RECYCLED WATER INVESTMENT DECISIONS: CASE STUDIES IN BALANCING THE COSTS, BENEFITS, AND RISKS

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ABSTRACT

The real costs, benefits and risks of recycled water schemes are generally poorly understood. However, this type of information is instrumental if effective recycled water investments are to be made in the future.

This paper presents the emerging findings from a project currently being undertaken by the Institute for Sustainable Futures at the University of Technology, Sydney. The project involves investigating the costs, benefits and risks of eight water recycling schemes representing the range of contexts faced by decision makers considering recycled water projects. Emerging findings of three of the case studies investigated so far are presented in this paper.

INTRODUCTION

Australia has seen significant developments in water recycling over the past decade. These have been largely driven by a confluence of interrelated factors including drought, community support, subsidies, sustainability interests, and other policy incentives. However, the cost-effectiveness of these investments from the 'whole-of-society' perspective remains poorly understood, hampering efficient investment in water recycling.

There are studies which analyse the institutional and regulatory barriers of water recycling (e.g. ACIL Tasman 2005, WSAA 2006, Dimitriades 2005). However very few attempts have been made to assess the full range of costs, benefits, and risks of water recycling projects, how they accrued to all parties over time, and how perceptions of real and actual costs, benefits, and risks impacted on decision making and assessments of success, or otherwise.

This type of assessment is limited by a lack of available data on actual costs and, in particular, realised benefits. This is in part due to "*a [historical] lack of practical, adequate and widely accepted methodologies to objectively assess the numerous costs and benefits of water recycling systems (including externalities)*" (Hatt et al. 2006).

Poor understanding of the spectrum and quantum of the costs, benefits and risks of water recycling at the project level, limits capacity to develop sound business case proposals for recycling that consider financial, economic, social and environmental outcomes.

The importance of this is recognised by the National Water Commission, who is an "*unambiguous supporter of expanded use of recycled water throughout Australia*", subject to conditions including that "*prior cost/benefit and risk analyses are conducted which take full account of social and environmental externalities and avoided costs*" (NWC 2010).

Water recycling proposals can be difficult to justify if considered on the basis of economic evaluations only (Chapman & Reichstein, 2005). Key factors such as the associated ecological effects or the avoided supply augmentation can be significant and may disadvantage the proposal if not taken into account (NWC 2010, Urkiaga et al. 2008).

However, even when the full suite of costs and benefits is considered, another important aspect which can impact the implementation of recycling projects, is the difference between the estimated costs and benefits, and those that are realised in practice. In the case of the Riverside Rocks sewer mining project in Queensland, although the decision to proceed with the project was based on its cost-effectiveness under a triple bottom line assessment, interviewees in a study of the project raised the issue of costs being quite high and "*not predicted from the beginning of the project*" (Davis & Farrelly, 2009).

The Institute for Sustainable Futures at the University of Technology, Sydney is currently undertaking a two year national collaborative research project funded primarily by the Australian Water Recycling Centre of Excellence. The project "Building Industry Capability to make Recycled Water Investment Decisions" aims to assist in filling this knowledge gap, that is, what kinds of costs, benefits and risks actually eventuate post implementation, and what lessons we can learn to help make more informed investment recycling decisions in the future.

The national landscape of water recycling has a great diversity of drivers and regulatory contexts, as well as investment, ownership and management arrangements. This means there are numerous combinations of why and how such schemes are implemented and the kind of stakeholders involved.

For a particular recycled water scheme, there is a complex web of interactions and relationships between stakeholders and how they benefit or bear the costs. Figure 1 shows an interpretation of these relationships loosely based on the NSW context which demonstrates this complexity.

In some ways, this diversity makes it difficult to compare recycling schemes across jurisdictions, scales and end uses. However, there are patterns in the way water recycling has been rolled out historically, and these patterns may have important implications for the future of recycling.

Drawing on the wealth of experience of 12 industry partners representing utilities, developers, local authorities, technology providers and regulators, this project seeks to span across this diversity, at the same time as delving into specific details, in order to discern the patterns that emerge.

The research has focused on identifying what the costs and benefits were, how they were distributed, and whether, in the end, they were viewed as significant or not by different stakeholders. This type of information is critical if we are to make better informed water recycling investment decisions in the future.

METHODOLOGY

The project has used a case study approach, focusing on schemes at precinct or larger scales. A total of eight case studies have been selected to reflect the complex web of cost and benefit interactions between key players, and the diversity of reuse schemes nationally. The case studies span:

- jurisdictions (QLD, regional and metropolitan NSW, VIC, SA);
- scales (precinct, cluster or larger from 0.17 to 20 ML/d);
- water sources (industrial sewage, residential sewage, stormwater);
- end-use types (residential, commercial, industrial and agricultural), and technologies;
- delivery models (public, private, and public-private partnerships); and
- age (in operation for 1 to 30 years).

The types of case studies chosen were selected through a highly participatory process with 12 industry partners involved in the project (providing funding and/or in-kind support). These industry partners represent utilities, developers, local authorities, technology providers and regulators.

Case study participants were identified and recruited with the assistance of partner organisations. For each case study four to seven people have participated in semi-structured interviews.

Table 1 shows the characteristics of the case studies discussed in this paper.

Table 1: Characteristics of water recycling schemes discussed in this paper

Categories	Wide Bay Water	Aurora	Darling Quarter
Jurisdiction	QLD	VIC	NSW
Size/scale	14.3 ML/d (3 plants)	3.5 ML/d	0.17 ML/d
End-use	Cane farms, hardwood plantations, council open spaces, golf course, Hervey Bay airport and dust suppression	Greenfield residential reuse for toilet flushing, garden watering, car washing and irrigation of public open space	Commercial building reuse for toilet flushing and cooling towers
Water source	Sewage	Sewage	Sewage (sewer mining)
Technology	(1) activated sludge/trickling filter, (2) activated sludge plus intermittently decanted extended aeration, (3) Membrane Bio-Reactor (MBR) with biological nutrient removal	Pre-filtration, ultrafiltration membrane treatment, UV disinfection and chlorination	Moving Bed Biofilm Reactor (MBBR), reverse osmosis
Delivery model/O&M arrangement	Owned and managed by public utility/local government authority: Wide Bay Water Corporation/ Fraser Coast Regional Council	Owned and managed by public utility - Yarra Valley Water	Privately owned and operated. Publicly licenced. Veolia is subcontracted by building manager Jones Lang LaSalle for O&M services
Year operation started	1992	2009	2011

CASE STUDY FINDINGS

The three case studies reported in this paper have been chosen to demonstrate how significant the local context is in determining costs, benefits, and risks, and to show a breadth of insights emerging from the study: a first generation environmental protection scheme from Queensland (Wide Bay Water), a first generation residential scheme from Victoria (Aurora), and a second generation commercial building scheme from New South Wales (Darling Quarter).

Wide Bay Water

Wide Bay Water Corporation first committed to the provision of recycled water in 1989. At that time, the Hervey Bay region was experiencing significant and rapid population growth. The coastal and riverine waters of Hervey Bay are sensitive to nutrient additions in part because nearby World Heritage-listed Fraser Island limits the potential for flushing. In addition, these waters hold significant environmental, recreational and commercial value to the region e.g., whale watching brings significant tourism revenue. Hence, there were growing concerns about the impact of disposing of increasing volumes of sewage effluent into these waters.

At the time, sewage and water services were under the control of the local council. Sewage treatment augmentation was necessary, and the investment decision was between a low level of treatment and disposal through an ocean outfall, or a high level of treatment before local disposal. As the quote below shows, timing is everything:

"The quick budget estimate at the time for a 3 kilometre ocean outfall was $3 million (1989) dollars... The Council Mayor threw it back in their face and said, 'I'm not facing the population of Hervey Bay to tell them our biggest single capital works expenditure for next year is to build an ocean outfall when the front page headline [in Sydney] is 'Turds on Bondi Beach'."

Wide Bay Water staff recognised that the cost of producing the quality of effluent required for disposal to sensitive waters was greater than the cost of producing recycled water for regional reuse in irrigation, so the decision was made to redirect the sewage infrastructure investment into creating a valuable product for the local economy, providing irrigation water for sugar cane and forestry.

In the gradual expansion of the scheme over the ensuing two decades, subsidies were both instrumental and plentiful. Wide Bay Water staff were particularly successful in securing funds from various Federal and Queensland State Government subsidies targeting nutrient removal, sugar cane industry reform, and recycling. For example, the Nikenbah component of the scheme was designed to take advantage of funds available during the Millenium Drought, targeted at building indirect potable reuse capacity across the state. Nikenbah was therefore designed to be capable of producing class A+ water, should it be required. In all, around one-third to one-half of construction and land costs were financed by these subsidies, significantly decreasing the cost to the community of continuing to expand the scheme. This is significant because Hervey Bay is categorised as an area of lower socio-economic activity, with a proportion of retired and unemployed constituents above the national average.

The scheme was originally focused on the sugar cane industry. The farming and processing of sugar cane in a local mill makes a major contribution to the local economy. Hence, in the middle of the drought period, access to recycled water was seen as particularly beneficial to maximise sugar cane productivity, as well as helping ensure the local mill remained operational.

However, demand from the sugar cane industry has been lower than anticipated. There are several factors at play. Firstly, demand is both seasonal and rainfall dependent, so demand varies whilst recycled water supply is fairly constant, except for seasonaility associated with tourism. Secondly, only around one-third of farmers took up the recycled water available. Many farmers chose not to make the required on-farm investment to shift from dry-land cropping to irrigated cropping. Reasons for this reluctance vary, and include both the structure of the local industry (many small scale and/or older farms), as well as concern about the salinity of the recycled water when local soils are already sodic (even though monitoring of demonstration farms has not revealed any issues to date).

Figure 2 illustrates the way Wide Bay Water intended to seek a model that would provide a source of revenue as well as additional long-term value to offset operating costs and depreciating infrastructure.

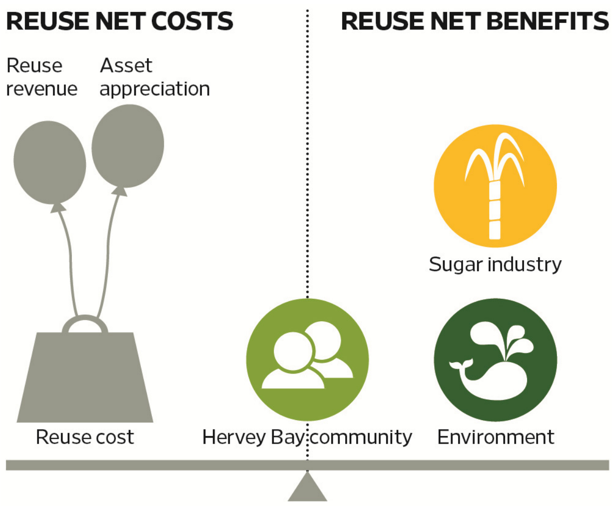

Figure 2: Balancing the net costs and benefits

In response to the lower than anticipated demand for recycled water from the sugar cane industry, Wide Bay Water invested in another alternative disposal strategy, once again seeking a model that would provide a source of revenue, as well as additional long-term value to offset operating costs and depreciating infrastructure. Land was purchased (an appreciating asset) and irrigated hardwood plantations were established, again with the help of subsidies. However, unfortunately in wet periods, land disposal remains an issue.

Currently, local views are mixed as to the overall value of the scheme. The institutional structures surrounding these recycled water investments have changed significantly over time through corporatisation and council amalgamations. This has led to differences of opinion about whether a utility should be operating assets like plantations. Environmental discharge licence conditions have become more stringent, and further subsidies in the future are viewed as unlikely. At the same time, there is a slowing of economic activity and growth, raising concerns about the community's capacity to absorb the current and future costs of the scheme.

There is growing recognition that a more comprehensive assessment of the range of costs and benefits is required (see Figure 3), and that the local community need to be properly engaged over the question of the future of the scheme.

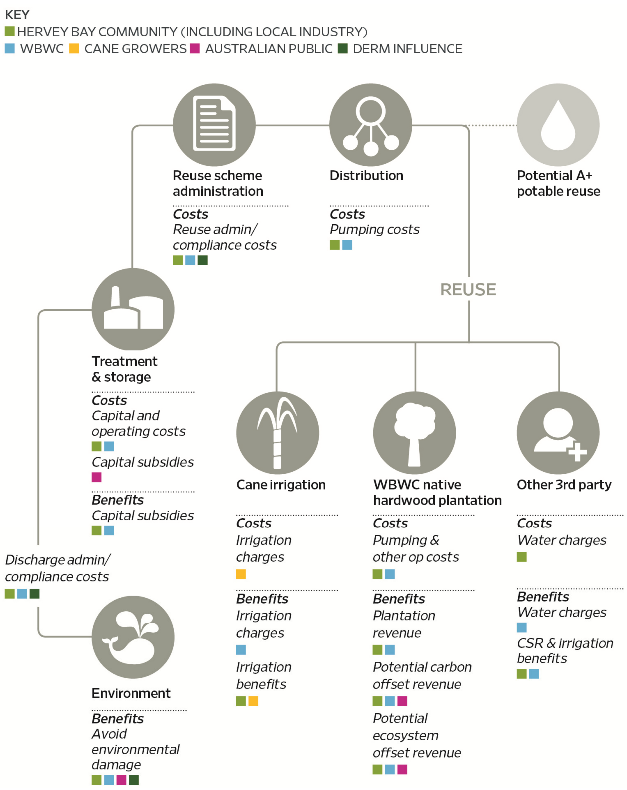

Figure 3: Stakeholder interest and influences in the costs and benefits of scheme components

Aurora

Aurora was the first large-scale residential third pipe scheme in Victoria. In the early 2000s, VicUrban, the Victorian state development agency, had a strong mandate to provide leadership in demonstrating sustainability to the development community. The low cost of raw land provided a feasible platform for VicUrban to take this commitment to the next level of implementation. Because the site was remote from the trunk sewer, alternative arrangements were necessary for sewage treatment, and this opened the possibility to include recycled water in the sustainability package. But this was new territory for all involved, so there was a great deal of uncertainty, as Figure 4 shows.

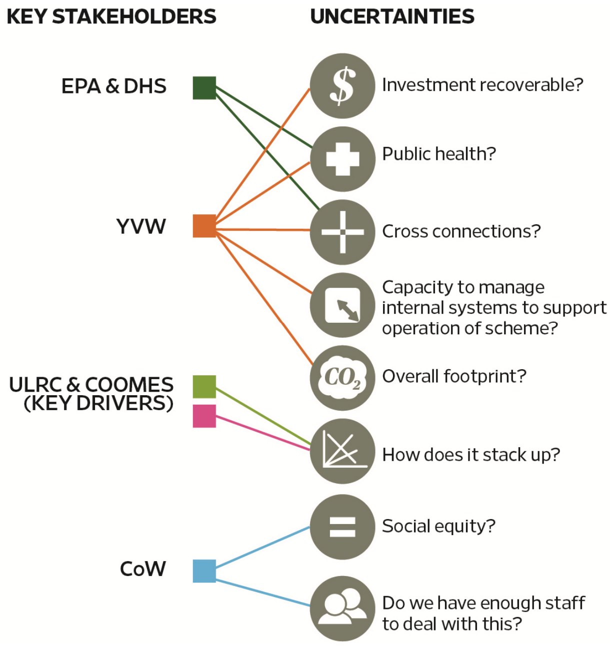

Figure 4: Early concerns and uncertainties faced by the stakeholders

Over time, Yarra Valley Water overcame its initial concerns and resistance. Supplying a lower quality of water to households for toilet flushing and garden watering was a bold idea that challenged some perspectives about what utilities should do. There was no local experience to draw from, and no guidelines or regulations in place at a state or national level, so it seemed like a very risky business in financial, operational and public health domains. Recycled water was a whole new product, so gearing up to provide it required major shifts in every aspect of Yarra Valley Water's operation, from customer service to emergency repairs. In addition to sharing regulators' concerns around public health and cross-connection risks, Yarra Valley Water also had a strong commitment to sustainability and they were uncertain about the overall footprint of the scheme.

Yarra Valley Water took a two-pronged approach to managing these risks. On the one hand, the utility embarked on a series of investigations in search of answers to address concerns and generate evidence to support their decision, by quantifying the risks. Findings challenged industry misperceptions, favouring the recycled water scheme on a number of aspects in relation to a business as usual scenario. On the other hand, to share the burden and benefits of these risks, Yarra Valley Water signed a covenant with the developer, the Victorian Environmental Protection Authority, and the local council.

Perhaps the most significant outcome for Yarra Valley Water of engaging in Aurora was the realisation of the value that trying a different solution would have for organisational collective learning. This value provided the confidence to embark on the recycled water scheme with a learning-by-doing approach. In the final analysis, this value was perceived to offset the costs.

After Yarra Valley Water had committed to recycled water provision, there were several significant shifts in the surrounding landscape, some positive, but mostly negative. Whilst the Victorian government did mandate a 20% recycling target, they also revised developer contributions to a flat $1,000 per lot per service, removing Yarra Valley Water's opportunity to recoup the additional capital expenditure from the developers. At the same time, the state development agency was re-structured, and what had been a very aggressive, high density land release plan was both watered down in terms of lot density and severely delayed, so was then further hindered by a general slowing of the residential market. All of this meant that the recycled water plant was mothballed for several years, and has had ongoing operational difficulties. At the same time, residents supplied with what they believe is recycled water have a higher demand than average, and this demand is met with potable water. So there are many ways in which Yarra Valley Water's costs increased and revenues decreased relative to forecasts.

There are different ways to view the additional costs associated with Aurora. On a per household basis for Aurora residents, the costs are high – about $4,000 to $5,000 per lot (2004$) in capital costs and around $1,000 to $2,000 per lot per annum in operating costs. However, because Yarra Valley Water has a statutory responsibility to supply water services to Aurora, and a responsibility to contribute to a mandated State government water recycling target, they are able to spread these costs and shortfalls across their entire customer base. The additional costs are of the order of $10 per household per year.

Aurora served a very important purpose as a learning vehicle not only for Yarra Valley Water but also for the whole recycled water sector in Victoria, including regulators, local councils, and developers. For example, it was instrumental in the development of recycled water guidelines. It has also contributed to Yarra Valley Water's acknowledged position as an industry leader in sustainability.

Darling Quarter

Darling Quarter was the first in-buiding wastewater recycling schemes to be licenced and operating under the NSW's Water Industry Competition Act (WICA).

Although pioneering in terms of approvals, it represents the second generation of plants, thus it benefited greatly from experience gained from implementing previous small scale in-building systems. This prior experience enabled the scheme's proponents to design out some risks and identify other potential considerations.

Property developer Lend Lease, the key proponents of the sheme, played a central role in this process. Acting on behalf of Darling Walk Trust, the building owner, it contracted the design, construction and operation of the plant to Veolia, and building management services to Jones Lang La Salle.

Lend Lease's commitment to sustainability and interest in developing a premium office building that would attract high profile tenants, were key drivers for the development of the scheme. Achieving a 6 star Greenstar rating was seen as essential to attract premium tenants, as those tenants find that green credentials are important for attracting the brightest staff (see Figure 5). In turn, a blackwater recycling plant was seen as a key initiative required to achieve the 6 star Greenstar rating.

Ultimately, the development was highly successful in attracting premium tenants even at the height of the 2008 Global Financial Crisis.

Figure 5: Drivers at Darling Quarter

Previous experience with odour problems and variations in the influent water quality meant that the proponents favoured sewer mining as a lower cost and lower risk option than on-site wastewater recycling. For example, in the case of breakdown, the intake valve can be shut and the plant can go offline, with no need to store untreated wastewater.

A shared strong interest in ensuring the success of the plant's operation led Lend Lease, Darling Walk Trust, and Veolia to agree on a "zero risk" approach, and share the costs of addressing risks of mutual concern. For example, the costs of managing the risk of malodour from the plant, and minimising public health risks through additional chlorine dosing in the storage tanks, were divided between the three parties.

Frequent and highly interactive engagement between stakeholders was key to the success of the plant. Lend Lease and Veolia worked closely to adapt the plant as new risks emerged and Veolia's operating team was involved in the design phase to ensure the design of the plant was practical and viable. This highly co-operative relationship was crucial in overcoming challenging space constraints to fit the treatment system, particularly as the need for new elements in the treatment train emerged. Veolia was contracted after the plant room had already been designed, therefore the plant had to be adapted to fit the size and shape of the room. For example, steel instead of concrete was used for storage tanks and a Moving Bed Bio Reactor (MBBR) was used instead of a Membrane Bio-Reactor (MBR). Although these space constraints had significant cost implications, the choice of an MBBR has proved beneficial as it has led to better plant performance than expected.

Due to difficulties experienced in previous similar small scale plants, Darling Walk Trust became involved in the procurement stage to select the construction and operation contractor. Although all stakeholders had an interest in having a functioning plant, the building owner was the only one with a long-term interest in this. Their involvement in this stage was important to ensure they were ultimately satisfied with decisions made to reduce design and operation risks.

Engagement of an engineer from Jones Lang La Salle (the building manager), one year before the completion of the project also contributed to its success, ensuring a smooth handover process.

Adopting a "zero risk" approach meant an increase in the capital costs by almost 30%, and a 30-35% increase in the operating costs, compared to initial estimates.The Guaranteed Maximum Price negotiated in the lease agreement means the rent cannot be increased above the initially estimated ceiling price to reflect these increased costs.

Although Veolia have a five year operation and maintenance (O&M) contract, O&M costs are reviewed on an annual basis according to actual costs incurred, and contractual negotiations of how these costs are shared are ongoing.

The benefits of all of these arrangement have been considerable. For Lend Lease, the green credentials of the scheme provided market differentiation and helped build their reputation as being able to successfully implement blackwater treatment facilities. For the building owner, the success and high profile nature of the building helped to enable a secure yield for super funds. It also helped to increase the value of the building investment portfolio and provided marketing collateral for the investment fund, which will be used to raise more capital overseas. For Veolia, the success of the MBBR plant at Darling Quarter has had international recognition and has also strengthened their reputation for being able to implement small-scale plants in the face of many challenges.

CONCLUDING REMARKS

What is emerging from this national collaborative research project is that investments in recycled water to date often do not 'stack up' by themselves financially. Projects get over the line either through the injection of significant government subsidies or through scheme owners/investors having the means to accept the additional costs in return for the less tangible or less direct benefits. In one case, a utility was able to distribute the costs across its entire customer base. This scheme did however provide important opportunities for organisational learning and development. In another, a private investor went the extra mile to ensure the highest sustainability rating for their new building, which secured ahead of time a premium tenant on a long term lease at the height of the Global Financial Crisis.

In the future, the demand for recycled water is likely to increase, not least from the drive to improve the liveability of our cities and retain much more water in the urban landscape. However, subsidies are less likely, so other mechanisms may be necessary to enable some public investments to proceed, such as accepting the financial gap, or facilitating shifts in the distribution of costs and benefits. Increases in the price of water and the cost of sewage treatment, alongside improving the capacity to access both of these revenue streams and streamlined regulations will improve the opportunity for private providers to enter the market.

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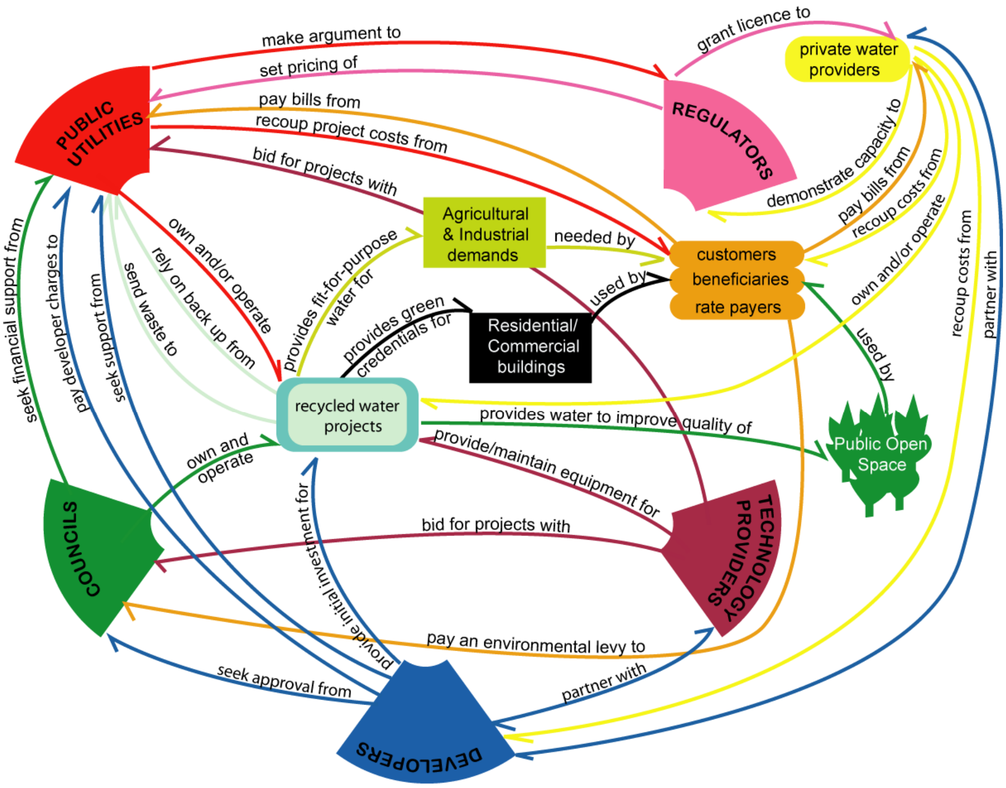

Figure 1: The complex web of cost and benefit interactions between key players in recycled water projects