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Impediments to Integrated Urban Stormwater Management: The Need for Institutional Reform

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ABSTRACT / It is now well established that the traditional practice of urban stormwater management contributes to the degradation of receiving waterways, and this practice was more recently critiqued for facilitating the wastage of a valuable water resource. However, despite significant advances in alternative ''integrated urban stormwater management'' techniques and processes over the last 20 years, wide-scale implementation has been limited. This problem is indicative of broader institutional impediments that are beyond current concerns of strengthening technological and planning process expertise. Presented here is an analysis of the institutionalization of urban stormwater management across Sydney with the objective of scoping institutional impediments to more sustainable management approaches. The analysis reveals that the inertia with the public administration of urban stormwater inherently privileges and perpetuates traditional stormwater management practices at implementation. This inertia is characterized by historically entrained forms of technocratic institutional power and expertise, values and leadership, and structure and jurisdiction posing significant impediments to change and the realization of integrated urban stormwater management. These insights strongly point to the need for institutional change specifically directed at fostering horizontal integration of the various functions of the existing administrative regime. This would need to be underpinned with capacity-building interventions targeted at enabling a learning culture that values integration and participatory decision making. These insights also provide guideposts for assessing the institutional and capacity development needs for improving urban water management practices in other contexts.

It is now well established that urban stormwater contributes to the degradation of urban waterway environments through adversely changing stream flow regimes, water quality, and aquatic ecosystem habitat (Wong and others 2000, Roesner and others 2001). The traditional design of urban stormwater drainage systems is directed at managing stormwater to minimize the risks associated with flooding in urban environments, which also perpetuates the waste of a potentially valuable and typically overlooked domestic and industrial water resource (Niemczynowicz 1999). Consequently, this traditional practice is increasingly considered out of touch with the environmental values of society and impedes the broader pursuit of advancing more sustainable urban environments (Thomas and others 1997, Newman and Kenworthy 1999, Wong and Eadie 2000).

Since the 1980s, there has been significant development of new management techniques and approaches to improve the sustainability of urban stormwater environments (Niemczynowicz 1999, Burkhard and others 2000). This has resulted in the design, testing, and scientific verification of a host of different stormwater improvement techniques for both retrofitting of existing urban areas and new development areas. These have been codified into a range of government and professional association guidance documents (see, for example, WEF 1998). Given the current availability of technological ingenuity and demonstrated reliability of a host of interventions, there still remains limited wide-scale implementation for advancing ''integrated urban stormwater management'' (IUSM).

The proposition that the current organizational administration of urban stormwater management is the most significant impediment to enabling the implementation of IUSM has been informed by experiential evidence from water managers working in the industry, as reported in Brown and Ball (1999), Brown and Ryan (2000), and Brown (2003). It has also been grounded by broader commentary that argues that when integrated environmental management approaches are superimposed onto conventional administrative regimes, there will inevitably be a number of administrative impediments. These typically include issues

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related to jurisdictional and institutional fragmentation resulting in overlapping and often undefined responsibilities between numerous organizations, followed by lack of organizational commitment to changing implementation practices (see, for example, Burby and May 1998, Cortner and others 1998, Danter and others 2000, Margerum 2001).

Increasingly, commentators highlight that the organizational administration of IUSM is yet the most challenging dimension to practical realization (such as Tyson and others 1993, Geiger and Hofius 1996, Lawrence and others 1999, Brown 2003). However, this is not to suggest that this change has not been attempted in practice. On the contrary, there have been a number of innovative programs proposed. However, as argued by Marsalek and others (2001) and Brown (2003), they have not been the subject of systematic research with the explicit agenda of advancing knowledge on how to institutionalize IUSM.

This paper presents a structured analytical assessment of the institutionalization of urban stormwater management over the last century across Metropolitan Sydney in an attempt to scope the administrative impediments to enabling the practice of IUSM. These results are intended to inform improved administrative practice and guide a new institutional focus in contemporary urban stormwater management and related water research areas.

Integrated Urban Stormwater Management

IUSM is a management concept that has evolved over the last 20 to 30 years largely in response to the knowledge that the rapid conveyance of urban stormwater led to the environmental degradation of receiving waterways (Wong and Eadie 2000). It has more recently been influenced by the growing interest in ''integrated urban water management'' and the idea that urban stormwater could provide a valuable water resource. Overall, it is a concept concerned with enabling more sustainable management of urban stormwater environments. However, the significance of IUSM does vary between places attracting more attention in places such as Australia, New Zealand, and many parts of the United States because the stormwater drainage network is typically separate system from the wastewater network, unlike many places across Europe.

Drawing from ongoing commentary over the last decade, both Lawrence and others (1999) and Chocat and others (2001) prepared position papers outlining expanded goals for the sustainable management of urban stormwater reflecting values of water conservation, pollution prevention, and ecological restoration. These need to be considered within initiatives such as demand management, cleaner production, and education interventions for reducing water consumption and pollution prevention at the outset. Goals for IUSM include (Chocat and others 2001, p. 63):

- *Flood reduction*—minimizing peak stormwater discharges from urban catchments
- *Pollution minimization*—by preventing, collecting, and/or managing pollution loads
- *Stormwater retention*—harvest and beneficial reuse of rainwater and stormwater runoff within or near the urban catchment
- *Urban landscape improvement*—showing rather than hiding water by functionally incorporating stormwater into urban streetscapes and green areas, and
- *Reduction of drainage investments*—innovative integration of stormwater systems into the urban environment for reducing the cost of infrastructure.

Therefore, harvesting and reusing rainwater and stormwater runoff locally in addition to reducing stormwater pollution for protection of the urban water environment are equally integral to the flood protection focus of IUSM initiatives. However, these are not always synergistic due to the historically separated administration of flood management, water quality management, urban design, and environmental protection (Brown 2003). Therefore, the need for intersectoral collaboration, involving stakeholder engagement and community participation in decision making, is typically advocated as important (see, for example, WEF 1998, Marsalek and others 2001), which is also reflective of the earlier integrated catchment management philosophy (Margerum 1999).

The Research Approach: A New Institutional Analysis

This case study of urban stormwater management across Metropolitan Sydney applies institutional theory as an analytic approach that considers the historical, context-rich, and practice-based perspective for revealing how patterns of organized action are shaped and institutionalized over time. Although there are numerous experts and commentators contributing to institutionalism (see, for example, Zucker 1988, Powell and Di Maggio 1991, Scott 1995), others have demonstrated the value of applying the institutional perspective to land-use planning and environmental management cases (such as Healey 1998, Lowndes 2001, and Motte 2001).

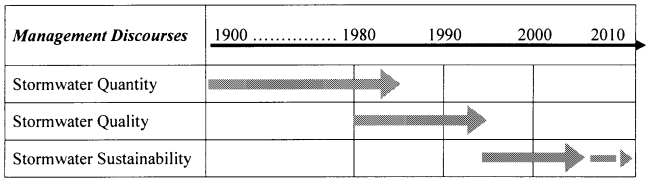

Figure 1. Prominent urban stormwater management discourses over the twentieth century.

Here the focus is on the extent of the institutionalisation of the three prominent urban stormwater management discourses, as shown in Figure 1, experienced across Metropolitan Sydney over the twentieth century. As discussed by Brown (2003), modern cities such as Sydney experienced the dominant "stormwater quantity" discourse well into the 1980s, with best thinking focused on optimizing the drainage infrastructure design for efficient flood protection. The "stormwater quality" discourse, focused on pollution control and waterway quality, evolved throughout the 1980s into the 1990s. The current "stormwater sustainability" discourse, presented earlier as IUSM, has largely evolved since the early 1990s.

This analysis was conducted through an extensive content analysis of local policy and industry literature and over 60 interviews with industry experts, local government engineers, and state regulatory officers. Scott's (1995) institutional approach, as shown in Table 1, was the analytical framework applied and proposes that there are three mutually dependent dimensions that enable and/or constrain an institutionalized practice that include "best practice thinking" (or cognitive), "social values" (or normative), and "organizational administration" (or regulative). "Best practice thinking" represents the dominant shared meaning and purpose of the practice. It explains the knowledge frameworks considered legitimate to shape the problem definition and corresponding action, which may be expressed through the "organizational administration" in a number of forms such as technologies, planning processes, organizational structures, policies, and laws. The "social values" represents the dominant shared values of the practice including the social norms of what are considered the appropriate processes or modes of action for pursuing these shared values. It explains how values and norms structure choices and organized actions. The "organizational administration" of the practice includes the implicit and explicit rules and sanctions. It explains how the implementation of the practice is organized around what are considered appropriate ways, reflecting "best practice thinking" for pursuing the dominant social values.

Case Study: Implementation of Urban Stormwater Management

Metropolitan Sydney Case Context

The bulk of Sydney's separate stormwater drainage system was constructed during the twentieth century. This principally involved the conversion of natural watercourses into stone- or concrete-lined stormwater channels and pipes (the trunk system) followed by the periodic and haphazard connection of a large system of local feeder drains (the local system) as new urban areas progressively expanded and developed. The purpose was to constrict floodplain areas by ensuring rapid and efficient conveyance of surface waters and stormwater runoff to enable ongoing urban land development (Aird 1961).

Local government, as the local land-use regulator, has traditionally had the long-standing and leading role in the provision of drainage infrastructure and services across Metropolitan Sydney (O'Loughlin 1994). The administrative areas of the 44 local government organizations (subject to amalgamations) are geographically bounded by historically defined political jurisdictions that are fragmented over an average of three stormwater catchment areas (NSW EPA 1998) and are often shared with adjacent local government organizations. State agencies are largely responsible for the remaining infrastructure that often straddles and traverses various sections of the local drainage system. *Sydney Water Corporation* is the most significant State manager responsible for the bulk of the trunk drainage system. Less significantly, the *Roads and Traffic Authority* and *State Rail* are responsible for managing any drainage infrastructure located within their infrastructure corridors (Engineers Australia 2003).

The estimated depreciated value of the stormwater drainage assets within Metropolitan Sydney have been estimated in excess of $3 billion, which excludes the land and environmental value of stormwater channels and urban creeks (Sharpin 2004). These assets comprise (Doswett 1994):

- approximately 20,000 km of local feeder stormwater drains,
- over 350 km of large stormwater trunk drains,

Table 1. Scott's (1995) institutional approach for explaining social practices

Dimension of institutions	Description	Explanatory power
Cognitive (knowledge)	• Shared meaning/purpose	Expressed through technologies, planning processes, organizational structures, policies, laws etc
	• Knowledge frameworks considered legitimate to shape problem definition/solutions	
Normative (values)	• Shared values and expectations	How values and expectations structure choices/organized actions
	• Social actions (norms) considered appropriate for pursuing objectives	
Regulative (administration)	• Rules and sanctions	How practice is organized according to what are considered appropriate actions to pursue shared values
	• Organizational forms	

- over 3000 formal storm sewer overflow points to harbors and river systems, and
- over 200 stormwater outlets that directly discharge onto ocean beaches.

The Sydney context is reasonably representative of contemporary urban stormwater trends and issues experienced across a number of modern cities, particularly for places with separate stormwater and wastewater drainage infrastructure (Brown 2003). Parts of Sydney's current drainage system provide inadequate flood protection for storm events larger than a one in 2-year annual recurrence interval storm, resulting in flooding and property damage (McManus 1996, Engineers Australia 2003). This lack of capacity has been exacerbated through urban development encroaching on floodplain areas, reflecting a lack of foresight for protecting these areas from increased exposure to flooding risk when upstream areas were developed (USPTF 1993).

Sydney's drainage contributes to the degradation of waterways through the transportation of polluted urban stormwater and storm sewer overflows, resulting in a number of observed adverse impacts on the waterway environment. These include: the sedimentation of waterways; algal blooms and excessive growth of aquatic weeds; reduction in the diversity of aquatic flora and fauna; increasing population of less desirable species of aquatic life; and overall reduction in waterway and foreshore amenity (McManus and Barter 2000).

Engineers Australia (2003) has concluded that Sydney's stormwater infrastructure is in a disturbing state and requiring immediate attention owing to inadequate capacity to cope with significant rain events, and with stormwater discharges not meeting desirable water quality and pollution standards (EA 2003, vi). Addressing these pressing issues is compounded by the complexity of the ownership and responsibility for stormwater assets and management arrangements. The institutionalization of IUSM principles and practices is essential for addressing many of these issues.

Stormwater Quantity Discourse

Until the late nineteenth century, the dominant focus was maintaining "public health" through sanitation with the construction of the first combined (wastewater and stormwater) drainage system between 1852 and 1890 (Aird 1961). Stormwater runoff was considered important to the extent it affected the hydraulic capacities required of sewers. By 1890, a separate stormwater system was initiated because the combined system could accommodate the demands of rapid urban development (Aird 1961). Because it was assumed that urban stormwater runoff was environmentally benign, the design and construction of the separate stormwater system was relegated to providing economically efficient conveyance of urban stormwater to meet flood protection objectives. Urban drainage was clearly the lowest profile water governance issue compared with water supply and wastewater (Aird 1961).

Until the 1980s, the community perceived urban stormwater as a public flooding nuisance with negligible social or ecological value (Wong and Eadie 2000). It has attracted such a low profile that local government only began determining the extent of the stormwater infrastructure within their boundaries for management studies and establishment of asset registers in the late 1990s and early 2000 (McManus and Barter 2000, Engineers Australia 2004). This is in stark comparison to the level of local organizational infor-

mation to what have been perceived as ''mainstream'' activities of local government, including road building, land development, and waste management (Dollery and Marshall 1997). The design and construction of stormwater drainage systems typically occurred as incidental or additional ''engineering works'' associated with road design and property subdivision. Therefore, the role of urban stormwater management (drainage) was typically allocated to a junior civil engineer located in the ''engineering'' department of local government (Brown and others 2001).

Given the low status afforded to urban stormwater, combined with rapid urban development and urban consolidation, the augmentation of the existing drainage system and poor maintenance practices resulted in increasing flooding problems. As a consequence, the common approach has been to increase local drainage capacity, which invariably led to the ''passing of the flooding problem'' to downstream areas outside of the municipal jurisdiction to another. Robinson and O'Loughlin (1999) also note how the period up to the 1980s marked an informal assumption by government engineers that best practice was to export flooding problems downstream and let downstream land users deal with them as they could.

This augmentation activity led to the development of specialized technical expertise, which adapted an economic-risk approach to urban drainage design, by a small and highly skilled research community. With the lack of community interest, stormwater quantity management was dominated by expert groupings of stormwater engineers including academic hydrologists and technical government officials largely in local government organizations often convened by the Institution of Engineers Australia as the primary technical society for sharing and developing urban stormwater management knowledge in the industry (Brown 2003).

Over much of the twentieth century, expertise was dedicated to improving the technical design and local optimization aspects of urban stormwater drainage infrastructure. Vicar's (1911 and 1914 as cited in Robinson and O'Loughlin 1999) provided the first Australian source of drainage infrastructure design information based on local rainfall data, the first empirical alternative to the UK design guides adapted for the Sydney context. Following this, the engineering profession primarily concentrated on empirically improving this work through collecting representative local data and applying rainfall and stormwater runoff estimation techniques to continuously inform and refine the design of more economically efficient drainage systems for flood control. From the 1970s, the sophistication of this economic-risk optimization approach was significantly enhanced with the development of an ongoing series of hydraulic and hydrologic computer software programs that improved the power of the rainfall-runoff estimations and subsequent design size of the stormwater drainage infrastructure. The Institution of Engineers Australia in the *Australian Rainfall and Runoff* series codified these ongoing developments for stormwater management practice first in 1958 and later updated in 1977, 1987, and 1999.

Stormwater Quality Discourse

The 1980s was a period of significant change in observed community values and best practice thinking, with the quality of urban stormwater gaining both international and local attention, directly challenging the assumption that urban stormwater runoff is environmentally benign. Although it is difficult to characterize the relationship between the changes in best practice thinking and community values, there appears to have been a synergistic shift, which mutually stimulated change in both of these dimensions.

Water quality and waterway pollution became an increasingly high profile public issue, with regular local and national media commentary during the 1980s. The community observed and was outraged by the visible sewer pollution on high profile beaches such as Bondi Beach from sewer overflows during storm events. This led to almost a quarter of a million people gathering on Bondi Beach in 1989 for a protest rally condemning the government for the pollution of Sydney's waterways (see Beder 1989 for an in depth analysis of this issue). Public concern was further exacerbated by a number of blue–green algal outbreaks in Sydney's Hawkesbury-Nepean River system in the early 1990s. These incidents, at this stage, were still largely perceived as a wastewater management issue, with the urban stormwater system receiving far less attention.

It was not until the early 1990s that urban stormwater was identified more broadly in the public realm as an equally significant part of the problem. This was partly informed by the outcomes of the launch of the now highly successful ''Clean-up Australia Campaign.'' This community volunteer program involved collecting and removing litter in and around Sydney Harbor. The first clean-up day, now an annual event, resulted in the collection of over 10,000 tons of rubbish from around Sydney Harbor (McManus 1996). It was soon publicly concluded that it was the stormwater drainage system that was transporting this rubbish and polluting Sydney's harbor and waterways.

Internationally, there was increasing expert evidence, particularly from North America, that the quality of urban stormwater is linked to adverse impacts on the waterway environment. These insights were adapted to inform local engineering research revealing that Sydney's urban stormwater contains high pollutant concentrations (see Cordery 1976 for the first Australian empirical investigation). This led to a flurry of local research into the design and development of stormwater quality pollution control technologies that could be fitted into the existing drainage infrastructure, now referred to as ''end-of-pipe'' solutions.

This first included gross pollution trap infrastructure that trapped pollutants such as gross solids (litter), organics (leaves and grass clippings), and heavy sediments flowing through the existing stormwater drainage system, which then need to be periodically cleaned and contents disposed at local landfills (see, for example, Allison and others 1998). These research activities have also led to the development of a significant private sector industry in the design, construction and maintenance of gross pollutant traps for stormwater quality treatment.

There was also another concurrent flurry of research into the use of constructed wetlands for stormwater quality treatment based on diverting stormwater runoff from the drainage system to wetlands for biological uptake and treatment of the pollutants (see, for example, Wong and others 1999). However, the adoption of these systems during this period has proved difficult for urban settings with limited available land space. Today, the outcome of these research activities has allowed these technologies to be adapted into built-up catchments through integration into the urban built form.

In 1989, the then *State Pollution Control Commission* of NSW, predecessor of the *Department of Environment and Conservation*, produced the first local stormwater management guidance manual encouraging local government to consider adopting stormwater quality controls to capture and remove pollution that was flowing through the stormwater drainage system. As discussed by O'Loughlin and Robinson (1999), this was stimulated and informed by the recent implementation and administration of stormwater quality controls in North America and in the Australian capital of Canberra. However, although there was a growing number of State government guidance documents, on-ground implementation of stormwater quality control technologies was, at best, slow and ad-hoc. O'Loughlin (1994) highlights that since the emergence of stormwater pollution as an issue, there has been a sustained reluctance from both local government and *Sydney Water Corporation* to take responsibility for stormwater quality management.

However, this was not the case for the local engineering professional community, which advanced a number of stormwater quality ''forums and meetings'' facilitated by the Institution of Engineers Australia and the Local Government Engineers' Association. O'Loughlin and Robinson (1999) highlight that the existing wave of stormwater quantity engineers strongly resisted advocacy from other engineering specialists in water supply and wastewater treatment areas for being the primary group dealing with stormwater pollution. At this stage there was a distinct lack of recognition that urban stormwater management should also include harvesting and integration into the urban landscape. The establishment of the Australian ''Stormwater Industry Association'' in 1992 soon addressed this activism over which professional group would be the primary caretaker of the urban stormwater quality issue by attracting the bulk of its membership from existing urban stormwater engineering professionals. This was followed by two national conferences on urban stormwater quality management organized by the Institution of Engineers Australia and the Stormwater Industry Association in Sydney in 1992 and Melbourne in 1995 as well as many other less formal technical gatherings.

In the context of institutional resistance and public pressure to address the high profile waterway pollution issues, *Sydney Water Corporation* commissioned a high profile engineering consultancy to conduct a technical assessment of pollution loads entering Sydney's waterways from treated sewerage effluents, sewer overflows, stormwater, and rainfall. The results of this investigation revealed that a large proportion of the pollution was caused by urban stormwater (CWP 1992). Sydney Water soon announced that half of the waterway pollution problem was a local government responsibility (O'Loughlin 1994).

Also during this period, there were a number of social attitude research programs implemented for determining community environmental values. In 1991, 64% of the sampled community in New South Wales stated that ocean pollution and/or freshwater pollution was the environmental issue of greatest concern (ABS 1993). Sydney Water also conducted a number of community surveys between 1991 and 1994, and generally found that the issue of ''protecting waterway health'' was ranked as the most important value (as reported in Dowsett 1994). Overall, the results of various social research interventions confirmed that, by the early to mid-1990s, protecting the health of

the waterway environment was a significantly important issue for the community.

Arising from this highly sensitized context of a mix of high profile algal bloom and beach pollution incidents, public and political announcements, technical studies, and scientific research into pollution control technologies, a State Inquiry was held in 1993 to scrutinize stormwater pollution issues (O'Loughlin 1994). This was facilitated through a special Stormwater Forum that brought together representatives from the community, Federal and State government agencies, local government, business and industry, peak and local nongovernmental green groups, and a number of relevant academics. The clear consensus from the Forum was that the current condition and management of urban stormwater across Sydney was not sustainable and that there were many administrative changes required. "Sustainable development" was reported as the agreed framework for future policy development and for implementing solutions to the current urban stormwater issues (USPTF 1993).

Stormwater Sustainability Discourse

It is difficult to mark a transition and clearly define all the related concurrent drivers to the stormwater sustainability discourse. However, during the 1990s a number of important contextual factors played a role in facilitating the advocacy of IUSM and include:

- increasing social value of waterway amenity and health, and the conservation of water resources
- rapidly evolving international research and best thinking in IUSM, integrated urban water management (IUWM), and ecosystem management approaches
- local urban stormwater policy development and technology codification, and
- political imperative of presenting a "clean Sydney Harbor" for the first green 2000 Olympics.

The NSW Environment Protection Authority's social research program reported in the *Who Cares about the Environment?* series (NSW EPA 1997, 2000, 2003) has continued to demonstrate the community's consistent and significant concern for the health of local waterways and water conservation. More recently water conservation has increased in social value, which can also be linked to the increasing media attention of Sydney's drought condition over the last 3 years. These observations in shifting community values reflect how the urban stormwater environment is an important resource for human and waterway sustainability, with waterways embodying both intrinsic and cultural value within the urban landscape (Lawrence and others 1999).

With the recognition that the existing stormwater system is ecologically unsustainable and no longer economically viable (within the wider context of IUWM), the technical insights from the stormwater quality discourse led almost seamlessly into the mid 1990s discourse for improved technologies for advancing more sustainable management techniques. In Australia, the development of technical expertise with waterway heath, pollution prevention and treatment, and harvesting and reuse aproaches has attracted the label of being an expression of "water sensitive urban design" (Whelans and others 1994, Wong 2001). Much of this is based on the implicit philosophy of managing urban stormwater in a distributed manner throughout the catchment using technologies that are integrated into the built form. The overall approach of Water Sensitive Urban Design necessarily requires and has attracted a broader range of disciplinary expertise that has resulted in an array of technologies and approaches from retrofitting and changing technical infrastructure, improving land-use planning and maintenance, and changing catchment behaviors and activities.

Although the development of IUSM techniques flourished over the last decade, the administration of these approaches has not been widespread. Since the Stormwater Forum in 1993, there have been various evolving forms of State task forces, advisory bodies, and policy groups producing a series of recommendations and strategic policy reports. The most significant outcome of these groups was the recognition of the need for an integrated approach for the administration of urban stormwater management between Sydney Water, local governments, and other relevant state agencies and community groups for sharing responsibility (USPTF 1993, McManus 1996). It was also acknowledged that significant impediments to achieving an integrated approach included (i) the current administrative arrangements; (ii) inadequate funding allocated to urban stormwater management at all levels of government; (iii) fragmented organizational responsibilities; and (iv) an overall lack of legal accountability (CEPA 1993, Sharpin 1996). In 1996 a strategic policy discussion report was released advocating the pursuit of sustainable urban stormwater management through the cooperative preparation of integrated catchment-based stormwater management plans developed by local government organizations (Sharpin 1996).

Since then, there has been significant political and public attention on Sydney offering the "first green" 2000 Olympics, and the amenity and health value of Sydney Harbor and other high profile waterways were

of significant concern. Sydney Water Corporation proposed the construction of a large sewer overflow collection system that was designed to capture and ultimately minimize the number of sewer overflows entering Sydney Harbor (WAP 1997). This proposal met with a number of community opponents concerned that it was a technological fix rather than a sustainable solution. After much debate and review, the NSW Government announced the additional funding of a Stormwater Trust of $60 million, which gave grants to local government for catchment-based planning and capital works for stormwater quality management (WAP 1997, Smith 1998). The State Premier, Mr. Bob Carr, launched this as a "Waterways Package" in May 1997.

In 1998, the now disbanded "Urban Stormwater Program" was formed and administered by the then Environment Protection Authority. This program mainly targeted local government with a strong community mass media education campaign and industry education component. It included a temporary legal regulatory direction, imposed on April 24, 1998, onto local government, Sydney Water, Roads and Traffic Authority and State Rail (Sharpin and others 1999). The directive required the joint preparation of catchment-based stormwater quality management plans detailing the catchment-based stormwater management techniques and processes they were committed to implementing over the next 5 years. The 44 local government organizations led the preparation of a total of 40 catchment-based plans for Metropolitan Sydney. The outcomes of this intervention, as evidenced by evaluation research reported by Brown and Ball (1999), Brown and Ryan (2000), Brown and others (2001), and Brown (2003), demonstrate that the overall outcome, although probably significant in raising broader administrative awareness of stormwater pollution issues, was indeed disappointing in practice.

The Program outcomes were limited to the production of a host of technically elaborate plans largely prepared by engineering consultants on behalf of local government. While the EPA regulators approved the plans, there was limited organizational commitment to implementation and for voluntary continuation of the interorganizational planning process. Although the Program has led to increased awareness of stormwater pollution issues, this has not resulted in a sustained regulatory legacy for sustainable urban stormwater management, but rather resulted in the production of a series of yet to be published information and guidance document packages for local government on the lessons associated with the program.

More recently, an alternative newly amalgamated State government organization, the *Department of Infrastructure, Planning and Natural Resources*, has taken on responsibility for addressing a host of sustainability issues associated with residential developments across New South Wales. This involved the mandatory introduction of a centralized computer-based planning tool in July 2004 (see www.basix.nsw.gov.au) that includes a requirement to achieve 40% reduction in potable water consumption in new and redevelopment projects. This initiative has the potential for advancing the adoption of stormwater retention and harvesting techniques as a water conservation measure.

In summary, the overall administrative expression of the stormwater sustainability discourse to date has been limited to the production of state position papers, social environmental attitudes research, and the implementation of a number of ad-hoc, yet state of the art, demonstration projects. These demonstration projects are based in new development or urban renewal settings and represent various facets of water conservation, stormwater pollution control, and ecological restoration. Some of these projects include the Kogarah Town Square redevelopment (Mouritz 2000), Victoria Park redevelopment (Wong 2004), and Sydney Olympic Park.

Institutionalization of the Management Discourses

The analysis of these evolving management discourses reveals radical change in the cognitive and normative dimensions of the practice of urban stormwater management across Metropolitan Sydney within the constraints of limited change in the regulative dimension. The review of each of the three management discourses, as shown in Table 2, reveals the institutional dominance of the stormwater quantity discourse well into the 1980s. The stormwater quality discourse reveals itself as a transitional management discourse during the 1980s and early 1990s. It served as a change management space for the significant shifts in community values and best practice thinking between the stormwater quantity and the significantly different stormwater sustainability discourse. The level and availability of technological ingenuity with the current stormwater sustainability discourse largely reflect contemporary social environmental values.

The stormwater quantity discourse as the traditional management practice was founded within a stable technocratic institutional form (see Fischer 1990) for the majority of the last century. Urban stormwater was valued as a low priority waste and managed for economically efficient flood protection. A "technical engineering elite", in isolation from external players,

Table 2. Institutional analysis of the Prominent stormwater management discourses

Management discourse	Cognitive (knowledge)	Normative (values)	Regulative (administration)
Stormwater quantity	Flood protection	Low-priority waste Managed for economically efficient flood protection	Monodisciplinary Functional activity Autonomous
Stormwater quality	Flood protection Pollution control	Low Priority Waste Managed for economically efficient flood protection and restoration of intrinsic and aesthetic values of waterways	Monodisciplinary Functional activity Autonomous
Stormwater sustainability	Flood protection Pollution prevention Water conservation Ecological restoration	High-Priority resource	Monodisciplinary Functional activity Autonomous

administered the stormwater system as a subservient functional activity of other broader and well-defined governmental services such as road building and property subdivision. This administration has been mutually constrained by the limited resources made available for the maintenance of stormwater infrastructure, which is also procedurally entrenched in local government operations and maintenance departments (Brown 2003).

The stormwater quality discourse characterizes the significant change in community waterway values as demonstrated through local community activism about polluted waterways within Sydney. Although stormwater was still largely valued as a waste, it was also considered important to restoring and maintaining the intrinsic and amenity value of receiving waterways. This value could be expressed as an aesthetic priority because the community was concerned about visually observed pollution, and led to the development of a host of stormwater pollution control traps and technologies, which were codified into a number of State agency practice guidance documents. With the administration of the environment more generally only being formalized in the late 1980s and early 1990s with a new State environment agency and a handful of local government organizations forming new environment sections, widespread implementation of stormwater quality management practices was not realized.

The stormwater sustainability discourse reflects significant and radical cognitive development with an exponential expansion in technical research and expertise into interventions to make the existing urban stormwater environments more sustainable. This reflects the perceived need to pursue sustainable total water cycle futures encompassing the community values of receiving waterway health, water conservation, flood protection, and pollution prevention. This marks a paradigmatic shift from the conceptualization of the problem from a low-priority issue of delivering efficient stormwater conveyance to a high-priority issue of stormwater being a valuable resource and instrumental to facilitating environmental sustainability. The administration of this discourse has been slow and incremental. The temporary regulatory instrument imposed on local government to enable catchment planning proved overall a disappointment, yet the evidence is clear that at least State level regulators were aware that the current administrative regime was the most significant obstacle to enabling IUSM. Therefore, again implementation has been ad-hoc and largely in the form of information and guidance document packages.

In summary, the institutionalization of both the stormwater quality and stormwater sustainability discourses has been significant from a cognitive and normative perspective. However, there has been minimal change in the regulative pillar supporting stormwater management practice. The analysis has served to reveal how well the stormwater quantity discourse is fundamentally embedded into the administrative context by inherently privileging and perpetuating unsustainable management solutions based around stormwater drainage objectives. The analysis clearly demonstrates that the implementation problem is the result of administrative inertia.

As discussed by Scott (1995), the depth of the institutionalization of a social practice is measured by its degree of inherent stability. Therefore, the analysis of current impediments to the institutionalization of the stormwater sustainability discourse needs to

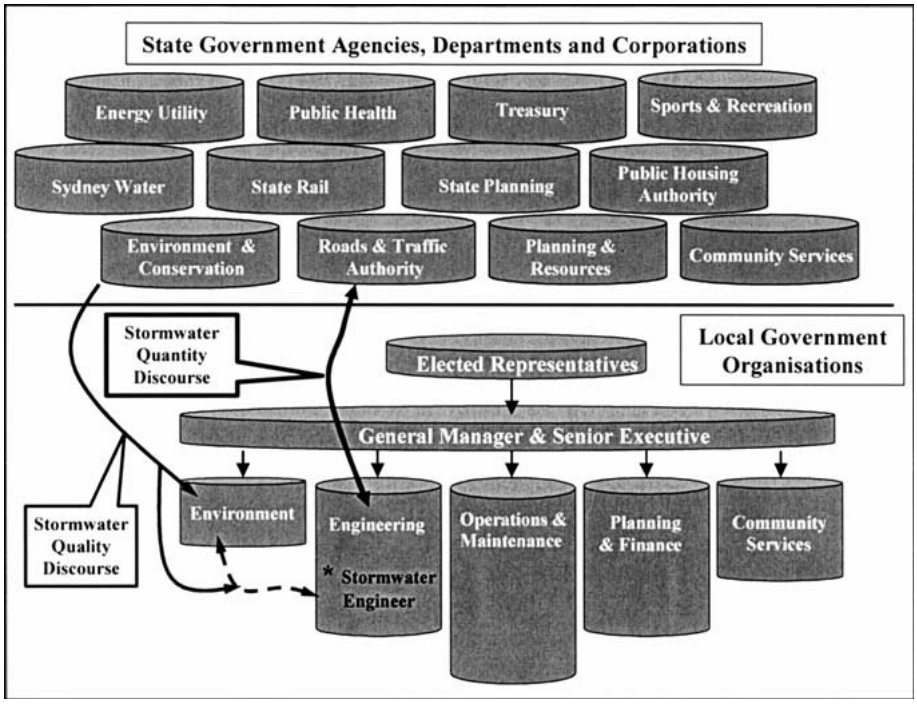

Figure 2. Simple representation of typical division, functional structure, and stormwater relationships.

encompass a more detailed review of the organizational administrative context to identify and characterize these inherent impediments.

Considering the Organizational Implementation Dilemma

From an institutional perspective, it is essential that the organizational administrative context is conducive to assimilation of the advanced cognitive and normative positions supporting the implementation of IUSM. Recognizing that the implementation problem is located within the administrative context is not novel. Local commentators such as Dowsett (1994), McManus (1996), Sharpin (1996), and Brown (2003) have reported that the current administration of urban stormwater management reflects an overlapping web of responsibility between local government and various state government organizations, characterized by conflict, overlapping accountability, complicated legislative context, and inadequate management and funding for sustainable stormwater management. This is certainly confirmed for the case of Metropolitan Sydney, particularly when superimposing ecosystem-based thinking on the current administrative arrangements.

Shown in the top half of Figure 2 is a typical representation of the numerous state agencies, departments, and corporations, and the bottom half presents the typical departmental structure of the 44 local government organizations. This structured pattern of environmental administration broadly reflects a technocentric administrative ideology where the environment is conceptualized as a machine with technically efficient State departments and organizations representing functionally based services and systems such as roads, water supply, wastewater collection, treatment and disposal, energy and communication utilities, public housing, and land-use planning. Local government, as the traditional implementation arm and top-down recipient of State policy, reflects the technocentric division through its functional silos (departments) of the State's environmental administration. This inherently facilitates strong vertical relationships between the sectoral spheres of government, resulting in interacting professional communities dominating sectoral processes (vertical relationships) rather than collaborative administration across and within the silos of local and state government departments (horizontal relationships).

The stormwater quantity discourse fitted seamlessly within the technocratic administrative regime. As a low-priority, expert-driven and subservient technical activity to road building and subdivisions, attention was largely limited to the engineering department of local government operating autonomously under the relevant regulatory requirements of the State Roads and Traffic Authority. The main concern is with sectoral planning and reductionist analysis. With the rise of

Table 3. Organizational Administrative Impediments to IUSM Implementation

Organizational administration	Dominant factors of the IUSM implementation dilemma
Power and expertise	Dominance of technical engineering knowledge Technical expert decision and policy making Stable knowledge/power relationship — threatened if shared Goal of technically simplifying complex urban water issues
Values and leadership	Stormwater as a low political priority, subservient to higher profile functions Economic efficiency high priority Distinct lack of leadership and/or stated vision for a sustainable water future Local government priorities on residential services and road maintenance Lack of institutional funding for stormwater management
Structure and jurisdiction	Technocrats removed from working with communities Functional state departments and agencies operating in isolation Numerous organizations with unclear responsibilities Top-down intergovernmental relationship between State and Local organizations Political rather than physical ecological boundaries for local administration

modern environmentalism, NSW along with other developed nations and states formed new environment departments within different levels of government. This reflects the inertia of the administrative system with the environment conceptualized as an add-on to the existing functional and largely autonomous organizational activities of governments. The stormwater quality discourse was expressed through the new State environment agency, which attempted to impose environmental management and planning regulations on local government for stormwater pollution control. However, there was much confusion over whether this was a job for the stormwater engineer or the new local environmental manager (Brown 2003). Nonetheless, while awareness may have been raised, a change in implementation practice was limited, with traditional stormwater quantity management practices prevailing.

The sustainable stormwater discourse poses the most significant challenge to the administrative context (Tyson and others 1993, Geiger and Hofius 1996, Brown 2003). This is because it requires a new form of governance facilitating integrated solutions and knowledge partnerships (Maksimovic and Tejada-Guibert 2001, Brown 2003). Vlachos and Braga (2001), Marsalek and others (2001), and Brown (2003) advocate that IUSM requires participatory, interdisciplinary, inter- and intraorganizational approaches within an adaptive management framework. For IUSM to be advanced, governance must be collaborative, adopting a holistic approach by including participation of community and all other stakeholders, comprising local and regional authorities, employers, environmentalists, decision-makers, politicians, and academics in the catchment management process (Vlahos and Braga, 2001; Marsalek and others, 2001). In sum, governance needs to be cross-sectoral, cross-organizational in the vertical and horizontal dimensions of government and nongovernment organizations. This is notably absent within the current organizational administrative context of urban stormwater management across Metropolitan Sydney.

As presented in Table 3, the organizational administrative impediments to enabling the implementation practice of IUSM can be typified into the characteristics relating to technocratic power and expertise, values and leadership, and structure and jurisdiction. From the outset, the technocratic structure of the administrative regime inherently privileges technical expertise and economic rationalism over an interdisciplinary alternative that values community participation in decision making and environmental sustainability. With sustainability necessitating a broader knowledge and skill base, this also challenges the traditional administrative domain of the established stormwater engineering community. These engineers have been responsible for providing a level of service that communities have learned to expect in terms of reliability and quality of water resources, flood protection and recently, protection of the amenity of local waterways. This reorientation attracts the implication of sharing of expertise status and the potential redirection of scare resources elsewhere. Given this, it is clear that an administrative regime that promotes a learning environment facilitating multidirectional information exchange is required whereby the public and various disciplinary technical experts gain broader understanding of the totality of factors involved. This is likely to be essential in dismantling institutional barriers and creating relationships, while fostering community support where there are conflicting societal goals.

Contemporary bureaucratic culture around urban stormwater management lacks high-level bureaucratic

and political support for change towards sustainability. While political leaders may have signed up to a vision of sustainability, the impediment appears to be the lack of executive bureaucratic leadership in implementation. This combined with the limited parameters of decision-makers' knowledge and bureaucratic inability to deal with competing interests, together with the electoral demands faced by politicians, further entrenches the institutional inertia. The inability to transform means the technocratic/expert-driven approach to policy and devising solutions to water issues continue to be the norm.

Conclusion

From the analysis, the current institutional framework, intergovernmental relations, entrenched implementation processes, and historical low political profile of urban stormwater are revealed as barriers to IUSM. These insights clearly point to the need for a redesign of the administrative regime from government as a structured organization to governance as a process where participation from different social groups, agencies, and sectors is linked, yet not restricted by similar organizational rules. A key ingredient to a successful reform to a governance approach include capacity building specifically directed at fostering horizontal integration of the various functions of the existing administrative regime underpinned by a learning culture that values integration and participatory decision making. By default, a participatory decision-making process will necessitate an adaptive approach to implementation. However, it is also envisaged that this process of destabilisation of the status quo will inevitably create a politically charged environment with the necessary renegotiation of relationships and resources.

This paper also contributes to the development of an overall conceptual approach for advancing future research activity on improving organizational administration that enables the institutionalization of IUSM. It has served to both confirm and contextualize the current implementation problem. Future research focused on mapping approaches that enable the practice of more sustainable urban stormwater management should be concerned with questions on how to best transform institutions. This review supports the broader integrated environmental management discourse by proposing that IUSM can only be fully realized in practice when the administrative regime reflects the intra- and interorganizational, interdisciplinary, catchment-based, and valued resource view of stormwater. However, the question remains as to what intervention pathway needs to be followed to get there. The research supports the hypothesis that a successful administrative regime would reflect the anthesis of the stormwater quantity discourse. Therefore, the form, culture, and operating context would be the literal opposite to a mono-disciplinary, functional-based activity carried out by organizations acting largely autonomously.

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