Peter Davies has worked in state and local government, as a consultant and university researcher. He is currently working for Ku-ring-gai Council as manager of catchments and sustainability, is an associate with the Centre for Local Government at the University of Technology Sydney and principal of Davies Consulting. Holding degrees in environmental science and law he has also co-authored two books and written numerous papers on environmental and catchment management, contracting and law for local government. In 2003 Peter was one of two Australians nominated to attend a United Nations Environment Program workshop in Japan on environmental education to develop management systems for the local environment. Peter is currently developing with the Department of Environment and Conservation an integrated decision making process to aid sustainable catchment management for local government.
INTEGRATED STORMWATER PLANNING

Peter Davies
Ku-ring-gai Council
Gordon & Richard McManus
Ecological Engineering

ABSTRACT

Integrated stormwater management planning is required to effectively manage catchment processes from a risk, community, environmental and economic perspective. The tools used by state and local government land managers to undertake this task must draw from a range of disciplines that are both robust and inclusive to ensure issues of governance, awareness and technology can satisfy the complementary and completing demands and values.

As part of a Stage 5 Strategic Grant from the NSW Stormwater Trust a new planning process for stormwater management is being developed. The project will prepare a 'second generation' stormwater planning manual that integrates the assessment of physical parameters of quality and quantity, and stream health to deliver holistic stormwater management solutions.

The project has drawn on existing frameworks and systems such as the NSW Floodplain Management Manual, NSW EPA stormwater management manual and other tools currently in development as part of the Stormwater Trust program.

Introduction

The consequence of poor stormwater quality have been of concern for the last 30 years. Beaches and waterways have been unsuitable for primary and secondary contact recreation due to stormwater and sewage pollution, creeks have become degraded, native bushland has been encroached by weeds, flooding continues to impact on property and natural areas and presently, the drought has heightened our need to conserve and reuse water.

The traditional response to these pressures has been through ad hoc planning dealing with single issues with little integration and appreciation of the urban water cycle. This has been reinforced by existing funding programs that focus on flood risk management to alleviate threats to life and property, and to a lesser extent on improving stormwater quality and bushland. Not surprisingly, the many state government agencies and local government departments that manage the various elements of the urban water cycle operate within their separate domains resulting in the inefficient use and management of water.

Our need to manage the consequence of declining quality and availability of water and impacts during flooding is recognised at the local to the international level. How and when we choose to address the various pressures and factors contributing to these will depend on the ability and willingness of individuals, organisations, specialists, politicians and communities to embrace an integrated approach.
Background

Local councils have a number of plans, policies and manuals that provide instruction and direction on the management of the urban water cycle. The manuals themselves are often produced by different state and local government departments and organisations with limited coordination and consistency.

The management of flooding is governed by the NSW Government Floodplain Management Manual, which provides for the development of sustainable strategies for managing human occupation and use of the floodplain from within a risk management hierarchy covering avoidance, minimisation and mitigation works. The manual focuses on flooding and reducing the flood risks within developed, potential developing areas and other lands. The manual makes reference to, and depending on circumstances, recommends that river and floodplain ecology, threatened species, Aboriginal sites and other ‘complementary issues’ be incorporated into the flood mitigation program. However the intent of the plan is targeted towards large and infrequent flood events and localised flooding.

Catchment Blueprints are designed to integrate water and land management within larger water-shed catchments across the State. These blueprints have been developed by the Department of Infrastructure, Planning and Natural Resources (DIPNR) who are also in the process of finalising the building sustainability index (BASIX) that will set minimum performance standards for new development across the State in relation to water and energy efficiency.

Stormwater quality is addressed via the catchment based stormwater management plans, as prepared by local government under direction from the Department of Environment and Conservation (DEC) (previously NSW Environment Protection Authority). The process for these plans is defined within the Managing Urban Stormwater: Council handbook. More recently many local councils are implementing their own guidelines and policies to couple stormwater quality within the broader concept of water sensitive urban design. The primary goal of the stormwater management plans is "to facilitate the coordinated management of stormwater within a catchment to maximise ecological sustainability and the social and economic benefits of sound stormwater management practices."

DEC is currently undertaking a review of its Managing Urban Stormwater series of documents. The original SMPs were designed to force planning, communication and management across councils and within and between other state government agencies on a catchment basis.

An evaluation of the stormwater management planning process in 1999 found that:

- implementation of the plans has been largely limited to projects funded by the Stormwater Trust due to a lack of council resources to fund the 'full' implementation program.
- community engagement in the planning process was very unsuccessful resulting in the plans not truly representing local values.
- there is a need to build on and improve the horizontal and vertical flow of information and skills across council structures.
- the focus of the stormwater management plans on quality was too narrow and needs to be integrated with quantity, runoff from non-urban areas and other environmental planning processes imposed on councils by the State Government.
To contextualise the development of a new planning framework interviews were undertaken with forty (40) councils in the Sydney region to determine the inadequacies and constraints to integrating stormwater quality and quantity. Not surprisingly council staff reported that communication within their organisation and the pathways for information exchange were not well developed and structures and accountabilities were not conducive to multi-disciplinary approaches (details of the results of the survey can be found in Appendix 1).

More recent discussions with some active councils showed that they are attempting to develop their own multi-disciplinary approaches to urban water management. Interviews with these officers also identified that council expectations are not being fully met as their staff and/or consultants struggle to fully understand the roles and priorities of the physical parameters (such as water quality, flood risk, riparian health, condition of the drainage infrastructure) and how to objectively evaluate potential treatment options against catchment objectives and targets.

**New planning approach**

This project is assisting the DEC and NSW Government Stormwater Trust to develop a second generation integrated stormwater management plan. The plan seeks to integrate stormwater engineering, flooding and risk management and environmental protection within the expectations of the community and other stakeholders, the capacity of local government and other land and water managers and within the context of state policy and planning instruments.

Fundamental to the success of the new planning approach is the need to ensure:

- the adoption of a multi-disciplinary within an environmentally sustainable framework
- a manageable process with appropriate information inputs
- an acknowledgment for the need to compromise around the integrity and validity of information to meet agreed visions and objectives
- that the process is as objective and rigorous as possible
- the process is just that a means to an end and should be flexible and adaptive as required and
- the need for continual improvement.

A key element to this process is the recognition that the impacts of rain have different implications on the physical, social and economic environment. Unlike existing plans this approach will plan for three categories within the hydrologic spectrum (frequent rain, infrequent storms and manor flooding storms) as illustrated in Figure 1. This is a significant departure from existing planning processes and it is intended that management outcomes will consider the benefits and impacts on each of the rain events within the catchment and sub-catchment. Under the proposed planning framework actions to address flooding must also consider other factors such as the health of the receiving water body, its surrounding natural or modified vegetation, current and future land use, social values and expectations, the ability of local government to maintain the proposed works and whether the project is moving towards achieving the adopted vision of the catchment.
The planning framework

A five step process has been developed that will form the framework for a new planning process:
1. context mapping
2. objective setting
3. option evaluation and alternative analysis
4. integrated strategy
5. adaptive management

The proposed steps and actions within the planning framework are described in the following sections.

Step 1 Context mapping

Context mapping is a high level assessment of the state of the physical, social, organisational, political and planning frameworks that influence integrated decision making and the management of stormwater. It serves to provide a snapshot of the existing and relatively attainable information that then informs opportunities, constraints, strengths and gaps. As part of this process there is a need to understand why the plan is being prepared in the first instance and what political interest or support exists. Information inputs are shown in Figure 2.
Information assisting the planning process is proposed to be divided into three categories based on the complexity, time and cost it takes to collect: tier 1 high order that can be collected in a matter of days; tier 2 detailed site investigation, modelling, surveys etc that would take week; and tier 3 thorough investigation aimed at determining the answer to a specific questions that are not answered through a tier 2 data collection process (refer to Figure 3).

Figure 3 Knowledge hierarchy
To facilitate a multidisciplinary approach, all information inputs to the tier 1 data gathering is required. Once collected a context map would be prepared to provide an analysis on factors affecting the management of the catchment. Outcomes would include, but not be limited to providing a:

- description of the physical and social catchment
- capability of the organisation
- purpose of the plan and associated political support
- condition and issues
- gaps and opportunities.

The language used in the context map must be clear to the general community as well as informing specialists as to condition and information needs that may be required in more detailed investigations within the catchment to inform good decision making.

**Step 2 objective setting**

The setting of objective for a catchment is an iterative process that is informed by three processes (refer to Figure 4):

1. ideals as set by policy, legislation or scientific community
2. values and expectations of the community, organisation, government and others
3. reality check against what can be delivered with the desired planning horizons of the plan, objective backcasting

The ideal objectives would relate to defined values set by the scientific community and relevant government agencies dealing with the physical, economic and social health of the catchment. Within the aquatic environment values would be set for water quality (such as National Water Quality Management Strategy\* and objectives arising from specific investigations commissioned under the Stormwater Trust\*)**, flooding and risk (New South Wales Government Flood Prone Land Policy) and others.

This process would be establishing the short, medium and long term vision for the catchment, referencing the organisation, residents, businesses, government and non-government authorities and others. Informing this process would be the context map providing the basis of knowledge across the areas affecting catchment health.

Knowing the 'ideals' and stakeholder visions it is necessary to establish realistic planning objectives at the catchment and sub-catchment scale, the target condition. This would be informed by past, present and future trends related to the environment, organisational, technological, planning social and political aspects. 'Backcasting' the objectives against what is and could be achievable is necessary to ensure the bar is not unattainable yet provides the capacity of stakeholders to stretch towards their goals through targeted and pro-active programs.
Step 3 Option evaluation

This step involves a high degree of interaction between steps 1 and 2 to determine through trial and analysis how various options may affect the objectives and targets which have been established. The framework for evaluating options will be based on economic, environment and social costs and benefits, which are currently being developed by the Stormwater Trust.

Critical to the evaluation of options is the need to ensure that frequent rain, infrequent storms and manor flooding storms are considered at the site, sub-catchment and catchment scale. This approach follows from the process developed by British Columbia Ministry of Water, Land and Air Protection and Environment Canada, as illustrated in Figure 5. This stage may require additional data gathering that may involve Tier 2 or 3 analysis or investigations to provide sufficient details. Decisions on what additional information to collect will depend on the data gaps, needs, resources and importance now and in the future.
Figure 5 Relating objects to rainfall

Step 4 Integrated strategy

The strategy will integrate all relevant interactions effecting the water cycle to aid resource management now and into the future. A triple bottom line decision tool will seek to provide the relative cost and benefit from an economic, social and environmental perspective. A separate consultancy will be issued by the Department of Environment and Conservation to assist in the development of this tool.

The strategy must also identify existing document and other plans that relate to the outcomes sought by the integrated stormwater plan. Some of this will have reference to the policy and planning context mapping undertaken in Step 1. For example council’s social plan, state of the environment report, management plan, long term financial plan, plans of management for park and reserves, the local environment plan (LEP), development control plans (DCP), place based master plans, section 94 contributions plan, special rate variations, minutes and recommendations of formal and informal advisory committees of Council, threatened species management plan, Floodplain management plans, Catchment Blue Prints.

Step 5 Adaptive management

The Strategy will be developed within an adaptive planning framework, including:

- **Implementation** - Actions to have pre determined evaluation processes by which to measure success against the criteria that the works were prioritised.
- **Monitor** - Monitoring of the outcomes against specific evaluation criteria relating to performance of stormwater management option or ecosystem health improvements.
• Review - Outcomes of actions delivered to be assessed against criteria and option evaluation framework to determine whether they contributed towards meeting the agreed objectives.

The outcomes of actions delivered will be assessed against criteria and option evaluation framework to determine whether they contributed towards meeting the agreed objectives. Consideration will be given to scenario planning in context of changing political, economic, social, technical, and environmental circumstances.

Conclusions

Water management planning continues to be dominated by disparate processes that are both placed on and undertaken by council. The development of a new planning framework aims to bring together these disparate processes together to develop a framework that seeks to integrate stormwater engineering, flooding and risk management and environmental protection within the expectations of the community and other stakeholders, the capacity of local government and other land and water managers and within the context of state policy and planning instruments. An important component to this outcome is the need for case studies that demonstrate examples of integrated decision making. These will be sought and are invited from local government and others to assist in the development and contextualisation of the planning framework.
Appendix 1 Review of the stormwater quality and quantity management and planning - Ecological Engineering

Limitations with current Stormwater Quality and Quantity Approaches

For both the design and implementation of stormwater quality and quantity, funding was identified as the main limiting factor. Funding was related to limited staff time and resources, and compounded by inexperienced staff, and lack of computer resources. Most councils are unable to undertake a comprehensive assessment of their catchments due to funding issues, and the work that is undertaken is focused on water quality modelling and issues as part of the floodplain management plan, on a case by case bases.

For water quality the main limitations relate to inadequate resources and funding, time, lab costs for samples, and short-term monitoring with no long-term commitment. Infrequent sampling was identified as not giving a true reflection of the environmental condition of waterways, and the ability of water quality to inform any decision making process is compounded by a lack of expertise, reliable data and reliable modelling assessment methods.

As reported in the evaluation of the stormwater management planning process (EPA 2000), it was identified through this survey that stormwater is affected by interdisciplinary silos within council, which create communication barriers, lack of cohesion, lack of accountability and integration, and a dislocation between maintenance and management.

From a technical point of view key questions which remain to be overcome for councils include:

- Flow modelling is based on statistical parameters rather than real storm analysis – issue when assessing stormwater quality and WSUD and the use of a deterministic approach to rain events not stochastic or real data
- Integration of outcome of models to deliver common actions both still in isolation
- Lack of certainty for environmental quality, difficulty with developers as council has no guidelines.
- Councils need actual water quality data via physical, chemical and biological monitoring and to identify the relationships between. This should be then used as baseline data for calibration of models and key performance indicators of aquatic ecosystem health.
- Water quality modelling is not event based, not related to catchment activities up stream, not related to assimilative capacity of the environment, not related to total flow (quantity), not related to actual storm events, does not measure through the catchment to determine where pollution
- Lack of integration between water quality monitoring for reporting (SoE etc) and catchment assessment WQ monitoring is done by environmental standards department. As a result water quality monitoring is not useful or appropriate for catchment management of design purposes or DA assessment.

Integrating Stormwater Quality and Quantity

While it is clear above that there is a lack of integration between council practices in integration of water quality and quantity, most councils (70%) identified that there were positive benefits in integrating water quality and quantity with responses stating that “both aspects are interdependent and need to be considered concurrently”, or it is necessary to “treat both for effective solutions”. The benefits to council of integrating the two included:

- Greater environmental awareness of impacts of works
- Ensure that up and downstream activities are managed consistently and within the capacity of the urban and natural environments.
- Influences concept of stormwater design, hard vs soft etc for more appropriate solutions
- Vital if council are to achieve community values.

While the link between quality and quantity is evident it is seen as complex, and for accurate and reliable modelling, more ‘real’ data is required to ‘prove’ current mitigation techniques.

While it is evident that most councils see benefits in the integration of stormwater quality and quantity, other councils could not see the benefits due to the fact that catchment characteristics whereby the LGA has “very small steep catchments with no major water quantity issues”, or it was not the responsibility of the person within council and so they focus on their own issues. Several councils identified that council has put an emphasis on stormwater flooding control and funds limit the installation of water quality devices which only get put in through external (grant) funding.

While most councils were able to identify a benefit from integrating water quality and quantity it was harder for councils to identify methods or processes for which to integrate the two. Councils noted that it is difficult to combine outcomes / results at an action level, and while some councils could cite possible techniques knowledge to integrated stormwater quality and quantity, the techniques ability to do so is limited. The majority of councils did not know of any such techniques or stated that it is “always a separate issue and treated separately”. From the previous question it can be said that while councils see the benefit of integration they have limited understanding of the processes available.

Council Processes – Consultation between quality and quantity managers on all proposed capital works by each party. Calculations by each respective party are carried out prior to finalisation of detailed design and selection of infrastructure.

Specific material that councils cited as integrating water quality and quantity include MUSIC modelling, WSUD, Council documents, and Australian Runoff Quality (IE Aust 2003), with further information available from CRCCH and Universities (such as UTS). While these tools themselves could assist councils in understanding water quality they themselves have limited application in actually integrating water quality and quantity. The MUSIC model enables catchment managers to determine the likely water quality emanating from specific catchments (IE Aust 2003), but it has a limited water quantity function. Similarly Australian Runoff Quality is aimed at providing an overview of the current best practice in the management of urban stormwater quality.

Councils limited knowledge on the integration of quality and quantity was confirmed when only a limited number of councils were able to identify practical examples where stormwater quality and quantity have been integrated into existing council practices. Examples given included consultation between quality and quantity managers on all proposed capital works, referencing between works between departments in councils, assessment of suitability of stormwater management options.

**Integrating Stormwater Quality and Quantity into Council’s current stormwater practices**

Specific examples of where councils identified possibilities of integrating stormwater quality and quantity into current practice include: DA assessment, Stormwater Management Planning, new Capital works should prioritise works with greater weighting to those that achieve multiple objectives, at a lot basis with OSD requirements and
stormwater reuse through rainwater tanks requirements, and Stormwater Quality Policy and OSD policy.

Suggested ways to assist councils improve their knowledge on water quality and quantity integration include:

- **Documentation** - Sharing of information, ARR type guidelines, Model DCP, technical manual, training for local govt, officers to gain experience. All documentation should present and promote examples of good working models for Councils to consider, adopt or use as a basis for improved stormwater management.

- **Models** - development of existing models, and ascertain relationships between models of quality and quantity.

- **Processes** - Incorporate stormwater quantity as part of the SMP, Essential tool to have a catchment study on quality and quantity, WSUD at source for all new development have quite an impact in our many residential LGA.

- **Stream Health** - Need to move away from addressing stormwater quality and quantity and refocus on improvements to stream condition and health.

---

**Endnotes**

11. The scale of rain events that affect the key issues as identified is designed to provide some relativity as to how they are perceived and managed under current planning processes. It does not represent limits of influence of rain frequency or duration on the parameters
13. Studies currently commissioned by the NSW Stormwater Trust include the preparation of environmental management objectives for freshwater aquatic ecosystem health; sustainable loads in receiving water (lakes and estuaries); urban stream integrity (stability); and urban bushland, guidelines for water reuse in new urban developments, planning and management of wetlands.
15. Adapted from British Columbia Ministry of Water, Land and Air Protection and Environment Canada (2002) A guidebook for British Columbia - stormwater planning p6-7