SRW’s Merrimu Reservoir entitlement exchange would have no adverse impact on SRW irrigators. Despite this, SRW decided not to accept the risk that the modelling could be incorrect. This raises a number of questions. How reliable are MUSIC and REALM for modelling this kind of situation? What can be done to give more assurances in future similar situations?

3. All parties in a planning process should be blunt about what they are willing to accept initially to avoid unnecessary spending on consultancy

Southern Rural Water’s risk adverse position on the water entitlement exchange mechanism is entirely justifiable. However if this was the inevitable conclusion, as seems likely in hindsight, then it would have been beneficial for all parties to reach this conclusion earlier and avoid paying for additional consultant studies, and also an independent review of the modelling. Future engagement processes of this type should carefully consider whether any consultant studies have the potential to be convincing, and if not, avoid unnecessary expense.

4. It is important that external funding bodies have the flexibility to cancel funding arrangements when project circumstances change

Due to the many re-scopes, delay of development and in particular the inability to agree on the entitlement exchange mechanism with Southern Rural Water, the decision by the Federal Government to withdraw federal funding was justified. There are many uncertainties involved in the planning of alternative water source schemes, and sometimes the risks and options for a scheme changes over time. Before construction commences, if project circumstances become more negative it is important that funders have an opportunity to withdraw funding, as occurred in this case.
5. Short election cycles have a large impact on infrastructure investments

Changing project circumstances are an objective reason for altering funding agreements and government support structures, however three year election cycles complicate matters. At a Federal level, funding was originally given by a Labor government, and then withdrawn by a Liberal government. At a state level, funding was given by a Liberal government, and now appears precarious under a Labor government. Planners need to carefully consider this issue when planning large infrastructure projects with a long planning phase, as money and effort can potentially be lost for political reasons. In the case of Toolern, the removal of funding does appear to be justified, although it does highlight this issue.

6. It is important to be consistent with language around the financial evaluation, and resultant financial viability of a scheme

In the business case documents provided by Western Water it states that, based on financial calculations “a net [financial] benefit would be derived [from the Toolern Scheme] even in the absence of any grant from the Commonwealth.” This raises the question of the legitimacy of requesting federal funding for an NPV positive scheme. However during consultation in relation to this case study it was expressed that the scheme did require federal funding to be financially viable. In either case it is important to have consistency in both the financials, and the narrative around them.

7. There is a large variation in the assumptions being used to assess alternative water source schemes

A 20 year evaluation period was used to assess the financial viability of the Toolern scheme. This is the shortest evaluation period of any of the projects considered in this research program, with the longest being 50 years. Compounding this issue is the fact that none of the business cases sufficiently explain or justify the period that they use. Some kind of industry forum on consistent financial evaluation processes for alternative water source projects may be beneficial.

8. Conclusions in business cases should genuinely acknowledge potential risks, rather than dismissing them as manageable or unlikely without evidence

In the Toolern business case it states that “potential risks … are all reasonably manageable by Western Water and unlikely to materially alter the financial outcomes or be an impediment to the scheme proceeding.” This is in stark contrast to the initial risk assessment conducted which concluded that multiple risks had a “high” risk rating. In reality three separate risks (1) inability to reach agreement with SRW, (2) funding being withdrawn, and (3) delays in the Toolern development, have all occurred and resulting in the original scheme not proceeding.

9. Planning a stormwater harvesting project produces many lessons for future stormwater harvesting schemes

The Toolern Stormwater harvesting scheme has provided a number of lessons for other stormwater harvesting schemes. These lessons include:

- The need for seasonal storage
- Best practice stormwater treatment devices allow for 50 - 60% of runoff to be intercepted and pumped at a low flow rate. This can be increased to 70 - 80% if additional ‘attenuation’ storage is included and sized at about 20% of the wetland size. Further upsizing of storage does not result in significant further increases in the annual volume of stormwater intercepted.
- Stormwater treatment elements and retarding basins are funded by development in order to mitigate development impacts, but funding for the ‘capture storage’ and stormwater transfer infrastructure is not similarly justified.
- Communal stormwater harvesting can be more financially viable than individual household rainwater tank harvesting in low rainfall areas (i.e. <500 mm/yr).
- Considering water entitlements outside the development area can unlock greater benefits from urban stormwater harvesting. This is particularly because of the ability to better align potable and non-potable water demands with available sources of a matching quality.
The number of “integrated” water projects and strategies across Australia is steadily growing; however there are gaps in knowledge surrounding the most effective way to manage their planning and decision making processes. As water projects and strategies become increasingly integrated, in terms of interactions between different water services, functions, and organisations, the planning processes for these become increasingly important and complex. This is due to increasing numbers of stakeholders, competing objectives, implicit non-market values and possible infrastructure options and combinations that are available.

RMIT University is working with Water Research Australia and Melbourne Water to investigate ways to improve the planning processes for Integrated Urban Water Management (IUWM) infrastructure at the strategy creation and physical project level. This study has divided the overall planning process into a generic list of planning components referred to here as a “planning framework” shown on the following page, collected information on a variety of real-world case studies, analysed and compared the differing approaches that have been used, and created guidelines to assist future planning efforts.

In this research a conceptual distinction has been made between; planning for “IUWM projects”, here meaning planning for discrete physical infrastructure assets which may or may not have been advised by a strategy, and planning for “IUWM strategies”, here meaning mid to long term strategies which are used to inform infrastructure portfolios for specified geographical areas.

The research objectives are to (1) understand the current and historical water infrastructure planning context, (2) catalogue and compare differing planning processes to determine which techniques are more effective, and (3) provide a platform from which future water infrastructure planning processes can be conducted in an informed manner.

This case study report is one of 16. These case studies were selected together with water industry experts and are shown in Table 2.

<table>
<thead>
<tr>
<th>Organisation</th>
<th>IUWM strategies</th>
<th>IUWM infrastructure projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barwon Water</td>
<td>Towards a Botanic Colac</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Review of IWCM options for Fyansford</td>
<td></td>
</tr>
<tr>
<td>City of Melbourne</td>
<td>Total Watermark</td>
<td>Fitzroy gardens SWH project</td>
</tr>
<tr>
<td>City West Water</td>
<td>Footscray IWM Investigation</td>
<td>Altona Recycled Water Project Stage 2</td>
</tr>
<tr>
<td>Private</td>
<td></td>
<td>Coldstream RW project</td>
</tr>
<tr>
<td>SA Water</td>
<td>SA Water’s Long Term Plan for Eyre Region</td>
<td></td>
</tr>
<tr>
<td>South East Water</td>
<td>Water Initiatives for 2050</td>
<td>Boneo Recycled Water Project</td>
</tr>
<tr>
<td>Water Corporation</td>
<td>Water Forever South West</td>
<td></td>
</tr>
<tr>
<td>Western Water</td>
<td>Recycled Water Strategy</td>
<td>Toolern SWH project</td>
</tr>
<tr>
<td>Yarra Valley Water</td>
<td>Northern Growth Area IWCM Plan</td>
<td>Coburg SWH project</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kalkallo SWH project</td>
</tr>
</tbody>
</table>
HOW TO READ THIS CASE STUDY

The researchers have developed an infrastructure planning framework to assist in the analysis of the case studies as shown below in Figure 1. A journal paper on this process has been published in Utilities Policy journal (Furlong, et al., 2016). For each of the case studies the researchers have recorded information on each of the planning components contained in blue boxes.

Figure 1 – Infrastructure planning framework developed to assist in case study analysis

Each case study begins with an introduction, followed by the details on planning, and then concludes with the findings which the researchers have extracted from the case study. Definitions and scopes of the planning components are shown below in Table 3. Contents of case studies have been approved by the lead organisations, although the findings are the opinions of the authors.

Table 3 - Meaning and included concepts of planning components

<table>
<thead>
<tr>
<th>Planning Component</th>
<th>Meaning and included concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Context</td>
<td>Anything which precedes the planning process, including political, environmental, and economic contexts, and preceding plans and strategies</td>
</tr>
<tr>
<td>Integrated project management</td>
<td>Project team functioning, management and reporting, and risk management</td>
</tr>
<tr>
<td>Community &amp; stakeholder engagement</td>
<td>Engagement with external stakeholder organisations and the broader community</td>
</tr>
<tr>
<td>Option identification and shortlisting</td>
<td>Identification of initial options and shortlisting prior to detailed analysis</td>
</tr>
<tr>
<td>Technical evaluation</td>
<td>Collection and analysis of technical information, including modelling and design, to provide data to inform the option selection stage</td>
</tr>
<tr>
<td>Option selection</td>
<td>Assessment, ranking, and/or scoring of options in order to determine the preferred option and planning recommendations</td>
</tr>
<tr>
<td>Governance and regulation</td>
<td>Analysis, review, and approval of planning recommendations by internal management and relevant external regulators</td>
</tr>
<tr>
<td>Financing</td>
<td>Financing arrangements (internal funding, cost sharing and/or grants)</td>
</tr>
<tr>
<td>Outcomes</td>
<td>Anything which comes after the determination of planning recommendations</td>
</tr>
</tbody>
</table>
INTRODUCTION

Western Water is a semi-rural water authority to the west of Melbourne which collects most of its water from rural dams but is also connected to the Melbourne grid for supplementary supply. The Toolern Urban Growth Area (UGA) is located on the south eastern edge of Melton (45km to the west of Melbourne). The development is within the state government’s designated western urban growth corridor and will provide an additional 22,000 dwellings for 50,000 new residents by 2030.

Toolern is within Western Water’s jurisdiction and does not have access to a secure source of water supply other than purchasing water from the Melbourne grid which is a long distance away. Upstream of the Toolern area is the Merrimu reservoir which supplies both Western Water and Southern Rural Water, a water authority which manages water for agriculture.

The proposed Toolern Stormwater Harvesting Scheme involves harvesting stormwater from the Toolern catchment and then trading this water to Southern Rural Water in exchange for some of their water entitlement within Merrimu reservoir. The scheme is intended to harvest and transfer stormwater from Toolern to Melton Reservoir, where it would be supplied to Southern Rural Water.

It was proposed that all of the stormwater from Toolern be traded to Southern Rural Water in exchange for implementing a permanent bulk entitlement transfer of 25% of their entitlement in Merrimu Reservoir. This was intended to allow a reduced potable water import from the Melbourne water supply grid to meet increasing urban demands in Western Water’s region. As part of this exchange Western Water was expected to provide assurance to Southern Rural Water and its irrigators that they will be no worse off under the proposed scheme.
Figure 3 – Schematic diagram of Toolern Stormwater Harvesting Scheme

Infrastructure for the Toolern scheme was intended to include the following:

- “Collect and treat” works within the Toolern development area itself. These involve collection and treatment facilities (e.g. wetlands) and flood mitigation works. These works are developer requirements regardless of whether the harvesting scheme goes ahead.

- “Harvest and transfer” works to transfer stormwater harvested to a point where it can be beneficially used (end-use point). The features are further attenuation works (e.g. storage, extended wetlands for efficient transfer), pumping stations and pipelines to Melton. These works are not developer requirements and so must be funded by Western Water and/or other stakeholders if they are to go ahead.

- “End use” infrastructure which facilitates the use of harvested water. If the water is given directly to SRW in an entitlement transfer agreement, then this would be minimal.

It was determined that the scheme be built in a number of stages as outlined in Table 4 below.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Timing</th>
<th>Average harvest (ML/year, % of capacity)</th>
<th>Capital Cost</th>
<th>Infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2013-2016</td>
<td>390 (12%)</td>
<td>$10.3M (Joint funding DSEWPAC &amp; WW)</td>
<td>• Construct within the Toolern development: 5 of 11 wetlands (attenuation storage only); associated transfer pipelines and install 2 pump stations &lt;br&gt; • Connect stormwater harvesting network outfall pipeline to Melton Reservoir &lt;br&gt; • Transfer 25% of SRW share (inflows and storage) of Merrimu to Western Water.</td>
</tr>
<tr>
<td>2</td>
<td>2016-2023</td>
<td>1,480 (48%)</td>
<td>$1.4M (WW only)</td>
<td>• Install remaining three pump stations on wetlands constructed in Stage 1 &lt;br&gt; • Transfer remaining agreed portion of SRW share of Merrimu to Western Water (if benefit later demonstrated).</td>
</tr>
<tr>
<td>3</td>
<td>2023-2030</td>
<td>3,083 (100%)</td>
<td>$10.3M</td>
<td>• 6 of 11 wetlands (attenuation storages only), 6 pump stations and associated transfer pipelines</td>
</tr>
</tbody>
</table>
The “collect and treat” works are outside the scope of the Toolern scheme because they have to be done anyway and will be funded by developers.

Western Water was granted a 50% subsidy funding agreement for the Toolern Stormwater Harvesting Scheme in 2013. However during further planning of the scheme Western Water was not able to come to agreement with Southern Rural Water for the exchange of 25% of SRW’s water entitlement within Merrimu Reservoir. And so in 2015 the Federal government determined that they could not be confident in the results of the scheme and the funding agreement has been cancelled by mutual agreement. Western Water is currently implementing a pilot trial version of the scheme in order to agree on a future exchange with Southern Rural Water potentially based on a 1ML for 1ML exchange mechanism.

**CONTEXT**

**Project Background**

The sustainable supply of water is one of the key challenges facing Western Water. Before 2004, local water supplies provided 100% of Western Water’s drinking water needs. In 2008/09, near the end of the “millennium drought” only approximately 6% of Western Water’s total potable demands could be met from local sources. In future there will be an increasing reliance on water from the Melbourne Water grid to meet growing potable water demands for growth unless Western Water can develop complementary alternative local sources of supply.

- Enhanced realisation of the value of stormwater potentially harvestable from the Toolern growth area as it is developed to offset the challenges associated with meeting water supply demands for a growing region
- Reducing the reliance on traditional systems and processes that provide limited flexibility and ability to improve Western Water’s resilience to climate variability and to deliver on government Integrated Water Management objectives
- Reducing the strain on urban waterways associated with high population growth in the western region

**Figure 4 – Scheme drivers**

Development in Toolern will further increase potable water demand to be supplied by Western Water. This is because it sits in a rain shadow and so will be reliant on potable water imported from the Melbourne supply grid. Growth in the area can be serviced in two ways; 1) extension of Melbourne Water’s infrastructure or 2) provision of a ‘locally’ based infrastructure portfolio.

The Growth Areas Authority took over the preparation of a Precinct Structure Plan (PSP) for Toolern from Council in October 2008. Consistent with Government policies the Toolern PSP which has been developed includes the requirement for Integrated Urban Water Management. In 2009 Western Water led the preparation of the Toolern Integrated Water Management Strategy. The strategy was prepared in consultation with a stakeholder reference group and considered a range of water management and sustainability related issues. This strategy determined that recycled water and precinct scale stormwater harvesting were required to meet potable water reduction targets.
Environmental, social and economic

The environmental, social and economic context for the Toolern scheme predominantly relates to the major millennium drought, expanding urban growth boundaries, and community perceptions of water supply in Melbourne’s west.

Between 1997 and 2007 much of Australia experienced a severe drought. The drought brought water restrictions, which meant that open spaces in many regions fell into a state of decay, making playing surfaces unusable and parklands barren. As recreational green space deteriorates there are significant negative health and well-being impacts on the community. This understanding has led to Melbourne’s water industry having an expanded mandate to be custodians of community well-being by minimising the occurrence of water restrictions.

Expanding urban growth boundaries and land development on the fringe of Melbourne is encroaching into the mid to upper reaches of many river systems and impacting on their ecological health. This increases the driver for IUWM projects which provide a higher level of protection for the environment and quality of life for urban communities. There are significant environmental benefits in reducing wastewater and stormwater discharges. This is particularly relevant to waterways adjacent to, or downstream of, greenfield site developments.

As a result of the drought, residents in Melbourne’s west have shown behavioural change in their attitude to water. In 1990, average water consumption levels for residents were 308 litres per person per day (l/p/d). Since 2009 Melton residents are one of the state’s lowest water consumers in Victoria at 170 l/p/d. The Melton community continues to have considerable interest in water saving measures. In focus group discussions for the Toolern Precinct, IUWM principles were considered to be a way of the future and thought by participants to be “mandatory” for new developments.

Organisational and political

The existing government policies which contribute to the organisational and political context of the Toolern Scheme are outlined in Table 5 below. As the Toolern Scheme is still being planned and implemented it has also been affected by some recent developments at both the State and Federal levels.

In December 2013, the then Minister for Water, Peter Walsh, released the Victorian Government’s new urban water policy, Melbourne’s Water Future, detailing the whole-of-water cycle strategy for Melbourne. The Toolern stormwater harvesting project provides an example of achieving Initiative 3.2.3 of the Government’s policy, to incorporate IUWM into growth area planning and urban renewal precincts. The Office of Living Victoria (OLV) which developed the policy has since lost its independent status and the new state government has yet to release its policy on alternative water source schemes.

At a Federal level $700M grant funding was made available for water conservation projects from 2008. Western Water was able to achieve a funding agreement. However following the completed construction of numerous seawater desalination plants at major cities across Australia and the end of the millennium drought there is no longer as much support available. This absence of urgency and support at the Federal level may have been a partial contributor to Federal support being removed for the Toolern scheme.

Changing government priorities have played out at both the Federal and the State Government levels. At a Federal level, funding was originally given by a Labor government, and then removed by a Liberal government. At a state level funding was given by a Liberal government, and now appears precarious under a Labor government. The funding is still available but the new Labor state government is paying little attention to the project, whereas it was a “flagship project” during the Liberal government and OLV era.
### Table 5 – Policy context for Toolern Scheme

<table>
<thead>
<tr>
<th>Level of Governance</th>
<th>Relevant policies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal government</td>
<td>• The National Water Initiative (NWI) committed all states and territories to innovation and capacity building to create Water Sensitive Australian Cities (Clause 92).</td>
</tr>
<tr>
<td>State government</td>
<td>• Environmental Protection Act 1970 and State Environment Protection Policies 2003 (Water of Victoria) - provide a legal framework for government agencies and communities to work collaboratively to protect and rehabilitate Victorian surface water environments</td>
</tr>
<tr>
<td>State government</td>
<td>• Victoria Planning Provision: Clause 56.07 sets out the planning requirements for potable water reduction, reused and recycled water, waste water and urban runoff quality, mandating WSUD for all residential subdivisions</td>
</tr>
<tr>
<td>Local government</td>
<td>• The Municipal Strategic Statement (MSS) sets down the goals and key directions for land use and development in the Melton City Council</td>
</tr>
<tr>
<td>Local government</td>
<td>• Local Planning Policy Framework identifies long-term directions for land use and development in Melton City Council o Toolern Precinct Structure Plan (GAA, 2009) Direction 4.5.7 Integrated water management objectives: to minimise potable water consumption, promote the conservation, and reuse of water, utilise all water resources including rainwater, recycled water, grey water and stormwater</td>
</tr>
<tr>
<td>Local government</td>
<td>• Manage the quality of stormwater run-off</td>
</tr>
</tbody>
</table>

**INTEGRATED PROJECT MANAGEMENT**

**Planning scale**

The Toolern project was identified through a local-scale servicing strategy undertaken by Western Water. The scheme was then planned by Western Water with a minor level of oversight and advice from a Project Working Group which included external stakeholders. It was not originally included as part of any larger scale planning process, although for a time it was showcased as a “flagship project” during the Office of Living Victoria era.

**Project team functioning and oversight**

Project team functioning and oversight for the Toolern Stormwater Harvesting Scheme is similar to that utilised by the other case studies considered in this research. The majority of the day to day functions in the planning of the project have been done by the Project Team in conjunction with external consultants.

The Project Team reports to the Project Director who is responsible for coordinating with the various stakeholders including the Project Working Group, the Customer Reference Group, and the government liaisons from various departments. The Working Group includes Melbourne Water, Southern Rural Water, the City of Melton, developers and funding bodies and its role was to provide advice and guidance to Western Water in relation to the project and to develop and re-assess strategies to address potential threats to the project’s success. The Office of Living Victoria became involved mid-way through the project planning.

Western Water was responsible for establishing, convening, engaging with, and organising the Working Group meetings. The Working Group typically met twice a year to discuss the Project and IUWM initiatives within the Toolern Precinct. A representative from the Department of Environment...
and Primary Industries sometimes attended these meetings. Some planners at Wester Water believe that the project should have been given more attention from the Project Working Group.

Risk management

Existing national and international research has suggested that planners are often overly optimistic when planning public infrastructure projects and the research has highlighted risk assessment methodologies as a crucial element in infrastructure planning. The risk assessment which has been included in the final Toolern scheme report is shown below. Each of the risks identified for this project were ranked using Western Water’s Enterprise Risk Matrix.
**Table 6 – Risk assessment**

<table>
<thead>
<tr>
<th>Risk</th>
<th>Risk rating</th>
<th>Mitigation</th>
</tr>
</thead>
</table>
| Inability to reach satisfactory agreement with SRW for permanent BE transfer | High | ➢ Detailed water resource modelling to assess impact on SRW irrigation customers and implement sufficient extent of harvesting network to offset BE transfer  
➢ In-principle support provided by SRW for BE transfer concept. |
| Irrigator discontent | Medium | ➢ Detailed water resource modelling to assess impact on irrigation customers.  
➢ Work with SRW on a communication strategy for any change to BE, and water quality |
| Inability to reach satisfactory agreement with Melbourne Water for diversion of stormwater from the development | Low | ➢ In-principle agreement in place between WW and MWC regarding diversion licences |
| Funding issues including having the funding retracted because of (1) not meeting funding milestones, or (2) reducing the funding sought from $9.2M to $5.2M | High | ➢ Without the funding the project becomes financially unviable. Therefore it is important to maintain continuous dialogue with the Commonwealth and track progress against detailed project program.  
➢ Meeting planned with DSEWPAC prior to final milestone submission to confirm all requirements are being satisfied. |
| Extreme dry climate conditions | Medium | ➢ Extensive water resource modelling undertaken to support preparation of the business case |
| Delays in development in Toolern | High | ➢ Ensure flexibility in agreement to manage risk of development progress.  
➢ Monitor development progress through planning referral process.  
➢ Learning from previous experience of Kalkallo scheme by liaising with Yarra Valley Water  
➢ Making sure funding milestones are flexible/open ended. |
| Hydrology modelling proves to be incorrect | Low | ➢ Experienced practitioners were involved in the water resource modelling and have adopted accepted industry practice. The DEPI approved REALM model has been used. |

**How the considered risks have played out**

With the benefit of hindsight it can be seen that the Project Team accurately assessed the potential risks associated with the scheme. All of the “high risk” rated items have eventuated. Western Water was not able to achieve agreement with Southern Rural Water over the 25% of their Merrimu Reservoir water entitlement transfer. This caused the Federal government to end the funding agreement.

In the risk assessment the possibility of losing the whole funding grant was considered, but for a different reason. Western Water was worried that when they first reduced the scope of the project, from the whole scheme to just Stage 1 and 2 for half the water, that the funding would be removed, although this did not turn out to be a big issue.

The Project Team has learnt from previous water industry experience with developers and determined that development forecasts are notoriously unreliable, as has also been the case in this example.
In this case the risk which proved to have the biggest impact was the inability to reach a satisfactory agreement with SRW over the water exchange mechanism.

**STAKEHOLDER AND COMMUNITY ENGAGEMENT**

![Stakeholder influence vs. impact map](image)

**Engagement objectives**

Western Water has considered it part of its mandate to inform the general public, developers, government bodies and potential residents of the benefits of IUWM, and the importance of utilising schemes such as Recycled Water and Stormwater Harvesting to conserve water. As part of this Western Water has sought to increase resident’s knowledge of their local climate and why alternative water supplies are integral to the liveability of the region.

Additionally Western Water has promoted a message to their customers that they are working to create a sustainable, liveable and productive community.

**Engagement process**

Western Water has sought to work in partnership with key funding bodies and stakeholders to ensure consistent messaging to the target audiences. Communications have been informative and promotional, rather than consultative, due to the specialist requirements of the Project.

This project, funded in part by the Federal Government, and being an innovative flagship project, has had a large amount of stakeholder interest. Western Water has sought to ensure stakeholder participation and awareness of project milestones and media opportunities at all times.

A total list of engagement steps taken by Western Water has included the following:

- Working closely with non-resident stakeholders (developers, local government, etc)
- Promoting educational visits to Western Water assets, including plans for a tour and “launch” for stakeholders
- Including the project in Western Water’s Class A Recycled Water Communications Strategy
- Promotional IUWM brochures for home buyers
APPENDIX B5 – TOOLERN STORMWATER HARVESTING PROJECT

- 1 page flyer at developers’ information centres
- Media releases and social media updates in Melton region about milestones relating to the Toolern project
- Advertising in local media about Western Water’s initiatives relating to stormwater harvesting and IWCM
- Information on Western Water’s website about IWCM at Toolern
- Signage across Toolern highlighting the benefits of Stormwater Harvesting in the precinct
- Western Water staff will be updated on the Toolern development and Stormwater Harvesting Project to promote pride and knowledge internally
- Articles in fortnightly internal newsletter (Tap & Spout)

The following list of stakeholders includes some that have been working on the Toolern Integrated Water Strategy since May 2009, and others who became involved more recently, or temporarily, such as the Office of Living Victoria.

Table 7 – Stakeholder interests and incentives

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Interests and incentives</th>
</tr>
</thead>
</table>
| Western Water | • Reduce reliance on potable water supplies  
• Ensure actions are consistent with policy, regulation and strategy |
| Melbourne Water | • Reduce reliance on potable water supplies  
• Protect stormwater quality and receiving waterway health |
| EPA Victoria | • Protect stormwater quality and receiving waterway health |
| Southern Rural Water | • Water quality protection for their catchment (Melton Reservoir)  
• Increase supply reliability for irrigators |
| Department of Sustainability, Environment, Water, Population and Communities | • Ensure federal funding is put to good use |
| Office of Living Victoria | • Promote IUWM and integrated planning |
| Sustainability Victoria | • Promote innovation and reduce greenhouse gas emissions |
| Parks Victoria | • Secure fit for purpose water solutions for Toolern Regional Park |
| Environmental groups (Friends of Toolern Ck & Pinkerton Landcare Gp) | • Maintaining or enhancing Creek flow quantity and quality  
• Making more water available for existing local indigenous plants. |
| Future residents and community | • High amenity values within the development area  
• A safe and reliable source of potable water for use in toilets, gardens and public space |
| Melton City Council | • Provision of an alternate low cost water supply to satisfy community expectations and provide improved amenity of community space |
| Developers/planners (Watsons & Taylors) | • Create a desirable package for customers |
| Growth Areas Authority | • Linking IUWM into PSP to create more liveable community  
• Efficient planning process which does not inhibit development |
Western Water has been progressively developing the Toolern stormwater harvesting project through a number of stages. Option identification and shortlisting was done at the first stage of this process, in 2009, which was called the Toolern Integrated Water Management Strategy.

The Toolern Integrated Water Management Strategy was led by Western Water but included the efforts of key stakeholders. After the strategy was completed, Western Water began working with the Growth Areas Authority to establish drinking water reduction targets in Toolern’s Precinct Structure Plan, which embedded a target of a 50% reduction in imported potable water. The strategy determined that the best servicing solutions for Toolern included a combination of several initiatives towards drinking water savings, such as recycled water use, and a precinct-wide stormwater harvesting scheme. Recycled water alone was unable to meet the 50% target.

Findings also showed that in such a low rainfall environment, rainwater tanks were not able to satisfy non-potable demands at an allotment level. Analysis showed that a 2 kL tank supplied from 150m$^2$ roof area would provide only 65% reliability for toilet flushing. Precinct scale initiatives were shown to provide superior feasibility and benefits in terms of cost and performance.

Table 8 summarises the findings from the Toolern Integrated Water Strategy.

<table>
<thead>
<tr>
<th>Water source</th>
<th>Advantages</th>
<th>Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mains water</td>
<td>• Existing infrastructure is accessible and regulations/approval process are well understood</td>
<td>• Requires Melbourne Water pipeline network to be augmented&lt;br&gt;• Reliance on single source lowers resilience to climate change&lt;br&gt;• Population growth and climate change is placing greater pressure on mains supply&lt;br&gt;• Ecological protection issues associated with environmental flows downstream of water supply reservoirs&lt;br&gt;• No means to reduce stormwater or wastewater discharges to the environment</td>
</tr>
<tr>
<td>Roof runoff capture and reuse</td>
<td>• Multiple water cycle benefits (mains water conservation and reducing stormwater volumes)&lt;br&gt;• Minimal treatment required as roof runoff is considerably cleaner than other alternative sources of supply</td>
<td>• Limited volume of supply to meet competing demands&lt;br&gt;• Variable reliability&lt;br&gt;• Potential increases in pollutant concentrations conveyed to receiving waters from other surfaces</td>
</tr>
<tr>
<td>Stormwater harvesting</td>
<td>• Multiple water cycle benefits (drinking water conservation and minimising stormwater hydrological impacts and water quality impacts on Toolern Creek and Kororoit Creek)&lt;br&gt;• Improved reliability of supply associated with stormwater harvesting in urban catchments compared to rural catchments due to hard surfaces generating a significant proportion of rainfall as runoff&lt;br&gt;• Local existing reservoirs (such as Melton Reservoir) could be used as storage facilities</td>
<td>• Land uptake associated with treatment measures</td>
</tr>
</tbody>
</table>
Appendix B5 – Toolern Stormwater Harvesting Project

The preferred infrastructure portfolio servicing Toolern was therefore determined to include wastewater recycling through a third pipe system and also stormwater harvesting. From this point onwards the inclusion of dual pipe recycled water was assumed, and precinct scale stormwater harvesting was then considered in addition to that.

Options were then looked at for what harvested stormwater could be used for, shown in Table 9.

<table>
<thead>
<tr>
<th>End Use Option</th>
<th>Description</th>
<th>Comment</th>
<th>Indicative capital cost</th>
</tr>
</thead>
</table>
| Direct potable substitution | Treat to potable standard and introduce stormwater directly into the potable water supply system through provision of additional treatment and transfer infrastructure connected to Melton Reservoir | • Approval from DHS not achievable at present  
• High infrastructure cost to implement  
• Cannot be implemented by June 2016 | $80 – 100M |
| Class A augmentation | Transfer harvested stormwater to a Class A facility to supply non-potable demand including residential demands, irrigation of public open space | • Sufficient supply from sewerage network is expected to service the demand.  
• Stormwater might be useful for achieving further reduction of potable demand | $60 – 70M |
| Irrigation only (agriculture) | Supply wetland treated stormwater to the Werribee and/or Bacchus Marsh Irrigation Districts | • No direct benefit for Western Water | $25 – 30M |
| Irrigation only (public amenity) | Supply wetland treated stormwater for ‘greening’ community assets | • Potentially competes with Class A system supply. (could potentially abandon future Class A system augmentations) | $30 – 40M |
| Environment | Transfer harvested stormwater to Melton Reservoir and hold in storage for regulated release. | • No direct benefit to Western Water | $0M |
| Irrigation (agriculture) with allocation transfer (swap with SRW) which was chosen as preferred option | Transfer harvested stormwater to Melton Reservoir for supply to the Werribee Irrigation District. Transfer rural irrigation supply entitlement into an urban water supply entitlement within Merrimu Reservoir to minimise import of potable water from the Melbourne grid. | • Provides direct benefit to Western Water in near term.  
• Opportunity to consider benefits of ‘un-allocated’ volume in Merrimu being transferred to Western Water | $0M |
Western Water determined that there was no additional funding available for an end-use scheme, meaning that only the bottom two options in Table 9 could be considered further. It was also determined that there was no financial benefit to Western Water from providing the water for the environment. Therefore the only viable option was the final one shown in Table 9, involving exchanging harvested stormwater for 25% of SRW’s entitlement in Merrimu reservoir.

TECHNICAL EVALUATION

Technical evaluation carried out as part of the planning of the Toolern Stormwater Harvesting Scheme has included the typical elements of cost and demand calculations. In comparison to other case studies, planning for the Toolern Scheme has included a greater effort towards water resource modelling at various stages of planning.

As part of the Toolern IWM Strategy Project, Western Water in conjunction with Melbourne Water, Southern Rural Water and other stakeholders made assessments of potential water resources and future water demands. Stormwater harvesting was identified as a key component of the IWM strategy as a result of initial water balance modelling using MUSIC Version 4 developed by eWater. MUSIC was an appropriate tool to represent the conjunction of Water Sensitive Urban Design (WSUD) based stormwater management and the regional scale water balance.

The end-use options investigation completed by a consultant was supported by water resource modelling (using REALM) to establish how the Toolern system operates under different climate, water availability and storage capacity availability scenarios with the inclusion of stormwater as a new water resource.

- Demand and revenue estimates
  - Demand estimates were calculated through Toolern growth assumptions
  - Revenue will be accrued through potable water sales

- Cost estimates
  - Capital expenditure for the options were calculated by Western Water with advice from consultants.

- Water resource (balance) modelling
  - Modelling was done to ensure that the water exchange with SRW would not have an adverse impact on irrigators (MUSIC and REALM software)

- Environmental impacts
  - MUSIC was used to demonstrate stormwater pollution reductions

The detailed water resource modelling work shows that:

- a permanent bulk water entitlement (BWE) transfer in Merrimu Reservoir is critical to Western Water capturing the necessary benefits to support the scheme.

- Transfer of 25% of SRW’s BWE guarantees no adverse impacts on irrigators, while transfer of 50% of SRW’s BWE does not absolutely guarantee this.

- In drier conditions (than the historical climate conditions) SRW and its irrigators are relatively better off and Western Water slightly worse off. However unless there is a return to dry conditions (similar to the “Millennium drought” conditions) in the immediate future and unless that type of climate condition is sustained in the long term, then the water savings benefits to Western Water would always be substantial enough to support the preferred scheme.
OPTION SELECTION (PROJECT JUSTIFICATION)

As part of the Toolern Integrated Water Management Strategy, Western Water determined the preferred option for the Toolern development to include both wastewater recycling and stormwater harvesting. From this point on the provision of dual pipe recycled water to Toolern was assumed, and Western Water explored options for stormwater harvesting. Eventually it was determined that there was only one viable option for stormwater end-use, which was exchange with Southern Rural Water.

This still left a number of options for the scheme in terms of overall size and also specific infrastructure options and how they should be staged. Four possible scenarios were developed to inform these decisions.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Description</th>
<th>Capital ($)</th>
<th>Stage 2</th>
<th>Total ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>New 600mm outfall, 2 of 11 wetlands/pump stations</td>
<td>8.1M</td>
<td>-</td>
<td>8.1M</td>
</tr>
<tr>
<td>B</td>
<td>New 600mm outfall, 5 of 11 wetlands, 2 pump stations</td>
<td>13.1M</td>
<td>Install 3 pump stations</td>
<td>1.4M</td>
</tr>
<tr>
<td>C</td>
<td>Utilise existing 450mm rising main, 2 of 11 wetlands/pump stations</td>
<td>3.9M</td>
<td>-</td>
<td>3.9M</td>
</tr>
<tr>
<td>D</td>
<td>Utilise existing 450mm rising main, 5 of 11 wetlands, 2 pump stations</td>
<td>10.3M</td>
<td>Install 3 pump stations</td>
<td>1.4M</td>
</tr>
</tbody>
</table>

An NPV assessment of the possible schemes was conducted to determine which was the most cost effective. Present values of benefits and costs (under Historical Climate conditions) for the potential project scenarios (at a 5% real discount rate and for a 20 year evaluation period) are shown in Table 10.

Net operating costs include the annual costs associated with the stormwater scheme, the additional costs associated with treatment at Melton WTP, minus pumping and chemical costs avoided due to any reduction in the supply of bulk water from the Melbourne water grid. Cost benefits from enhanced WW operational flexibility over time were not included. Capital costs in Table 11 are slightly smaller than those shown in Table 10, as this is how they are shown in the Western Water business case.

The main conclusions able to be drawn from the Historical Climate assessment are that: the stormwater project provides a net financial benefit to Western Water. This means that “a net benefit would be derived even in the absence of any grant from the Commonwealth”. It was also found that scenarios that utilise the existing 450mm diameter Western Water pipe have higher net benefits.
Improving Planning Processes for IUWM Infrastructure

### Table 11 – NPV assessment of options ($1000s)

<table>
<thead>
<tr>
<th>Item</th>
<th>Scenario A Stage 1 only</th>
<th>Scenario B Stage 1 and 2</th>
<th>Scenario C Stage 1 Only</th>
<th>Scenario D Stages 1 and 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benefits</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avoided cost of bulk water ex Melbourne water grid</td>
<td>21,001</td>
<td>21,001</td>
<td>21,001</td>
<td>21,001</td>
</tr>
<tr>
<td>Capital cost</td>
<td>7,714</td>
<td>13,628</td>
<td>3,714</td>
<td>10,961</td>
</tr>
<tr>
<td>Scheme grant (50%)</td>
<td>-3,857</td>
<td>-6,238</td>
<td>-1,857</td>
<td>-4,905</td>
</tr>
<tr>
<td>Net Operating costs</td>
<td>3,077</td>
<td>3,789</td>
<td>2,594</td>
<td>3,467</td>
</tr>
<tr>
<td>Total costs</td>
<td>6,934</td>
<td>11,179</td>
<td>4,451</td>
<td>9,523</td>
</tr>
<tr>
<td>Net Benefit</td>
<td>14,066</td>
<td>9,822</td>
<td>16,550</td>
<td>11,477</td>
</tr>
</tbody>
</table>

This NPV assessment showed scenario C stage 1 only as the option with the highest NPV, followed by option A. Options B and D have lower, but still positive NPVs, because these options cost more but come with higher supply security for Southern Rural Water. Western Water needed to come to an agreement with SRW over the exchange mechanism. For this reason Western Water chose Scenario D as the preferred option, as it created greater supply security.

As explained in the Outcomes section of this report, after WW and SRW were unable to achieve agreement on the water exchange mechanism, WW now sees Option C as the preferred scenario.

### Governance and Regulation

The fundamental difference between the Toolern scheme and the other case studies considered by this research is that for the other schemes the major implementation hurdle for the schemes was government support and cost justification. In the Toolern scheme the major hurdle has turned out to be Western Water’s inability to demonstrate that the water entitlement exchange would not have a negative impact on SRW customers.

Health regulation by the Department of Health, and Environmental regulation by the Environmental Protection Authority have not been major issues for the Toolern scheme, and financial regulation has not been an issue because of the early award of federal funding from the NUWDP Funding Agreement.

Therefore the major hurdle that the Toolern Scheme was required to pass was the contractual agreement with SRW for the exchange of harvested stormwater for a share of upstream water entitlements. This exchange for 25% of SRW’s share in Merrimu reservoir was unable to be negotiated as will be explained in more detail in the outcomes section of this report.

### Financing

Australian Government funding under the NUWDP Agreement for the Toolern Stormwater Harvesting project was capped at 50 per cent of eligible capital costs up to a maximum of $9,235,783 (exclusive of GST). The Government funding was divided into two payment stages, a Concept Phase and implementation Phase.

After the Project Concept Phase was complete some significant cost reduction opportunities were identified, such as 2.3km of an existing de-commissioned pipeline that could be utilised. Western Water therefore reduced their funding request to $5,523,376 in total.

Because agreement could not be reached between Western Water and Southern Rural Water over the exchange mechanism, and the slowdown in development within Toolern, the federal government cancelled their stage 2 funding agreement with Western Water by mutual agreement in 2015. $410,000 of Federal funding and $600,000 of Western Water funding was spent on planning.
OUTCOMES

No agreement with Southern Rural Water on water entitlement exchange mechanism

The water resource modelling outcomes suggested a transfer of 25% of SRW share of Merrimu Reservoir to WW in exchange for the stormwater harvesting by the ultimate precinct scale scheme would improve reliability of allocations and have no adverse impacts to SRW irrigators. An independent review of the MUSIC and REALM data verified the above findings.

However SRW was reluctant to agree to a transfer of bulk entitlements based on modelling data alone and offered a one of one swap of water volumes between stormwater transferred to Melton Reservoir for water in Merrimu. Without an agreement to transfer 25% of SRW’s BWE, the Federal government and Western Water’s Board could no longer be guaranteed of reductions in potable water volumes drawn from the Melbourne water grid and a return on investment.

Federal funding has been withdrawn

The Federal government advised WW in late 2014 that they would no longer be providing matching funding for the ultimate precinct scale harvesting scheme, “without a clearly identified end water user with a contract to take harvested water, the proposed activity cannot deliver its outcome with a high degree of certainty.” The funding agreement for the ultimate precinct scale project was terminated by mutual agreement in early 2015.

Future of the Toolern scheme

Development in Toolern is two years behind schedule, with about 15 lots per month being sold compared to a projected 30 lots per month. Development in Toolern has now reached a trigger point for the first wetland to be built by developers.

The ultimate precinct-scale harvesting scheme has been put on hold. A pilot version of the project will be constructed in 2016 to verify the harvest yields achievable. The aim of the pilot is to trial the agreed water exchange mechanism with SRW (one for one) and facilitates the advancement of the ultimate project.

The pilot trial will run for 5 years to see if a future stormwater harvesting scheme would be cost effective, and if the MUSIC and REALM results are accurate. The pilot scheme is expected to cost $800,000 with $225,000 of this coming from funding given by the Office of Living Victoria before it was dissolved. If the pilot goes well there may be flexibility to explore arrangements with SRW which will make a larger scheme viable, however the future of any larger scheme is very uncertain.
IMPROVING PLANNING PROCESSES FOR IUWM INFRASTRUCTURE

FINDINGS

1. Collaboration between urban and agricultural water utilities can be difficult due to conflicting objectives and may require State Government involvement and assurances

Western Water, as a semi-urban water utility, and Southern Rural Water, as an agricultural water utility have different customers and objectives. If the Toolern scheme was entirely climate-independent, risk-free, well-understood or a proven concept, then it may have been possible to reach agreement with SRW over the water entitlement exchange mechanism. However, as this was not the case, SRW had an incentive to be risk averse in order to protect their customers. Perhaps a State Government intervention and guarantee that irrigators would be no worse off could function as an insurance mechanism in future similar situations. It seems likely that the result, of losing the Federal Grant and the full scheme not proceeding, has not been beneficial for either Western Water or Southern Rural Water.

2. It can be difficult to prove the benefits of an innovative scheme through modelling alone

Modelling suggested that the Toolern Scheme, with a 25% of SRW’s Merrimu Reservoir entitlement exchange, would have no adverse impact on SRW irrigators. Despite this SRW decided not to accept the risk that the modelling could be incorrect. This raises a number of questions. How reliable are MUSIC and REALM for modelling this kind of situation? What can be done to give more assurances in future similar situations?

3. All parties in a planning process should be blunt about what they are willing to accept initially to avoid unnecessary consultancy costs

Southern Rural Water’s risk averse position on the water entitlement exchange mechanism is entirely justifiable. However if this was the inevitable conclusion, as seems likely in hindsight, then it would have been beneficial for all parties to reach this conclusion earlier and avoid paying for additional consultant studies, and also an independent review of the modelling. Future engagement processes of this type should carefully consider whether any consultant studies have the potential to be convincing, and if not, avoid unnecessary spending.

4. It is important that external funding bodies have the flexibility to cancel funding arrangements when project circumstances change

Due to the many re-scopes, delay of development and in particular the inability to agree on the entitlement exchange mechanism with Southern Rural Water, the decision by the Federal Government to withdraw federal funding was justified. There are many uncertainties involved in the planning of alternative water source schemes, and sometimes the risks and options for a scheme change over time. Before construction commences, if project circumstances become more negative it is important that funders have an opportunity to withdraw funding, as occurred in this case.

5. Short election cycles have a large impact on infrastructure investments

Changing project circumstances are an objective reason for the altering of funding agreements and government support structures, however three year election cycles complicate matters. At a Federal level, funding was originally given by a Labor government, and then removed by a Liberal government. At a state level funding was given by a Liberal government, and now appears precarious under a Labor government. Planners need to carefully consider this issue when planning large infrastructure projects with a long planning phase, as money and effort can potentially be lost for political reasons. In the case of Toolern, the removal of funding does appear to be justified, although it does highlight this issue.

6. It is important to be consistent with language around the financial evaluation, and resultant financial viability of a scheme

In the business case documents provided by Western Water it states that, based on financial calculations “a net [financial] benefit would be derived [from the Toolern Scheme] even in the absence of any grant from the Commonwealth.” This raises the question of the legitimacy of requesting federal funding for an NPV positive scheme. However during consultation in relation to this case study it was expressed that the scheme did require federal funding to be financially viable. In either case it is
7. There is a large variation in the assumptions being used to assess alternative water source schemes

A 20 year evaluation period was used to assess the financial viability of the Toolern scheme. This is the shortest evaluation period out of any of the projects considered in this research program, with the longest being 50 years. Compounding this issue is the fact that none of the business cases sufficiently explain or justify the period that they use. Some kind of industry forum on consistent financial evaluation processes for alternative water source projects may be beneficial.

8. Conclusions in business cases should genuinely acknowledge potential risks, rather than dismissing them as manageable or unlikely without evidence

In the Toolern business case it states that “potential risks … are all reasonably manageable by Western Water and unlikely to materially alter the financial outcomes or be an impediment to the scheme proceeding.” This is in stark contrast to the initial risk assessment conducted which concluded that multiple risks had a “high” risk rating. In reality three separate risks (1) inability to reach agreement with SRW, (2) funding being withdrawn, and (3) delays in the Toolern development, have all occurred and resulting in the original scheme not proceeding.

9. Planning a stormwater harvesting project produces many lessons for future stormwater harvesting schemes

The Toolern Stormwater harvesting scheme has provided a number of lessons for other stormwater harvesting schemes. These lessons include:

- The need for seasonal storage
- Best practice stormwater treatment devices allow for 50 - 60% of runoff to be intercepted and pumped at a low flow rate. This can be increased to 70 - 80% if additional ‘attenuation’ storage is included and sized at about 20% of the wetland size. Further upsizing of storage does not result in significant further increases in the annual volume of stormwater intercepted.
- Stormwater treatment elements and retarding basins are funded by development to mitigate development impacts, but funding for the ‘capture storage’ and stormwater transfer infrastructure is not similarly justified.
- Communal stormwater harvesting can be more financially viable than individual household rainwater tank harvesting in low rainfall areas (i.e. <500 mm/yr).
- Considering water entitlements outside the development area can unlock greater benefits from urban stormwater harvesting. This is particularly because of the ability to better align potable and non-potable water demands with available sources of a matching quality.

REFERENCES


P., W., Multiple occasions. *Meeting to discuss Toolern project* [Interview] Multiple occasions.


Appendix B6 – Coburg Stormwater Harvesting Project

<table>
<thead>
<tr>
<th>Lead organisation</th>
<th>Yarra Valley Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Melbourne’s inner north</td>
</tr>
<tr>
<td>Water source</td>
<td>Stormwater from urban catchment</td>
</tr>
<tr>
<td>Treated water quality</td>
<td>Class A</td>
</tr>
<tr>
<td>End use</td>
<td>Parks and 3rd pipe to apartments</td>
</tr>
<tr>
<td>Predicted volume</td>
<td>213ML/year</td>
</tr>
<tr>
<td>Actual volume (average so far)</td>
<td>Project cancelled</td>
</tr>
<tr>
<td>Total Capex</td>
<td>$~15M (2009$)</td>
</tr>
<tr>
<td>Predicted production cost</td>
<td>$~4470/ML (2009$)</td>
</tr>
<tr>
<td>Customer charge</td>
<td>$~1500/ML (2009$)*</td>
</tr>
<tr>
<td>Interesting aspects of this case study</td>
<td>Risk management, community engagement, option selection, governance and financing</td>
</tr>
</tbody>
</table>

Table 1 – Case study information (*75% of the potable water price)

Authors: Casey Furlong, Lachlan Guthrie, Saman De Silva
RMIT University
Coburg Stormwater Harvesting Project was designed to harvest stormwater from two transfer drains, Harding and Urquhart Street Drains, for non-potable use within new apartment buildings. Flows were to be directed into an 8ML underground concrete storage tank under McDonald Reserve, Bell Street, Coburg. This underground tank was designed to supply a new up-to 1ML/day Class A treatment plant and .5ML above ground balancing storage tank. The project was expected to supply approximately 213ML of recycled water each year via a 3rd pipe system to new apartment buildings, as well as irrigation of parks.

The project won a 50% funding grant from the Federal Government, although the project was later cancelled by YVW due to a cost increase from the original estimate of $13.28M to a total of $16.5M revealed through tendering. The major reason for the cost increase was unexpected geological conditions, as well as some unexpected stakeholder requirements.

**Findings (researcher opinion)**

1. Planning for Coburg correctly identified uncertainties around growth estimates to be a project risk

Similar to the Kalkallo case study, development in the Coburg area has not progressed at the speed predicted by planning estimates. Coburg as a case study lends additional weight to the already held view within the water industry that council and developer growth and planning estimates cannot be relied upon. Planning for Coburg identified this risk from the outset. All future alternative water projects in new development areas need to seriously consider this risk and mitigation strategies such as staging and trigger points for when to begin construction of water assets.

2. As predicted project costs increased it was commendable that YVW had the flexibility, and also the necessary governance to cancel the project

In reality there are always uncertainties and unpredictable circumstances which can affect infrastructure planning outcomes. When water utilities are planning infrastructure projects it is important to have a mechanism by which, if project circumstances change to become less favourable than predicted, the utility can change its mind and not proceed with the project. In other words, knowing when enough is enough and it’s time to cut losses. The Coburg scheme had so much effort put into its planning as well as achieving a government grant. When project circumstances changed, and the total project Capex increased in the order of 25%, YVW made the tough but smart decision to cancel the project. The $2M lost on planning and design is likely less than the financial losses YVW would have incurred if the scheme had gone ahead.

3. Financial assessments should attempt to justify the total project cost rather than only justify internal costs and exclude Federal funding

In certain aspects of the financial assessment of the Coburg scheme, such as the cost comparison with potable water, YVW has only considered costs as those which would be paid by YVW. Government grant money has not been included in the assessment, and therefore YVW has only attempted to justify roughly half of the scheme’s up-front costs. In the future it is recommended that if a scheme is to receive a 50% government subsidy it should still include 100% of the cost in the financial assessment, regardless of where it comes from, as this best reflects the impact to the community as a whole. There is also an additional question of whether a federal funding subsidy is appropriate for water infrastructure within an affluent and major city.

4. Logical and consistent financial evaluation processes are needed to justify future projects

When Federal funding is included, actual production costs for this scheme were expected to be $4.47/kL. This is a high cost for an alternative water scheme, and is even higher than the Kalkallo Stormwater Harvesting Project, which was planned to produce potable water, whereas the Coburg project was intended to produce only Class A. In the future alternative water project overall cost shortfalls should be justified through logical and consistent evaluation of economic, social and environmental benefits.
5. Perhaps a larger contingency should be included in future cost estimates for project of this type

Costing estimates for Coburg have turned out to be inaccurate in the order of 25%. The major reasons for this were: unexpected geological conditions at the site location, expenses related to additional stakeholder amenity requirements, and overall underestimation of tender prices. Perhaps a review of this event by costing experts within Melbourne’s water industry could be beneficial to re-evaluate contingencies for future stormwater harvesting projects.

6. Government and community drivers are always changing

Initially the Coburg project was given a Federal grant because of the popularity of alternative water source schemes after the millennium drought and the government policies that followed. Four years on there was no real drive for this kind of project other than environmental and innovation drivers. This needs to be considered in the planning of future projects as a risk, in terms of how shifting drivers will affect the planning and subsequent use of alternative water source schemes.
WIDER RESEARCH PROGRAM - IMPROVING PLANNING PROCESSES FOR IUWM INFRASTRUCTURE

The number of “integrated” water projects and strategies across Australia is growing steadily; however there are gaps in knowledge surrounding the most effective way to manage their planning and decision making processes. As water projects and strategies become increasingly integrated, in terms of interactions between different water services, functions, and organisations, the planning processes for these become increasingly important and complex. This is due to increasing numbers of stakeholders, competing objectives, implicit non-market values and possible infrastructure options and combinations that are available.

RMIT University is working with Water Research Australia and Melbourne Water to investigate ways to improve the planning processes for Integrated Urban Water Management (IUWM) infrastructure at the strategy creation and physical project level. This study has divided the overall planning process into a generic list of planning components referred to here as a “planning framework” shown on the following page, collected information on a variety of real-world case studies, analysed and compared the differing approaches that have been used, and created guidelines to assist future planning efforts.

In this research a conceptual distinction has been made between: planning for “IUWM projects”, here meaning planning for discrete physical infrastructure assets which may or may not have been advised by a strategy, and planning for “IUWM strategies”, here meaning mid to long term strategies which are used to inform infrastructure portfolios for specified geographical areas.

The research objectives are to (1) understand the current and historical water infrastructure planning context, (2) catalogue and compare differing planning processes to determine which techniques are more effective, and (3) provide a platform from which future water infrastructure planning processes can be conducted in an informed manner.

This case study report is one of 16. These case studies were selected together with water industry experts and are shown in Table 2.

<table>
<thead>
<tr>
<th>Organisation</th>
<th>IUWM strategies</th>
<th>IUWM infrastructure projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barwon Water</td>
<td>Towards a Botanic Colac</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Review of IWCM options for Fyansford</td>
<td></td>
</tr>
<tr>
<td>City of Melbourne</td>
<td>Total Watermark</td>
<td>Fitzroy Gardens SWH project</td>
</tr>
<tr>
<td>City West Water</td>
<td>Footscray IWM Investigation</td>
<td>Altona Recycled Water Project Stage 2</td>
</tr>
<tr>
<td>Private</td>
<td></td>
<td>Coldstream RW project</td>
</tr>
<tr>
<td>SA Water</td>
<td>SA Water’s Long Term Plan for Eyre Region</td>
<td></td>
</tr>
<tr>
<td>South East Water</td>
<td>Water Initiatives for 2050</td>
<td>Boneo Recycled Water Project</td>
</tr>
<tr>
<td>Water Corporation</td>
<td>Water Forever South West</td>
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</tr>
<tr>
<td>Western Water</td>
<td>Recycled Water Strategy</td>
<td>Toolern SWH project</td>
</tr>
<tr>
<td>Yarra Valley Water</td>
<td>Northern Growth Area IWCM Plan</td>
<td>Coburg SWH project</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kalkallo SWH project</td>
</tr>
</tbody>
</table>
HOW TO READ THIS CASE STUDY

The researchers have developed an infrastructure planning framework to assist in the analysis of the case studies as shown below in Figure 1. A journal paper on this process has been published in Utilities Policy journal (Furlong, et al., 2016). For each of the case studies the researchers have recorded information on each of the planning components contained in blue boxes.

Figure 1 – Infrastructure planning framework developed to assist in case study analysis

Each case study begins with an introduction, followed by the details on planning, and then concludes with the findings which the researchers have extracted from the case study. Definitions and scopes of the planning components are shown below in Table 3. Contents of case studies have been approved by the lead organisations, although the findings are the opinions of the authors.

Table 3 - Meaning and included concepts of planning components

<table>
<thead>
<tr>
<th>Planning Component</th>
<th>Meaning and included concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Context</td>
<td>Anything which precedes the planning process, including political, environmental, and economic contexts, and preceding plans and strategies</td>
</tr>
<tr>
<td>Integrated project management</td>
<td>Project team functioning, management and reporting, and risk management</td>
</tr>
<tr>
<td>Community &amp; stakeholder engagement</td>
<td>Engagement with external stakeholder organisations and the broader community</td>
</tr>
<tr>
<td>Option identification and shortlisting</td>
<td>Identification of initial options and shortlisting prior to detailed analysis</td>
</tr>
<tr>
<td>Technical evaluation</td>
<td>Collection and analysis of technical information, including modelling and design, to provide data to inform the option selection stage</td>
</tr>
<tr>
<td>Option selection</td>
<td>Assessment, ranking, and/or scoring of options in order to determine the preferred option and planning recommendations</td>
</tr>
<tr>
<td>Governance and regulation</td>
<td>Analysis, review, and approval of planning recommendations by internal management and relevant external regulators</td>
</tr>
<tr>
<td>Financing</td>
<td>Financing arrangements (internal funding, cost sharing and/or grants)</td>
</tr>
<tr>
<td>Outcomes</td>
<td>Anything which comes after the determination of planning recommendations</td>
</tr>
</tbody>
</table>
Coburg is one of Melbourne’s oldest suburbs with development occurring in the area since the mid 1800s. Coburg is located about 10km north of Melbourne CBD, within Moreland City Council, and has a population of approximately 24,000.

Coburg Stormwater Harvesting Project was designed to harvest stormwater from two existing drains, Harding and Urquhart Street, which are located at the eastern boundary of the designated Coburg Principal Activity Centre. New drains constructed as part of developments in the area will be directed into these existing drains. Peak dry weather flows and a large proportion of wet weather flows were to be diverted from these drains into an 8ML underground storage tank beneath McDonald Reserve. This underground tank would then supply water to a new up to 1ML/day treatment plant and then onto a .5ML balancing storage for supply.

Treated stormwater was intended to be supplied via a 3rd pipe system to all new apartment buildings and also for watering of parks and public open space including Coburg Central Reserve, McDonald Reserve, and Coburg Senior High School.

The Coburg project was aiming for the following targets:

- up to 213ML of water harvested each year – net volume of imported drinking water reduced by up to 50%
- urban runoff, nitrogen and phosphorous discharged into waterway reduced by 21%, 27% and 42% respectively
- seven times less energy use than desalination
- capital and operational costs can be recovered by YVW within a 25 year period (with a 50% subsidy)
Project Background

In 2003 the Victorian Government developed a growth strategy for Melbourne which identified 26 Principal Activity Centres around which development should be focused. Coburg was identified as one of these areas. Later that year Moreland City Council developed the Central Coburg 2020 Structure Plan to provide further structure for future development in the area.

In 2009 Melbourne Water and Moreland City Council commissioned a BMT WBM report investigating the possibility of a wetland system to treat stormwater from the Harding Street Main Drain catchment. This report found that a constructed wetland would cost in the order of $2M and may be impossible due to the topography around the discharge to Merri Creek. An additional finding of the report was that a stormwater harvesting scheme may be a more cost-efficient option in the long run.

YVW management determined that Coburg was one of the most viable sites for a stormwater harvesting scheme within their business area. The main criteria for this judgement included:

1. High amount of redevelopment within an existing suburb
2. Year round non-seasonal demand for recycled water (toilets, clothes and car washing)
3. Large surrounding areas of public open space which require watering
4. Available land for a treatment plant and storage tank
5. Proximity to large drainage infrastructure
6. Willingness of council to explore alternative servicing options

Consultants were then commissioned by YVW in 2009 to investigate how it would be possible to deliver a stormwater harvesting and reuse project in Coburg, and the specifics of such a scheme.

Figure 3 – Kalkallo project drivers

Other than a mandate to pursue the best community and water service outcomes YVW also have additional drivers to showcase and trial new and innovative approaches to urban water service delivery to expand water service options within future developments. Coburg was intended to produce a transferable methodology, setting new benchmarks for planning and urban development targets for the rest of Victoria and Australia.
The funding proposal stated:

_Yarra Valley Water has already committed effort to resolving whether stormwater can be used as a potable source with the Kalkallo Stormwater Project, and now seeks to solve the challenge of ‘how to select a site for a viable stormwater project’ with the Coburg Stormwater Harvesting and Reuse Project._

**Relevant existing water infrastructure**

Coburg is an existing suburb which is fully serviced by water, sewerage and drainage services, but is not currently connected to a recycled water supply or has any mandated 3rd pipe areas. A schematic of how the new stormwater treatment plant would connect to existing drains is shown in Figure 4.

![Figure 4 – Site layout](image)

**Environmental, social and economic**

The planning of Coburg began slightly after the end of the “millennium drought”, which lasted between 1998 and 2007. Over this drought period the water resources situation in Melbourne steadily worsened to the point where authorities were operating in crisis mode. During the drought and for a number of years afterwards there was widespread support in the community for recycled water and stormwater harvesting schemes.

**Organisational and political**

Major drought conditions created a window of opportunity for water service providers to receive support for innovative alternative water source projects. Support existed both internally within YVW and externally in relation to both state regulators and federal grant suppliers. YVW was strongly pushing an environmental focus for the business. However as the planning of Coburg stretched out into 2013 and beyond, the ability to use the drought as the primary driver for the project became less justifiable.
Planning scale

The Coburg scheme was identified through a semi-structured strategic planning process conducted by the water retailer Yarra Valley Water, at the subregional scale, looking for opportunities to implement IUWM. It was not identified or planned as part of, or related to, a wider city or regional scale water strategy.

Project team functioning and oversight

The model selected for the functioning of the project team was one that placed a large amount of responsibility on a single person – the project manager. In this role the project manager was responsible for management of all stakeholders, consultants and the project team, which included engineers and a community consultation expert who developed the stakeholder and community engagement plan. The Stakeholder Reference Group was made up of representatives from Melbourne Water, Moreland City Council, the Merri Creek Management Committee and the National Urban Water and Desalination Plan.

Risk management

Existing national and international research has pointed towards over-optimism in the planning of public infrastructure projects and highlighted risk assessment methodologies as a crucial element in infrastructure planning. Typical project management and construction risks are not central to the themes of the current research, and so a focus will be placed on risks specifically associated with alternative water source projects. The major risks which were included in the planning of Coburg can be seen in Table 4.
Table 4 – Major risks considered in the planning of Coburg

<table>
<thead>
<tr>
<th>Risk</th>
<th>Mitigation strategy</th>
</tr>
</thead>
</table>
| No users for recycled water | • Establish an engagement plan (elaborated on in following section of case study)  
  • Stage reticulation construction as developments commence  
  • Maintain regular communication with developer in regards to development progress |
| YVW unable to obtain planning permit | • Engagement plan  
  • Engage early with DPCD  
  • Engage early with stakeholders and seek letters of support prior to application |
| YVW unable to secure land purchase from Pentridge Village (PV) | • Identify benefits to PV  
  • Utilise PV early to seek support of body corporate |
| PV unable to secure variation on planning permit for WSUD requirements | • Identify benefits to PV and support application with DTPLI |
| YVW unable to obtain design support from relevant stakeholders | • Engagement plan  
  • Engage both parties early  
  • Seek design input from parties rather than purely review  
  • Regular updates and communication |
| Jurisdiction over land changes | • Seek written approvals early |

How the considered risks have played out

The YVW project team has effectively identified two out of three of the key risks which have eventuated. Risks around planning estimates and risks around receiving design support from stakeholders did turn out to be significant issues, so it is excellent that these were identified early in the planning process.

There is an ever growing body of water industry experience around the risks associated with development estimates. YVW has, based on past experience with the Kalkallo Stormwater Harvesting Project and other projects, realised the significant impact of unreliable development planning projections from both councils and developers. Developments around Coburg are currently more than two years behind schedule.

Stakeholder issues around the design of the project have also been correctly identified as an issue. The project has been cancelled due to a cost increase that can be partly attributed to stakeholder requirements, such as assistance in improving the amenity of the reserve. This will be discussed further in the stakeholder and community engagement, financing, and outcomes sections of this case study.

Another risk which was not considered was that the original costing estimates could be inaccurate. It is questionable whether planners should be required to consider such a risk in the future as this may be impossible, however it may be that some sort of evaluation of current costing estimates for stormwater harvesting schemes is required to ensure they are more accurate for the next project. Cost increases occurred at multiple stages in the project for a variety of reasons including: unexpected geological conditions at the site location, expenses related to additional stakeholder amenity requirements, and overall underestimation of tender prices.
IMPROVING PLANNING PROCESSES FOR IUWM INFRASTRUCTURE

STAKEHOLDER AND COMMUNITY ENGAGEMENT

Engagement process

Stakeholder engagement for this project began early to get Moreland City Council on side, and because of this the council has been supportive of the project. Risk assessment conducted by YVW planners identified the need for a specific and detailed stakeholder and community engagement plan to manage these variables. The issues which could come up with stakeholders and the community were identified to be:

- Location, size and appearance of treatment plant and above ground storage tank
- Disruption to sporting clubs and community use of McDonald Reserve during construction and rehabilitation of surface
- Dust and noise for local residents and Coburg Senior High School
- Truck movements and work hours
- Concerns about the quality and safety of recycled treated water

Objectives of the stakeholder engagement plan were to achieve understanding, interest and acceptance of the project amongst key stakeholders, and to demonstrate to stakeholders that stormwater can be safely treated and recycled in an urban environment. To achieve these objectives some primary messages were developed for use in all engagement processes including that: recycled stormwater will provide lasting benefits to the community, reduce demand on Melbourne’s water storages, impacts during and after construction will be minimised, community will be well informed before and during the project and that the project will have lasting environmental benefits for the Merri Creek.

One particularly interesting thing about the engagement strategy selected by YVW is the concept of using their project manager as a front of house for community, so the community knows they can talk to a real person. This strategy was conducted in conjunction with letters to the local community and some door knocking.

The stakeholders with an interest in the Coburg project are shown in the table below.

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**Figure 6 – Stakeholder influence vs. impact map**

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Grant funders

Yarra Valley Water

Regulators

Developers

Local Council

Melbourne Water

Fans of Merri Creek

Australian tax payers

YVW customer base

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One particularly interesting thing about the engagement strategy selected by YVW is the concept of using their project manager as a front of house for community, so the community knows they can talk to a real person. This strategy was conducted in conjunction with letters to the local community and some door knocking.

The stakeholders with an interest in the Coburg project are shown in the table below.
## Table 5 – Stakeholder interests and incentives

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Interest/incentives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Yarra Valley Water</strong></td>
<td>YVW has an interest in providing good community outcomes, as well as being innovative and developing new water servicing strategies.</td>
</tr>
<tr>
<td><strong>Moreland City Council (MCC)</strong></td>
<td>MCC is interested in increasing the liveability of the Coburg area, receiving a drought resilient water supply for their parks, and improving the amenity of surrounding grounds.</td>
</tr>
<tr>
<td><strong>Local State and Federal Members of Parliament</strong></td>
<td>Same as above</td>
</tr>
<tr>
<td><strong>Coburg Senior High School</strong></td>
<td>The treatment plant was to be located near this school, as well as to supply water to its grounds. The school has an interest in resilient water supplies as well as ensuring the plant is aesthetically pleasing.</td>
</tr>
<tr>
<td><strong>McDonald Reserve – Sporting Clubs</strong></td>
<td>Same as above</td>
</tr>
<tr>
<td><strong>Residents in surrounding streets</strong></td>
<td>Same as above</td>
</tr>
<tr>
<td><strong>Pentridge Village Developers</strong></td>
<td>It can be assumed that developers have an incentive to make their development more amenable and appealing to sell their developments at a higher price.</td>
</tr>
<tr>
<td><strong>Merri Creek Management Committee</strong></td>
<td>MCMC and other such groups have an incentive to encourage the project to help protect the Merri Creek which is downstream. They have been given a voice in the planning process through consultation.</td>
</tr>
<tr>
<td><strong>Melbourne Water</strong></td>
<td>Melbourne Water has an obligation to protect waterways. The Coburg Project would have helped with this aim.</td>
</tr>
<tr>
<td><strong>Federal Government (grant funders)</strong></td>
<td>The purposes of the federal grants were to encourage investment in alternative water source schemes. Therefore the administrator of the fund has an incentive to ensure that the fund is distributed to worthwhile projects.</td>
</tr>
<tr>
<td><strong>YVW broader customer base</strong></td>
<td>YVW’s broader customer base will have to pay for any project costs which are not covered by revenue from the scheme or the federal grant. They have not had an opportunity to have an influence on the outcome of the scheme. YVW management has acted in their interest and cancelled the project once the unrecoverable gap became too large after cost increases.</td>
</tr>
<tr>
<td><strong>Australian tax base</strong></td>
<td>The $6 million federal grant was to be funded through tax collection from the wider Australian community, which makes every Australian a minor stakeholder whose incentive is to ensure the funds are used wisely.</td>
</tr>
</tbody>
</table>

Stakeholder and community engagement processes for the Coburg project can largely be considered to be comprehensive and effective. However one issue that came up was council requirements for aesthetic buildings and surrounding facilities, such as improvements to the cricket pitch and sport lighting, adding to the costs of the project. As it was Moreland City Council’s reserve, they were entitled to place requirements on its use. It is considered that YVW was successful in negotiating down a significant proportion of the council’s requirements. In the future perhaps costing estimate techniques could be updated to assume similar council requirements.
OPTION IDENTIFICATION AND SHORTLISTING

No official option identification process was conducted looking at other options to implement within the Coburg area. Stormwater harvesting in the area was considered to be the only alternative water source option due to there being no nearby sewer, and the fact that Melbourne Water was considering building a wetland to treat stormwater from Coburg drains.

Other circumstances leading to the identification of this project were that YVW was actively looking for a location to implement stormwater harvesting to a 3rd pipe scheme, as outlined in the Project Background section of this case study.

Various options were considered in terms of the sizing of the underground storage tank as part of the 2009 consultant report entitled “Investigation Of Coburg Principal Activity Centre Stormwater Harvesting And Reuse Project”.

TECHNICAL EVALUATION

Technical evaluation for this project was conducted through a combination of the consultant report, cost databases, Moreland City Council estimates and contractor quotes as well as internal evaluation procedures by the YVW project team. The evaluation on the Coburg project was along the lines of:

1. Demand and revenue estimates
2. Cost estimates
3. Water balance and reliability modelling
4. Environmental impacts

It is assumed that the underground concrete tanks, drainage offtake structures, above ground storage tank and connecting pipe work will last for 100 years. Maintenance of the underground tanks will be minimal and will consist of flushing out sediments on a periodic basis. The treatment plant will have a life of 25 years.

- Demand and revenue estimates
  - Demand estimates were calculated through direct engagement with developers.
  - Revenue estimates for the options were calculated by multiplying assumed prices by estimated demands.

- Cost estimates
  - Capital expenditure for the options were calculated by the consultant report, cost databases, Moreland City Council estimates and contractor quotes as well as internal evaluation procedures.

- Water balance modelling
  - Modelling to determine reliability with different storage tank sizes

- Environmental impacts
  - Modelling to determine environmental benefits received from the project in terms of flow and nutrient reductions to Merri Creek
OPTION SELECTION (PROJECT JUSTIFICATION)

In some of the case studies utilised in this research various decision support systems were used to select final infrastructure options. In the case of Coburg it was determined from an early stage in planning that the preferred option was a stormwater harvesting scheme, and the location of this scheme. Treatment train design was not contentious, and the only feature of the project which has been was the underground storage size and target reliability. Storage size determination varied as time went on through a trial and error and expert-driven process. Therefore this section will focus not on option selection, but rather project justification.

Project justification

Once initial technical evaluation was conducted YVW determined that cost effectiveness of the project was marginal and that YVW would need to receive an external grant to go ahead with the scheme. YVW was therefore required to justify the cost of this scheme to the Department of Sustainability, Environment, Water, Population and Communities to receive a grant for half of the project cost. Figure 7 shows this data after a 50% subsidy from a federal grant has already been included. The actual cost of production for water is $4470/ML (this is the original YVW assessment before the cost increase which would have made the per volume price even higher) (Yarra Valley Water, 2010).

As can be seen from Figure 7, Coburg is only cost effective with a 50% subsidy, because the full cost recovery of Coburg treated water is higher than the cost of potable water. Therefore as additional justification for the project YVW has put forward the case of indirect financial benefits to Melbourne Water, in the form of nitrogen reduction, and developers, in the sense that the scheme is cheaper than developers constructing their own smaller sustainable water scheme.

Figure 7 – Cost comparison of Coburg versus potable water supply (assuming 50% subsidy)
Indirect Financial Benefit 1 – Nitrogen Reduction

The Coburg scheme would have reduced nitrogen levels discharged to the Merri Creek. In Melbourne developers are required to meet minimum requirements for nutrient removal in stormwater captured on their development. If developers are unable or unwilling to meet this nutrient removal requirement then they are required to pay Melbourne Water a financial contribution to for development of stormwater treatment offsets in another location. When the planning of Coburg was done this contribution was set at $1,110 per kg of nitrogen per year.

In this case the nitrogen load removed due to stormwater harvesting was estimated to be 658 kg per year.

\[ 3.09 \text{ kg/ML} \times 213 \text{ ML/year} = 658 \text{ kg/year} \]

This results in a nitrogen reduction equivalent to $730,380 in offset charges.

\[ 1,110 \times 658 = 730,380 \]

This value is not a direct cost saving to YVW; however it is potentially a cost saving to Melbourne Water because it could theoretically be done instead of another nitrogen reducing project elsewhere in the drainage system. This is also a way of putting a dollar value on the environmental benefits produced through the scheme.

There is a precedent for this due to the fact that Melbourne Water has been considering the construction of a wetland to treat discharge to Merri Creek predicted to cost up to $14M. Implementing the Coburg Stormwater Harvesting project would have lessened the requirement, or size, for such a wetland.

Indirect Financial Benefit 2 - Reduced Development Costs

Moreland City Council at the time was encouraging developers in the area to include sustainable and environmentally sensitive design components, including a focus on reducing demand on traditional water supplies. This has resulted in a number of new developments attempting to plan in their own decentralised alternative water source schemes, from rainwater to stormwater and even blackwater recycling schemes.

If YVW had proceeded with the Coburg scheme then this would have given all new development in the area access to a centralised, safe, properly managed recycled water supply, negating the need for individual building scale schemes.

YVW intended to charge developers a once off fee in the form of a New Connection Contribution for access to this supply set at $282 for apartments and $564 for houses (as determined by the Essential Services Commission). This has been included in the financial evaluation. YVW determined that this charge was significantly lower than the building scale alternatives which developers were considering.

GOVERNANCE AND REGULATION

Health regulation

As YVW had already learnt from the Kalkallo Project, the planning of Coburg again revealed that health regulation is not currently ready for stormwater reuse schemes, as there are no clear approval processes and jurisdiction for decisions. However as Coburg was not a potable reuse scheme this was less of an issue.

Financial regulation

The Coburg Project involves a total budget of less than $50M so it did not require approval from the Department of Treasury and Finance. Although the ESC reviews a Water Plan provided by YVW every 5 years, the ESC does not review every individual project planned to be undertaken by YVW as part of a Water Plan assessment. As the Project is not specifically listed in the plan, it was not subjected to a detailed scrutiny by the ESC either. Therefore the financial regulation for this scheme essentially was conducted by the Federal Department of Sustainability, Environment, Water,
Population and Communities as part of assessing the grant application. However in the end the final decision came from the YVW board around how much money they were prepared to lose over the scheme, opting to cancel the project after the cost increases.

FINANCING

The estimated capital cost of the project was $13.28M (including GST). Funding was sought from the National Urban Water and Desalination Plan for 50% of the capital cost which equated to $6.640M (including GST). This was justified through the fact that the money would go towards reducing potable water demand - a key objective of the fund.

Over the years that this project went on, the estimated cost increased from $13.3 to $16.5, making the scheme gradually more obviously unfeasible for YVW. A variety of attempts were made to reduce costs and also find additional funding sources.

YVW calculated that they could recover $6-7M from fees.

Federal government was chipping in $6.64M.

Melbourne Water and the Office of Living Victoria were convinced at the last minute to provide $.5M each.

This equated to $14.64M. However there was no conceivable way to get project costs to a level where YVW would not incur a significant loss, and therefore the project was eventually officially cancelled by the YVW board.

OUTCOMES

Even though the Coburg scheme had received a federal grant for half its estimated cost, significant cost increases resulted in the project becoming unviable and being cancelled by Yarra Valley Water in 2013. These cost increases can be attributed to:

a) unexpected geological conditions in the area
b) local stakeholder requirements around aesthetics and features
c) overall underestimation of tender prices

The surrounding development, which Moreland City Council indicated would have its first apartments beginning to be constructed the following year, has not started yet 2 years later. This was correctly identified as an issue during the risk assessment, that planning estimates are generally overly optimistic. Approximately $2M YVW spent on planning and design for the scheme was lost.

FINDINGS (RESEARCHER OPINION)

1. Planning for Coburg correctly identified uncertainties around growth estimates to be a project risk

Similar to the Kalkallo case study, development in the Coburg area has not progressed at the speed predicted by planning estimates. Coburg as a case study lends additional weight to the already held view within the water industry that council and developer growth and planning estimates cannot be relied upon. Planning for Coburg identified this risk from the outset. All future alternative water projects in new development areas need to seriously consider this risk and mitigation strategies such as staging and trigger points for when to begin construction of water assets.

2. As predicted project costs increased. It was commendable that YVW had the flexibility, and also the necessary governance to cancel the project

In reality there are always uncertainties and unpredictable circumstances which can affect infrastructure planning outcomes. When water utilities are planning infrastructure projects it is important to have a mechanism by which, if project circumstances change to become less favourable
than predicted, the utility can change its mind and not proceed with the project. In other words, knowing when enough is enough and it’s time to cut losses. The Coburg scheme had so much effort put into its planning as well as achieving a government grant. When project circumstances changed, and the total project Capex increased in the order of 25%, YVW made the tough but smart decision to cancel the project. The $2M lost on planning and design is likely less than the financial losses YVW would have incurred if the scheme had gone ahead.

3. Financial assessments should attempt to justify the total project cost rather than only justify internal costs and exclude Federal funding

In certain aspects of the financial assessment of the Coburg scheme, such as the cost comparison with potable water, YVW has only considered costs as those which would be paid by YVW. Government grant money has not been included in the assessment, and therefore YVW has only attempted to justify roughly half of the schemes up-front costs. In the future it is recommended that if a scheme is to receive a 50% government subsidy it should still include 100% of the cost in the financial assessment, regardless of where it comes from, as this best reflects the impact to the community as a whole. There is also an additional question of whether a federal funding subsidy is appropriate for water infrastructure within an affluent and major city.

4. Logical and consistent financial evaluation processes are needed to justify future projects

When Federal funding is included, actual production costs for this scheme were expected to be $4.47/kL. This is a high cost for an alternative water scheme, and is even higher than the Kalkallo Stormwater Harvesting Project, which was planned to produce potable water, whereas the Coburg project was intended to produce only Class A. In the future, alternative water project overall cost shortfalls should be justified through logical and consistent evaluation of economic, social and environmental benefits.

5. Perhaps a larger contingency should be included in future cost estimates for project of this type

Costing estimates for Coburg have turned out to be inaccurate in the order of 25%. The major reasons for this were: unexpected geological conditions at the site location, expenses related to additional stakeholder amenity requirements, and overall underestimation of tender prices. Perhaps a review of this event by costing experts within Melbourne’s water industry could be beneficial to re-evaluate contingencies for future stormwater harvesting projects.

6. Government and community drivers are always changing

Initially the Coburg project was given a Federal grant because of the popularity of alternative water source schemes after the millennium drought and the government policies that followed. Four years on there was no real drive for this kind of project other than environment and innovation drivers. This needs to be considered in the planning of future projects as a risk, in terms of how will shifting drivers affect the planning and subsequent use of alternative water source schemes.
REFERENCES


Yarra Valley Water, 2010. *Coburg Principal Activity Centre Stormwater Harvesting and Reuse Project Funding Submission*, s.l.: s.n.


**Appendix B7 – Kalkallo Stormwater Harvesting Project**

<table>
<thead>
<tr>
<th>Lead organisation</th>
<th>Yarra Valley Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Melbourne’s northern fringe</td>
</tr>
<tr>
<td>Water source</td>
<td>Stormwater from urban catchment</td>
</tr>
<tr>
<td>Treated water quality</td>
<td>Potable</td>
</tr>
<tr>
<td>End use</td>
<td>Potable network (3rd pipe network until proven safe)</td>
</tr>
<tr>
<td>Predicted volume</td>
<td>360ML/year</td>
</tr>
<tr>
<td>Actual volume (average so far)</td>
<td>0ML/year (delay in development)</td>
</tr>
<tr>
<td>Total Capex</td>
<td>$~20M (2009$)</td>
</tr>
<tr>
<td>Predicted production cost</td>
<td>$4430/ML (2009$)</td>
</tr>
<tr>
<td>Customer charge</td>
<td>$1500-2500/ML*</td>
</tr>
<tr>
<td>Interesting aspects of this case study</td>
<td>Risk management, community engagement, option selection and financing</td>
</tr>
</tbody>
</table>

**Table 1 – Case study information** (*based on initial class A price, followed by increasing potable price*)

**Authors:** Casey Furlong, Lachlan Guthrie, Saman De Silva  
**RMIT University**
IMPROVING PLANNING PROCESSES FOR IUWM INFRASTRUCTURE

EXECUTIVE SUMMARY

The Kalkallo Stormwater Harvesting and Reuse Scheme is an innovative project to deliver sustainable water supply to a new industrial/commercial complex on a greenfield site approximately 30km north of Melbourne CBD. The scheme intends to source stormwater from a 160ha commercial catchment through a wetland system and 65ML storage basin. Water will then be transferred to an extensive 1 ML/day treatment plant. Water will be initially utilised within a newly created non-potable recycled water network. Monitoring and testing will be conducted for a number of years to provide evidence that produced water is safe for drinking, and then the treated water will be injected into the local potable network. YVW received $9.665M (50%) of the estimated capital cost of the project from the Federal Government.

Due to poor economic conditions arising during the Global Financial Crisis, the commercial development which forms the source catchment has not yet been constructed. A time-restrictive funding arrangement has resulted in the plant being constructed anyway, before the surrounding development, leaving the plant temporarily without a water source or water user. The treatment plant sits unused awaiting development. YVW recently received word that the first development in the area is about to commence, and so in the near future the plant is likely to begin operation.

Findings (researcher opinion)

1. Uncertainties around growth estimates should be included in risk assessments

Kalkallo as a case study supplies additional evidence to a growing understanding within the water industry that development growth estimates are often overly optimistic. Developers, council planners, and planning organisations seem to all have a tendency to estimate growth at the upper limit of what can be expected. In many cases now the water industry has lost money by assuming that growth estimates will be accurate. In the case of Kalkallo it seems possible that YVW underestimated the potential risk of development proceeding far slower than predicted. This issue should be considered seriously in the risk assessments of all future water infrastructure projects. Risk assessment findings then also need to be considered carefully in Option Selection processes.

2. Projects which are already NPV negative should take an extra conservative view of potential risks, and also have the flexibility to adapt if project circumstances change before construction

Planning decisions in the Kalkallo case need to be understood in the context of a time-restrictive funding arrangement. At a certain point YVW had to decide whether to build the treatment plant without a guarantee that the Kalkallo development would go ahead, or return the federal grant money. YVW made a decision to proceed with the project without certainty about what development would go ahead in the area and when. In future cases of projects having marginal economics, i.e. being unfeasible without a grant, perhaps the water industry should err on the side of being conservative rather than innovative.

3. Funding arrangements for infrastructure require time-flexibility to accrue savings through deferral benefits

If future government grants are to be given to water projects, the timeline for the grants should be increased to include significant flexibility to ensure that infrastructure spending can be deferred until it is needed. This would have prevented the situation that has occurred in the Kalkallo scheme, which has had a significant negative impact on the financial bottom line of the project. However there may be no possible avenue through which to change government grant policies and procedures.

4. Federal grants should only be used to fund water infrastructure projects in special circumstances

The results of this project raise questions around the practice of using federal grants to help finance infrastructure projects. If a project is unable to stand on its own merits and source funding from beneficiaries of the scheme, then there are only certain circumstances when the project should be constructed. Government subsidies are generally reserved for communities who do not have the financial status to support their own infrastructure, for example regional communities with low
populations. If water recycling projects are to continue into the future a shift towards beneficiary pays financing systems is required. In the case of Kalkallo however, as a truly innovative pilot trial, some benefit is certainly provided to the wider Australian community and the global scientific community, although the level of this benefit is difficult to assess.

5. Benefits are received from using a single contractual interface to ensure accountability

An additional finding from the Kalkallo case study is that there should be a single interface with contractors to ensure accountability. More recent case studies from the water industry demonstrate that the industry has already learnt its lesson on this matter.

6. Community perceptions around drinking treated stormwater are a risk

When the development is completed and the scheme is turned on, even if the Department of Health determines that scheme is producing potable water there is a risk that the community will not want to drink it. Because the community does not exist yet it is not currently possible to ask residents for their input. This creates an interesting situation where community engagement will need to be done well after scheme planning is finished. In future schemes of this type the risk that the community will not want to drink the treated water should be included in the risk assessment.
The number of “integrated” water projects and strategies across Australia is steadily growing; however there are gaps in knowledge surrounding the most effective way to manage their planning and decision-making processes. As water projects and strategies become increasing integrated, in terms of interactions between different water services, functions, and organisations, the planning processes for these become increasingly important and complex. This is due to increasing numbers of stakeholders, competing objectives, implicit non-market values and possible infrastructure options and combinations that are available.

RMIT University is working with Water Research Australia and Melbourne Water to investigate ways to improve the planning processes for Integrated Urban Water Management (IUWM) infrastructure at the strategy creation and physical project level. This study has divided the overall planning process into a generic list of planning components referred to here as a “planning framework” shown on the following page, collected information on a variety of real-world case studies, analysed and compared the differing approaches that have been used, and created guidelines to assist future planning efforts.

In this research a conceptual distinction has been made between; planning for “IUWM projects”, here meaning planning for discrete physical infrastructure assets which may or may not have been advised by a strategy, and planning for “IUWM strategies”, here meaning mid to long term strategies which are used to inform infrastructure portfolios for specified geographical areas.

The research objectives are to (1) understand the current and historical water infrastructure planning context, (2) catalogue and compare differing planning processes to determine which techniques are more effective, and (3) provide a platform from which future water infrastructure planning processes can be conducted in an informed manner.

This case study report is one of 16. These case studies were selected together with water industry experts and are shown in Table 2.

Table 2 – Case studies utilised in research program

<table>
<thead>
<tr>
<th>Organisation</th>
<th>IUWM strategies</th>
<th>IUWM infrastructure projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barwon Water</td>
<td>Towards a Botanic Colac</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Review of IWCM options for Fyansford</td>
<td></td>
</tr>
<tr>
<td>City of Melbourne</td>
<td>Total Watermark</td>
<td>Fitzroy Gardens SWH project</td>
</tr>
<tr>
<td>City West Water</td>
<td>Footscray IWM Investigation</td>
<td>Altona Recycled Water Project Stage 2</td>
</tr>
<tr>
<td>Private</td>
<td></td>
<td>Coldstream RW project</td>
</tr>
<tr>
<td>SA Water</td>
<td>SA Water’s Long Term Plan for Eyre Region</td>
<td></td>
</tr>
<tr>
<td>South East Water</td>
<td>Water Initiatives for 2050</td>
<td>Boneo Recycled Water Project</td>
</tr>
<tr>
<td>Water Corporation</td>
<td>Water Forever South West</td>
<td></td>
</tr>
<tr>
<td>Western Water</td>
<td>Recycled Water Strategy</td>
<td>Toolern SWH project</td>
</tr>
<tr>
<td>Yarra Valley Water</td>
<td>Northern Growth Area IWCM Plan</td>
<td>Coburg SWH project</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kalkallo SWH project</td>
</tr>
</tbody>
</table>
APPENDIX B7 – KALKALLO STORMWATER HARVESTING PROJECT

HOW TO READ THIS CASE STUDY

The researchers have developed an infrastructure planning framework to assist in the analysis of the case studies as shown below in Figure 1. A journal paper on this process has been published in Utilities Policy journal (Furlong, et al., 2016). For each of the case studies the researchers have recorded information on each of the planning components contained in blue boxes.

![Diagram of infrastructure planning framework](image)

**Figure 1 – Infrastructure planning framework developed to assist in case study analysis**

Each case study begins with an introduction, followed by the details on planning, and then concludes with the findings that the researchers have extracted from the case study. Definitions and scopes of the planning components are shown below in Table 3. Contents of case studies have been approved by the lead organisations, although the findings are the opinions of the authors.

<table>
<thead>
<tr>
<th>Planning Component</th>
<th>Meaning and included concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Context</td>
<td>Anything which precedes the planning process, including political, environmental, and economic contexts, and preceding plans and strategies</td>
</tr>
<tr>
<td>Integrated project management</td>
<td>Project team functioning, management and reporting, and risk management</td>
</tr>
<tr>
<td>Community &amp; stakeholder engagement</td>
<td>Engagement with external stakeholder organisations and the broader community</td>
</tr>
<tr>
<td>Option identification and shortlisting</td>
<td>Identification of initial options and shortlisting prior to detailed analysis</td>
</tr>
<tr>
<td>Technical evaluation</td>
<td>Collection and analysis of technical information, including modelling and design, to provide data to inform the option selection stage</td>
</tr>
<tr>
<td>Option selection</td>
<td>Assessment, ranking, and/or scoring of options to determine the preferred option and planning recommendations</td>
</tr>
<tr>
<td>Governance and regulation</td>
<td>Analysis, review, and approval of planning recommendations by internal management and relevant external regulators</td>
</tr>
<tr>
<td>Financing</td>
<td>Financing arrangements (internal funding, cost sharing and/or grants)</td>
</tr>
<tr>
<td>Outcomes</td>
<td>Anything which comes after the determination of planning recommendations</td>
</tr>
</tbody>
</table>
INTRODUCTION

The Kalkallo Stormwater Harvesting Scheme is a project of international significance. It is possibly the first project of its kind in the world that seeks to implement direct potable recycling of stormwater, but certainly the first in Australia. It is innovative in two ways: from a water security perspective, in the sense that theoretically it could result in a 90% reduction in imported water, and from a waterway protection perspective, from reducing the total runoff from the catchment by 45%.

Kalkallo is located approximately 28km north of the Melbourne CBD, within the Hume City Council Local Government area. In Kalkallo a large greenfield site (730 Ha) was in the early stages of being developed for commercial use, and Yarra Valley Water (YVW) saw this as an opportunity to investigate an innovative and sustainable water servicing option. The Project involves collecting stormwater, from a 160 Ha catchment, which will be treated to a drinking water standard using an advanced treatment train. The treated water is intended to be used to supplement the existing potable water supply in the areas surrounding Kalkallo, however this is dependent upon years of water quality monitoring and the results of future community consultation. The estimated capital cost of the project was $19.3M (excluding GST), with a target commissioning date of August 2011. The stormwater treatment process for the Kalkallo Project is shown in Figure 2 below.

![Figure 2 – Kalkallo Project treatment train](image)

Construction of the Project was completed in early 2013 at a total cost of $20.2M (excluding GST), however commissioning was delayed due to issues with the DAFF system. YVW and the supplier disagreed on whether the DAFF’s capabilities had been achieved, and after some site testing and discussion between the parties the matter was settled and closed.

The commercial development around the plant, which is the stormwater source catchment, is not yet under construction. This means there are no properties for the plant to service locally and has resulted in delaying the production of water. It is not viable to turn the plant on in the current circumstances. YVW has recently been informed that the first development in the Kalkallo area is soon to commence, so there is optimism the plant may be used once the first stage of development is complete.


Project Background

In 2007, YVW began considering water servicing strategies for land in Melbourne’s north expected to be included in an expanded Urban Growth Boundary. As part of this strategy, it became apparent that there was a potential opportunity to use local stormwater or sewage treated to a high standard for potable reuse purposes. After detailed option assessment, YVW determined that the best option for the area was treated stormwater (further details in Option Identification and Option Selection sections later in this report). YVW approached Merrifield Corporation, a partnership between MAB Corporation and the Gibson Property Group to discuss the idea of a stormwater reuse scheme around Kalkallo. The drivers behind the Kalkallo project can be seen in Figure 3.

In 2008 YVW and Merrifield Corporation came to an in-principle agreement to pursue a stormwater recycling scheme at Kalkallo. In 2009, a submission was made to a Federal Government grant scheme known as the National Urban Water and Desalination Plan - Stormwater Harvesting and Reuse Projects, for funding. The application was successful and YVW received $9.7M (50%) of the estimated capital cost of the Project.
Relevant existing water infrastructure

The Kalkallo area is currently an undeveloped greenfield area. The area is not currently serviced by any water supply and sewerage networks. In order to provide facilities at the treatment plant YVW needed to connect directly to a water transfer main and bring forward a sewerage main development. Figure 4 shows the undeveloped nature of the site.

![Site layout](image)

Figure 4 – Site layout

Environmental, social and economic

The planning of Kalkallo was started during the "millennium drought" which lasted between 1998 and 2007. During this time the water resources situation in Melbourne steadily worsened to the point where authorities were operating in crisis mode. Over the period immediately following the drought there was widespread support in the community for recycled water and stormwater harvesting schemes.

Organisational and political

Major drought conditions created a window of opportunity for water service providers to receive support for innovative alternative water source projects. Support existed both internally within YVW and externally in relation to both state regulators and federal grant suppliers. YVW was strongly pushing an environmental focus.
**INTEGRATED PROJECT MANAGEMENT**

**Planning scale**

The Kalkallo scheme was identified through a semi-structured strategic planning process conducted by the water retailer Yarra Valley Water, at the subregional scale, which looked for opportunities to implement IUWM. It was not identified or planned as part of, or related to, a wider city or regional scale water strategy.

**Project team functioning and oversight**

The first step in the planning of Kalkallo was to get all key stakeholders to collaborate and explore possible options for servicing the Kalkallo area. This partnership involved representatives from five different organisations including: water supply and sewerage planners from YVW, stormwater planners from Hume City Council, stormwater planners and water quality specialists from Melbourne Water, the land developer Merrifield Corporation, and the Department of Health. The project team functioning during the initial stages of planning for the Kalkallo project is shown in Figure 5.

![Project team functioning and oversight during planning phase](image)

Figure 5 – Project team functioning and oversight during planning phase

Once the basic parameters of the scheme were determined together with external stakeholders, the majority of the project delivery phase was conducted by private design consultants and construction contractors employed and monitored by YVW. Treatment plant machine suppliers and construction contractor tenders were issued separately. This created an issue of a lack of clarity, in other words a management headache, when the treatment train did not perform correctly.
The decision was made to separate the tenders because YVW felt that since this project was the first of its type they wanted to have as much control as possible over scheme components to minimise design risk. However in reality this resulted in the construction being more difficult to coordinate. YVW has determined that in future, planning processes design and construction should be included within the control of a single primary contractor, to ensure a single contract interface.

**Risk management**

Existing national and international research has pointed towards over-optimism in the planning of public infrastructure projects and highlighted risk assessment methodologies as a crucial element in infrastructure planning. Typical project management and construction risks are not central to the themes of the current research, and so a focus will be placed on risks specifically associated with alternative water source projects. The major risks included in the planning of Kalkallo can be seen in Table 4.

<table>
<thead>
<tr>
<th>Risk</th>
<th>Mitigation strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed water quality risks from chemicals and pollutants – operational and public safety risk</td>
<td>First flush diversions, wetlands, treatment, monitoring</td>
</tr>
<tr>
<td>Water storages attracting insects – amenity risk</td>
<td>Aeration and appropriate design</td>
</tr>
<tr>
<td>Lack of potential market for treated water – financial risk</td>
<td>Work with developers, planning and further risk assessment processes</td>
</tr>
<tr>
<td>Lack of community interest – legacy risk</td>
<td>Community engagement</td>
</tr>
<tr>
<td>Change in water quality regulations – financial risk</td>
<td>Managed through identifying bodies and establishing a relationship</td>
</tr>
<tr>
<td>Failure to gain necessary approvals – financial risk</td>
<td>Appropriate planning and further risk assessment</td>
</tr>
</tbody>
</table>

**How the considered risks have played out**

As the Kalkallo commercial/industrial development, which is the feed water catchment, has not yet been constructed, it is currently unknown whether the final feed water quality will match what was predicted. So far there have been no issues with insects in the water storage.

In terms of demand for the treated water, there is currently no demand as there has been no development. When the development is completed in the future, there is still a significant risk that the community will not want to drink the treated stormwater. In Melbourne’s north there is currently an excess of non-potable Class A quality recycled water, and so this would be a negative result for YVW and the community.

Community acceptance in the future is still impossible to judge. Changing regulations have not presented any issue for this project so far, and all the relevant approvals were achieved without any particular issue. However after 2-3 years of operation YVW will be required to give water quality data to DoH to receive approval for potable reuse of treated water. It is possible that achieving community support for drinking this treated water could be as much of an obstacle as DoH approval. The solution to both is a comprehensive water quality monitoring program, which will have to demonstrate the safety of potable water produced by the scheme.

**Risks that should be given greater weight in future projects**

The risks that have turned out to be the most significant problems for the Kalkallo project have not been single distinct risks, but rather the risk of multiple factors acting in combination. These two combinations were:

1. Incorrect planning/growth estimates when operating with a time restricted funding agreement
2. Malfunction of treatment plant components when operating with multiple separate contractors creating a lack of clarity in terms of treatment train performance
By far the biggest risk for the Kalkallo project has turned out to be the lack of development in the area. At the time it was decided to go ahead with the treatment plant, the developers gave assurances that the commercial development would begin shortly. In the future it is evident that major financial decisions should not rely upon assurances. Planning estimates being over optimistic would not have been so major an issue if YVW had the opportunity to delay construction of the plant until commercial development began, however the funding arrangement with the Department of Sustainability, Environment, Water, Population and Communities stipulated that construction had to be completed by 2013. In the future all projects of this type should have the flexibility to delay or cancel construction if there appear to be any variations from the planning estimates.

The use of a separate design consultant and construction contractor in this project has made the responsibility for subsequent treatment plant performance somewhat ambiguous, resulting in increased risk to YVW because responsibility cannot be clearly allocated.

STAKEHOLDER AND COMMUNITY ENGAGEMENT

Engagement process

Extensive stakeholder engagement was undertaken from the very beginning of the planning of Kalkallo. A stakeholder reference group consisting of YVW, Melbourne Water, Hume City Council and MAB Corporation was formed. These stakeholders were consulted and provided input during all stages of the project. The Department of Sustainability and Environment (DSE) and the Department of Human Services (DHS) were also given information about the project.

It was originally intended that, during the design stage, a detailed Community Engagement Strategy would be developed to inform commercial and residential end-users of the stormwater project. However due to the Kalkallo area being a greenfields site, and also the delay in the development of the commercial area around the plant, there was no existing community to consult. YVW now intends to wait until the commercial development is completed before consulting with the local community about the idea of using treated stormwater for potable purposes.

As part of this process YVW may engage in a widespread consultation program across its whole service area and in conjunction with the Department of Health to determine at a wider scale whether potable reuse of stormwater is appropriate. Evidence of plant performance over a 2-3 year period will be required before the DoH is likely to grant approval for potable reuse of the water.

Stakeholders

Yarra Valley Water

YVW has an incentive to act in line with both government and organisation policy which is supportive of alternative water source schemes. There is also an incentive to trial this new technology so that they can potentially install stormwater to potable schemes in other areas. YVW is also expected to achieve lowest community cost for their customers. As the main organisation responsible for the project they have the greatest influence.

Developers

Due to the fact that the commercial development has not commenced, and the land packages have not been sold, the developers act as proxies for future end users. In this case it can be assumed that developers have an incentive to make their development more amenable and appealing in order to sell their developments at a higher price. Developers have a high level of influence through being able to design the specifics of their development.

Grant funders

The purposes of the federal grants were to encourage investment in alternative water source schemes. Therefore the administrator of the fund has an incentive to ensure that the fund is distributed to worthwhile projects. Grant funders had the ability to decide whether the project was worthy of the grant.
YVW broader customer base

YVW’s broader customer base will have to pay for any project costs not covered by revenue from the scheme or the federal grant. They have not had an opportunity to influence the outcome of the scheme; however at the time Kalkallo was planned it was known that the community was in favour of alternative water sources schemes.

Australian tax payers

The almost $10 million federal grant is funded through tax collection from the wider Australian community, which makes every Australian a minor stakeholder whose incentive is to ensure the funds are used wisely.

Melbourne Water Corporation

Melbourne Water has an obligation to look after the interests of the wider population of Melbourne and also to protect waterways. Implementation of alternative water source schemes will likely defer the next major water infrastructure augmentation, and therefore has the potential to provide a benefit to Melbourne Water customers. The Kalkallo project will also help protect waterways.

Local government (Hume City Council)

Local government has not played a major role in the planning of the scheme. Hume City Council has an incentive to encourage amenable development and growth in their area, and an ability to approve developments.

Fans of the Merri Creek

YVW was in contact with the Merri Creek Management Committee during the planning of the Kalkallo project. The MCMC and other groups such as Friends of the Merri Creek have an incentive to encourage the project to help protect the Merri Creek which is downstream. They have been given a voice in the planning process through consultation.
Regulators

Regulators act as proxies for the government of the day, who have their own political ideologies, but are mandated to act in the best interest of the public at large. Regulation for this project can be divided along the lines of financial, health and environmental regulation and will be covered in the Governance and Regulation section later in this case study report.

OPTION IDENTIFICATION AND SHORTLISTING

Preliminary strategy development for the area around Kalkallo began in 2007. YVW hired a consultant in 2009 to conduct a study to assess possible options in the area, including a stormwater harvesting scheme. This was labelled the Kalkallo Integrated Water Management Project. This was conducted together with the stakeholder reference group and identified and assessed 11 options for integrated water services for the entire development site (730ha).

Options were determined through collective brainstorming of YVW planners together with consultants. Options shortlisted for further assessment included:

1. Base case, traditional servicing scenario
2. Base case with rainwater tanks at each lot
3. Rainwater tanks at each lot, topped up from communal stormwater storage. Stormwater storage backed up by imported class A recycled water
4. (A) Third pipe with stormwater backed up by imported class A
4. (B) Third pipe with stormwater backed up by imported class A and rainwater tanks on each lot
4. (C) Third pipe with stormwater backed up by imported class A and communal rainwater tank
4. (D) Development scale capture and treatment of stormwater – distributed via potable network
5. (A) Imported class A recycled water
5. (B) Treatment of Kalkallo wastewater to class A and reuse
6. (A) Development scale capture and treatment of roof runoff – distributed via potable network. Recycled class A water imported and distributed via third pipe
6. (B) Development scale capture of roof runoff with offsite treatment at Yan Yean Treatment Plant to potable standard. Treated rainwater to offset usage of Mt Ridley portable supply. Recycled class A water imported and distributed via third pipe.

Results of analysis are shown in the Option Selection section of this case study.
The technical assessments which facilitate the selection of a preferred option were as follows:

**Demand estimates**
- Demand estimates were calculated through direct engagement with developers.

**Cost estimates**
- Standard costing procedures.

**Revenue estimates**
- Revenue estimates for the options were calculated by multiplying assumed prices by estimated demands.

**(IWM) Water balance modelling**
- Technical assessment conducted by a consultant as part of the Kalkallo IWM project

**Life cycle assessment of environmental impacts**
- Focussed on greenhouse gas emissions and was conducted by Life Cycle Strategies

**Sustainability assessment framework**
- A form of multi criteria assessment which combined economic, social and environmental factors.

### OPTION SELECTION

Water balance modelling and concept designs were developed for each option and a life cycle assessment was carried out to ascertain the corresponding environmental impacts. Options were then assessed using a rigorous sustainability assessment, which considered economic, environmental and social impacts. The results of this are shown below.

![Sustainability Scores by Primary Criteria](image)

**Figure 7 – Sustainability scores for shortlisted options for Kalkallo development**

- **Economic**
- **Environment**
- **Social**
- **Total Scores**
Scores showed that precinct scale stormwater harvesting (4D) was the 4th ranked out of 11. However this work highlighted that either rainwater or stormwater harvesting for potable reuse had a number of benefits when compared with other options (including traditional servicing). Following on from this, Yarra Valley Water commissioned another investigation to further refine the preferred option, which was titled Rainwater/Stormwater Options Assessment (conducted in 2009 by a consultant).

Consultants were engaged again to explore options for harvesting and treating either rainwater or stormwater from the development. Concept designs of the two collection systems were developed and the quality of the source water was characterised, enabling the required treatment to be designed. Costing of the options revealed that stormwater harvesting from a single 160 Ha catchment, rather than the entire 730 Ha development was the preferred option. It was also proposed that the stormwater could be treated to a standard suitable for direct injection into the potable water supply system.

**Project justification**

Once the final option had been selected, YVW determined that cost effectiveness of the project was marginal and that they would need an external grant to go ahead with the scheme. YVW was therefore required to justify the cost of this scheme to the Federal Department of Sustainability, Environment, Water, Population and Communities to receive a grant for half of the project cost. YVW justified the project by showing how the levelised cost of produced water is impacted by the inclusion of indirect financial benefits. Figure 8 shows this data after a 50% subsidy from a federal grant has already been included. The actual cost of production for water is $4430/ML (Yarra Valley Water, 2009).

![Figure 8 – Comparison of Kalkallo Project levelised cost versus potable water cost](image)

**Indirect Financial Benefit 1 – Nitrogen Reduction**

The project will reduce the nitrogen load discharged to the downstream Kalkallo Creek, Merri Creek, and Port Phillip Bay. In Melbourne it is mandated that new developments meet minimum requirements for stormwater treatment. When developers cannot meet their nutrient removal requirements, they are able to pay Melbourne Water a financial contribution towards future capital works, which will offset the increased load somewhere else in the system. This contribution is currently set at $1,110 per kg of nitrogen per year. The nitrogen load reduction due to stormwater harvesting in Kalkallo is expected to be 1,461 kg per year.
Therefore the Kalkallo project results in a nitrogen reduction equivalent to $1.6M in total offset charges. However even though the project is expected to provide these benefits to the MW waterway, YVW did not attempt to charge MW for this benefit.

**Indirect Financial Benefit 2 - Deferment of Other Capital Works**

Due to the distance of Kalkallo from the existing metropolitan system, there are large costs associated with extending potable water supply infrastructure to the area. There is an existing potable water supply main which runs along the Hume Highway to supply Wallan which can be used initially, however increased demand from the Kalkallo development means that a second transfer system will be required soon after development commencement. New infrastructure assets which will soon be required include:

1. One water supply tank located at YVW’s existing Craigieburn Reservoir site (~$11M)
2. One major water supply main along the future E14 roadway from Craigieburn Reservoir to Kalkallo (~ $18M)
3. One water supply tank to be located at YVW’s existing Mount Ridley Reservoir site (~ $5M)

The Kalkallo project does not eliminate the need for these assets; however it does enable their construction to be deferred. Development forecasts indicated a deferral period of at least 3 years. Assuming an interest rate of 5% per annum and a total capital cost of $34M, YVW is likely to save approximately $1.7M per annum in financing costs through deferral. This calculation includes the assumption that Kalkallo will eventually supply drinking water.

**Financial assessment assuming 50% federal grant subsidy**

As can be seen in Figure 9, if YVW receives the federal grant, and doesn’t include any indirect benefits, the project was expected to pay for itself over approximately 20 years.

![Figure 9 – Financial returns on the project with 50% government subsidy included](image-url)

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GOVERNANCE AND REGULATION

1.1 Health regulation

One of the learnings out of this project is that health regulation is not currently ready for stormwater to potable reuse schemes. This is because Kalkallo is the first of these schemes to occur, possibly anywhere in the world, and regulation almost always lags behind technology and practice. This caused significant issues for the planning of Kalkallo due to there being no clear approval processes and jurisdiction for decisions. It is a regulator’s job to be cautious, and therefore to manage this YVW has endeavoured to adhere to or exceed the expectations of several key standards and documents used by regulators to guide their decisions. The documents that YVW has used to guide their treatment train assessment included:

1. Class A recycled water guidelines – which are possibly more stringent that necessary as they apply to sewage source water rather than stormwater
2. Australian Drinking Water Guidelines – which were found to be lacking in detail in regards to limits on contaminants and pathogens
3. Australian Guidelines for Water Recycling: Managing Health & Environmental Risks (Phase 2): Stormwater Harvesting & Reuse (July 2009) – which provide some guidance for managing risks associated with stormwater treatment, however guidance is based on limited data and recommends a conservative approach. It does not cover treatment for potable use

It is clear that being the first organisation to implement one of these schemes has resulted in an increased workload for YVW. After 2-3 years of water quality monitoring for the scheme, even if the Department of Health does give approval for potable reuse, the planning result will still depend upon the community perspectives on drinking treated stormwater.

1.2 Financial regulation

The Kalkallo Project involves a total budget of less than $50M so it did not require approval from the Department of Treasury and Finance. Although the ESC reviews a Water Plan provided by YVW every 5 years, the ESC does not review every individual project planned to be undertaken by YVW as part of a Water Plan assessment. As the Project is not specifically listed in the plan, it was not subjected to a detailed scrutiny by the ESC either. Therefore the financial regulation for this scheme essentially was conducted by the Federal Department of Sustainability, Environment, Water, Population and Communities as part of assessing the grant application.

FINANCING

Financing of the project relates to where the money was sourced from. Due to receiving a federal grant it was expected that 50% of the costs would be covered by the grant and 50% by YVW. In this case a minor cost increase of approximately $900,000, due mostly to the developer deciding against expectations to charge YVW for the land under the treatment plant, has resulted in YVW initially paying slightly over 50% of the total cost. Because of delays in rate of surrounding development the overall financial bottom line of the project has become more negative, and YVW has had to cover additional losses.

OUTCOMES

The combination of time limitations on the relevant government grant, and slower than expected development of the area, has resulted in the treatment plant being built prior to development in the area, and sitting unused because it is not efficient to run the plant at all in the current circumstances. Merrifield Corporation (the developers) have been insistent that they intend to continue with the commercial development around the site, however it was impossible to know if, and when, this would
I PROVING PLANNING PROCESSES FOR IUWM INFRASTRUCTURE

happen. YVW received word in May 2015 that the first development in the area was about to commence.

These issues have severely impacted the financial viability of the scheme, although it is difficult to quantify to what extent.

On the positive side, now that development is about to begin, the scheme may soon be in operation, and YVW and the wider water industry can use these learnings to improve future planning processes. Once development in the area has been completed the scheme will initially supply water to a Class A non-potable recycled water system. Water quality monitoring will be undertaken to demonstrate that treated stormwater is of the standard required by the Department of Health for potable water supply. Community consultation will also be needed to determine if the community is happy to drink treated stormwater prior to supplying this water to the drinking water network.

FINDINGS (RESEARCHER OPINION)

1. Uncertainties around growth estimates should be included in risk assessments

Kalkallo as a case study supplies additional evidence to a growing understanding within the water industry that growth development estimates are often overly optimistic. Developers, council planners, and planning organisations seem to all have a tendency to report growth estimates at the upper limit of what can be expected. In many cases now the water industry has lost money by assuming that growth estimates will be accurate. In the case of Kalkallo it seems possible that YVW underestimated the potential risk of development proceeding far slower than predicted. This issue should be considered seriously in the risk assessments of all future water infrastructure projects. Risk assessment findings then also need to be considered carefully in Option Selection processes.

2. Projects which are already NPV negative should take an extra conservative view of potential risks, and also ensure flexibility to adapt if project circumstances change before construction

Planning decisions in the Kalkallo case need to be understood in the context of a time-restrictive funding arrangement. At a certain point YVW had to decide whether to build the treatment plant without a guarantee that the Kalkallo development would go ahead, or return the federal grant money. YVW made a decision to proceed with the project without certainty about what development would go ahead in the area and when. In future, cases of projects with marginal economics, i.e. being unfeasible without a grant, perhaps the water industry should err on the side of being conservative rather than innovative.

3. Funding arrangements for infrastructure require time flexibility in order to accrue savings through deferral benefits

If future government grants are to be given to water projects, the timeline for the grants should be increased to include significant flexibility to ensure that infrastructure spending is deferred until it is needed. This would have prevented the situation which has occurred in the Kalkallo scheme which has had a significant negative impact on the financial bottom line of the project. However there may be no possible avenue through which to change government grant policies and procedures.

4. Federal grants should only be used to fund water infrastructure projects in special circumstances

The results of this project raise questions around the practice of using federal grants to help finance infrastructure projects. If a project is unable to stand on its own merits and source funding from beneficiaries of the scheme, then there are only certain circumstances when the project should be constructed. Government subsidies are generally reserved for communities without the financial status to support their own infrastructure, for example regional communities with low populations. If water recycling projects are to continue into the future a shift towards beneficiary-pays financing systems is required. In the case of Kalkallo however, as a truly innovative pilot trial, some benefit is certainly provided to the wider Australian community and the global scientific community, although the level of this benefit is difficult to assess.
5. Benefits are received from using a single contractual interface to ensure accountability

An additional finding from the Kalkallo case study is that there should be a single interface with contractors to ensure accountability. More recent case studies from the water industry demonstrate that the industry has already learnt its lesson on this matter.

6. Community perceptions around drinking treated stormwater are a risk

When the development is completed and the scheme is turned on, even if the Department of Health determines the scheme is producing potable water, there is a risk that the community will not want to drink it. Because the community does not exist yet it is not currently possible to ask residents for their input. This creates an interesting situation where community engagement will need to be done well after scheme planning is finished. In future schemes of this type, the risk that the community will not want to drink the treated water should be included in the risk assessment.

REFERENCES


Appendix C – Survey data
<table>
<thead>
<tr>
<th>Start Date</th>
<th>Organisation</th>
<th>State</th>
<th>What does Integrated Water Management mean to you?</th>
<th>What do you think are the main objectives of IWM?</th>
<th>If IWM is implemented effectively, what do you think would be the main impacts on the community?</th>
<th>In your opinion what actions/methods/steps does implementing IWM specifically involve?</th>
<th>How relevant is IWM currently?</th>
<th>How relevant do you see IWM being in the future?</th>
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<tbody>
<tr>
<td>01/11/2016</td>
<td>DELWP</td>
<td>VIC</td>
<td>Open-Ended Response</td>
<td>Open-Ended Response</td>
<td>Open-Ended Response</td>
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<td></td>
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<td>place based planning to achieve multiple benefits across the water cycle</td>
<td>to work collaboratively across different elements of the water cycle to achieve better outcomes instead of focusing on a single element. This can achieve greater community value for the investment</td>
<td>Better community outcomes, multiple benefits from a single project, better use of investment (lowest community cost not lowest organisational cost)</td>
<td>Collaboration is very important. Without a commitment to working across organisations including areas outside of your control, you can't get innovative solutions</td>
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<td>Extremely relevant</td>
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<td>All forms of water are used effectively to meet community needs that would extend well beyond traditional water &amp; sewer services.</td>
<td>Water resources are managed effectively to provide public health and environmental outcomes. This should consider wider impacts of electricity and transport demands and their footprint on our community.</td>
<td>Large infrastructure projects would not be necessary. More local solutions.</td>
<td>Need to have: 1. an overall plan water (&amp; other services) management for a region. 2. demonstrate to the community the benefits of IWM - so some trial projects 3. inter agency collaboration</td>
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<td>taking a whole of water cycle approach to planning and delivering services, as well as integrating water and urban planning. To ensure that water is not a limit on city’s sustainability, liveability or resilience. Economic growth and better health. Collaboration between silos, understanding local opportunities and acting on them, having clear objectives for each aspect of the water cycle, valuing the full range of benefits that can be achieved/impacted by water services.</td>
<td></td>
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<td>01/04/2016</td>
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<td>Water Management referring to management of infrastructure associated with delivering water services, as well as the nature of services supplied. Integrated refers to alignment in objectives and working methods between branches of the company associated with providing customer or asset services. Reduce overhead by seeking alignment between working theory/objectives/practice from the lowest to the highest possible level (that still maintains administrative applicability). Increased formal and informal dialogue between relevant levels of an organisation, as well as across traditionally siloed divisions/business units, in particular, customer/service providers and asset/product providers. Where relevant, reliable understanding between government and industry on the current and future policy directions with shared vision for future of domestic and industrial water service outcomes.</td>
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<td>Bringing management of all parts of the water cycle together and managing as a whole for social, economic and environmental benefits.</td>
<td>Social, environmental and economic benefits. Not sure - too broad a topic.</td>
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<td>Wholistic water management for maximum community benefits</td>
<td>Improved well being, reduced costs and healthier environment</td>
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<td>Wholistic water management for maximum community benefits</td>
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<td>01/03/2016</td>
<td>Sydney Water</td>
<td>NSW</td>
<td></td>
<td>an effective and efficient management of water</td>
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<tr>
<td>01/03/2016</td>
<td>Sydney Water</td>
<td></td>
<td></td>
<td>Taking and total livecycle approach of the total system including stakeholders, customers and regulators</td>
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<td>12/28/2015</td>
<td>Opus</td>
<td>Western Australia</td>
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<td>Date</td>
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<tr>
<td>12/23/2015</td>
<td>Hume City Council</td>
<td>Vic</td>
<td>Considering the impacts of water service delivery and impacts on waterways in a holistic manner (environmental, social, financial cost benefits) in order to determine the best overall outcome (combination of treatments) for a specific site or proposal.</td>
<td>Very relevant</td>
<td>Extremely relevant</td>
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<td>Ideally to identify what the most important objectives are for the specific site / proposal and then test a variety of options according to how they would perform against those specific objectives. In general the objectives will be environment, social and financial: protect waterway health; optimal use of alternative water sources; resilience of water supply for various uses (including greening) in ongoing drought / climate change conditions; cost of water.</td>
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<td>Water services and a system that delivers better than Business As Usual outcomes at an acceptable cost.</td>
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<td>- identify site specific objectives with stakeholders ideally including the community - identify long list of treatment options and use PAM and initial cost benefit analysis to reduce these to a short list - detailed testing of shortlisted options and cba - application of cost allocation framework - key stakeholders / community agree on preferred option - aim to integrate into planning scheme framework</td>
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<tr>
<td>12/22/2015</td>
<td>E2Designlab</td>
<td>VIC</td>
<td>Management of all parts of the water cycle and consideration of land planning and community well-being aspects at once.</td>
<td>Very relevant</td>
<td>Extremely relevant</td>
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<td></td>
<td></td>
<td>Improved environmental outcomes Additional water supply options, particularly alternative sources Improved liveability Greater stakeholder collaboration</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Urban greening Improved microclimate Water security Cleaner waterways Environmental awareness</td>
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<tr>
<td>12/22/2015</td>
<td>Sydney Water</td>
<td>NSW</td>
<td>Understanding of all water management aspects and land planning - requiring multiple disciplines. Review of all aspects of water cycle Appreciation of interactions Optioneering of interventions and effect on all parts of water cycle, environment and liveability</td>
<td>Very relevant</td>
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<tr>
<td>12/22/2015</td>
<td>Evoqua Water Technologies</td>
<td>Queensla nd</td>
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</tbody>
</table>
The consideration of the whole water cycle when considering how to service an area to provide the best whole of community outcome. Whole of water cycle includes rainwater, stormwater, potable water, sewage, recycled water and waterways.

The objectives are to provide the best outcome from a whole of community benefit when factoring in liveability and essential services.

Generally speaking the cost of implementation of IWM can be higher, but there are non monetised benefits such as liveability, nuisance flooding, amenity and environmental outcomes that can not always be monetised.

A collaborative approach to servicing.

Very relevant

Extremely relevant
<table>
<thead>
<tr>
<th>Date</th>
<th>Authority</th>
<th>Location</th>
<th>Description</th>
<th>Relevance</th>
<th>Relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td>12/22/2015</td>
<td>City West Water</td>
<td>Victoria</td>
<td>Coordinated approach to the planning and implementation of all aspects of the water cycle to maximise social, environmental and economic outcomes. Considers the whole water cycle - water, sewerage, drainage, rainfall, groundwater, stormwater/flood management whilst also addressing population growth, climate variability, environment and amenity.</td>
<td>Extremely relevant</td>
<td>Extremely relevant</td>
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<td></td>
<td>Sustainable water supply solutions, diversifying and optimising all sources of water to withstand future droughts and floods. Consideration of climate change, heat island effect and population growth. Healthy waterways and environmental flows to waterways. Liveability and improved open space. Stakeholder collaboration in planning and delivering IWM.</td>
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<td></td>
<td>Reliable and resilient water supply systems. Cost effective water solutions. More liveable and heather communities through addressing heat island effect, better quality of open passive and active open space, healthier waterways.</td>
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<td>Open collaboration between all stakeholders. Agree with stakeholders governance structure, roles and responsibilities, objectives, levels of service, project plan etc. Undertake water balance, capture data to enable options identification and short listing of options. Development of the options and scenarios. Technical and financial (NPV, CBA) modelling of options. Identification of preferred option. Address any regulatory issues associated with preferred option. Stakeholder agreement on distribution of costs and funding for delivery of preferred option and coordinated capital investment plan.</td>
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</tr>
<tr>
<td>12/22/2015</td>
<td>Hume City Council</td>
<td>VIC</td>
<td>Management of the water cycle as a whole (as opposed to separate standalone streams). Treat all water streams as a resource, maximum efficiency of use, using water multiple times.</td>
<td>Very relevant</td>
<td>Extremely relevant</td>
</tr>
<tr>
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<td></td>
<td>Diversification of water sources, less likelihood of water restrictions during dry periods, higher quality green spaces, reduced urban heat. Objective / goal setting (short and long term), planning to get there (short and long term), communication across multiple agencies, implementation, review and evaluation.</td>
<td></td>
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</tbody>
</table>
management of the water system and associated issues from floods to urban ecology and pollution management, to providing alternative water as a more sustainable way of developing the city, catchment management - working with partners, development of open space, water sensitive cities, policies, projects, regulations....

to manage the water system holistically for environmental and social outcomes (for some agencies it will be for economic outcomes too)

decreased flooding, more green open space, fit for purpose water available for a variety of uses, strong water quality and biodiversity outcomes

strategic planning for the water system, integrating that planning with other planning, such as land use planning, and policy development, so that we are reinforcing IWM through many strands. It also involves many different people, businesses, land owners, government agencies, all doing their bit to contribute - whether that is fencing off waterways, or ensuring no oil spills, or installing a rainwater tank, or ensuring land is kept aside in urban renewal areas for sewer mining plants, or investing in stormwater harvesting systems, or evaluating the impact of different actions - we need research and evaluation to make sure we are on track for higher level goals.

Very relevant

Very relevant

Appendix C
<table>
<thead>
<tr>
<th>Date</th>
<th>Entity</th>
<th>Location</th>
<th>Description</th>
<th>Relevance</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>12/21/2015</td>
<td>engineering consultancy</td>
<td>Victoria</td>
<td>It's about infrastructure and water source planning for the future taking into consideration all sources of water available, understanding all benefits that are not just for human consumption, such as the environment. To achieve sustainable water management practices that consider the right water for the right use. We should have more sustainable water sources available.</td>
<td>Relevant</td>
<td>Extremely relevant</td>
</tr>
<tr>
<td>12/21/2015</td>
<td>Department of Water</td>
<td>WA</td>
<td>Considering all parts of the water cycle in determining the best way to deliver water for consumption, the environment and community benefit. Protecting the environment; making water available and affordable to meet the demands of water customers and communities. Less reliance on large scale network solutions and more emphasis on local water management options (e.g. stormwater); potentially more recycling in some settings and reduced reliance on scheme water supplies; more community awareness of water conservation.</td>
<td>Somewhat relevant</td>
<td>Very relevant</td>
</tr>
<tr>
<td>12/20/2015</td>
<td>City of Melbourne</td>
<td>Vic</td>
<td>Managing the entire water cycle in an connected, cohesive, integrated way for the benefit of the whole community and the environment. achieving best whole of community benefits for current and future communities. minimal cost for maximum benefits, usually multiple benefits. cross agency collaboration and partnerships. exploring multi-beneficial options determining effective cross agency governance.</td>
<td>Very relevant</td>
<td>Extremely relevant</td>
</tr>
<tr>
<td>Date</td>
<td>Organization</td>
<td>Location</td>
<td>Key Points</td>
<td>Coordination</td>
<td>Role</td>
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<tr>
<td>12/20/2015</td>
<td>Consulting</td>
<td>QLD</td>
<td>Balancing the needs of various sectors competing for water use, while not negatively impacting on water resources.</td>
<td>Coordination across sectors. Breaking the silos. Best possible outcomes for water resources.</td>
<td>They can contribute to WRM, their voice will be better included.</td>
</tr>
<tr>
<td>12/20/2015</td>
<td>Sydney Water</td>
<td>NSW</td>
<td>Working across disciplines to achieve holistic outcomes (in terms of environment, cost, quality, customer needs) with how we manage our water supply and wastewater services.</td>
<td>To achieve sustainable water supply and build resilience in the water industry in the face of climate change, cost contraints, policy, community expectations etc.</td>
<td>Better awareness of the social, environmental and economic value of water. Engagement in maintaining sustainable use of water. Embracing aspects of water management like stormwater and wastewater recycling.</td>
</tr>
<tr>
<td>12/20/2015</td>
<td>Australian Red Cross</td>
<td>Victoria</td>
<td>It means thinking about the big picture, it means thinking about the broader consequences and implications of your work, moving beyond a siloed approach to water management.</td>
<td>Economic efficiencies, social equity, environmental sustainability, Clarity and confidence in how their resource is managed, reduced costs, better management of their resource.</td>
<td>Create authorising environment Clarify roles and responsibilities (utilities and community) - most important step Put management arrangements in place (localised) Monitor and Evaluate</td>
</tr>
<tr>
<td>Date</td>
<td>Consultant</td>
<td>Location</td>
<td>Key Points</td>
<td>Relevance Notes</td>
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<tr>
<td>12/20/2015</td>
<td>G&amp;M Connellan Consultants</td>
<td>Vic</td>
<td>Adopting a holistic approach to water resource management to support liveability and sustainability of urban areas</td>
<td>Very relevant</td>
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<td></td>
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<td>Sustainable use of water resources. A water cycle that reflects the competing needs of people and the environment</td>
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<td>Improved liveability/well being. More sustainable urban landscapes/environment. Increased awareness and valuing of adopting a holistic approach to water resource management</td>
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<td>Establishing baseline data/information of each element. Recognition of the role and inter-relationships of the various components of the water cycle. Monitoring, analysing and reporting of IWM project/scheme performance</td>
<td>Very relevant</td>
<td></td>
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<tr>
<td>12/19/2015</td>
<td>optamax</td>
<td>WA</td>
<td>Whole of cycle management. Maximise security. Manage demand. Think about the whole cycle, not just parts</td>
<td>Extremely relevant</td>
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<td>More awareness and better choices</td>
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<td></td>
<td>Communication programme clear objectives and progress measures. Proof of benefits and proof costs are as expected</td>
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<tr>
<td>12/19/2015</td>
<td>independent consultant</td>
<td>Western Australia</td>
<td>The management of all aspects of water (water cycle), including detailed analysis of stakeholder and future scenarios</td>
<td>Extremely relevant</td>
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<td>To ensure a sustainable decision making. The community will have a stronger participation in decision making and will have an adverse impact because some outcomes of IWM will demonstrate value only in the future (for example, some infrastructure will only benefit the community in the future but they are required to be build today...)</td>
<td>Extremely relevant</td>
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<td>Requirements management stakeholders management documentation clear communication and constant monitoring of the actions are focused on the initial identified need</td>
<td>Extremely relevant</td>
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<tr>
<td>Date</td>
<td>Author</td>
<td>Location</td>
<td>Comments</td>
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<tr>
<td>12/19/2015</td>
<td>retired (ex-water industry)</td>
<td>Victoria</td>
<td>Getting all players in the water industry with regard to effective planning and decision making. 1. efficient and effective servicing strategy. 2. efficient and effective infrastructure for the long term. Cost effective projects that deliver high value outcomes. Good planning and communication. Also ensuring that the community understands the value of water. Relevant Very relevant</td>
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<tr>
<td>12/18/2015</td>
<td>Department of Water</td>
<td>WA</td>
<td>Considering all the water elements in an area/environment; considering all water in a water balance. Make best use of all water resources. Use of all WR; use less potable water; conserve natural water ways. Consider all water components; working together. Relevant Extremely relevant</td>
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<tr>
<td>12/18/2015</td>
<td>GHD</td>
<td>WA</td>
<td>It means the integration of different areas of water management form supply, treatment, reuse etc. to reduce water use and to ensure the artificial constructed aspects of the urban water cycle are working together to the best ability. Reduced water usage and improved wetland and environmental water health. Looking at the urban water system at all stages of the process and holistically assessing how they interact and could be improved. Getting coordination from the various agencies and stakeholders. Ongoing assessment of what can be improved. Very relevant Extremely relevant</td>
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<td>Date</td>
<td>Company/Authority</td>
<td>Location</td>
<td>Description</td>
<td>Relevance</td>
<td>Rating</td>
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<tr>
<td>12/18/2015</td>
<td>e2designlab</td>
<td>Victoria</td>
<td>All streams of the water cycle (drinking, stormwater, groundwater, wastewater) are taken into consideration in the planning and design of servicing infrastructure. Solution are context specific based on the bio-physical characteristics and governance arrangements.</td>
<td>Relevant</td>
<td>Extremely relevant</td>
</tr>
<tr>
<td>12/18/2015</td>
<td>Retail water company</td>
<td>Vic</td>
<td>Multiplicity of stakeholders, costs, benefits, responsibilities.</td>
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<tr>
<td>12/18/2015</td>
<td>Metropolitan Planning Authority</td>
<td>Victoria</td>
<td>Streamlining, reduce wastage, better outcomes from a united approach.</td>
<td>Extremely relevant</td>
<td>Extremely relevant</td>
</tr>
<tr>
<td>12/18/2015</td>
<td>Sydney Water</td>
<td>NSW</td>
<td>Best risk, cost and value in water and wastewater service provision to meet customer needs.</td>
<td>Relevant</td>
<td>Very relevant</td>
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<tr>
<td>12/17/2015</td>
<td>Cardno</td>
<td>QLD</td>
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<tr>
<td>Date</td>
<td>Organisation</td>
<td>Location</td>
<td>Description</td>
<td>Benefits</td>
<td>Relevance</td>
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<tr>
<td>12/17/2015</td>
<td>Australian Water Association</td>
<td>WA</td>
<td>Integrating the water cycle for maximum efficiency, environmental benefits, community benefits and there are no ‘waste’ streams. Water management is considered with other resources such as electricity and can be integrated in production cycles.</td>
<td>Sustainability - improved community, economic, social, environmental outcomes. Reduced wasteage, improved understanding of water and other resources, increased efficiency, better standard of living.</td>
<td>Somewhat relevant</td>
</tr>
<tr>
<td>12/17/2015</td>
<td>YVV</td>
<td>VIC</td>
<td>Holistic management of water in the urban environment.</td>
<td>Enhanced liveability, enhanced health and wellbeing, trust in government and water industry organisations.</td>
<td>Very relevant</td>
</tr>
<tr>
<td>12/17/2015</td>
<td>City of Melbourne</td>
<td>VIC</td>
<td>To attempt to restore the natural water cycle by reducing the impacts of urbanisation. To use water efficiently and effectively. To consider all aspects of water - environmental, social and economic.</td>
<td>Enhanced liveability, enhanced health and wellbeing, trust in government and water industry organisations.</td>
<td>Extremely relevant</td>
</tr>
<tr>
<td>12/17/2015</td>
<td>SA Water</td>
<td>SA</td>
<td>Utilising all water sources for fit for purpose uses.</td>
<td>Undertaken too early it will result in more costs to the provider. It will also result in a range of water sources with differing levels of security. If is implemented effectively then it is undertaken at the time when the cost of existing water sources become equal to the cost of new water sources.</td>
<td>Somewhat relevant</td>
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<td>Use all available water sources.</td>
<td>Better modelling of the trigger and pricing points for investment so we do not jump in too soon.</td>
<td>Somewhat relevant</td>
</tr>
<tr>
<td>Date</td>
<td>Origin</td>
<td>Location</td>
<td>Description</td>
<td>Relevance</td>
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<tr>
<td>12/17/2015</td>
<td>Melbourne Water</td>
<td>VIC</td>
<td>An IWM service delivers customer needs by uncovering ways in which water cycle systems and multi-functional assets can work together to deliver these outcomes as efficiently as possible. The research identifies benefits that scale from local to metropolitan-wide and which accrue to customers, communities and shareholders alike.</td>
<td>Very relevant</td>
<td>Very relevant</td>
</tr>
<tr>
<td>12/16/2015</td>
<td>WISER Analysis</td>
<td>VIC</td>
<td>An attempt to manage the three waters in a way that delivers best value to customers and the environment. The research focuses on reducing the extraction of water from the environment to sustainable limits, utilising fit-for-purpose water for non-potable uses to help achieve this.</td>
<td>Somewhat relevant</td>
<td>Relevant</td>
</tr>
<tr>
<td>12/16/2015</td>
<td>DELWP Victoria</td>
<td></td>
<td>A review of the costs and benefits of the optimum use of all potential water sources and their potential target uses. The research focuses on cost-effective water supply, public health and flood mitigation.</td>
<td>Somewhat relevant</td>
<td>Somewhat relevant</td>
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<tr>
<td>12/16/2015</td>
<td>Monash Vic</td>
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<tr>
<td>12/16/2015</td>
<td>SA Water</td>
<td>SA</td>
<td>A review of the costs and benefits of the optimum use of all potential water sources and their potential target uses. The research focuses on cost-effective water supply, public health and flood mitigation.</td>
<td>Somewhat relevant</td>
<td>Somewhat relevant</td>
</tr>
</tbody>
</table>

To deliver IWM, Melbourne Water needs to:
1. Drive the collaborative planning of individual IWM projects, and its own assets, so that our customers' needs are delivered and so that city-wide outcomes are delivered.
2. Drive the evolution of regulatory and operating environment to support the efficient planning and delivery of IWM.
3. Embed IWM as process and responsibility across its approach to the delivery of services.
<table>
<thead>
<tr>
<th>Date</th>
<th>Organization</th>
<th>Location</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>12/16/2015</td>
<td>CSIRO</td>
<td>VIC</td>
<td>Taking a systems view to water management, acknowledging that there are many aspects of the system are not just about infrastructure but about people, their behaviour, as well as environment. In particular it acknowledges the nature of the water cycle in any shape or form. It also implicitly incorporates notions of stakeholder engagement and participation in decision making; especially as IWM involves multi-stakeholder problems so there needs to be mechanisms in place to address such dilemmas.</td>
</tr>
<tr>
<td>12/16/2015</td>
<td>Melbourne Water</td>
<td>Victoria</td>
<td>Planning holistically for the entire water cycle servicing including water supply, sewerage, drainage and waterways.</td>
</tr>
</tbody>
</table>

Enhancement of the environment. Measures that confer multiple benefits for humans and the environment.

Improvements in liveability and amenities such as trees, parks, gardens, healthier waterways and reduction of heat island effect.


1. Finding solutions to multi-stakeholder problems
2. Utilising the system perspective to achieve better outcomes through synergies, tradeoffs etc.
3. Moving beyond traditional strategies, and thus opening up the decision option space; hence having the chance for better decisions

1. Diverse parts of the community achieving more of their desired outcomes
2. Better environment
3. More bang for water companies/policy makers buck

1. Setting up effective methods for involving stakeholders in decision making
2. Collect data and apply analytical approaches to understand integrated water systems

Very relevant

Extremely relevant

Relevant

Relevant
<table>
<thead>
<tr>
<th>Date</th>
<th>Water Authority</th>
<th>Location</th>
<th>Summary</th>
<th>Objectives</th>
<th>Collaboration</th>
<th>Funding/Management Approval</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>12/16/2015</td>
<td>South East Water</td>
<td>VIC</td>
<td>Integrated Water means a holistic consideration of all aspects of the water cycle and optimisation of the interactions between them.</td>
<td>A robust water supply system, that minimises the likelihood and impact of water restrictions, and provides best for community water use outcomes.</td>
<td>Very relevant</td>
<td>Very relevant</td>
<td>Relevant to the community and environment, to provide greater value for a similar or lower cost than a traditional servicing solution.</td>
</tr>
<tr>
<td>12/16/2015</td>
<td>City West Water</td>
<td>Victoria</td>
<td>Considering all water sources thus having a diverse water supply system.</td>
<td>Generally community will be supportive.</td>
<td>Very relevant</td>
<td></td>
<td>Relevant to the reduction of water restrictions and improved waterways.</td>
</tr>
<tr>
<td>12/16/2015</td>
<td>Barwon Water</td>
<td>VIC</td>
<td>Seamless/ one water</td>
<td>Improved waterways, greater choice/flexibility</td>
<td>Relevant</td>
<td>Relevant</td>
<td>Relevant to the development of a resilient supply network.</td>
</tr>
<tr>
<td>12/16/2015</td>
<td>Melbourne Water</td>
<td>VIC</td>
<td>IWM is a way to use excess water and stop it being wasted and going into the sewer or surface water system. IWM is also reusing sewage so that we reduce reliance on potable water - to make a more resilient supply system.</td>
<td>If it’s implemented effectively I believe that it can only mean a win win to the community - they get a resilient supply network that will cater to future generations.</td>
<td>Relevant</td>
<td>Very relevant</td>
<td>Relevant to the preservation of valuable drinking water (during a drought), however current objectives are now about optimising all aspects of the network to keep up with the population growth and impacts on sewage disposal and water supply.</td>
</tr>
<tr>
<td>12/16/2015</td>
<td>South East Water</td>
<td>Victoria</td>
<td>IWM is a way to use excess water and stop it being wasted and going into the sewer or surface water system. IWM is also reusing sewage so that we reduce reliance on potable water - to make a more resilient supply system.</td>
<td>If it’s implemented effectively I believe that it can only mean a win win to the community - they get a resilient supply network that will cater to future generations.</td>
<td>Extremely relevant</td>
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<td>Relevant to the preservation of valuable drinking water (during a drought), however current objectives are now about optimising all aspects of the network to keep up with the population growth and impacts on sewage disposal and water supply.</td>
</tr>
<tr>
<td>Date</td>
<td>Organisation</td>
<td>Location</td>
<td>Issue/Problem</td>
<td>Outcome/Opportunity</td>
<td>Relevance</td>
<td>Relevance</td>
<td></td>
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</tr>
<tr>
<td>12/16/2015</td>
<td>South East Water</td>
<td>VIC</td>
<td>It means considering the flows of and opportunities of water flows and uses in the urban environment as a whole, whether drinking water, sewer, drainage or environmental water.</td>
<td>Making the most of available water to deliver outcomes most efficiently to deliver TBL outcomes.</td>
<td>Very relevant</td>
<td>Very relevant</td>
<td></td>
</tr>
<tr>
<td>12/16/2015</td>
<td>Western Water</td>
<td>VIC</td>
<td>Utilising the entire water cycle to determine optimal solutions</td>
<td>Derive the best TBL outcome taking a broad view of the issue/problem</td>
<td>Relevant</td>
<td>Very relevant</td>
<td></td>
</tr>
<tr>
<td>12/16/2015</td>
<td>South East Water</td>
<td>VIC</td>
<td>Utilising the entire water cycle to determine optimal solutions</td>
<td>Community acknowledgement - perhaps in the longer term! when they are fully appreciated</td>
<td>Very relevant</td>
<td>Very relevant</td>
<td></td>
</tr>
<tr>
<td>12/08/2015</td>
<td>Melbourne Water</td>
<td>VIC</td>
<td>Taking a look at the big picture and finding ways to best manage drinking water supply, sewage, stormwater, groundwater, irrigation water, waterways</td>
<td>Healthy communities and environment, efficient and affordable services, fairness, transparent and effective decision making</td>
<td>Relevant</td>
<td>Relevant</td>
<td></td>
</tr>
</tbody>
</table>