

Exploring Links Between Ownership, Governance and Condition of Stormwater Quality Improvement Devices

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SUMMARY

Local councils use the development approval process to place responsibility for stormwater treatment with private landholders rather than relying solely on publicly owned sub-catchment or end of pipe solutions. This practice manifests in residents having a significant role in maintaining stormwater quality assets. While there may be sound motivation for transferring responsibility for the management of assets that provide a common good, that is water quality of local waterways, to individuals, it raises its own problems.

This exploratory research has identified that governance factors such as motivation, awareness and capacity are likely to have a relationship to outcomes for stormwater quality improvement devices in both public and private ownership. The maintenance of decentralised solutions for waterway health, particularly on individual lots, is compromised by the self-interested actions (or inactions) of individuals, suggesting that local government decision-makers must consider property scale and ownership-type when allocating responsibility for devices; advocate visual integration; and facilitate public surveillance. Devices placed in private ownership through the development process must be supported by education and regulation if they are to succeed. There is sufficient argument to support further investigation of the wider applicability of the research in other local government areas.

STATEMENT OF ORIGINALITY

This work has not previously been submitted for a degree or diploma in any university. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made in the thesis itself.

Ruby Ardren

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RESEARCH MOTIVATION

When planning for new precincts or major subdivisions, I, as a council officer, make decisions that impact the future effectiveness of the stormwater system and the health of the region's waterways. One significant decision is whether stormwater quality improvement devices (SQIDs) will be located in the public domain, managed privately under strata arrangements, or located on private property under Torrens title. Occasionally a precinct or subdivision may end up with a hybrid of these.

In following the progress of developments in the study area, I observed that SQIDs were not always cared for as required under the development approval and indeed were sometimes significantly compromised, rendering the developments incapable of meeting their designed water quality objectives.

While researchers have considered the governance barriers local councils experience in operating and maintaining infrastructure, there is little understanding of the barriers experienced by the owners and managers of private properties, and whether it is even likely they can bear the responsibility of managing infrastructure. If local councils place infrastructure on private property that is intended to benefit the wider community; we need to understand how best to support these owners in managing their infrastructure to ensure waterway benefits are realised.

1. INTRODUCTION

Urban waterway health is a complex problem. As a complex problem, the many agencies charged with the management of parts of the urban water cycle, geographically or administratively, have sought a transition to cleaner waterways with a response centred on water sensitive urban design (WSUD) solutions.

The literature review asserts that the solution (WSUD) is facing challenges with field performance that could impact its future uptake (Sharma et al., 2016; Oulton, 2016; Hoban & Gambirazio, 2018). Just as the problem of urban waterway health is complex, the solutions, even singular ones such as reliance on stormwater quality improvement devices (SQIDs), have interdependent and interrelated factors contributing to their failure. SQIDs are supposed to improve the quality of urban runoff, but do not always successfully perform their primary function because they are not being maintained (Oulton, 2016). That the devices are often poorly designed or constructed in the first place adds complexity (Hoban, A. & Gambirazio; Melbourne Water, 2017). Secondly, there are numerous examples in New South Wales (NSW) where some of the responsibility and thus cost of maintenance has been transferred from the public domain (local government) to the private domain (eg. Penrith City Council, Blacktown City Council, Mid-Coast Council); and Blacktown City Council for one has confirmed that privately owned devices are sometimes poorly maintained (Cadman, 2019). Within this question of maintenance is a broader policy problem of clarifying who is accountable for the management of public assets and who is best placed to carry this responsibility. Socially, clean waterways resonate positively with the community, yet individual values and behaviours lie closer to Hardin's notion of the tragedy of the commons (Hardin, 1969).

To determine this, we need to understand variables including who has the most potential to do maintenance better (capacity and awareness), who is most motivated, and can tools such as regulation and education improve outcomes for waterway health.

2. STORMWATER GOVERNANCE IN AUSTRALIA

Urban development increases the area of impervious surfaces, which impacts aquatic and riparian environments by reducing infiltration and increasing stormwater runoff and the frequency and duration of peak streamflows (Loperfido et al., 2014). These effects lead to a deterioration of waterway condition, which show modified flows, reduced levels of dissolved oxygen, raised temperatures and increased levels of pollutants including litter, sediment and nutrients (Roy et al., 2014; CTEnvironmental, 2014; Hopkins et al., 2017).

In the 1970s, shifting community concerns forced states to consider urban rivers as a vital part of the city (Brown, 2005; Roy et al., 2014; Davies and Wright, 2014) and enact new legislation that regulated industrial point source and wastewater pollution. This was followed by further social awareness of the value of urban waterways resulting in major state government investment in wastewater infrastructure (Beder, 1989) and stormwater pollution policy and controls (Davies et al., 2011; Brown, 2005; Fletcher et al., 2015). In Western Australia, the term water sensitive urban design entered Australia's policy vernacular (Mouritz, 1992).

WSUD has transformed our approach to water management, responding to urban planning objectives as wide-ranging as “water security, public health, flood protection, waterway health, amenity, economic vitality, equity and long-term sustainability” (Kuller et al., 2017, p266). SQIDs are a structural method for managing waterway health and providing flood protection under the WSUD ethos. Devices range from those that address stormwater retention, detention or the removal of pollutants like litter, sediments and nutrients; to those designed for wider benefits such as increasing infiltration, stormwater harvesting, or combined habitat, treatment and flood control such as wetlands (Kuller et al., 2017).

Unlike conventional drainage solutions that have well developed policies and guidelines (Wong & Engineers Australia, 2006), these nascent approaches lacked established policy, planning and guideline traditions (Moglia et al., 2010; Dalrymple et al., 2018). Local government, most often charged with the responsibility for urban waterway health (exceptions exist such as the utilities Melbourne Water in Victoria, and Sydney Water who manages some trunk infrastructure in Sydney), has found itself poorly prepared for the demand on internal capacity and resources necessary to implement and maintain WSUD systems (Dalrymple et al., 2018).

Assuming appropriate design and construction has occurred, SQID performance in removing pollutants is reliant on them being maintained appropriately (Blecken et al., 2017). Unlike traditional grey stormwater infrastructure where maintenance is done on an infrequent, reactive basis (Thomas et al., 2016), SQIDs require regular monitoring and maintenance to achieve the pollutant removal objectives. There is a gap in NSW between the required amount of funding for maintenance and the actual amount of funding available for maintenance for example through the NSW Stormwater Levy (Local Government NSW, 2015) and some local councils lack the organisational support, institutional arrangements and the expertise required to manage these hybrid grey/green infrastructure interventions (Blecken et al., 2017). Underscoring this institutional challenge is the poor design and handover of many structures in the first place (Goonetilleke, Egodawatta & Rajapakse, 2011).

2.1. DECENTRALISATION AND DISTRIBUTED SYSTEMS

It is common practice for NSW local government to require private developments to install water treatment structures in the private domain. In part, the legitimacy of this approach has been supported by an at-source mantra within WSUD ideas (Fletcher et al., 2015). In Sweden and the USA and in Victoria (Blecken et al., 2017), Australia (Goodman & Douglas, 2008) for example, this has resulted in WSUD falling to multi-dwelling lots managed under strata or community title, or to individual private lots through the development assessment and approval process. Privatisation and decentralisation of water treatment has also been motivated by:

- an economic desire to increase the tax base through greater density without increasing demands on expenditure and property rates for individuals (Goodman, Douglas & Babacan, 2010)
- a riparian focus to aim to replicate (or at least move nearer to) natural pre-urban conditions of infiltration by managing stormwater runoff closer to its source (Loperfido et al., 2014)
- a pollution focus to have more runoff treated and capture in small storm events including reducing sediment export (Hopkins et al., 2017).

There remains, however, an operational and maintenance tension. Centralised SQIDs tend to be simpler to inspect and maintain (Blecken et al., 2017), while the smaller and numerous decentralised assets (Loperfido et al., 2014) are, generally and anecdotally, not being inspected or maintained as private owners are limited by their knowledge and

willingness to undertake maintenance (Blecken et al., 2017). Therefore, an urban water paradox exists, the community and their elected governments want cleaner waterways, and yet in many areas, neither are prepared to take ownership and responsibility for this. Toner et al. (2005) have questioned whether this decentralised approach has been a step too far in the move to empower communities, particularly as poorer households who are unable to absorb this additional cost.

Just as the early days of public stormwater quality management worldwide lacked clear policy and frameworks (Brown, 2005), there are no recognized frameworks for the ownership and management of decentralised systems (Yu, Brown & Morison, 2012). Strata and community title estates have databases that list physical assets on common property requiring maintenance in accordance with planning approval. As of June 2019, there were 937 community schemes in NSW (Russell & Pitt, 2020), although there is no data on how many of these manage WSUD infrastructure.

Community title legislation introduced in 1989 provides an alternative to strata management for horizontal subdivisions, where individuals own their house lots but share common facilities (Community Futures Research Centre, 2008; Kenna & Stevenson, 2010). These estates more often resemble a type of local government than an association of private owners (Kohn, 2004) and are managed by an owner's corporation funded by compulsory membership fees collected from all property owners in the estate (Goodman, Douglas & Babacan, 2010). They manage common property that can include private roads, recreational facilities, and security, with the mode increasingly offering environmental features such as vegetation, WSUD, and energy-efficiency (Goodman & Douglas, 2008).

2.2. GOVERNANCE

The performance of SQIDs is a product of planning, design, installation and maintenance (Thomas et al., 2016), all of which is guided by engineering specifications and governance models that determine how the device will be managed throughout its life cycle. The Canadian Institute on Governance (IOG, 2018) defines governance as “who has power, who makes decisions, how other players make their voice heard and how account is rendered”. The focus on SQID management has centred on the technical aspects of maintenance rather than understanding the socio-economic factors and governance frameworks most likely to influence performance outcomes for SQIDs (White & Lloyd, 2004; Kuller et al., 2017; McShane, 2006; Morison & Brown, 2011; Sharma et al., 2012).

While local government's role in SQID management has been well considered, this is less well researched within the community title arena, within which there has been a focus on traditional grey infrastructure assets such as private roads (Goodman & Douglas, 2008; Kenna & Stevenson, 2010) and none related to managing assets that provide a public benefit.

The literature identifies five main governance themes that intersect with urban stormwater management: responsibility, asset management, capacity, awareness and motivation. Bennett et al., 2018 noted responsibility (decision-making processes, legal instruments, organisational structure), asset management (planning, maintenance and renewal) and capacity (skills, resources, finances, networks, empowerment) are key factors that can work for or against environmental stewardship. These factors are widely agreed upon as governance themes along with awareness and motivation (e.g. Yu, Brown & Morison, 2012; Fitzgerald & Laufer, 2016; Hopkins, Grimm & York, 2018; Moglia et al., 2010; Morison & Brown, 2011; Bennett et al., 2018; IOG 2018).

2.2.1. Responsibility

PRIORITISING | DECISION-MAKING
ROLES AND RESPONSIBILITIES
MONITORING | ORGANISATIONAL DYNAMICS

The introduction of WSUD into established urban areas has resulted in the co-existence of conventional stormwater systems with new decentralised infrastructure (Yu, Brown &

Morison, 2012). This complexity necessitates the use of new governance models and significant changes to established institutional arrangements (Moglia et al., 2010). It is often unclear who the appropriate owner and manager of WSUD systems should be (Yu, Brown & Morison, 2012). Local government, typically, has poor synergies between teams responsible for flood management (water quantity), water quality management, urban design and environmental protection (Brown, 2005; Sharma et al., 2012). For effective environmental management and integrated policy-making, cooperation between these different teams is essential (Moglia et al., 2010). Brown (2005) found that local government was indecisive about whether the stormwater engineer or the environment manager should be responsible for managing SQIDs, and this indecision persists today (Fitzgerald & Laufer, 2016). Councils in the area of a study of community title estates in Victoria lacked clear policy on implementing and managing SQIDs (Goodman, Douglas & Babacan, 2010).

In community title schemes in New South Wales, the developer remains a member of the owner's corporation until owners of one-third of the lots are members (NSW Land Registry Services, 2000). The initial property manager is the choice of the developer, who may place the developer's wishes above those of the residents, for example by keeping levies low, which can impact funds available for maintenance. Many are concerned that these arrangements serve the interests of the developer over those of the future owners, resulting in a disempowered and uninformed community receiving assets in poor working condition (Blandy, Dixon & Dupuis, 2006).

2.2.2. Asset management

PLANNING | TECHNOLOGY
RISK MANAGEMENT
RECORDS | REPORTING

Assets cannot be managed effectively without records and reporting, which serve to improve the accountability of managers and inform decision making on whether and/or when to maintain, modify, refurbish, or dispose of an asset.

These records and reports then inform future capital expenditure. (Edwards, 2012) Asset management of public infrastructure has predominantly been considered the domain of local government. Yet, this tier of government has been found to have inconsistent policies and regulations for WSUD infrastructure, with risks poorly understood and not incorporated into policy and planning compared to well-established guidelines for centralised infrastructure (Moglia et al., 2010; Sharma et al., 2012; McShane, 2006).

2.2.3. Capacity

SKILLS | ADAPTABILITY | NETWORKING
PUTTING LEARNING INTO PRACTICE
FINANCIAL AND HUMAN RESOURCES

A number of studies have reviewed the capacity of local government to implement and manage WSUD and found them deficient (Morison & Brown, 2010; Sharma et al., 2012). Early efforts

were made to build the capacity of councils (e.g. White & Lloyd, 2004) but ongoing studies reveal that WSUD assets remain in poor condition and are not achieving their designed pollutant load reduction targets (Thomas et al., 2016; Dalrymple et al., 2018). While some councils such as Blacktown Council in NSW have a dedicated WSUD compliance team, many more local councils in NSW are impacted by the security of funding sources, with some relying on diminishing annual budgets rather than typically more secure targeted stormwater or environmental levies (Fitzgerald & Laufer, 2016). WSUD implementation and management is competing with growing demand for local government services, and

community preference for spending on community infrastructure such as public open space, community buildings, and sporting facilities (McShane, 2006).

Council staff, despite their institutional shortcomings, are sceptical that residents and owner's corporations have the skills, capability and experience necessary to manage infrastructure sometimes worth millions of dollars (Bennett et al., 2018; Goodman, Douglas & Babacan, 2010; Kenna & Stevenson, 2010). Just as many councils have raised environmental levies to fund stormwater quality projects, it is also likely that owners' corporations will be forced to rely instead on special levies rather than sinking funds to manage these new asset classes (Goodman, Douglas & Babacan, 2010).

Work required to manage assets on community title estates is inequitably distributed amongst members of the estate (Goodman, Douglas & Babacan, 2010; Toner et al., 2005). They receive very little institutional support (Kenna & Stevenson, 2010), and given they can find the legal structures surrounding major assets difficult to negotiate, and assets lose visual amenity as they become run down, owners end up wanting to hand assets back to Council, who are reluctant to take on sub-optimal systems (Kenna & Stevenson, 2010; Goodman, Douglas & Babacan, 2010; Sharma et al., 2016). Private individuals can also avoid maintenance because they lack confidence in identifying problems (Kreutzwiser et al., 2011).

2.2.4. Awareness

KNOWLEDGE

Local government staff have shown a persistent lack of understanding of maintenance tasks, costs, and the current condition and performance of their assets; potentially exacerbated by the interdisciplinary requirements for managing green stormwater devices (Thomas et al., 2016; McShane, 2006; Lim, 2017; Sharma et al., 2016).

In many cases, awareness of SQIDs and their incumbent responsibilities relies on the effective transfer of information, either through the development approval or the property transfer processes (Moglia et al., 2010). Sharma et al. (2012) observe that if someone is being 'gifted' infrastructure they should understand their ongoing responsibilities with maintenance plans that outline specific tasks, roles and responsibilities, expertise and resources required. Under community title, residents have been found to have low levels of awareness of the costs and liabilities associated with their ownership of property (Goodman & Douglas, 2008; Blandy, Dixon & Dupuis, 2006). Residents were particularly

unsure of the content of community management statements and positive covenants (Kenna & Stevenson, 2010).

Involving private individuals in stormwater management is hampered by their lack of awareness of both the mechanics of stormwater management but also the outcomes of beneficial behaviour (Brown et al., 2016). Sharma et al. (2012) advocated involvement of the future owner of the device in the initial planning and design phase to improve their knowledge and commitment, but this is not possible on private properties where a developer carries out construction on behalf of the future and unknown owner. Lack of involvement in the construction phase increases the argument for devices being visible, as Kuller et al. (2017) thought those assets hidden underground were likely to be out of sight and out of mind.

2.2.5. Motivation

CARE FOR THE ENVIRONMENT
WILLINGNESS TO ACT
CONNECTION TO PLACE
CIVIC RESPONSIBILITY

When local government implements WSUD they are factoring in the other benefits of public infrastructure, such as definition of place, social capital, and human health and well-being (McShane, 2006; Davies et al., 2011). WSUD systems can improve water quality,

reduce mains water consumption, preserve ecosystems and enhance landscape amenity (Sharma et al., 2016). Despite the recognised benefits, councils are more likely to dedicate capital funding to build WSUD infrastructure than operational funding for ongoing expenses and maintenance, often because of declining revenue and competing priorities such as welfare services for an ageing population (McShane, 2006; Sharma et al., 2016).

The community has identified they are concerned about waterway health and the degradation of biodiversity (Brown, 2005; Morison & Brown, 2011) and they also wish for well-maintained landscapes and public amenity (Kenna & Stevenson, 2010; Sharma et al., 2016). In a Victorian survey, residents thought stormwater was beneficial to waterways and flooding was the only negative outcome of increased stormwater flows (Brown et al., 2016). Concern and desire may not be enough when environmental behaviour is also linked to attitudes and an individual's sense of responsibility towards an issue (Gao et al., 2016).

The community can be motivated to participate in environmental behaviours for the personal satisfaction of achieving outcomes (balanced against the perceived benefit to resources expended) and external rewards or sanctions such as fines or legal

mechanisms and enforcement. Visible outcomes at a local scale assist with engagement, as does equivalent action in the surrounding environment by other stakeholders.

Environmental behaviour is also predicted by participants' awareness, level of control over the issue, attitudes, verbal commitment and sense of responsibility. (Bennett et al., 2018; Gao et al., 2016)

In 1968, Hardin introduced the term 'tragedy of the commons' to illustrate what might be expected when individuals share a scarce resource and are each motivated to protect their own interests above those of the community (Hardin, 1969). In the case of stormwater, waterways are the commons to which the community must protect, however; the benefit of behaviours that provide a common good, that is the water quality of local streams, is so diffuse that it does not encourage action (Brown et al., 2016).

There must be a strong perceived benefit before individuals will engage in environmental behaviour. Participants must feel they can make a difference, and this can be influenced by many factors including social norms, knowledge, skills, awareness of problems, and the ease of performing the action (Kreutzwiser et al., 2011). While the environmental benefit of raingardens might be recognised, there is a perceived lack of personal benefit (Brown et al., 2016), with raingardens seen as taking private space, of unclear purpose, not providing direct benefit to their household and potentially creating a risk of property damage. Similarly, property owners subject to restrictions applied to their land to protect endangered vegetation communities were unhappy about the impingement on their right to use and manage their land as they wished (Moon & Cocklin, 2011). Property owners felt raingardens contributed positively to amenity unless they were neglected and seen as detracting from the appearance and enjoyment of their yard (Brown et al., 2016; Fitzgerald & Laufer, 2016; Gao et al., 2018; Kenna & Stevenson, 2010).

2.3. REGULATION AND COMPLIANCE

Land use policy and development controls incorporate SQIDs to ameliorate some of the impacts of increased imperviousness and stormwater runoff as part of an overall approach to WSUD (Lloyd, Wong & Chesterfield, 2002). Conditions of consent under the *NSW Environmental Planning & Assessment Act 1979* are imposed on development applications to set out the terms under which the project may proceed. They are used to regulate, avoid, minimise and mitigate the environmental impacts of the project and set out monitoring and reporting requirements (NSW DPE, 2017). Local government compliance officers are empowered to enforce the conditions of consent. Further, protection can be

applied through a Section 88B instrument under the *NSW Conveyancing Act 1919*. Under this instrument a 'restriction on the use of land' identifies the land restricted, the prescribed authority imposing the restriction and the terms of the restriction. The prescribed authority can also include and enforce a 'positive covenant' on the instrument that sets the conditions for maintenance and/or repair (NSW Land Registry Services, 2019). Conditions of consent and the instrument formed under Section 88B *NSW Conveyancing Act 1919* combine to give council compliance officers the tools they need to 'encourage' individuals to rectify any issues, such as fines and court orders.

Regulation often lags behind advances in urban water management practices (Moglia et al., 2010). By privatising SQIDs, councils may reduce operational costs and demand for limited public open space but they also have to relinquish control over the outcomes (Goodman & Douglas, 2008). A proactive inspection and audit schedule may be the best way to achieve compliance on private properties (Kreutzwiser et al., 2011), with councils like Blacktown City Council taking on dedicated WSUD compliance officers for the task (Cadman, 2019).

White & Lloyd (2004) noted the need for organisations to build capacity in regulation and enforcement to achieve better stormwater management (White & Lloyd, 2004). This may be difficult, with the NSW Independent Pricing and Regulatory Tribunal's (2014, p1) review of local government compliance and enforcement identifying that NSW councils had "121 regulatory functions, involving 309 separate regulatory roles, emanating from 67 State Acts" with activities ranging from building to public health and safety and licensed activities.

The West Australian Public Sector Commission (2015) found that because of the extensive role of councils as regulators there was a need to consider alternative methods for achieving compliance, for example by allowing for community surveillance. Behaviour can be influenced by the proximity of interested parties (Fennell, 2011), as demonstrated by the monitoring and reporting behaviour of neighbours of non-compliant residents during severe water restrictions in Sydney at the time of the Millennium Drought in the mid to late 2000s.

Gao et al. (2018) argues that the effectiveness of stormwater management and beneficial outcomes for waterways relies on a critical mass adopting the measures across a catchment. It also relies on those measures being maintained to achieve their objectives.

2.4. RESEARCH INTENTIONS

This literature review highlights the lack of knowledge about the governance structures supporting the widespread decentralisation of stormwater quality management. This study explores councils' decision to trust private individuals with the care of devices that contribute to a common good i.e. waterway health; and investigates the contribution (or not) of regulation and compliance to achieving waterway health objectives. Essentially the study considers whether there is a relationship between the condition of SQIDs under their care and their understanding of responsibility, level of motivation, awareness, asset management, and capacity to manage the devices.

3. METHOD

3.1. AIM

This exploratory study used case studies to develop an understanding of how individuals responsible for SQIDs on private or community title lots experience SQID management (Creswell, 2015). Case studies are useful when the researcher wants to understand *why* an outcome has occurred (Goodrick, 2014). In these cases, the aim was to explore what it is about the owner's motivation and ability to maintain the SQIDs under their care that has contributed to the SQID being in good or poor condition.

Use of case studies will allow a detailed examination of governance using both qualitative and quantitative data and will concentrate on causal relationships within and between cases (Goodrick, 2014) thus exploring *why* an outcome has occurred – in this case what it is about the owner's motivation and ability to maintain the SQIDs under their care that has contributed to the SQID being in good or poor condition (Berg-Schlosser et al., 2012). To develop the case studies, five governance variables were considered: motivation, awareness, capacity, responsibility and asset management, as defined in the literature review.

The researcher originally intended to conduct qualitative comparative analysis of the case studies, however the sample size for this exploratory study was insufficient for this method (Berg-Schlosser & De Meur, 2009). The number of participants was limited due to the exploratory nature of the study and its aim to determine future research directions. The intent was not to draw general conclusions relating to the subject matter.

3.2. CONTEXT

The study was conducted in a 1997 urban land release area in New South Wales, Australia, located within an affluent coastal area containing large areas of bushland. The area has various established community title estates and private developments that, at the time of research, had been occupied for at least three years.

The study area contains a mix of light industry and medium density housing. Between 1997 and 2010 a sector-based approach to development resulted in sizeable estates created from large numbers of consolidated lots. From 2010, due to a need to encourage more rapid development in the land release area to avoid escalating infrastructure costs

being funded from an increasingly insufficient development contribution¹ fund indexed to inflation only, sectors were redefined and individual lots were subdivided resulting in smaller estates. WSUD was integral to the strategic plan for the area from its inception. (Council source, 2010)

Infrastructure in the land release area may be: owned and managed by the local council, under strata or community title, under the care and control of private individuals. Within strata and community title developments, property owners must join the owner's corporation, pay annual fees, and are legally responsible for maintenance and replacement of assets that are subject to the provisions of development approval consent. Lots within the community title developments are privately owned under Torrens Title. Unlike other areas where this type of development is seen as a way for residents to exercise greater control over the appearance and management of their area (Goodman & Douglas, 2008), the imposition of community title in this area has not been driven by the developers, but rather has been executed at the behest of the local Council.

3.3. PARTICIPANTS

The researcher's experience in local government contributed to an understanding of the subject council's decision-making processes and priorities. Demographics of participants were not considered for this exploratory study, as Councils were considered unlikely to target education about maintenance to owner's education level or age, as in most cases the owners have not chosen to install them; and income was not thought to be a limiting factor, as the research was conducted in an affluent area. Collecting demographic data may be useful to consider in any broader studies on SQID maintenance, as factors such as age, education and income may influence the individual's governance of SQIDs.

Qualitative interviews and focus groups were conducted with purposively sampled stakeholders. Participants were chosen to represent three types of asset manager: private, community title and local government. The researcher's practice-based and local knowledge informed selection of a group of participants who had occupied their private properties for at least three years and had responsibility for SQID maintenance or in the case of local council participants had a detailed knowledge of a relevant area of responsibility. The selection of sites also relied on access to comprehensive property records including planning history, service requests, and site plans.

¹ Developers pay the consent authority a contribution based on the size of the development that will fund the provision of infrastructure and services required as a result of increasing population density (O'Flynn, 2011)

Public owners were represented by local council staff responsible for stormwater asset management, catchment management, development engineering (two staff), and development compliance (two staff) (six in all). The council is responsible for over 250 SQIDs that range from constructed wetlands, to bio-swales, sediment basins and a large number of proprietary gross pollutant traps; the exact number is currently unidentified. The council has an additional 64 devices that are simple in-situ sediment basins located at stormwater pipe outlets into waterways. Of the 250 known SQIDs managed by the local council, 58 are in the study area, of which 26 are vegetated and 32 are proprietary gross-pollutant traps. All the gross-pollutant traps are on the council's asset register and are inspected and maintained on a regular basis. Only two of the vegetated SQIDs in the study area are on the council's asset register, which is atypical for the council involved and possibly related to the study area being a land release area that was historically subject to different processes than those followed in the remainder of the council area. Condition assessments were completed for two water quality ponds that were on Council's asset register. The two ponds were part of a larger treatment train managed by Council in one subdivision that also had five gross-pollutant traps and two dry detention basins. The subdivision once had a number of swales, which have since been removed; the reason for this could not be found in Council's records. The dry detention basins double as public open space and are managed and maintained as parks, so were not included in this study.

Two community title estates were included in the study. The first was a large residential estate of 190 dwellings whose stormwater treatment train was commissioned in 2004 and contained swales, gross pollutant traps and water quality and detention ponds, all on common land. The estate had no SQIDs located on the individual private lots. Three members of the estate's owner's corporation were interviewed as a group, with the property manager interviewed separately.

The second community title estate had 39 dwellings and two retailers, with bio-retention swales, an on-site detention tank, proprietary gross-pollutant trap and filter cartridges on the common land managed collectively by the estate. A developer who was also a member of the owner's corporation was interviewed. Of the 39 privately owned residential lots in the second community title estate, 17 dwellings that had been occupied since 2016 were approached for an interview, with five owner-occupiers agreeing to an interview and a further respondent providing some information before discontinuing the discussion (as provided for by the ethics approval). The raingardens on the private lots were owned and cared for by the owners of each lot.

3.4. INTERVIEWS

Owners or managers of SQIDs were asked questions relating to each of the five governance variables defined in the literature review: responsibility, asset management, capacity, awareness and motivation. For example, a participant was asked what they knew about the SQIDs on their land, how they managed them (if they do) and what resources they had to support ongoing management. All SQIDs were subject to development consent and legal instruments that required the devices were maintained, therefore regulation and compliance was explored in additional detail with council staff and those managing community title estates.

To supplement these data, council's records for each of the case study properties and SQIDs were reviewed for their planning, design, construction and maintenance history and any customer requests or complaints

3.5. CONDITION ASSESSMENTS

Condition assessments were conducted on the SQIDs described in Table 1.

Table 1: Condition assessments completed for SQIDs

Responsible manager	SQID	Notes
Council	2 water quality ponds	Assessed
	5 gross pollutant traps	Maintenance reports & photos
Owner's corporation (large community title estate of 190 dwellings)	2 water quality ponds	Assessed
	5 gross pollutant traps	Verbal report, not viewed
	Multiple swales	Assessed
Disputed responsibility between owner's corporation and local council	Detention pond	Assessed
Owner's corporation (small community title estate of 39 dwellings)	Carpark bio-retention	Assessed
	Gross pollutant trap	Verbal report, not viewed
	On-site detention tank	Verbal report, not viewed
Private individuals (on above small community title estate)	17 x 3m ² front yard raingardens	Assessed
	17 x 6m ² rear yard raingardens	Full assessment for 5, remaining 12 had their presence and level of vegetation determined using Nearmap (2019) satellite imagery

The two public and the community title-owned vegetated SQIDs, including water quality ponds and bio-retention swales, were inspected for the presence of erosion;

sedimentation; vegetation cover, condition and type; structural condition; faults such as odour or standing water; and suitability of access for maintenance (Goonetilleke, Egodawatta & Rajapakse, 2011). The same assessment was carried out for the raingardens of the five individual lot owners agreeing to participate in the study (10 raingardens in total). The participants did not give permission for photos to be taken of their raingardens. The scoring system for the SQIDs' condition is described in Table 2. Scores could range between 0-36 points for raingardens and swales and 0-40 points for water quality ponds, with a maximum score indicating very good condition with only routine maintenance required.

Table 2: Scoring table for condition assessments of SQIDs

Feature of SQID	Assessed for*	Score 0	Score 1	Score 2	Score 3
Device altered from design	R, S, P	Removed	Changed so limited or no function	Changed but functional	As designed or improved
Objects in device that aren't part of design (e.g. pots, fountains)	R, S	Covered	Function restricted	Some impact	No objects present
Broken structure e.g. damage from cars	R, S, P	Covered (not P)	Limits function	Still functional	Unaffected
Condition of mechanical equipment	P	Non-operational	Operational and serviced or N/A	(Not used)	(Not used)
Collapsed, buried or blocked pipes	P	Fully blocked	Partially blocked	(Not used)	Clear
Scour	R, S	Covered	Water restricted to one channel	Multiple small scour channels	No Scour
Sediment	R, S, P	Covered (Not P)	Large area limiting function	Small area	None visible
Water pooling on surface	R, S	Covered	Pooled water not draining	(Not used)	No water or draining appropriately
Vegetation cover 6-8/sqm	R, S	None/ bare	One tree/weeds 25% cover	50% cover or thin/ patchy	75% or more cover, even spread
Edge vegetation	P	None/weeds	Patchy and/not weedy	50% cover, few weeds	75% cover, few weeds
Vegetation cover in macrophyte zone	P	None	Patchy, 25% cover	Moderate, 50% cover or 100% thick cover	75% cover, even spread

Feature of SQID	Assessed for*	Score 0	Score 1	Score 2	Score 3
Vegetation condition (P – in macrophyte zone)	R, S, P	None/ dead	Unhealthy/ weedy	Some unhealthy	Healthy
Unsuitable vegetation e.g. Annuals	R, S	None	Unsuitable	Mixed	Appropriate
Surface algae/scum	P	More than 50% cover	Less than 50% cover	Limited/ patchy cover	Not present
Filamentous algae	P	More than 50% cover	Less than 50% cover	Limited/ patchy cover	Not present
Water weeds	P	More than 50% cover	Less than 50% cover	Limited/ patchy cover	Not present
Litter	R, S, P	Litter present or covered	(Not used)	(Not used)	Not present
Faults: odorous, turbid, discoloured, stagnant, mosquitoes	R, S, P	Covered (Not P)	2 or more faults	1 fault	Clear/good
Response	R, S, P	Replace	Rectify	Maintain/ clean	Routine

*R = raingardens, S = swales and bioretention swales, P = water quality ponds

The researcher did not have permission to access the remaining properties, so these raingardens were assessed for whether:

- they were fully or partially covered by decks, bins, pots, fountains, or bird baths, or had been reduced in size
- they contained vegetation
- the remaining area of the yard had been partially or completely covered by an impervious surface (due to the relevance of impervious area to water quality).

The presence and alterations to these raingardens were assessed by viewing them from the publicly accessible street or by using satellite imagery from Nearmap (2019).

3.6. DATA MANAGEMENT AND ANALYSIS

Interviews were recorded and transcribed, except for the five full interviews with private owners, which were recorded in survey forms and notes. The participant interviews were grouped as follows:

- Council (C) (three interviews in total) with two development engineers, two compliance officers, a stormwater manager and a catchment officer.

- Large community title estate (CT-L) (two interviews in total) with three representatives of the owner's corporation, and the property manager
- Small community title estate (six interviews) with the developer (CT-S) (who was also a member of the owner's corporation and a property owner) and five private individuals (P1-P5).

The five governance themes and key variables for each were drawn from the interview data, supplemented by the literature. Data management and coding was supported by the use of NVivo software (V12.6.0), which allowed queries of data for themes specific to each case (Jackson & Bazeley, 2019). These features were able to be coded and thus were also able to be analysed quantitatively, as described below. Feedback on regulation and compliance had broad-ranging application across several themes and was discussed qualitatively rather than considered in the quantitative analysis.

Quantifying the variables for each participant allowed the exploration of which key variables, or combinations of variables are most likely to explain the outcome of SQID condition, with more than one solution being possible. The qualitative data were given a quantitative value by grading each selected variable from 0-1 with a range of scores in between (Bazeley, 2018; Boyatsis, 1998). Table 3 demonstrates how the indicator variables and scoring for each theme were related to a question or questions asked in the interview and the types of responses received. A justification for the scoring is also provided.

Table 3: Quantifying qualitative responses

Theme	Relevant research questions	Qualitative response		Justification of score
Responsibility > Defined roles & responsibilities	<ul style="list-style-type: none"> What is your role/involvement with...? Whose responsibility is it to manage SQIDs on this property/ the common property? is it always clear? How do you engage with other teams/people? What process is followed once a SQID is handed over/ once you own a SQID? What steps would you take to investigate a stormwater issue? 	Roles of all involved clearly defined	1	Likely to take/ support action as understands own responsibility and those of others
		Some roles defined, sometimes responsibility unclear	0.7	Likely to result in less productivity than possible
		Responsibility more likely to be unclear than clear	0.3	Unlikely to be productive
		No understanding of personal role, or roles of others	0	No action expected/ taken, or expects others to take action
Asset Management > Handover	<ul style="list-style-type: none"> What are the successes and failures of SQID handover to Council? What are your thoughts on the effectiveness of (various legal instruments)? Tell me what records are available to you. As a developer, what have you put in place to transfer information? When you moved to this property/started this role, did you receive any information/training about the SQID? 	Clear handover process that is applied consistently	1	Subsequent owner well prepared
		Handover process is not consistent. May be some gaps e.g. types of records or handling of private devices	0.7	Subsequent owner has a reasonable chance of managing the SQID appropriately
		Handover limited in past, but effort being made to improve records etc. and future handovers are likely to improve	0.5	Subsequent owner has a an improved chance of managing the SQID appropriately
		Issues with handover process, may be trying to improve for next owner, future handover may be limited.	0.3	Subsequent owner has some information but is likely to need help
		No handover process and/or will have no process and/or SQID to handover to the next owner/manager	0	Impaired ability of subsequent owners to manage the SQID
Asset Management > Scheduling & Prioritisation	<ul style="list-style-type: none"> What usually triggers maintenance? How do you decide on priorities? 	Provided evidence of use of schedules or prioritisation	1	SQIDs perform well and do not cause issues. Owner well-prepared for resource demands
		Some prioritisation occurring – SQID receives some form of regular inspection and/or maintenance	0.5	SQID less likely to have issues and owner better prepared for resource demands.

		Reactive only	0	SQIDs are only dealt with as problems arise – could lead to increased costs/ issues
Asset Management > Records	<ul style="list-style-type: none"> Where are the gaps in records? What is Council's involvement with managing SQIDs on private land? Tell me about the documents and records you keep for the SQIDs? What are the successes and failures of record management? 	Excellent record management	1	Information available to manage SQIDs
		Records are kept but there are some gaps	0.7	May have good records for some SQIDs but not others, or may have incomplete records
		Consistently reported gaps in records	0.3	Managing SQIDs is hampered by lack of records
		No records kept	0	May be difficult to locate SQID or know how to maintain
Asset Management > Life cycle planning/ risk management	<ul style="list-style-type: none"> What do you think you'll do with this SQID in the long term? What has your estate done to prepare for future maintenance? What does Council do in terms of life cycle management? Do you have plans for dealing with big or unexpected expenses / rectification or replacement? 	Full life cycle planning in place, able to cope if previously unidentified SQIDs added to responsibilities	1	Prepared for rectification/ replacement of SQIDs
		Some life cycle planning occurring	0.7	Funds set aside, plans in place but one/ both may be insufficient
		Some understanding/ implementation of planning, may have no confirmed idea of what to expect in life cycle	0.3	Has considered life cycle e.g. funds but no real planning
		They understand and support paying strata fees	0.1	More likely to pay fees
		No life cycle planning evident	0	Unprepared for rectification/ replacement of SQIDs
Capacity > Resources	<ul style="list-style-type: none"> How are you involved with managing SQIDs? How do you decide priorities? Are there sufficient funds to manage SQIDs? How do you feel about your/ the estate's responsibilities? 	People, funds, time adequate or not raised as an issue	1	While other factors may be affecting SQID management, resources are not the issue
		Issues were raised with resources, but there are only some gaps in performance	0.7	A moderate application of resources, but more could be done
		There are major shortages of resources that impact performance	0.3	A minimal application of resources affecting performance

	<ul style="list-style-type: none"> What proportion of your team's work is proactive? 	No funding, time or people resources to manage SQIDs	0	Insufficient resources are available to complete their task
Capacity > Seek help and learn	<ul style="list-style-type: none"> Where would you seek help or advice? How do you engage with others? Do you provide advice to other parts of Council/ private owners? What information/ training/ handover have you received? How comfortable are you in dealing with SQIDs? How do you decide priorities? Tell me about your experience in dealing with... 	Knew what to ask and where to go to seek help, could provide evidence of others seeking help from them	1	Ability to learn or solve issues is not a limited factor
		Provided evidence of not always knowing how to seek help	0.7	Good ability to learn but could do better e.g. improve their networks
		Demonstrated some awareness of how to get help, but had not interest	0.4	Potentially capable of seeking help if interested
		Often didn't know how to seek help/ resolve an issue	0.3	May not seek appropriate help or be able to resolve issues
		Didn't demonstrate an ability to seek help	0	Poor ability to learn or resolve issues
Awareness > Location of SQIDs	<ul style="list-style-type: none"> How does the stormwater get from your roof to the street? Where does it go after that? Can you tell me about what your estate is doing to manage stormwater? How familiar do you think Council is with the stormwater quality improvement devices they own and manage? Where are the gaps in knowledge or records? What is Council's involvement with managing stormwater quality devices on community title or private land? 	Could name all SQIDs and where they were	1.0	Knowledge of the presence of SQIDs allows maintenance (or regulation) to take place
		Could name and locate the SQIDs they were responsible for and provide some detail on SQIDs they had an interest in	0.9	Individuals are more likely to support action on commonly held SQIDs if they know about them. Council staff are more likely to take action on private devices if they know about them.
		Could name SQIDs they were directly responsible for	0.7	Owners know about the SQIDs they are supposed to maintain but may resist paying fees/providing management of SQIDs in which they have a level of 'interest'
		Could name some SQIDs (either their own or others)	0.4	Some potential for maintenance if they know there is a SQID
		Could provide some detail of SQIDs they were responsible for once prompted	0.2	These owners didn't have immediate recall, but were able to discuss locations once prompted as to their existence
		No knowledge of any SQIDs	0	No knowledge, maintenance unlikely

Awareness > Function of SQID/s	<ul style="list-style-type: none"> How does the stormwater get from your roof to the street? Where does it go after that? Why do you think the water passes through that garden? Can you tell me about what your estate is doing to manage stormwater? Tell me what the (devices) do? 	Provided a detailed response that included references to the SQID removing pollutants from stormwater or waterways. For Council – understanding of target pollutants and performance	1	Full understanding of the function is likely to be associated with correct maintenance of SQIDs
		Able to connect stormwater, the plants and the garden ‘working’ and/or they associated the garden with water quality but didn’t know how it worked. For Council – gaps in their knowledge of desired SQID outcomes	0.7	More likely to maintain the vegetation
		Thought the SQID was for detention only – felt that they only needed to be able to drain freely	0.3	Unlikely to maintain the vegetation, thus impairing function
		Unable to provide an explanation of SQID function even after being informed of their existence	0	Unlikely to maintain appropriately if at all
Awareness > How to maintain SQIDs	<ul style="list-style-type: none"> What do you do to maintain/what is involved in maintaining... What steps do you think might be necessary to maintain... Do you ever provide advice on SQIDs to other parts of Council/private owners? 	Knew to keep filter media clean, sediment removed, plants healthy etc.	1	More likely to maintain the SQIDs appropriately
		Knew to keep pipes clear and plants healthy, but unable to provide specific information	0.8	This level of maintenance would ensure the SQID was functional
		Knew to maintain as a stormwater structure – keep pipes clear etc.	0.5	Prevents property damage from flooding but doesn’t improve water quality
		Maintain as normal garden/pond	0.4	Might lead to impaired drainage and property damage
		Thought that keeping the structure in place means it still works	0.1	Less work to rectify the SQID
		No understanding that the SQID required maintaining/ retaining	0	Likely that complete replacement required
Awareness > Legal	<ul style="list-style-type: none"> Have you received information about 	Legal restrictions, maintain, knew what they had to do	1	Awareness not a reason for lack of action

obligations	<ul style="list-style-type: none"> the SQID/s on your property? What would you do if Council asked you to maintain, fix or replace the SQID on your property? What might the status of the estate's SQIDs mean for the estate and private owners? Tell me about your compliance role? What powers do you have under the Conveyancing/EP&A Act? 	Some gaps in understanding of legal restrictions, requirements hampering ability to achieve compliance	0.8	Generally aware but could be improved to improve outcomes
		Some recall of legal documents and recognition that someone else has an interest	0.5	Some awareness would mean the individual is on the look-out for requirements/ issues
		Awareness that they might not be compliant but no understanding of exact legal restrictions	0.2	Might try to conceal non-compliance and act with the knowledge they might be doing the wrong thing
		No idea of legal restrictions, powers or rights	0	Lack of awareness significantly reduces chance of complying/ executing regulatory activities
Awareness > Management responsibility	<ul style="list-style-type: none"> Who is expected to manage/maintain/replace... Who is responsible for the SQIDs on the estate? Describe the steps involved in maintaining... What is Council's involvement with managing SQIDs on private land? Do you get involved with SQIDs or provide help to other parts of Council? 	Knew who was responsible for all devices	1	More likely to maintain if they believe they are /team is responsible
		Had a good idea - knew their own and some others	0.9	More likely to maintain their own SQID and support the maintenance of others, less inaction due to uncertainty
		Knew direct responsibility	0.8	More likely to maintain their own SQIDs
		No understanding	0	May lead to inaction due to belief someone else responsible
Motivation > Level	<ul style="list-style-type: none"> Why did you choose to live in this area? How does the SQID provide/ not provide value to your property/ estate/ area? What would you do if asked to maintain, fix or replace the SQID? Where does stormwater sit in relation to other compliance activities? What is Council's driver for stormwater management? Why invest? 	Was generally positive about SQIDs	1	Likely to support and manage SQIDs
		Described more positive motivations relating to their SQID than negative	0.7	More likely than unlikely to support and manage SQIDs
		Equally positive and negative about the SQID	0.5	Will probably manage the SQID, but had negative views
		Described more negative motivations relating to their SQID than positive	0.3	More unlikely than likely to manage SQIDs – may manage to avoid compliance action
		Was generally negative about SQIDs	0	Unlikely to manage SQIDs

Where a case did not fit the prevailing trend in the analysis, further qualitative investigation of that case was carried out to determine the cause of the deviation (Bazeley, 2018). Similarly, subjects were not quantitatively scored when they did not easily slot into a single governance theme, such as communication and compliance. These data were incorporated into the overall analysis.

The participant's final score for each governance theme is the sum of their score for each of the variables, thus allowing a quantitative value to represent how they comply with that theme. For instance, 'awareness' has five variables, giving a total potential score of 5. After adding the scores for the five variables, a participant may be graded 'aware' (5) or 'unaware' (0), or they may also be graded as 'more aware than unaware' (e.g. 3.5) or 'more unaware than aware' (e.g. 2.1).

The score each participant received for each graded governance theme was then normalised as a percentage and related to the score that they had received for the condition assessment of the SQIDs for which they were responsible. Governance scores and the level of agreement between these scores and condition assessments were then considered across all case study participants to determine any possible relationships and trends between the governance themes and SQID condition.

3.7. ETHICS

Human research ethics approval was obtained in May 2019; review reference 5201950818751. Participation in the study was voluntary and interviewees were offered the opportunity to withdraw from the process at any time or refuse photos of their SQIDs. The researcher works for the local council and had agreement from the local council that relevant information collected from residents would not be shared with council for the purpose of regulatory action. All reported data is de-identified and all data identifying participants will be stored in a locked cabinet separate from the interview data for five years and will then be destroyed.

4. RESULTS AND DISCUSSION

The results of the researcher's visual condition assessments of the SQIDs are presented. Each of the five governance themes is then analysed for points of difference between types of owners and managers and for relationships to the results of the condition assessments. Regulation and compliance is then discussed.

4.1. CONDITION ASSESSMENTS

The background of each SQID assessed as part of the study is provided below, followed by a summary of the condition assessment and scoring for each SQID. Full scoring for the condition assessments is contained in Appendix One.

4.1.1. Condition scores for interview participants

Full condition scores were allocated to the vegetated SQIDs managed by study participants (Table 1) according to the scoring system described in the method in Table 2. For the analysis of governance factors, average scores were used for the two ponds and the two groups of swales on the large community title estate. Scores were not given to gross-pollutant traps or other proprietary devices, as they were not accessed for this study, however; notes on their maintenance history and estimated condition are provided (Table 4).

In addition to assessing a small number of raingardens (10 of the 34) in detail, the researcher assessed all the raingardens (34) by either viewing them from the street or from aerial photos. It was useful to report on any modifications to all the raingardens, despite not having interview data for the majority of cases, as the simple assessment of whether structures had been built over the raingardens and the degree of vegetation clearly illustrated the degree of non-compliance with the legal restrictions on their properties. The 10 raingardens that had a full condition assessment did not have a condition that was proportionally representative of the condition of the full number (34) of raingardens.

Table 4: Summary of condition assessment scores for interview participants

Owner/ manager	SQID*	Maintenance history	Condition Assessment summary	Cond % [#]
Council (C) Commissioned 2004, Council took ownership after a two-year maintenance period in 2006.	WQP1	Minimal maintenance in 2007 to remove weeds and algae. Major clean and rehabilitation in 2013, including sediment removal, regrading and planting (Image 1). Since 2013, removal of priority weeds.	Sediment in both the open water zone and macrophyte zone (Image 2). No obvious algae, no odour and clear water. The outer macrophyte zone was weedy and unhealthy, with litter visible. Pipes clear and in good condition (no history of flooding of the site or the subdivision). Overall, the pond was structurally sound and needed a 'deep' clean to remove built-up sediment and weeds, followed by replanting; similar to the major maintenance carried out in 2013.	73
	WQP2	Treated for weeds on multiple occasions but no significant maintenance. Removal of priority weeds.	Excess vegetation (Image 3), some problems with <i>Ludwigia peruviana</i> and young <i>Casuarina glauca</i> on banks. Clear water, some filamentous algae in open water areas. Pond structurally sound with clear drains. Requires vegetation management.	90
	GPTs x 5	Audit of Council-owned gross-pollutant traps in 2012. Since then these GPTs inspected monthly and cleaned when more than 80 percent full.	Clean and do not require rectification	n/a
Large community title (CT-L) Commissioned in 2004.	WQP1	Border vegetation and weeds maintained by landscapers, and weeds and algae have been hand harvested from a boat as required.	Minimal macrophytes and substantial algae on the surface. Some silt accumulation; inlet and outlet pipes clear. (Image 4)	58
	WQP2		A fountain for aeration, an aging monoculture of <i>Phragmites australis</i> and algae on the surface amongst the reeds. Outlets starting to become overgrown and will need clearing. (Image 5)	68
	FDP		Spillway had accumulated fine sediments and weeds, ongoing issues with algae and odour. No litter. Council has scheduled removal of some sediment at the spillway to improve flow and manual harvesting of weeds as a 'goodwill' gesture.	48
	Swales Grp1	Additional gravel added in 2018.	Swales largely consist of gravel with sparse cover of <i>Lomandra longifolia</i> . Some minor pooling of water on borders with lawn area, possibly due to compaction from lawnmowers.	72
	Swales	Additional gravel added in 2018.	Extensive swales across the estate had poor gravel or grass cover	64

Owner/ manager	SQID*	Maintenance history	Condition Assessment summary	Cond % [#]
	Grp1		with mature <i>Melaleuca ericifolia</i> (swamp paperbarks). More likely to be damaged by cars, or have garden vegetation planted in them. Some pooling of water.	
	GPTs x 5	Cleaned in 2018 for the first time. Light to heavy sediment loads.	No further inspections since 2018.	n/a
Small community title (CT-S) Commissioned in 2016 along with all raingardens below.	Bio-retention swale	Regular care by landscapers, clean of swale and drains annually.	No scouring, simply needing weeding and supplementary plantings. (Images 6-8)	86
	GPT and filters	Cleaned in 2018 and at the time were in very good condition, with little sediment to remove.	No further inspections since 2018.	n/a
Private individual 1 (P1)	RG front	None	A storage bin covered two-thirds of the area. Tree in remaining third, no groundcover.	22
	RG rear	None	Completely covered by deck.	6
Private individual 2 (P2)	RG front	As for garden	Small number of pots, otherwise well vegetated and healthy.	97
	RG rear	As for garden	Some filter media removed, some large pots, grate clear. Original vegetation replaced with ornamentals.	86
Private individual 3 (P3)	RG front	As for garden	Healthy with one pot.	97
	RG rear	Altered	Altered to resemble a rock-lined pond. A wall sectioned off one-third of the pond, and that third was covered with board and artificial turf. The remaining two-thirds had been deepened and lined with rock, essentially rendering the raingarden detention only.	50
Private individual 4 (P4)	RG front	None	Completely covered by storage cabinet.	17
	RG rear	None	Completely covered by deck.	6
Private individual 5 (P5)	RG front	As for garden	Storage bin partially shaded raingarden, causing it to have no understorey or groundcover in the shaded portion, but a good mix of sedges and shrubs in the remaining portion.	78
	RG rear	As for garden	Some ornamentals and a pedestal fountain.	89

*WQP-Water Quality Pond; GPT – Gross Pollutant Trap; FDP-Flood Detention Pond; RG-Raingarden. [#]Refer to Appendix One for scoring

SQIDs managed by the same person or group received similar condition scores except for Individual 3, who had an excellent raingarden in their front yard and a highly modified raingarden in their rear yard.

Two-thirds (22) of the 34 raingardens were either partially or fully covered by decks or storage cabinets, had been reduced in size, were used to store garbage bins, or had little to no vegetation, and therefore served little more function than detention (Images 9-11). Another eight were still functioning as a raingarden but had patchy, unhealthy or unsuitable vegetation, or the presence of pots and other objects impeding flow and treatment. Also notable was the lot impervious area increasing within 2.5 years of occupation, suggesting that hardstand areas draining to the subdivisions water management facilities may be causing them to exceed their design capacity (Figure 1).

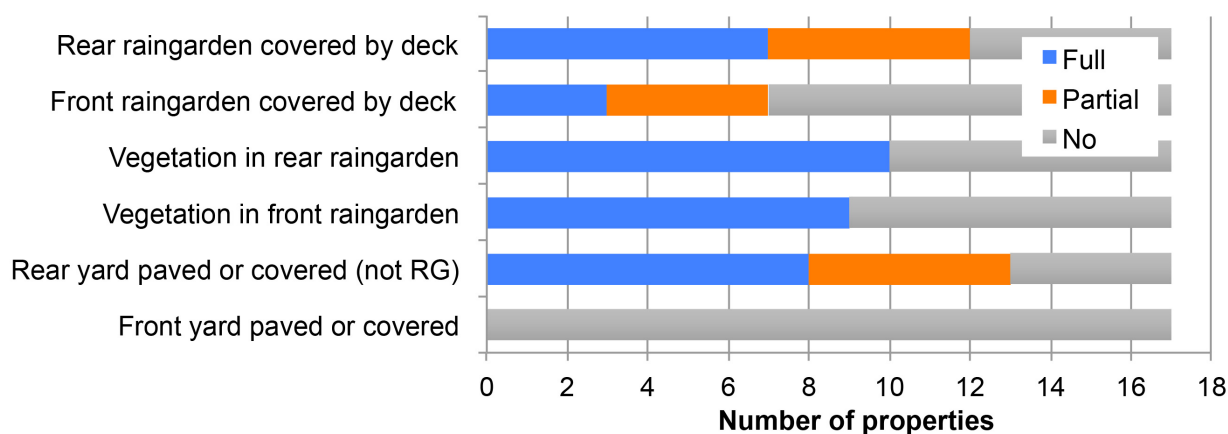


Figure 1: Coverage of raingardens and yards on individual private lots

The area of the rear yards ranged from approximately 37m² to 56m². The largest lots were more likely than the smaller lots to retain a full-sized raingarden in the rear yard, with four raingardens remaining unaltered in the rear yard of the six largest lots.

Interestingly, the raingardens on the properties that faced public open space and a public road were in far better condition than those facing the private cul-de-sac on the estate. None had been significantly altered or covered on the public-facing side of the estate, whereas nearly all the raingardens facing the private road were bare, altered, or covered.



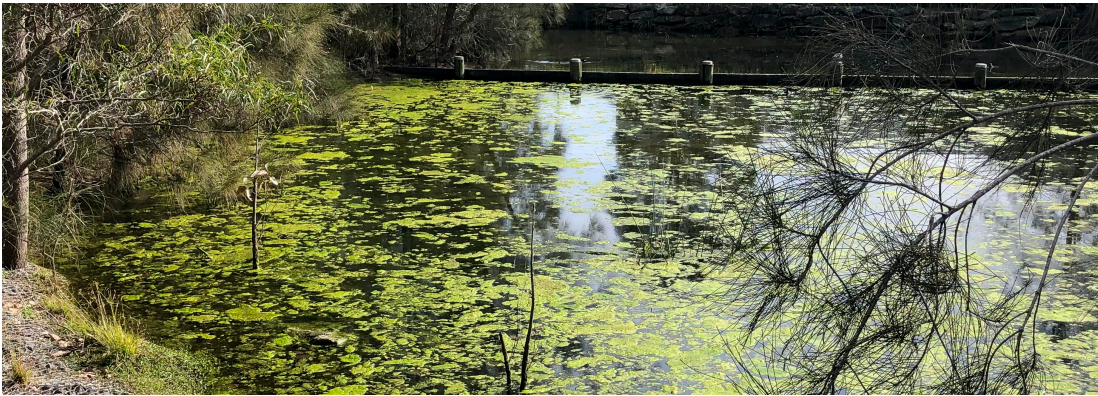
Image 1: Council's main pond after rehabilitation in 2013



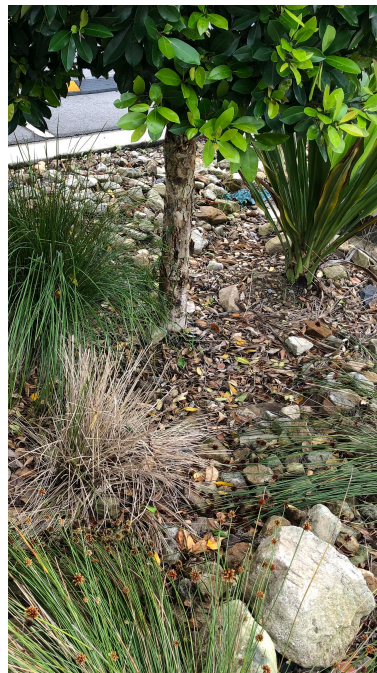
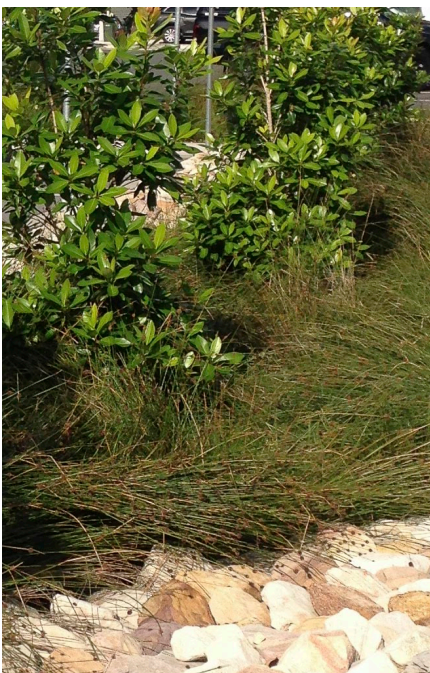
Image 2: Council's main pond in 2019 in need of maintenance



Image 3: Council's smaller pond overgrown and weedy in 2019



Images 4-5: The water quality ponds on the large community title estate in 2019



Images 6-8 (left to right): The bio-retention on the small community title estate in 2017 (6) with thick and appropriate vegetation cover; in 2019 (7-8)



Image 9: Raingardens clearly present in each rear yard in 2016



Image 10: Between 5-8 months after occupation, property owners began building over their raingardens



Image 11: After two and a half years a large number of raingardens had been built over

(Nearmap, 2019)

4.2. GOVERNANCE FACTORS

Each governance factor was quantitatively scored based on each group or individual's qualitative response to the interview questions and according to the method set out in Table 3. The quantitative score for each factor is compared to their condition scores and supported by a qualitative discussion. Full details of the scoring, including justification of scores is included in Appendix Two.

4.2.1. Responsibility

Clearly defined roles and responsibilities had no bearing on the condition of the SQIDs in this study. Individuals were the clearest about their responsibilities, whereas larger organisations were likely to experience some uncertainty about and duplication of roles (Figure 2).

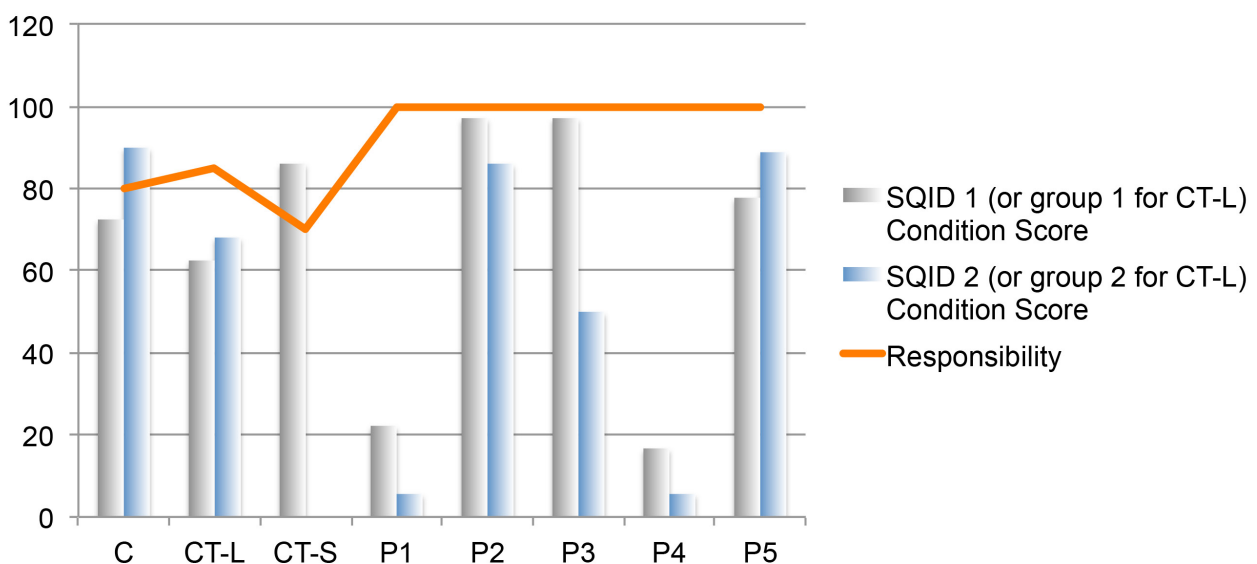


Figure 2: The relationship between responsibility and the condition of SQIDs

The owner's corporation and the property manager understood their complementary positions in managing assets on common land and didn't raise any issues with duplication of roles. The developer interviewed in the study also owned a lot on the small community title estate and was a member of the owner's corporation; an atypical role for a developer. Both he and some residents reported that residents sought him out for advice rather than going straight to the committee, possibly because he established a relationship with them early when he met with each person as they occupied their property. This could create an imbalance in power and undermine the owner's corporation; so far it appears to have provided some benefits in terms of transfer of information to the occupants of the estate.

He has focused on keeping the committee informed to aid their decision-making, and refuses to participate in decisions regarding the estate, instead opting to sit on the committee in an advisory capacity only. This presents a very different view of developer involvement in estate management to that raised by Blandy, Dixon & Dupuis (2006), who were concerned that developers would put their own interests ahead of the residents. Champions serve some use for local council in providing a conduit to the other residents on the estate, and councils could achieve greater compliance by identifying someone in each estate that has established strong internal networks and supports the council's objectives.

Records of decision-making are critical in resolving issues. The flood detention pond (of disputed ownership) was a late addition during development of the large community title estate and does not appear on many of the plans, including the plan of lot 1 of the estate – the common land. The flood detention pond does get a mention in the community management statement, where it is clear that it is the responsibility of the estate to manage, as it is on their land. The presence of a stormwater pipe discharging water from outside the estate into the pond complicates responsibility, as does Council's management of a number of other facilities in the estate including the playground and an endangered ecological community. Council processes have improved to the degree that these discrepancies now only occur in rare situations by ensuring there is a clear division between estate-managed and council-managed assets. For example, council drainage in newer subdivisions in the study area is rebuilt to bypass estate-managed drainage.

SQIDs owned by the local council are under the care and control of a number of teams within the organisation, for example they might be built by a capital projects team, and managed by either a stormwater assets team or a parks team. Discrepancies and unclear lines of responsibility such as these cause significant confusion and increase workloads for all involved. This has been an identified problem for local councils for decades (Brown, 2005), and while councils are more aware of an ideal scenario for responsibility, the issue appears to be no closer to being resolved.

The objectives of teams were different as well, so when teams responsible for constructing SQIDs are more focused on project delivery than long-term objectives and operational requirements (such as a capital projects team who then hands over responsibility for operation to another team), the teams responsible for operation (such as the stormwater or reserves teams) may be frustrated by missing details.

4.2.2. Asset management

While asset management had some relationship to asset condition, the practice was principally the domain of the larger organisations in the study due to managing larger quantities of assets and dealing with government reporting requirements, which was reflected in the use of life cycle planning (Figure 3).

Local councils have to prepare an annual report for their ratepayers that addresses all their activities and spending, and strata/community title owner's corporations and property managers are required to keep maintenance records and an asset register for all community property under the *NSW Community Land Management Act 1989*.

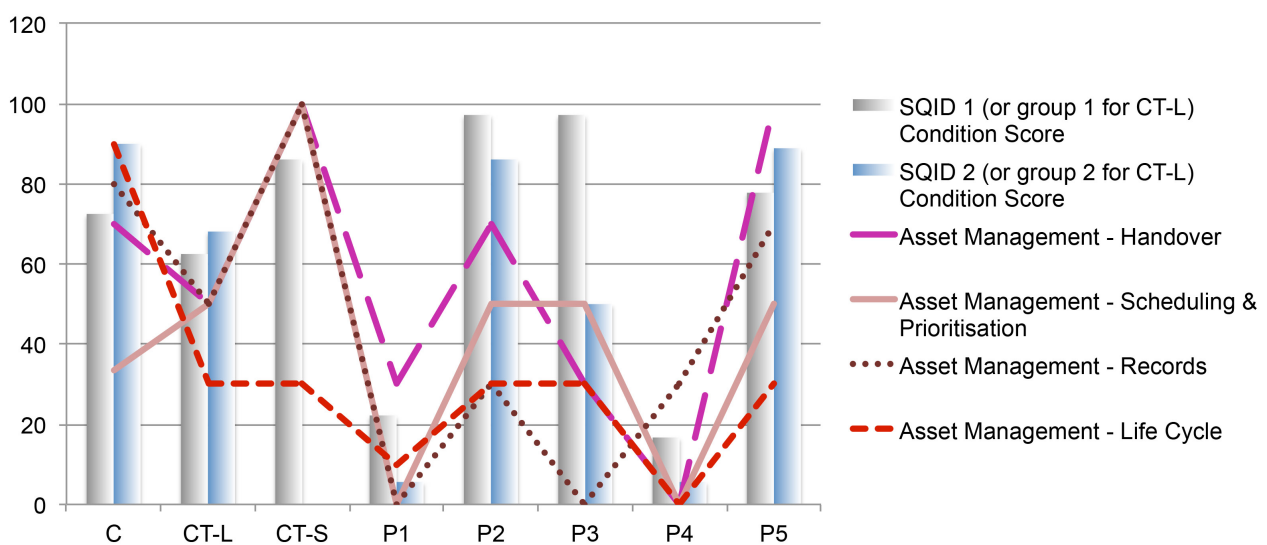


Figure 3: The relationship between asset management and the condition of SQIDs

Private property owners can be required (as were the participants in this study) in conditions of development consent applied under the *NSW Environmental Planning and Assessment Act 1979* or legal instruments attached to their property title under the *NSW Conveyancing Act 1919* to keep maintenance records and make them available to their local council on request.

The interviews revealed that none of the private individuals kept records, but they also had poor awareness of their legal obligations to maintain their raingardens (Figure 5). While the owners may have been informed of this obligation years before and failed to recall it, there may also have been a poor handover process, which is critical in asset management, especially when buyers of property in estates may not be involved in the design and construction of their dwellings. The case of one private individual (P5) (Figure 3) may demonstrate the value of a good handover. Recall was probably aided by their recent

purchase of the property, however; the real estate agent in this case had correctly described the purpose of the raingardens to the new owners and had reinforced their legal responsibilities and the owner was able to recall the content of the estate handbook, which provides information on the raingardens. Recall is obviously affected by time, with several of the private owners on the small community title estate saying they had no records despite the developer asserting that he had personally met with each resident when they moved into the estate and provided them with a 'very comprehensive manual for their house and for the estate'. He said he intended to maintain this practice with any new owners for the time being.

The local council had improved their internal handover processes so that SQIDs were immediately placed on an asset register with all the necessary documentation attached, but admitted they were dealing with legacy issues for SQIDs that had missed the system. The larger community title estate complained of missing records due to the three-time change in ownership of their estate during the construction phase. Development conditions of consent are a way local councils could improve information transfer between owners, even during the construction phase.

Council's lack of an asset register for private devices affected their ability to identify the locations and owners of private SQIDs. The local council also hadn't thought through the best way to receive records, particularly reports provided to meet reporting requirements, with most going to a single location for registration and sometimes failing to reach the officers that needed to review them. There's potentially an opportunity for improvement with the introduction across NSW of the online planning portal (<https://www.planningportal.nsw.gov.au/onlineDA>), where development applications are submitted and tracked. While this is not currently a function, it is worth considering whether the reports required to meet the conditions of consent could easily be submitted to this portal and a notification sent to a registered email.

Scheduled maintenance of SQIDs was rare across all participants, however the small community title estate appeared to maintain their SQIDs on a schedule of sorts, giving the bio-retention swale an annual clean and the gross pollutant trap and filters a clean every two years. Private individuals maintained their raingardens along with the rest of their garden, responding reactively when a problem such as odour or weeds occurred. The large community title estate was much the same. The local council scheduled maintenance for their grey infrastructure e.g. gross pollutant traps, litter booms and said they were considering methods for prioritising maintenance for their grey infrastructure

based on the performance of each SQID and the priority of the catchment, rather than the current system of scheduling maintenance based on recommendations from the manufacturer. They had no plans for vegetated devices, perhaps reflecting their lack of capacity in this area (see Section 4.2.3).

4.2.3. Capacity

The capacity of organisations and individuals to manage SQIDs in terms of skills, education, networks, time, human and financial resources had some relationship to SQID condition (Figure 4).

Council acknowledged their lack of necessary skills and knowledge in managing vegetated SQIDs, and all private owners managed SQIDs in the same way as they did other landscaped areas, suggesting that education across the board is a priority. The local council had the best access to training of all the participants but wasn't proactive about seeking it out due to competing priorities for resources, even though staff felt unprepared to keep up with rapidly changing technologies. This suggests that the 'seeking help' aspect of capacity may be influenced by the 'resourcing' aspect of capacity.

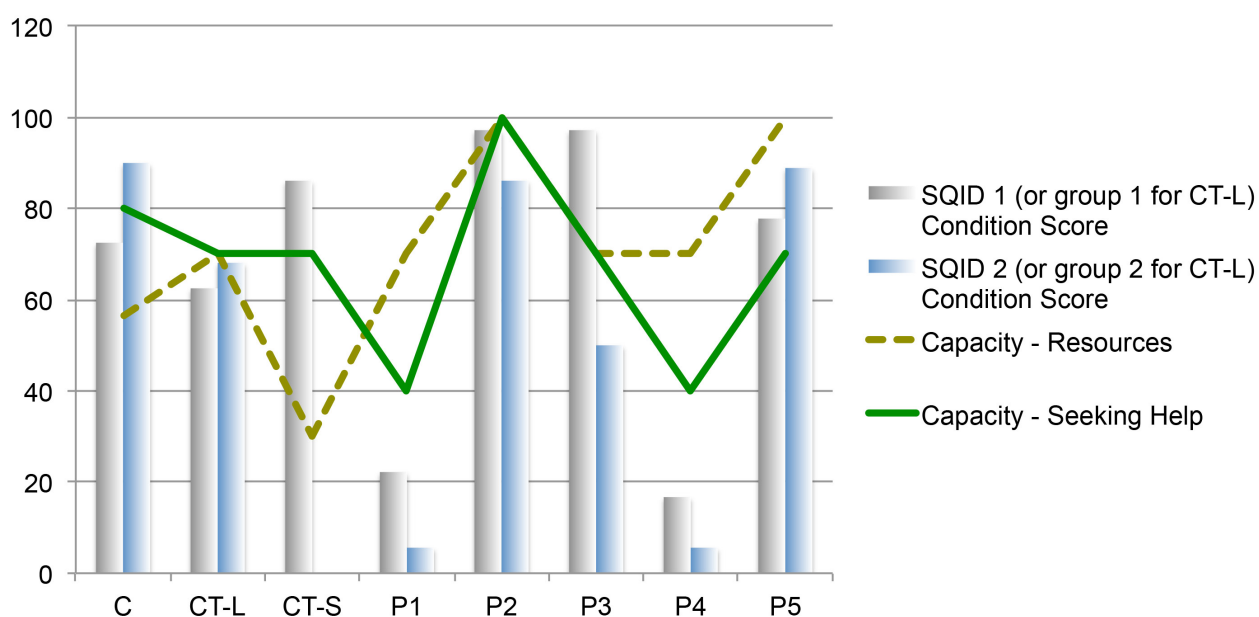


Figure 4: The relationship between capacity and the condition of SQIDs

The ability to maintain SQIDs appropriately was also restricted by access to sufficient resources. Local council staff felt they had insufficient time, people and funds to respond to the issues they've identified with SQIDs, particularly legacy issues such as identifying, auditing and rehabilitating devices that were not currently on Council's asset register. The

size of a community title estate may have some bearing on capacity, as the smaller estate noted that residents didn't have the time necessary to conduct the committee's duties, whereas the larger estate said their retired members could cope with the workload.

The local council compliance staff said they were unable to conduct any compliance activities related to water management facilities, as they had insufficient resources to meet their objectives in terms of more pressing concerns such as inspecting on-site septic systems, illegal land clearing and asbestos dumping. Council's lack of regulatory capacity was evident in the field, as the developer reported: "I didn't know (local council) bothered looking at anything to be frank." This is discussed further in Section 4.3 Regulation and Compliance.

All participants in the study relied on their personal networks, supporting the argument to seek out and support champions, as identified in Section 4.2.1. On community title estates it makes sense to find this champion among the owner's corporation, as private individuals identified this group as a source of information. Council staff mentioned the advantages of building stronger relationships between the development engineers and stormwater engineers, as it had resulted in assets better conforming to Council's standards when handed over from the developer.

4.2.4. Awareness

All participants were aware of their responsibility for SQIDs, so this was not related to SQID condition, whereas the other key elements of awareness were (location, function, maintenance and legal obligations) (Figure 5).

The lack of awareness of private individuals of their legal obligations is notable, and may have played a part in the removal and modification of SQIDs on their lots.

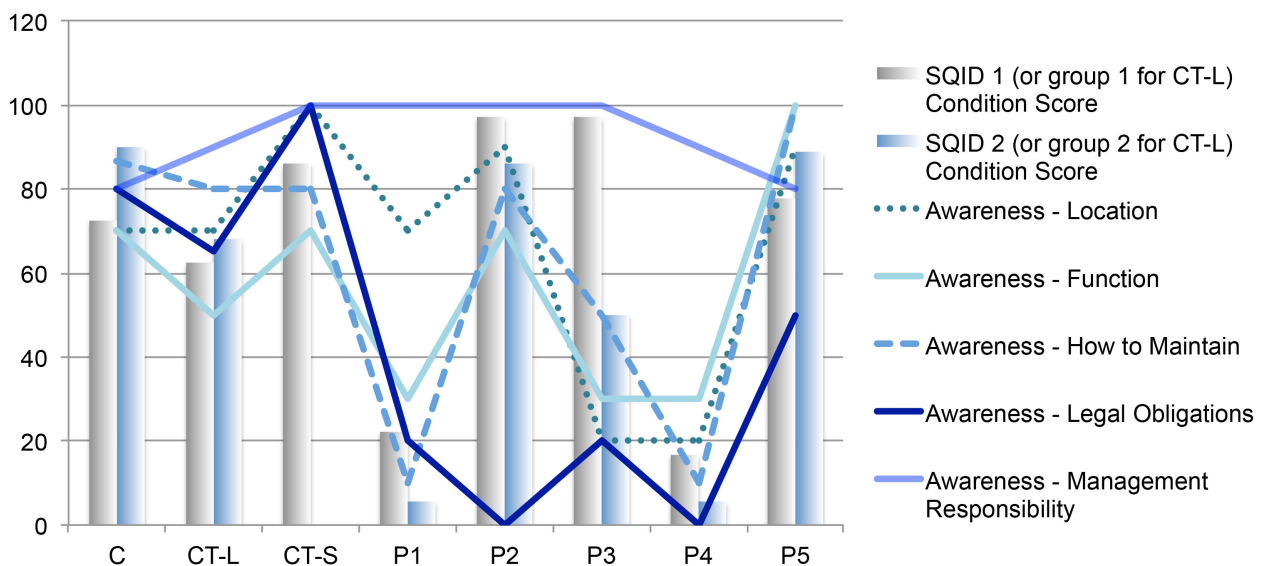


Figure 5: The relationship between awareness and the condition of SQIDs

Once the score for management responsibility is removed, the local council achieved an average score of 77 percent for awareness. The council is a large organisation with responsibility for over 250 SQIDs, but despite having asset management systems and expertise, they did not know the location of all SQIDs, nor what each was designed to do, nor how to maintain all of them. Better integration of the planning system with the asset management system would help prevent future knowledge gaps from occurring. In their favour, they had conducted an audit of stormwater devices in one part of their local government area and intended to audit the remaining devices in the near future. They had also considered and intended to implement performance monitoring of SQIDs.

The local council had an excellent understanding of how to maintain grey infrastructure, but lacked confidence in maintaining vegetated devices. They had teams that dealt with the maintenance of civil infrastructure and those that dealt with landscaping and none that were comfortable with both areas of expertise. The council built a number of raingardens that were converted to garden beds due to design issues affecting their performance. Failures like these may affect the local council's willingness to build SQIDs in the future.

The owner's corporation and property manager of the larger community title estate claimed that their limited knowledge of their SQIDs was due to three changes of ownership during construction of the estate resulting in disjointed planning and lost records. They achieved an overall awareness score of 66 percent. The knowledge they did have was as a direct result of intervention by the local council in 2018. The owner's corporation had been experiencing odour in the flood detention pond. After commissioning a study to look at how to improve water circulation, they sought the local council's advice on finding a

council-owned pipe discharged into the pond. The owner's corporation admitted in their interview: "prior to meeting with Council and discussing (the gross pollutant traps and swales) we had no idea they existed and no idea that we needed to maintain them". Notably, the Community Management Statement for the estate listed the water management facilities and required preparation of a maintenance manual, however, none of those interviewed were familiar with this document.

The estate had maintained their ponds since they were commissioned by maintaining edge vegetation and on a number of occasions, removing algae and weed from the ponds by hand from a boat; the focus being on maintaining amenity and preventing nuisance and impacts on residents. The interaction between the owner's corporation and the council in 2018 led to the owner's corporation arranging for their five gross pollutant traps to be cleaned for the first time in twelve years. The first trap had so much sediment the owner's corporation was "a bit worried we were going to fill up the tanker", but because two of the others had very little sediment, they assumed there was no urgency to schedule the next round of maintenance: "Well we're hoping that next time won't be for quite a while. Because if that was 12 years worth, it isn't too bad is it?" This comment further demonstrates their lack of awareness because it doesn't account for all the sediment and litter that may have remobilised and moved downstream and in to their water quality ponds during that 12-year period.

The developer of the smaller community title estate knew the location of all the SQIDs on the estate, understood the vegetation was critical to the function of the vegetated devices, and knew what maintenance was required on all SQIDs including cleaning the filter media in the bio-retention. They received an overall average score for awareness of 88 percent; a high result that reflected the individual's involvement in the entire process from design through to operation. It was not clear how effectively the developer had shared his knowledge with the rest of the owner's corporation: he was aware of the SQIDs but had "not got around to telling everyone about them yet". This was evident when a member of the owner's corporation was approached for an interview and said the estate was not affecting the water quality of the creek, yet both their personal raingardens were covered and unvegetated. While the developer remains involved in the estate, the SQIDs will be appropriately cared for. Intervention from the council in the form of education of the committee on responsibilities and life cycle management of assets may be required to ensure the developer transfers his knowledge to the committee in an enduring way.

Information about ownership and maintenance responsibilities provided to private owners of properties containing SQIDs is typically limited to that (if any) received from the salesperson (if buying off the plan), real estate agent, or conveyancing solicitor. The individual property owners on the small community title estate had poor awareness, with average scores of 15, 30, 33, and 60 percent for those that had lived on the estate for three years, and 85 percent for the resident that had just bought their property two months earlier. Even though the four longer-term residents had received a visit and a handbook from the developer shortly after they occupied their property, they couldn't recall receiving an information pack from the developer and remembered the salesperson describing the raingardens as a 'soak away' type area. Clearly there are problems with retention of information, and this needs to be addressed by the local council, to ensure SQIDs are retained and maintained.

The private residents could identify their own raingarden (individuals P3 and P4 only with prompting), but their knowledge of devices on common land was limited, which could negatively impact their willingness to support strata fee increases or special levies to pay for future rectification work on the SQIDs. They were far more likely to understand the detention function of a SQID than the pollutant removal function. Those residents that thought SQIDs served purely a detention function were much more likely to have removed the vegetation from their raingarden and altered it in some way, for example by covering it or lining it with rocks. If they maintained their raingarden(s) at all, they treated it as they did the remainder of their garden.

Both community title estates were aware they had legal responsibilities in terms of maintaining the common assets on their estates (Figure 5). The larger community title estate was not familiar with the details of the legal restrictions and positive covenants under which they operated, and the developer of the smaller estate, while familiar, did not think council carried out compliance activities; this belief may have contributed to him not building awareness of legal responsibilities with residents. The four private individuals who had bought their properties off the plan could recall seeing the raingardens on the plans but were not able to recall the property title documents. A discussion of their response to the repercussions of non-compliance is included in Section 4.3.

4.2.5. Motivation

Motivation appears to be a strong driver for why someone did or didn't retain or maintain their SQID, therefore having a direct connection to SQID condition (Figure 6).

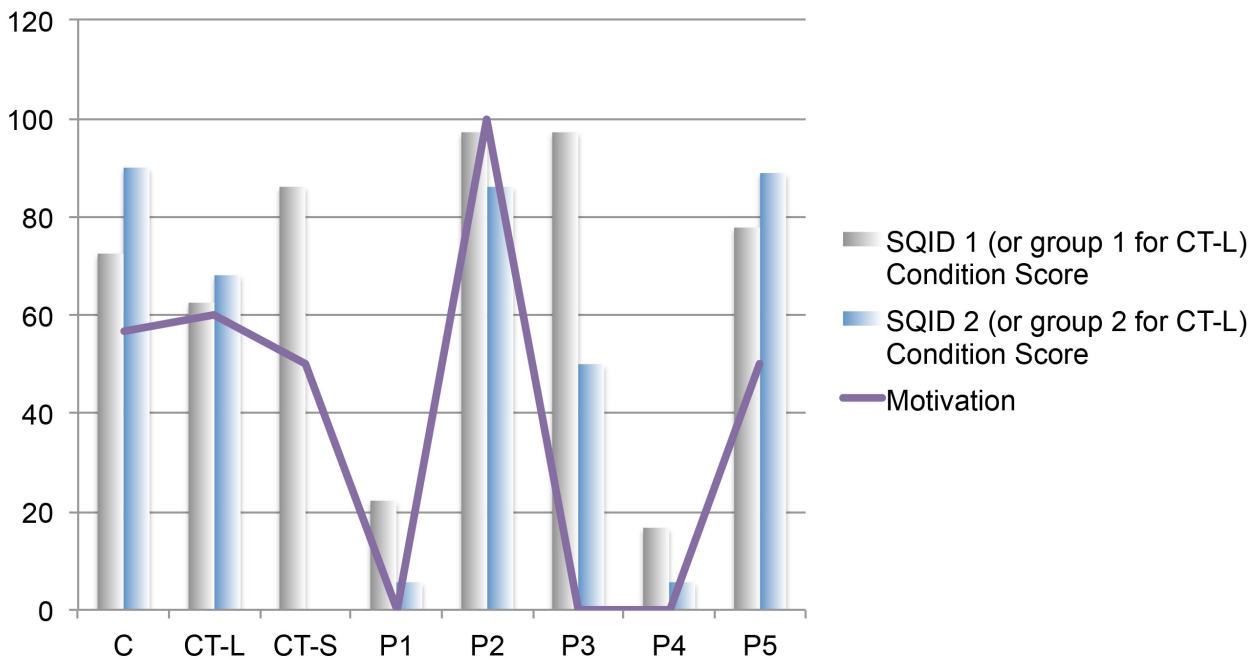


Figure 6: The relationship between motivation and the condition of SQIDs

The local council staff were divided in their opinions of SQIDs. The stormwater and catchment officers thought SQIDs helped meet water quality objectives and were personally driven by a desire to improve public health and a perceived community interest in 'nice, clean waterways', amenity, and reducing plastic pollution. This was interesting because the private owners in the study said being close to waterways and the environment was important to their decision to move to the area, but was not one of the major reasons, because they also lived there to downsize, be close to family or buy somewhere affordable.

Council staff may have had reasons for supporting SQIDs but also believed that the provision of SQIDs was "a standard service" provided to communities by local councils. Water quality objectives were generally acknowledged by all the local council participants as second to the local council's main driver of protecting people and property, with stormwater quality not considered a big enough 'risk' to be of primary concern. They noted the importance of needing tangible outcomes, which was supported by the opinion of the compliance officers who thought SQIDs didn't work and were an unnecessary expense and nuisance for property owners, partly because of the land take required. The council

thought the lack of obvious benefits affected the ability to attract funding and resources for SQIDs, as their installation didn't provide 'ribbon-cutting' events.

Participants in the study, regardless of their typology, were split on the amenity of vegetated SQIDs. The owner's corporation of the larger estate thought the water quality ponds were a major contributor to the amenity of the estate, attracting birds and people engaging in passive recreation, and felt under significant pressure from their residents to manage the water quality ponds for amenity by addressing odour and algae problems. Integration with the surrounding environment was an important theme for all SQIDs, with raingardens in particular more acceptable when perceived as integrating well with the rest of their landscaped areas. This highlights the critical importance of local council ensuring during review of stormwater and urban designs that vegetated SQIDs are well integrated and add to the amenity of the development and the precinct (for larger devices).

Private owners raised the demand for and usability of private open space as a reason for covering or reducing the size of their raingarden, which reinforces the need for integrated design. Some felt the raingarden detracted from the value of their property, attracted snakes, and presented a drowning risk to small children.

All study participants, whether public or private, raised competing priorities for their money and time as one of the reasons they didn't maintain their SQIDs.

4.3. REGULATION AND COMPLIANCE

Regulatory oversight is an interesting area and often just operates one way. However, where councils have placed assets in private ownership they become both operators and regulators. In essence the community, either through complaint or electoral preference (voting), serve a quasi 'political regulatory' role that seeks to hold to account the actions of government. Clearly this is a far less sensitive tool through which to enact change.

For private owners, there are conditions of consent that require the SQIDs to be maintained, but they are often poorly written and ambiguous. Consent documents get lost with time, have to be looked up by new owners, and may be hard to locate for older properties.

Local councils tend to rely heavily on legal devices such as Instruments under Section 88B *NSW Conveyancing Act 1919* to regulate stormwater devices under private ownership. The restriction on the use of land requires that property owners obtain the written consent

of the local council before making any alterations to a SQID, thus notifying owners of Council's 'interest' in the property. The positive covenant ensures maintenance, specifying the aspects of maintenance they must consider, and is often quite specific. The private individuals and community title estates in the study had Section 88B Instruments on the title of their property.

Council staff regarded the Instrument under Section 88B *NSW Conveyancing Act 1919* as a useful way of alerting prospective buyers and new owners to their responsibilities. The conveyancing solicitor interviewed for the study said he brings any devices listed on the Instrument to the attention of a buyer and summarises what it says, although he did note that it would be good to have a plan on the document to show where SQIDs are located, particularly on strata type properties. One member of the council staff went so far as to say that with the positive covenant in place the device would then be "maintained appropriately and there is no cost to ratepayers", but later amended this assertion by saying the documents were only as good as your regulatory presence; "you can put all these conditions on that you want but unless you've got a compliance presence or an ability to audit [the devices], they can be completely useless as well".

The compliance staff were concerned that positive covenants were an unfair financial imposition on residents given the local council was inactive in this space and gave an unrealistic expectation that the local council was actively regulating SQIDs. In truth, the residents were largely unaware of the positive covenant and that the local council even conducted compliance in the area (or should be) (see Figure 5). The condition assessments of the private properties in the case study revealed that the majority of properties were non-compliant in some way with the conditions of their consent and the positive covenant on their property. Residents that had covered their raingardens expressed surprise that they might be asked to remove the item and rectify the raingarden, with several saying they wouldn't comply. The developer said: "I didn't know you bothered looking at anything to be frank. I just assumed that it was a compliance thing at the start and it was a bit of a tick in the box exercise; admittedly it's an expensive and it's a serious tick in the box, it's not something you do lightly, but I really didn't know what Council was doing."

There were several possible reasons for a lack of enforcement action from the local council. Firstly, compliance staff and development engineers were unsure of who had the power under the *NSW Conveyancing Act, 1919* to enforce positive covenants. Compliance staff were much surer of their powers under the *NSW Environmental Planning and*

Assessment Act, 1979 and therefore tended to enforce conditions of consent rather than relying on restrictions and positive covenants. Secondly, due to workload, compliance staff rarely worked proactively and only responded to customer complaints or referrals from other business units, and as raised in Section 4.2.5, prioritised issues according to risk. They had never had a complaint about a stormwater system and compared this to 50 complaints a year about their 1900 on-site sewerage systems in the local government area. The compliance staff suggested that a public health outbreak would be required before the government would commit resources to inspections and compliance activities for stormwater considering local councils had insufficient resources to respond to the list of items they already had to regulate under the *Local Government Act, 1993*. This was a lengthy list including: fire safety, swimming pool fences, food premises, on-site systems, service station vapour recovery, cooling towers, skin pen artists (tattoo parlours), public pools, and brothels. Food premises was the only item where 100 percent of premises were inspected because of a legislated requirement to report back to the State Government. Considering on-site sewerage systems present a much greater risk to public health than stormwater and there is no reporting requirement to State Government on compliance for these systems under the *Local Government Act 1993*, it seems unlikely that legislation will be put in place that covers reporting on private compliance with SQID maintenance.

Finally, council staff recognised the value of an asset register of private devices because among other tasks it could alert staff when a maintenance report was due. Even though staff would still have to allocate resources to chase up and administer reports, at least there would be a record of compliance and non-compliance. Without an asset register they lacked the capability to conduct inspections and audits.

A consideration of the issues with regulation and compliance and how they might be addressed is discussed in the next chapter.

5. POLICY IMPLICATIONS

The Council in the study had excellent strategies and policies in place to support the implementation of WSUD in the area, but was less likely to have clear directions in terms of maintenance of SQIDs and evaluation of performance. Broadly, the larger institutions (local councils and bigger strata bodies) have formal systems and usually the resources to proactively manage their WSUD features. At the other end of the spectrum, the knowledge and practice of households is highly variable. These findings reveal the importance of understanding the socio-institutional and governance factors that drive WSUD outcomes.

From this study and the literature we can see that key drivers to improve WSUD governance across both private and public domains include:

- organisational dynamics
- policy guiding the location of SQIDs that considers owner-type, lot size, location and integration on the lot
- targeted regulation and compliance that supports the SQID ownership model
- improved transfer of information from developer to owners/managers of SQIDs.

5.1. ORGANISATIONAL DYNAMICS – LOCAL COUNCILS

Private individuals had a simple methodology for understanding their responsibilities in terms of the SQIDs, stating that if the devices were on their land they were their responsibility. Their simple organising structure was markedly different to that of the local council, whose complex organisational dynamics, division of roles and responsibilities, and decision-making processes led to unnecessary confusion and wasted resources in relation to managing SQIDs. It is worth reinforcing the point that despite local councils in particular having an understanding of these issues for some time (raised for example by Brown, 2005), they have not yet been resolved.

A common complaint when residents contact their local council about SQIDs that require maintenance is that they get ‘passed around’, as the staff are unable to identify who can assist the customer with their issue. The staff interviewed in this study stated they preferred responsibility to be centralised to an ‘expert’ team that could respond to the hybrid hard (engineering) and soft (landscape) requirements of SQIDs to avoid the failures that occurred with vegetated systems due to their lack of knowledge of either vegetation management or stormwater management. In addition, when SQIDs were designed and constructed under the management of an internal project team, often as part of a wider

development, information silos impacted consultation and communication, resulting in devices that didn't always comply with operational requirements. This could perhaps be resolved with the development and use of key performance indicators focusing on operational objectives.

5.2. THE IMPORTANCE OF LOT SIZE AND TYPE OF OWNER

Raingardens in small back yards compete with the individual's desire for private open space. Locating the SQIDs in public view assists with public surveillance, which is important to achieve compliance. The rear yards of the private lots in the study ranged in size from 37–56m² and therefore the reduction of private open space caused by the 6m² raingarden was substantial when accounting for landscaping that was also to be retained under their conditions of consent. There was widespread construction of decks, roofing and paving over raingardens within six months from the time residents occupied their properties. The desire for private open space was the principal reason given by all affected residents for covering their raingardens, supported by the fact that the rear yard was more likely to be covered than the front yard. This finding is in agreement with Moon & Cocklin (2011) who found property owners subject to restrictions applied to their land to protect endangered vegetation communities were unhappy about the impingement on their right to use and manage their land as they wished. The developer of the small community title estate said he wouldn't put raingardens in a rear yard again because so many there had been compromised. This, then, is something local councils should consider as a rule when reviewing development applications, particularly for those developments conducting cut and fill and able to grade sites to allow drainage to the front of the lot.

It is possible that smaller SQIDs such as raingardens and rain barrels on individual lots will not achieve acceptable outcomes for waterway water quality and biodiversity, perhaps because they aren't retained or maintained as revealed in this study. A study by Roy et al. (2014) revealed that small devices distributed on individual lots across 30 percent of a catchment had seen very little response in water quality, periphyton and macroinvertebrates in the catchment, although this may also have been because a larger percentage of the catchment had to be treated before a result could be seen. This argument should be explored further in a broader range of legislative environments and local government areas before determining whether councils should limit installation of SQIDs on individual properties under a certain size or rather, whether it would be sufficient – and cost effective – to improve targeted education and compliance activities for

individual owners. Further study and development of systems for individual properties would also be useful, as better integration into the space available on the lot and improved ease of maintenance might improve their retention. It may be that it is more appropriate to distribute SQIDs across the catchment in public land, moving the devices to the nature strip in public land and placing them under public care (as long as their maintenance was properly resourced).

Another advantage of a wider study would be the ability to test the hypothesis that larger community title estates have greater capacity to manage SQIDs than small estates. This was not possible in this study, as different types of participants were selected for each of the community title estates ie. the owner's corporation and property manager for the large estate, versus the developer for the small estate. Due to the developers involvement from planning and design to operation, the parties were expected to have markedly different levels of capacity and awareness.

5.3. DIVESTING RESPONSIBILITY AND THE DEMAND FOR REGULATION

If local government divests responsibility for the operation and maintenance of SQIDs to private owners, they must accept the likely necessity of conducting education and regulation. This must be considered in light of education not always leading to improved awareness (Bennett et al., 2018).

Due to a lack of perceived risk from poorly performing SQIDs, the local council relied on legal instruments for regulation, hoping to at least capture the few owners of SQIDs who were concerned about non-compliance. But where is the risk of being found non-compliant when the local council has no regulatory presence? The developer of the small community title estate didn't think council conducted compliance activities and regarded the initial compliance requirements during development as 'tick in the box' activities. Furthermore, he had possibly passed on his belief to the residents of the estate when they were asking for advice on modifications to their back yards. The residents seemed aware of some risk of scrutiny because the raingardens in the front yards facing public open space were all intact whereas those facing the estate's internal private road were either covered or bare of vegetation.

The local council relied on legal instruments and conditions of consent, but acknowledged that they were only as effective as their compliance presence and ability to audit the devices, a view supported by Morison and Brown (2011) and Moglia et al. (2010). The

Council had an excellent asset management system in place for more traditional 'grey infrastructure' stormwater pipes, pits and gross pollutant traps, so had the capacity to apply the same system to the management of private devices.

The increased impervious area of the private lots and the lack of maintenance of the raingardens mean that the estate is probably not meeting the water quality objectives for the development. This is just one example of a development not meeting its water quality objectives. If this outcome is applied across multiple sites, it suggests that the council is unlikely to be achieving catchment based water quality objectives.

The residents in the study area claimed the natural environment of the area was important to them in local council consultations for strategic planning (Council source, 2018), but this was not reflected in their care of the SQIDs in their backyard. Commitment to WSUD has been associated with education and wealth (Morison & Brown, 2011). It is potentially the case then that an even lower level of compliance might be found in local government areas with less extensive natural environment areas and lower socio-economic background due to a lack of public and organisational commitment. This idea should be explored further.

5.4. EDUCATION

Kreutzwiser et al. (2011) states that the community are motivated to participate in environmental stewardship for the personal satisfaction of achieving outcomes (balanced against the perceived benefit to resources expended) and by external rewards or sanctions such as fines or legal mechanisms and enforcement. Their motivation can be influenced by many factors including social norms, knowledge, skills, awareness of problems, and the ease of performing the action. Visible outcomes at a local scale assist with engagement, as does equivalent action in the surrounding environment by other stakeholders (Bennett et al., 2018; Gao et al., 2016). Environmental behaviour is also predicted by participants' awareness, level of control over the issue, attitudes, verbal commitment and sense of responsibility (Gao et al., 2016).

This exploratory study identified two clear occasions where education has resulted in positive action. An individual was able to relay that their real estate agent had told them the raingardens must remain and be maintained. Given the initial peak and then subsidence of building activity on newly occupied lots, educational interventions would

appear to be most important for this group during the first two years of occupation and when property ownership is transferred.

The large community title estate owner's corporation had responded to a local council intervention and maintained their gross pollutant traps, following which they were much more receptive to advice. The developer of the small community estate demonstrated the value of having a champion for the objectives of the estate, meeting with new owners and acting as a go-between and source of information for both the residents and the owner's corporation.

Owner's corporations of community title estates, which can be found via their registered property managers, provide a more centralised target than individual property owners for council's education and compliance activities. The owner's corporation participants in the study said they are more likely to respond due to a greater sense of responsibility as a representative and manager of their 'community'. Considering this, local councils should preference community title over individual lots for subdivision developments where the estate is to be responsible for its own stormwater quality management. When councils place the responsibility for SQIDs with private owners, it appears it may be necessary for them to regulate these owners, establishing registers of private assets, conducting regular audits of private devices and increasing their compliance presence on the ground. Further to this, evaluation of the effectiveness of regulation of private owners of SQIDs needs to occur, to ensure this approach achieves the desired outcomes of well-maintained SQIDs. If we continue with the present approach of placing SQIDs on private property, in many cases without education or regulation, it is likely that waterway health outcomes will not be delivered.

6. CONCLUSION

In a scenario where design and construction of the SQIDs are effective, the success of SQIDs in improving waterway health is then predicated on effective maintenance and management of the devices. By considering community estate managers and private individuals, who also commonly own and maintain SQIDs in Australia, this exploratory study has built on previous work investigating the governance of local councils in managing SQIDs. The study was conducted in a single geographical area that had one consent authority, to limit the influence of varied legislation and planning controls on outcomes.

The findings make a case for further research into the relationship between governance and the condition of SQIDs because there appears to be a relationship between motivation, awareness, and capacity of SQID owners and managers and the governance frameworks that support good asset management practice. In particular, further research is necessary to investigate how the condition of SQIDs on individual private lots is related to: lot size and the demand for private open space; and location on the lot and enabling of public surveillance.

The research would be best conducted in a wide variety of local government areas, perhaps in different states of Australia or even internationally, to understand whether the findings vary under differing planning controls, legal instruments and compliance models and for areas with varied socio-economic status (reflecting educational status) and natural environment values. Opportunities exist to incorporate outcomes from a similar study considering local government governance of SQIDs, conducted by Thomas et al (2020) in Victoria, Australia.

The researcher originally intended to conduct qualitative comparative analysis of the case studies, however the sample size for this exploratory study was insufficient for this method (Berg-Schlusser & De Meur, 2009). The number of participants was limited due to the exploratory nature of the study and its aim to determine future research directions. This method would suit a wider study, making use of the method and survey tools developed in this study.

SQIDs can improve waterway health outcomes. This is conditional on improvement of governance and other decision-making frameworks affecting the owners and managers of these devices. If local councils choose to continue requiring SQIDs on private property they must focus on both the social and technical aspects of policy. This includes

improvements to the transfer of information to new and subsequent owners of the devices and engaging in ongoing educational and compliance activities to motivate, support and where necessary enforce through regulation the maintenance of SQIDs. It is important that SQID implementation, education and compliance programs implemented by progressive councils such as Blacktown City Council and Mid Coast Council in NSW are evaluated.

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APPENDIX ONE: CONDITION ASSESSMENT SCORES

RAINGARDENS	Condition	Multiplier	P1 (front)	P1 (rear)	P2 (front)	P2 (rear)	P3 (front)	P3 (rear)	P4 (front)	P4 (rear)	P5 (front)	P5 (rear)
Device altered from design	Removed	0	0	0	0	0	0	0	0	0	0	0
	Changed so limited or no function	1	1	1	0	0	0	1	1	1	0	0
	Changed but functional	2	0	0	0	1	0	0	0	0	1	1
	As designed	3	0	0	1	0	1	0	0	0	0	0
	Score Altered		1	1	3	2	3	1	1	1	2	2
Objects in device that aren't part of design (e.g. Pots)	Not assessable or N/A	0	0	1	0	0	0	0	0	1	0	0
	Function restricted	1	1	0	0	1	0	1	1	0	0	0
	Some impact	2	0	0	1	0	1	0	0	0	1	1
	No objects present	3	0	0	0	0	0	0	0	0	0	0
	Score Objects		1	0	2	1	2	1	1	0	2	2
Broken structure e.g. Walls or damage from cars	Not assessable	0	1	1	0	0	0	0	0	1	0	0
	Limits function	1	0	0	0	0	0	1	0	0	0	0
	Still functional	2	0	0	0	0	0	0	0	0	0	0
	Unaffected	3	0	0	1	1	1	0	1	0	1	1
	Score Broken		0	0	3	3	3	1	3	0	3	3
Scour	Covered	0	1	1	0	0	0	0	1	1	1	0
	Water restricted to one channel	1	0	0	0	0	0	0	0	0	0	0
	Multiple small scour channels	2	0	0	0	0	0	0	0	0	0	0
	No Scour	3	0	0	1	1	1	1	0	0	0	1
	Score Scour		0	0	3	3	3	3	0	0	0	3
Sediment slugs	Covered	0	1	1	0	0	0	0	1	1	0	0
	Large area limited function	1	0	0	0	0	0	0	0	0	0	0
	Small area	2	0	0	0	0	0	0	0	0	0	0
	None visible	3	0	0	1	1	1	1	0	0	1	1
	Score Sediment		0	0	3	3	3	3	0	0	3	3
Water pooling on surface	Covered	0	1	1	0	0	0	0	1	1	0	0
	Pooled water not draining	1	0	0	0	0	0	0	0	0	0	0

RAINGARDENS	Condition	Multiplier	P1 (front)	P1 (rear)	P2 (front)	P2 (rear)	P3 (front)	P3 (rear)	P4 (front)	P4 (rear)	P5 (front)	P5 (rear)
	No water or draining appropriately	3	0	0	1	1	1	1	0	0	1	1
	Score Water		0	0	3	3	3	3	0	0	3	3
Vegetation cover 6-8/sqm	None/ bare	0	0	1	0	0	0	1	1	1	0	0
	One tree/weeds 25% cover	1	1	0	0	0	0	0	0	0	0	0
	50% cover or thin/ patchy	2	0	0	0	0	0	0	0	0	1	0
	75% or more cover, even spread	3	0	0	1	1	1	0	0	0	0	1
	Score Veg Cover		1	0	3	3	3	0	0	0	2	3
Vegetation condition	None/ dead	0	0	1	0	0	0	1	1	1	0	0
	Unhealthy/ weedy	1	0	0	0	0	0	0	0	0	0	0
	Some unhealthy	2	0	0	0	0	0	0	0	0	0	0
	Healthy	3	1	0	1	1	1	0	0	0	1	1
	Score Veg Condition		3	0	3	3	3	0	0	0	3	3
Unsuitable vegetation e.g. Annuals	None	0	0	1	0	0	0	1	1	1	0	0
	Unsuitable	1	1	0	0	0	0	0	0	0	0	0
	Mixed	2	0	0	0	1	0	0	0	0	1	1
	Appropriate	3	0	0	1	0	1	0	0	0	0	0
	Score Unsuitable Veg		1	0	3	2	3	0	0	0	2	2
Litter	Litter present or Covered	0	1	1	0	0	0	0	1	1	0	0
	Not present	3	0	0	1	1	1	1	0	0	1	1
	Score Litter		0	0	3	3	3	3	0	0	3	3
Faults: odorous, turbid, discoloured, stagnant, mosquitoes	Covered	0	1	1	0	0	0	0	1	1	0	0
	2 or more faults	1	0	0	0	0	0	0	0	0	0	0
	1 fault	2	0	0	0	0	0	0	0	0	0	0
	Clear/good	3	0	0	1	1	1	1	0	0	1	1
	Score Faults		0	0	3	3	3	3	0	0	3	3
Response	Complete replacement	0	0	0	0	0	0	1	0	0	0	0
	Rectification	1	1	1	0	0	0	0	1	1	0	0
	Maintenance/ clean	2	0	0	0	1	0	0	0	0	1	1
	Routine	3	0	0	1	0	1	0	0	0	0	0
	Score Response		1	1	3	2	3	0	1	1	2	2
	SCORE	36	8	2	35	31	35	18	6	2	28	32
	Adjusted to %		2	6	97	86	97	50	17	6	78	89

SWALES	Condition	Multiplier	CT-L 1	CT-L 2	CT-S
Device altered from design	Removed	0	0	0	0
	Changed so limited or no function	1	0	0	0
	Changed but functional	2	0	1	0
	As designed	3	1	0	1
	Score Altered		3	2	3
Objects in device	Covered	0	0	0	0
	Function restricted	1	0	0	0
	Some impact	2	0	1	0
	No objects present	3	1	0	1
	Score Objects		3	2	3
Broken structure	Covered	0	0	0	0
	Limits function	1	0	0	0
	Still functional	2	1	1	0
	Unaffected	3	0	0	1
	Score Broken		2	2	3
Scour	Covered	0	0	0	0
	Water restricted to one channel	1	0	0	0
	Multiple small scour channels	2	1	1	0
	No Scour	3	0	0	1
	Score Scour		2	2	3
Sediment slugs	Covered	0	0	0	0
	Large area limited function	1	0	0	0
	Small area	2	1	1	0
	None visible	3	0	0	1
	Score Sediment		2	2	3
Water pooling on surface	Covered	0	0	0	0
	Pooled water not draining	1	1	1	0
	No water or draining appropriately	3	0	0	1
	Score Water		1	1	3
Vegetation cover 6-8/sqm	None/ bare	0	0	0	0
	One tree/weeds 25% cover	1	1	1	0
	50% cover or thin/ patchy	2	0	0	1
	75% or more cover, even spread	3	0	0	0
	Score Veg Cover		1	1	2
Vegetation condition	None/ dead	0	0	0	0
	Unhealthy/ weedy	1	0	0	1
	Some unhealthy	2	1	1	0
	Healthy	3	0	0	0
	Score Veg Condition		2	2	1
Unsuitable vegetation	None	0	0	0	0
	Unsuitable	1	0	0	0
	Mixed	2	0	1	1
	Appropriate	3	1	0	0
	Score Unsuitable Veg		3	2	2
Litter	Litter present or Covered	0	0	0	0
	Not present	3	1	1	1
	Score Litter		3	3	3
Faults: odorous, discoloured, turbid, stagnant, mosquitoes	Covered	0	0	0	0
	2 or more faults	1	0	0	0
	1 fault	2	0	0	0
	Clear/good	3	1	1	1
	Score Faults		3	3	3
Response	Complete replacement	0	0	0	0
	Rectification	1	1	1	0
	Maintenance/ clean	2	0	0	1
	Routine	3	0	0	0
	Score Response		1	1	2
	SCORE	36	26	23	31
	Adjusted to %		72	64	86

PONDS	Condition	Multiplier	C-Main	C-Other	CT-L 1	CT-L 2
Device altered from design	Removed	0	0	0	0	0
	Changed so limited or no function	1	0	0	0	0
	Changed but functional	2	0	0	0	0
	As designed or improved	3	1	1	1	1
	Score Altered		3	3	3	3
Broken structure e.g. Walls or damage from cars	Limits function	1	0	0	0	0
	Still functional	2	0	0	0	0
	Unaffected	3	1	1	1	1
	Score Broken		3	3	3	3
Condition of mechanical equipment	Non-operational	0	0	0	0	1
	Operational and serviced or N/A	1	1	1	1	0
	Score Mech Equipment		1	1	1	0
Collapsed, buried or blocked inlet or outlet pipe	Fully blocked	0	0	0	0	0
	Partially blocked	1	0	0	0	0
	Clear	3	1	1	1	1
	Score Pipes		3	3	3	3
Sediment Slugs	Large area limited function	1	0	0	0	0
	Small area	2	1	0	1	1
	None visible	3	0	1	0	0
	Score Sediment		2	3	2	2
Edge vegetation	None/weeds	0	0	0	0	0
	Patchy and/not weedy	1	0	0	1	0
	50% cover, few weeds	2	0	0	0	1
	75% cover, few weeds	3	1	1	0	0
	Score Edge Veg		3	3	1	2
Vegetation cover in macrophyte zone	None	0	0	0	0	0
	Patchy, 25% cover	1	0	0	1	0
	Moderate, 50% cover or 100% thick cover	2	1	0	0	1
	75% cover, even spread	3	0	1	0	0
	Score Macrophyte Veg Cover		2	3	1	2
Vegetation condition in macrophyte zone	None/ dead	0	0	0	0	0
	Unhealthy/ weedy	1	1	0	1	1
	Some unhealthy	2	0	1	0	0
	Healthy	3	0	0	0	0
	Score Macrophyte Condition		1	2	1	1
Surface algae (scum)	More than 50% cover	0	0	0	1	0
	Less than 50% cover	1	0	0	0	0
	Limited/patchy cover	2	0	0	0	1
	Not present	3	1	1	0	0
	Score Surface Algae		3	3	0	2
Filamentous algae	More than 50% cover	0	0	0	0	0
	Less than 50% cover	1	0	0	1	1
	Limited/patchy cover	2	0	1	0	0
	Not present	3	1	0	0	0
	Score Filamentous Algae		3	2	1	1
Water weed	More than 50% cover	0	0	0	0	0
	Less than 50% cover	1	1	0	0	0
	Limited/patchy cover	2	0	1	1	1
	Not present	3	0	0	0	0
	Score Water Weed		1	2	2	2
Litter	Present	0	1	0	0	0
	Not present	3	0	1	1	1
	Score Litter		0	3	3	3
Faults: standing water, odorous, turbid, discoloured, stagnant, mosquitoes	2 or more faults	1	0	0	1	0

PONDS	Condition	Multiplier	C-Main	C-Other	CT-L 1	CT-L 2
	1 fault	2	0	0	0	1
	Clear/good	3	1	1	0	0
	Score Faults		3	3	1	2
Response	Complete replacement	0	0	0	0	0
	Rectification	1	1	0	1	1
	Maintenance/ clean	2	0	1	0	0
	Routine	3	0	0	0	0
	Score Response		1	2	1	1
	SCORE	40	29	36	23	27
	Adjusted %		73	90	58	68

APPENDIX TWO: QUANTITATIVE SCORING OF QUALITATIVE GOVERNANCE DATA

Theme > Function	CA	CA Justify (St-water & Catchment)	CF	CF Justify (Compliance)	CG	CG Justify (Engineers)
Responsibility > Defined roles & responsibilities	0.7	Duplication of roles between stormwater and parks teams. Sometimes decisions about design or documents aren't communicated to the relevant team. Multiple teams installing and maintaining SQIDs so inconsistent processes and unclear responsibility. Sometimes important process steps are missed. Despite this, usually known which team looks after a particular device? Also deal with private certifiers that they can't control as easily. Poor understanding of ownership of some devices (Council and private).	0.7	Unclear lines of responsibility as depends on stage of development who responds to an issue. Various legislation can be used, so they go on a best fit basis, which changes who deals with it. Unclear on delegations under the Conveyancing Act.	1	They had no doubt on allocation of responsibilities they were associated with.
Asset Management > Handover	0.7	Robust and recognised process but sometimes not applied, or applied well, particularly when SQIDs are built by teams that will not manage the operation of the devices (e.g. major projects). No process for private devices or to ensure residents get an appropriate handover. Legacy issues with devices that weren't handed over means for some SQIDs don't know location or don't have plans or operation manuals.	0.7	Conditions of consent sometimes poorly written and open to interpretation. Compliance not consulted about processes to ensure private ownership will deliver outcomes. When early work not done well, compliance difficult.	0.7	Maintenance manuals don't always cover all the necessary information, such as the intent of the device. Recognised that there was very little handover for private owners. Good communication between engineers and future Council asset owners.
Asset Management > Scheduling & Prioritisation	0.5	Know how to do it and have aspirational goals but limited by resources. At the moment GPTs, trash racks etc. are cleaned based on recommended frequencies, not by optimal frequency and not by priority. Vegetated devices are only maintained when resources allow. Many need maintenance. SQIDs not on register don't get maintained. Environmental data to prioritise SQIDs not well coordinated. Some reactive maintenance. Much better record on grey infrastructure than green.	0	Very resources poor, so compliance action only in response to complaints. Many competing priorities.	0.5	Perhaps don't always think through the best setup during construction to ensure future scheduling and prioritisation is appropriate, e.g. thorough maintenance manuals. Sometimes sufficient that documents aiding these decisions are submitted by developers.
Asset Management > Records	0.7	Where assets are on the register, particularly more recent ones, very good records and record system. Recognised that some devices not on the asset register. No register for private SQIDs. Can be difficult to find the records needed e.g. original plans and what targets the SQID was designed to meet.	1	High level of record keeping due to accountability and legal requirements.	0.7	Haven't thought through how best to manage records. They're obtained, but a report may be required to Council and then gets lost in the system. Relying on the records unit.
Asset Management > Life cycle planning/ risk management	1	Budget set aside, assets depreciated (that are on the register). Good process. Sufficient backing to renew a SQID on a reactive basis if necessary. Have conducted audits at times to review process.	1	Engage private owners to achieve rectification before using fines, focus on fixing the problem.	0.7	Good planning for council-owned devices but haven't thought about how private devices might best be managed long term and making sure steps in place to replace other than section 88B instrument.

Theme > Function	CA	CA Justify (St-water & Catchment)	CF	CF Justify (Compliance)	CG	CG Justify (Engineers)
Capacity > Resources	0.7	Regular mention of needing more people and time, and while funding was mentioned as an issue; it was also considered that funds were available for replacement and if there were any issues. An element of needing to 'catch up' due to legacy management.	0	Complete inability to address compliance needs related to auditing SQIDs and ensuring compliance. Large compliance load with many other priorities and SQIDs not seen as a priority.	1	This team raised no issues with resources
Capacity > Seek help and learn	0.7	Understood capabilities of each team and when they were lacking, good communication with other teams in Council and comfortable seeking external help. Strong on procurement. Noted that other teams should be coming to them for advice and didn't e.g. Parks and Major Projects and felt this had led to unnecessary failures. Good access to training for those with SQIDs as their primary role, but other managers not a priority. Not proactive in seeking training.	1	Relied on other teams to provide the expertise they didn't have. Demonstrated ability to seek help They regularly receive training and were keen for more.	0.7	Other teams come to them for advice and they provided examples of going to other teams for their expertise. They had received training but didn't think it was sufficient as they felt they weren't keeping up with the rapidly changing technology of water management and SQIDs.
Awareness > Location of SQIDs	0.7	This score was given because they knew the location of most of their SQIDs (and all new ones from previous three years) and vaguely knew of others. They have a process to 'find' assets. They admitted to some legacy issues and that they didn't know where private SQIDs were, but had the records to find them.	0.7	Only had knowledge of SQIDs they had to deal with directly for compliance reasons.	0.7	Could only relate to SQIDs for which they had been responsible for DA, certification or issues.
Awareness > Function of SQID/s	0.7	While they understood what they should know, they acknowledged significant gaps in their understanding of what all their SQIDs were designed to achieve and had done no performance monitoring. Some of this due to transfer from Major Projects team. Also acknowledged that DA conditions didn't ensure new private owners understood function.	0.7	Their understanding came from a different context. They knew about SQIDs because wetlands are used for on-site wastewater systems so understood the concepts, and expressed some gaps in knowing the function of devices they had to deal with for compliance reasons.	0.7	While the information was always in the DA documents, which are publically available, they agreed that this information wasn't always passed on to new owners in a useful form e.g. with the maintenance manual.
Awareness > How to maintain SQIDs	0.8	Generally competent particularly with GPTs etc., but less confident with vegetated devices beyond landscaping. Some older devices had no operation manual. Felt field civil staff had poor knowledge, particularly in differentiating good vegetation from weeds and how to remove sediment. More about having staff that do civil and those that do landscaping and don't have teams that combine knowledge. Main weakness was in drainage media - understanding how maintenance helped the device work. Parks had switched SQIDs back to gardens to make them easier to maintain.	0.8	General understanding of how the systems worked and what might be required but no specific knowledge and not confident in providing advice.	1	Expressed confidence in how to maintain SQIDs. Involved with the preparation of maintenance manuals and certifying devices.

Theme > Function	CA	CA Justify (St-water & Catchment)	CF	CF Justify (Compliance)	CG	CG Justify (Engineers)
Awareness > Legal obligations	0.8	Good understanding of legal instruments and legislation. Recognised gaps in their education of private owners. Sometimes gaps in understanding of legal position e.g. responsibility for maintenance when Council drainage enters private device (although they have a legal team to provide assistance). No asset register of private devices to chase compliance.	0.8	Felt that conditions of consent were sometimes written poorly. Understood obligations (even if they didn't have time to meet them). Some confusion over Conveyancing Act and enforcing positive covenants.	0.8	Good understanding as this team establishes the legal restrictions during Das. Not clear on responsibilities/powers under Conveyancing Act.
Awareness > Management responsibility	0.8	Generally good, but some devices under dispute. Sometimes the people that would be managing the device aren't involved in the planning and construction of it, which leads to gaps/ issues with performance.	0.8	Sometimes confusion over whether something has been dedicated to Council or not, or which part of Council is responsible e.g. device in creek area could be stormwater team, or catchments team, or parks if it's in a reserve.	0.8	Acknowledged some confusion in responsibility particularly for community title assets vs Council.
Motivation > Level	0.7	Protection of people and property. Believe the community wants improvement of water quality and obligation to improve public health. Amenity. Standard service provided by Councils now. Also mentioned cost, resources for maintenance and conflicting priorities with other capital projects that have more visible benefits. Heavily influenced by community priorities. Some educational value esp. from nets at beach outlets. Recognised importance of them working so people don't become disillusioned with them.	0.3	Noted need for more land, that they don't work that well, reference to people possibly improving the value of their property by removing them, legal expense for property owners to establish legal restrictions. Don't achieve big enough outcomes to get the attention of Councillors/ funding. A nuisance for private owners. But noted that the environment was a high priority.	0.7	Didn't talk a lot about motivation, regarded the provision of SQIDs as something they had to oversee. Not negative though.

Theme > Function	CTJ	CTJ Justify (Owner's Corporation)	CTL	CTL Justify (Property Manager)	CTM	CTM Justify (Developer & OwCo)
Responsibility > Defined roles & responsibilities	0.7	Council look after some things on the estate and not others, which creates confusion, plus felt that Council should be responsible for some things. Confident in their role and division of responsibility between the committee and the property manager.	1	Understood own responsibility and that of the committee.	0.7	His role as developer and member of the committee that doesn't make decisions, just provides assistance, is clear to him but confusing to others. Because of knowledge and experience, has potential to undermine committee decisions.
Asset Management > Handover	0.5	Change in developers meant that later houses didn't connect to stormwater according to original plan. Limited records due to change in developers AND strata company.	0.5	Lack of appropriate documents. Estate went through three developers, and several property managers too. No handover from previous manager.	1	Developer involved in estate. Meets with every property owner when they move in and provides them with an extensive guide to their SQIDs and their legal responsibilities. Also provides guidance later on when they have questions. Owns property there so intends to stay involved for the long term. Provides plans and all other relevant docs to chairman of committee. Recognised that sales and agents probably didn't tell the owners much.

Theme > Function	CTJ	CTJ Justify (Owner's Corporation)	CTL	CTL Justify (Property Manager)	CTM	CTM Justify (Developer & OwCo)
Asset Management > Scheduling & Prioritisation	0.5	Landscapers remove weed and algae from surface of ponds six-monthly. Also weed swales. GPTs reactive, also reactive maintenance when issues with odour.	0.5	Reactive when there's a problem. Maintenance is discussed regularly.	1	Said they cleaned every two years, and landscaper cleans out bio-retention swale every year. Regularly maintained.
Asset Management > Records	0.3	Knowledge of records was limited. Said they lacked plans. Weren't familiar with the community management statement because they 'know what they are doing', but also said records is what they pay their property manager for.	0.7	No detailed plans. Assets are added to a register as plans are obtained, so improving. Minutes of all committee decisions and managed by property manager.	1	Developer involved so has ensured the committee have all relevant plans and docs.
Asset Management > Life cycle planning/ risk management	0.3	Good sinking fund but no understanding of what might be required in the long term for the SQIDs. Want to be prepared though.	0.3	Good sinking fund, some plans, confident that a special levy would be successful due to large size of estate.	0.3	Sinking fund, but under stress as operational funds poorly managed. Financial records lucky to be checked by committee once a year even though received every month. No long term plan for assets. Property manager just sacked due to poor performance.
Capacity > Resources	0.7	Raised costs as a hurdle as they were anxious to retain a buffer of funds. Situation has improved since developers gone, as developer kept levies low as they didn't want to contribute. Committee felt property manager was short on time. Committee happy to contribute time.	0.7	Felt the estate was well-resourced and had a dedicated committee, but raised that additional levies would be met with resistance from the residents.	0.3	Scheme relies on private individuals to contribute time to the management of communal land and they don't have the time e.g. only check financial reports once a year.
Capacity > Seek help and learn	0.7	Extensive internal network, have found contractors e.g. engineers and landscapers through estate members. Landscaping company manager lives on estate. Established contacts at Council, but still haven't been able to resolve issues like lack of plans. No training provided - skills are gained through experience.	0.7	Property manager has approached Council with varied success, usually just through the service desk. Don't receive training, just learn on the job. Experienced property manager though, including with community title estates, so understood obligations. Poor knowledge of SQIDs.	0.7	Residents either come to developer or committee for advice. Usually seek help internally. Landscaper through internal connection. Capable people on committee but limited knowledge of managing SQIDs and legal requirements. No training and unlikely to take it up.
Awareness > Location of SQIDs	1	Due to intervention in previous years the committee knew the location of all SQIDs.	0.4	Wasn't able to name all SQIDs on the estate.	1	Involved with construction and could name all SQIDs
Awareness > Function of SQID/s	0.7	Vague understanding of the role of all the SQIDs, but didn't specifically talk about pollutants.	0.3	Aware of estate's responsibilities that included maintaining the SQIDs he was aware of.	0.7	Thought the function of the raingardens wouldn't be reduced too much if they were covered with decks as the rain would still get through, but did recognise the plants had a function.
Awareness > How to maintain SQIDs	0.8	Knew a little about the right sort of vegetation in the ponds and that the GPTs needed clearing, but sometimes got tasks confused and uncertain of some requirements.	0.8	Knew to keep ponds clear of weeds, check stormwater flows and make sure no pollutants enter. Once prompted on presence of GPTs, knew they needed clearing regularly.	0.8	Pretty good understanding of maintenance, including vacuum cleaning of GPTs, but only mentioned landscaping rather than clearing filter media.
Awareness > Legal obligations	0.5	Some recall, but not familiar. None had recently looked at the community management statement or title documents they received when they bought into the estate. Also not all clear on set up of community	0.8	Reasonable understanding. Understood obligations as property manager, and obligations of committee to carry out maintenance.	1	Understood obligations, despite thinking that Council wouldn't chase them up. Reminds residents on regular basis but said they would still push the limits.

Theme > Function	CTJ	CTJ Justify (Owner's Corporation)	CTL	CTL Justify (Property Manager)	CTM	CTM Justify (Developer & OwCo)
		title vs Torrens.				
Awareness > Management responsibility	0.9	Some disagreement about responsibility with Council and lack records/ resources to find out.	0.9	Some disagreement about responsibility with Council and lack records/ resources to find out.	1	Very clear on resident vs community title vs council responsibilities. Said committee understood too.
Motivation > Level	0.7	Add amenity, integrates development with surrounding bush, work as detention, birds, good for walking, weed and algae and odour are constant issues, costly maintenance and difficult to do as well, perception that Council is abdicating responsibility even though they pay rates, but when they manage themselves they've got more control.	0.5	Poor amenity, smell, scum. Expensive. Property manager so only considered management issues. Wasn't overly negative.	0.5	Contributed to landscaping, rainwater tanks allow for reuse within the house, good for climate change, landscaping contributes to privacy, but expensive to install, residents don't like them because it stops them using their property the way they'd like (space), plus hazard when full

Theme > Function	P1	P1 Justify	P2	P2 Justify	P3	P3 Justify	P4	P4 Justify	P5	P5 Justify
Responsibility > Defined roles & responsibilities	1	Understood own and community title ownership and responsibility	1	Understood own and community title ownership and responsibility	1	Understood own and community title ownership and responsibility	1	Understood own and community title ownership and responsibility	1	Understood own and community title ownership and responsibility
Asset Management > Handover	0.3	Sales guy gave limited information at purchase. Unlikely to execute adequate handover to next buyer due to his level of awareness of the system and the legal instruments. He had also covered it and had no intention of removing the deck or the bins in the future.	0.7	Sales guy gave limited information, but owner had good knowledge of the SQID and intended to keep it. Didn't have a complete knowledge of function and maintenance and didn't know about legal instruments.	0.3	Very limited understanding and claimed they hadn't received a handover at purchase. The raingardens are still there but their ability to handover information and a raingarden in good condition limited.	0	No memory of handover, no knowledge of the raingardens or related documents and both raingardens covered.	1	Had received an excellent handover from the real estate agent, knew they couldn't remove the gardens, knew they needed maintaining and knew what they were for. Also aware of documentation. Could be relied on to handover to next owner.
Asset Management > Scheduling & Prioritisation	0	None, as both raingardens are covered.	0.5	SQID has been incorporated into the garden, so is maintained as a garden when the rest of it is.	0.5	Mentioned maintaining the vegetation in one and keeping the grate clear in the other.	0	None, as both raingardens are covered.	0.5	Maintaining as a garden
Asset Management > Records	0	No records and not familiar with property title.	0.3	Didn't keep records but was familiar with the records for the community such as the community management statement	0	Had no records and was not familiar with title/covenant.	0.3	Had no records but remembered seeing the raingardens on the plans when property bought	0.7	Had the guide for the raingardens and recalled the title had details.

Theme > Function	P1	P1 Justify	P2	P2 Justify	P3	P3 Justify	P4	P4 Justify	P5	P5 Justify
Asset Management > Life cycle planning/ risk management	0.1	Not intending to change own raingardens and unable to see issues as both covered. Understood community committee was responsible for common devices.	0.3	Understood they were responsible for keeping the raingardens there and working and that they paid fees to maintain the common SQIDs, but no evidence of planning.	0.3	Intend to retain the raingardens, even though they think they have negative value. They've altered one to better fit with their needs. Understood the use of the levy.	0	No intention of rectifying the covered raingardens and didn't know there were community SQIDs	0.3	Had no intention of removing the SQIDs and had considered maintenance.
Capacity > Resources	0.7	Gardens were covered but the owner did not raise issues with resources.	1	No constraints with resources mentioned and seemed happy to maintain the garden.	0.7	Pointed out the gardens were hard to maintain and a 'pain' but they are looking after them anyway.	0.7	Gardens were covered but the owner did not raise issues with resources.	1	No issues raised - happy to take on all responsibilities.
Capacity > Seek help and learn	0.4	Knowledge of part of the raingardens function and the role of the community committee suggests they would be able to start seeking help. Had no interest though as raingardens covered.	1	Would contact the developer for help. Was also confident in speaking to the committee.	0.7	Identified the community committee as first port of call for help but said they had no information on the raingardens	0.4	Said they wouldn't seek help, as they had no intention of replacing. Knew about the community committee and had personal contact with one of them, so potentially could seek help.	0.7	Very self-reliant and confident that they would find everything they needed in the property information pack.
Awareness > Location of SQIDs	0.7	Knew about both raingardens, but could only name the OSD. Didn't know about bio-retention, GPT etc.	0.9	Could name everything except the GPT and even knew the creek area was Council's.	0.2	Couldn't identify SQIDs at first, but was able to provide more information once they were pointed out. Only knew about the 'big tank' on common land.	0.2	Was able to recall the builder telling them about the flood controls at purchase after prompting.	0.9	While they could provide detail on their own SQIDs, they were newly moved in and had no knowledge of the community SQIDs, however they intended to go to the next AGM.
Awareness > Function of SQID/s	0.3	Described the raingarden as slowing the water down and filtering into the ground and didn't think covering it impaired its function.	0.7	Mostly described a detention function, but felt that the water soaking in from the garden benefited the plants in it and that keeping the plants health was important for the garden.	0.3	Thought SQIDs were to control the release of water only.	0.3	Little more than a drain with some soak in to reduce flooding	1	Explained full function of raingardens including pollutant removal.
Awareness > How to maintain SQIDs	0.1	Believed the covered gardens were functional.	0.8	Knew the function of the raingarden relied on the plants being healthy, and that drainage was also important.	0.5	Had gone to some lengths to maintain drainage function of rear SQID following alteration, but no plants.	0.1	Had retained for drainage.	1	Understood need to keep clear of sediment and keep plants healthy

Theme > Function	P1	P1 Justify	P2	P2 Justify	P3	P3 Justify	P4	P4 Justify	P5	P5 Justify
Awareness > Legal obligations	0.2	Wasn't aware of details on title documents or positive covenant but concerned about photos and Council finding out	0	Surprised that Council might ask them to fix or replace the raingarden.	0.2	No knowledge but concerned about photos as the rear garden was covered	0	Confused and said they wouldn't want to replace them if Council asked.	0.5	While they weren't able to identify actual restrictions, they knew they weren't able to remove the devices and new they had related documents.
Awareness > Management responsibility	1	Once informed of communal devices, knew committee was responsible for them and understood his own.	1	Knew responsibility for their devices and the community ones, and even the line between community and Council.	1	Understood personal responsibility and purpose of levy.	0.9	Knew the difference between their own and the community SQIDs on prompting.	0.8	Only new to the property. Knew they had responsibility, but didn't know community responsibilities
Motivation > Level	0	Space was a higher priority than the gardens, which were covered. Had no intentions to change the current setup.	1	Felt it added value in terms of flood control and not a problem as they've integrated it with the remaining garden landscaping. Said easier for them as they had more space (larger lot).	0	Despite retaining the gardens and sort of maintaining them, felt they had a negative impact on property value and were a waste of space. Didn't think Council would have a good reason for asking them to fix the SQIDs so legal compliance also not a motivating factor.	0	Raingardens detracted from property, took space, smelt damp, and provided habitat for snakes.	0.5	Neutral. Thought the SQIDs were pleasant to look at but took too much space

Theme > Function	CA	CF	CG	CTJ	CTL	CTM	P1	P2	P3	P4	P5
SCORES											
Responsibility (out of 1)	0.7	0.7	1.0	0.7	1.0	0.7	1.0	1.0	1.0	1.0	1.0
Asset Management (out of 4)	2.9	2.7	2.6	1.6	2.0	3.3	0.4	1.8	1.1	0.3	2.5
Capacity (out of 2)	1.4	1.0	1.7	1.4	1.4	1.0	1.1	2.0	1.4	1.1	1.7
Awareness (out of 5)	3.8	3.8	4.0	3.9	3.2	4.5	2.3	3.4	2.2	1.5	4.2
Motivation (out of 1)	0.7	0.3	0.7	0.7	0.5	0.5	0.0	1.0	0.0	0.0	0.5
SCORES adjusted out of 1											
Responsibility	0.7	0.7	1.0	0.7	1.0	0.7	1.0	1.0	1.0	1.0	1.0
Asset Management	0.7	0.7	0.7	0.4	0.5	0.8	0.1	0.5	0.3	0.1	0.6
Capacity	0.7	0.5	0.9	0.7	0.7	0.5	0.6	1.0	0.7	0.6	0.9
Awareness	0.8	0.8	0.8	0.8	0.6	0.9	0.5	0.7	0.4	0.3	0.8
Motivation	0.7	0.3	0.7	0.7	0.5	0.5	0.0	1.0	0.0	0.0	0.5

APPENDIX THREE: ETHICS APPROVAL

Appendix 3 of this thesis has been removed as it may contain sensitive/confidential content