30th Hydrology and Water Resources Symposium
4 - 7 December 2006
Launceston, TAS

Experiences in Developing an Upgraded OSD Policy for the City of Wollongong

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Abstract: In 1978 Wollongong City Council commenced development of an OSD Policy for the City. The original policy was implemented in the early 1980s. Over the years this policy was revised several times but remained focused on the control of discharges at a developing site's outlet. In recent years a need for catchment-wide control became apparent, as did a need for more effective control of the design, construction and maintenance of the physical OSD system. This paper describes the experiences of the authors in developing an upgraded OSD policy for the City. It discusses Council's objectives, the subsequent review process, the technical background to the PSD and SSR requirements for the City and the implementation process. It is concluded that to be effective, OSD policies must reflect local objectives and be backed by effective education and maintenance review programs.

Keywords: OSD, Stormwater, Policy, Operation, Maintenance, PSD, SSR

1. INTRODUCTION

The City of Wollongong covers an area of 712 km^2 and is located on the NSW coast some 70 km south of Sydney, on an elongated narrow band of coastal land confined by the Pacific Ocean to the east and the Illawarra escarpment to the west. It has a population of about 200,000 people. Residential development stretches to the north and south of Wollongong's CBD. The climate is temperate with average annual rainfall varying between 1,100-1,400 mm and occurring fairly uniformly throughout the year.

The CBD and residential areas occupy a major proportion of the coastal band of land on which Wollongong is located. This band is aligned in a north-south direction, varying in width from 2km in the north to 10km in the south of the City. The pronounced escarpment rises to a plateau 600m above sea level which produces strong orographic effects for storms moving onshore from the ocean, resulting in very heavy localised rainfalls. Streams in the region run west to east and are short. They are very steep in the upper reaches (20-30%) and become quite flat in the lower reaches (1-2%) as they approach the ocean.

Wollongong City Council was one of the first councils in Australia to implement a policy requiring on-site detention of stormwater for new development to reduce the impact of urbanisation on stormwater runoff. The development of on-site detention to control stormwater from development commenced in 1978. The original policy was introduced in the early 1980s and was based on a simple calculation to determine the required storages. In 1988 Council adopted a revised policy based on the use of triangular hydrographs. This remained the policy until 2006 and applied to all development with the exception of single residential dwellings on individual allotments and additions to dwellings of less than 100 m^2. The objective of this policy was to control stormwater runoff from developing sites such that the peak discharge from the site did not exceed that prior to development, in a 5 year Average Recurrence Interval (ARI) event or greater.

By 1995 it had become evident that there were a number of limitations with the policy as applied at that time. In particular, there were strong concerns that insufficient storage was being provided. This concern arose from the realisation that while peak discharges were not being increased at the site boundary by the policy, it was unknown whether this was the case elsewhere in the catchment. Technical investigations using up-to-date hydrologic models confirmed these potential shortcomings. The only way to overcome this concern was to undertake a catchment wide review of the policy. Other limitations with the policy included;

- all development types were not covered
- lack of design details for the OSD system which led to poor and inconsistent designs
- lack of requirements to ensure that the system was constructed properly; and a
- lack of requirements ensuring that the system would be regularly maintained and

that owners were aware of the presence of the OSD system.

The initial review objective was to determine discharge and storage requirements from a catchment based analysis which would ensure that there would be no increases in peak discharge at all downstream locations. Subsequent objectives included the development of appropriate controls for the design, construction, maintenance and legal protection of the OSD system.

2. THE REVIEW PROCESS

In 1996 Wollongong City Council commenced a review of its on-site detention strategy. Council initially engaged the University of Wollongong to undertake a catchment based analysis under the direction of Associate Professor Michael Boyd. The objective of this work was the determination of permissible site discharges (PSDs) and corresponding site storage requirements (SSRs) which would prevent an increase in peak discharges occurring at any downstream location for a range of events ranging in magnitude from a 5 to 100 year ARI. The scope of this brief also included an investigation into whether there were areas where OSD would not be beneficial.

The runoff routing model, WBNM, developed by Boyd, Rigby and VanDrie[1996] was used in this review. Wollongong has a large number of individual catchments and whilst recognising that each catchment will behave differently, it was concluded that similarly located, shaped and sized catchments would be similar in behaviour. On this basis, separate models were built of four representative catchments.

These four representative catchments varied in location, catchment size and slope, level of existing development and level of potential future development. The program to undertake this study was initially twelve months. However, due to limited resources, delays in the collection of data and time spent in the establishment of an appropriate methodology, this review was not completed until 1999.

The modelling was carried out for a range of recurrence intervals and storm durations. The peak flood discharges were calculated at the outlets of each subcatchment of the four catchments for the corresponding critical storm duration. A base date of 1982 was adopted for the purposes of determining increases in impervious areas, reflecting the time when the original OSD policy was first implemented.

Impervious areas used to represent ultimate development were calculated on the basis of percentage impervious values as shown in Table 1. These were values specified in Council's Drainage Design Code.

Table 1
Maximum Percentage Impervious Area for Each Land Use Zoning

Zone	Description	Impervious Area
2(a)	Low Density Residential Lots	60%
2(b)	Medium Density Residential Lots	80%
2(c)	High Density Residential Lots	90%
3	Commercial Area	100%
4	Industrial Area	100%
5(a)	Special Uses	60%
5(b) & 5(c)	Railways, Main Roads	95%
6(a)	Public Recreation Area	25%
7&8	Environment Protection	5%

This initial study demonstrated that future development would cause flood discharges to increase throughout each catchment. The models were then used to investigate the on-site detention required (in terms of Permissible Site Discharge (PSD) and Site Storage Requirement (SSR)) to achieve effective discharge control throughout the catchments for the full range of recurrence intervals and storm durations. The SSR was determined on the basis that High Early Discharge (HED) pits were to be used. The findings from this study, Boyd [1999] produced results as shown in Table 2.

Table 2
Permissible Site Discharge and Site Storage

Catchment	PSD_{100} (l/s/ha)	SSR_{100} (m3/ha)
Mullet Creek	100	890
Allans Creek	100	890
Fairy Creek	150	790
L.B. Kelly Creek	200	630

3. POLICY AND IMPLEMENTATION ASSESSMENT STUDY

Following completion of the 1999 study, SMEC Australia was engaged to review the existing OSD policy and recommend options for improvement. Areas which particularly required attention included design and construction practice, operation and maintenance and legal protection of OSD systems. Implementation of an effective consultation program to allow for meaningful community input into the process and a review of OSD policies from other councils.

3.1 Community Consultation

Significant time was invested in consulting with various groups to seek their input. Workshops with key stakeholder groups were conducted to inform them of the project, to identify fundamental issues, any controversial issues and any improvements that could be incorporated into the revised policy. These groups included ten Neighbourhood Committees (NC), development industry (DI) representatives and representatives from Wollongong City Council (WCC).

Briefing papers were prepared for each group to generate discussion and quite a number of issues were raised. The major issues raised, SMEC [2000b], during consultation with the separate stakeholder groups are summarised in Table 3. It should be noted that considerable concern was expressed in regards to the size of the storages required, particularly by the development industry.

Table 3
Major Issues Raised During Consultation

Issue	Raised by
OSD part of wider floodplain management plan	WCC
When OSD is required or exempt	WCC, NC, DI
Development approval process	WCC, DI
Design philosophy and criteria	WCC, DI
Storage volumes too high	DI
Construction and Certification	WCC, DI
Covenants	WCC, NC, DI
Maintenance responsibility	WCC, NC, DI
Education	WCC, NC
Reuse of water	WCC, NC

3.2 OSD Policies Of Other Councils

An evaluation the policies of several other Council's OSD policies, in conjunction with a literature review, highlighted a number of design, construction and maintenance issues that needed to be considered in the course of this study. OSD policies from the Upper Parramatta River Catchment Trust (UPRCT), Fairfield City Council, Ryde City Council, Gosford City Council and The Sydney Coastal Councils Group were reviewed. The review was divided into main categories of policy aims, design philosophy, certification and maintenance.

This review showed that these authorities had policies that varied considerably in respect to their approaches to the management of OSD. UPRCT had the most detailed and stringent requirements and it was this model that Wollongong City Council initially adopted as the base for its own strategy, particularly in respect to design philosophy.

3.3 Operational and Maintenance Issues

A major issue facing OSD is maintenance and long term viability. Residents may not be aware of the purpose of the OSD facility and may not maintain it, may fill it in or modify it in such a way that the detention capacity is lost. An investigation was undertaken involving the inspection of a number of OSD systems which were installed under the 1988 policy.

During the inspections it was found that the state of the OSD systems investigated was such that maintenance was generally not being undertaken on a regular basis. The reasons for this lack of maintenance may have included difficulty in accessing the relevant sections of the OSD system, or a lack of awareness of property owners for their responsibility, or need for, regular maintenance. Other common findings included inconsistency in design and lack of consideration of long term maintenance of the systems, during the design and/or construction phase.

Design and construction issues which emerged from these inspections included a wide variety of above and below ground systems with little consistency in design and questionable sizing of system components. It is believed that this was mainly due to the lack of effective design and construction guidelines in the 1988 policy. Other systems inspected revealed that construction was not always undertaken in accordance with approved drawings. The situation found in the field was of concern and steps clearly needed to be taken to address these concerns.

The new 2006 policy, City of Wollongong [2006], now requires maintenance of the OSD system to be considered as part of the design process and a maintenance schedule must be submitted with the Construction Certificate. Design requirements have been included in the 2006 policy covering system elements including storages, grates, orifice plates, overflows and debris control. In regards to ensuring the OSD systems will be constructed in accordance with approved designs, the 2006 policy requires a Certificate of Hydraulic Compliance from the OSD designer certifying the works. It is expected that OSD designers will be reluctant to certify these works if they have not supervised the works during construction.

3.4 Legal and Administrative Issues

The literature review and consultation process identified several issues where legal advice was required to clarify how they should be managed in the new policy. These areas were principally related to construction and maintenance. Legal advice was sought on these matters and the outcomes from the advice which are now requirements in the new policy include:-

- A template developed by SMEC in 2004, for a Certificate of Hydraulic Compliance which requires signature
- A Restriction On Use of Land developed by the City of Wollongong in 2006, to protect OSD systems from future alteration
- A Positive Covenant developed by the City of Wollongong in 2006, requiring the owner of the land to maintain the OSD system

Conditions of consent wording also needed to be made more concise to reduce and/or eliminate potential responsibility by Wollongong City Council for the facilities operation after construction.

Concern was raised by Council's planners and building assessors/inspectors in relation to potential increases in assessment times and resources required to accommodate the new policy. They felt that the inclusion of single dwellings in the policy and the need to also follow up with requests for legal documents from applicants would place additional demands on their time. It was agreed that this aspect would need to be monitored and managed as the Policy matures.

3.5 High Early Discharge (HED) or Standard Storage

Due to an overwhelming response from engineering consultants and developers during the public consultation phase, querying the magnitude of the storages that would be required, it was decided to investigate whether storages could be reduced by the use of standard storages in lieu of the HED outlets proposed. The model was also rebuilt such that flows were routed through the storages as opposed to the earlier analysis which modelled the reduction in peak flows from the individual sites. The resulting PSDs and SSRs are shown in Table 4 below, SMEC[2001].

Table 4
Permissible Site Discharge and Site Storage

Catchment	PSD_{100} (l/s/ha)	SSR_{100} (m3/ha)
Mullet Creek	200	450
Allans Creek	250	500
Fairy Creek	400	450
L.B. Kelly Creek	250	450

A further workshop was held with engineering consultants and developers in February, 2002 to discuss the ammended requirements. Whilst there was a considerable reduction in the storage requirement from the earlier analysis developed in 1999, concern was still expressed regarding the difficulty of implementing such storages and the differences in the underlying objectives and assumptions of Wollongong's policy from those of other Councils.

To ensure all possible options were explored, Council resolved to commission a further review. The brief for this final review was to evaluate all assumptions made in both the Boyd and SMEC modelling and to explore all approaches that might permit the proposed PSD and SSR levels to be further refined.

4.0 TECHNICAL BASIS FOR THE ADOPTED OSD POLICY

4.1 Methodology Generally

In response to this brief, a full review of the technical objectives and the procedures by which PSD and SSR requirements had been derived was undertaken by consultants Forbes Rigby in 2004. In general the methodology adopted involved;

- A review of Council's technical objectives
- A review of the previous methodologies
- A review of 'local' PSD requirements
- A review of 'local' SSR requirements; and
- A review of catchment wide PSD and SSR requirements.

These tasks and their associated findings are described in the following sections.

4.2 Technical Objectives

Several technical objectives directly influence the PSD and SSR levels ultimately required to manage flows from a developing site. These include;

- The base date for the pre-development condition
- The manner in which 'ultimate' development is defined
- The level of control proposed for 'ultimate' development; and
- The hydraulic characteristics of the basin proposed to control discharges

Upon further review, the following technical objectives were adopted;

- A base date of 1982 for existing development (onset of OSD in Wollongong).
- Ultimate development to be defined as all current planning zones fully developed with the sampled percent impervious cover increased by 10% of the difference between Council's lot level values and those sampled
- OSD to ensure discharges anywhere in a catchment do not exceed pre-development levels by more than 5% in events from a 5Yr ARI to a 100Yr ARI
- Basins to be designed such that SSR_5 develops at PSD_5 and SSR_{100} develops at PSD_{100}

While mostly similar to the earlier objectives, the manner in which ultimate development was defined was quite different. This is a major factor in the reductions in OSD ultimately achieved and given its significance, a factor that needs very careful thought.

4.3 Technical Methodology

Earlier investigations, Boyd[1999] and SMEC[2001], had considered the impact of a fixed level of PSD and SSR on post-development discharges using WBNM models of four representative Wollongong catchments. In these earlier reviews, PSD and SSR levels were applied at a fixed rate at the subareal level and adjusted to achieve control of post-development discharges. As summarised in Tables 2 and 4 this procedure produced significantly different PSD levels for each catchment.

In reviewing these earlier approaches it became apparent that PSD can not logically be applied at a fixed level to a range of subareas of widely different sizes. PSD must, all else being equal, vary with a subarea's size.

The methodology adopted in this final review was then to;

- Establish scaling relationships for the peak discharge from sites of different area and impervious cover
- Establish scaling relationships for the storage required to maintain a site's local (outlet) discharges at pre-development levels; and to
- Establish appropriate levels of PSD and SSR required to maintain discharges anywhere in a catchment to pre-development levels

The modelling process behind this review of local and catchment wide PSD and SSR is described further in a companion paper to this conference by Rigby & Milevski[2006].

4.4 PSD for Local Control

Using hydrologic models of four synthesised sites, representative of the rainfall gradients in the city it was found, Rigby and Milevski[2006] that the peak discharge rate from a site in Wollongong in 5 Yr ARI and 100 Yr ARI events could be represented by;

Q_{p5} =F1*F2*0.004*$I_{50Yr-1h}$ (m^3/s/ha) and
Q_{p100}=F1*F2*0.007*$I_{50Yr-1h}$ (m^3/s/ha)

Where F1 is a factor reflecting the site's percent impervious cover and F2 is a factor reflecting site area.

When developing from a natural site, the PSD for local (outlet) control then becomes;

PSD_5 =F2*0.004* $I_{50Yr-1h}$ (m^3/s/ha) and
PSD_{100}=F2*0.007* $I_{50Yr-1h}$ (m^3/s/ha)

4.5 SSR for Local Control

Using the same four synthesised sites, it was found, Rigby and Milevski[2006] that the required storage levels for a basin capable of attenuating post-development discharges to natural levels in a 5 Yr ARI and 100 Yr ARI event could be represented by;

SSR_5 =F3*F4*PSD_5/F2 (m^3/ /ha) and
SSR_{100}=F3*F4*PSD_{100} /F2 (m^3/s/ha)

Where F3 is a factor reflecting the developed site's percent impervious cover and F4 and F2 are factors reflecting site area.

4.6 PSD & SSR for Full Control

Using the four representative catchments previously developed by Boyd and SMEC, these relationships were then used to map the required 1ha local PSD and SSR levels up to the equivalent subareal levels, eliminating earlier concerns as to the lack of scaling equivalence in modelled PSD and SSR values.

The required catchment wide levels of PSD and SSR were then derived from these local PSD and SSR levels by progressively reducing PSD and increasing SSR until peak discharges from the ultimate development were not elevated by more than 5%, relative to the pre-development levels, anywhere in each catchment. The required level of catchment wide PSD was found to be two thirds of that required for local control and the SSR for catchment wide control was found to be one and a half times that for local control.

The final requirements for PSD and SSR to meet the nominated objectives in Wollongong for control of runoff from a developing natural site, are then;

PSD_5 $=F2*0.00267*I_{50Yr\text{-}1h}$ ($m^3/s/ha$) and
$PSD_{100}=F2*0.00467*I_{50Yr\text{-}1h}$ ($m^3/s/ha$)
SSR_5 $=F3*F4*2.25*PSD_5/F2$ (m^3/ha) and
$SSR_{100}=F3*F4*2.25*PSD_{100}/F2$ (m^3/ha)

Where F2, F3 and F4 are as previously noted and described by Rigby & Milevski [2006]..

While the PSD for a site with prior development can be readily determined by increasing the above PSD by the factor F1, a similarly direct solution is not available for SSR. SSR for a site with prior development was therefore based on the difference between the SSR required for a natural to post development site and the SSR for a natural to pre-development site.

As indicated in Table 5, the above levels of PSD and SSR do result in peak discharges in a few locations exceeding pre-development levels by a small margin. There is however a significant reduction in discharge generally across most catchments, with post development discharges in some locations reducing by more than 30%.

Table 5
Impact of OSD Policy 2006 on Peak Flows

Catchment	Min	Avg	Max
LB Kelly Ck	+1%	-6%	-17%
Fairy Ck	+5%	-18%	-37%
Alans Ck	+4%	-5%	-29%
Mullet Ck	+4%	0%	-17%

Note: A positive impact represents an increase in peak flow

5.0 THE IMPLEMENTATION PROCESS

It was important that the new policy be able to carry sufficient weight if it was ever tested in court. The best way of achieving this outcome was to follow a process similar to introducing a Development Control Plan (DCP). This required that it be placed on public exhibition for a minimum period of 28 days with feedback from the community being considered. Prior to this being done however, Council needed to endorse the proposed policy for exhibition, which it did, subsequently exhibiting the policy in March, 2006. Council is very supportive of the new procedure and while acknowledging that it had taken some time to release the updated policy, it understood there were complex issues which had to be dealt with along the way.

Only four submissions were received from the exhibition with only minor concerns being raised. A report to Council was prepared for its consideration to adopt the new policy which it did in June 2006. The new policy came into effect on 1 September, 2006, allowing a period of two months between the date of Council adoption and the commencement of the new policy, to allow practitioners to become familiar with the new procedures.

The new policy is available either in hardcopy or may be accessed via Council's website. To assist future users of the policy an information session was held in July 2006 to present the new policy, its inclusions and requirements.

5.1 The Future

Council will be implementing a program of random audits of the OSD infrastructure for the purposes of ensuring that systems have been built correctly, are being maintained and issuing notices to owners when particular items need to be maintained. Ongoing monitoring will also occur in respect to:-

- the extent of compliance of development and construction certificate applications
- feedback on difficulties in applying new policy
- impact on staff resources

A further study may have to be undertaken to resolve the issue of whether the storage in rainwater tanks may be used for OSD purposes, that is, what percentage of the tank can be assumed to be available as effective OSD storage. In the meantime, additional air-space will have to be provided in the rainwater tank if it is to be relied on for OSD.

6.0 CONCLUSIONS

It is concluded from the progressive development of the new OSD policy for the city of Wollongong that;

- It is important that OSD policies be developed that reflect local objectives and local environmental constraints
- An ever increasing number of OSD policies are now being published online, providing an excellent starting point for development of a locally based policy
- Customisation of design requirements for a particular Local Government Area can be readily achieved using the procedures presented in this paper, with existing hydrologic models
- A 'no significant increase anywhere' OSD policy can lead to a significant reduction in post-development peak discharges averaged across a catchment (viz. a catchment-wide reduction in Average Annual Damage should arise as OSD is added to a developing catchment)
- Adding OSD controls or upgrading from local to catchment wide controls is mostly seen as an unwelcome imposition on current development. Regular education and consultation programs are an absolutely fundamental component of the review and implementation processes.
- Since even the best educational programs will not convince all members of the community as to the need for and benefits of OSD, ongoing inspection and review of facilities must be provided to confirm that these facilities continue to function as intended.

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