Alternative Technology for Stormwater Management

Sustainable Drainage Systems – Report and South African Case Studies

Report to the
Water Research Commission

by

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This report forms part of a series of two reports. The other report is *Alternative technology for stormwater management: The South African Guidelines for Sustainable Drainage Systems* (WRC Report No. TT 558/13).

Executive summary

Background

Stormwater management in the urban areas of South Africa has, and continues to, predominantly focus on collecting runoff and channeling it to the nearest watercourse. This means that stormwater drainage currently prioritises quantity (flow) management with little or no emphasis on the preservation of the environment. The result has been a significant impact on the environment through the resulting erosion, siltation and pollution. An alternative approach is to consider stormwater as part of the urban water cycle, a strategy which is being increasingly known as Water Sensitive Urban Design (WSUD) with the stormwater management component being known as Sustainable Drainage Systems (SuDS).

SuDS attempts to manage surface water drainage systems holistically in line with the ideals of sustainable development. It aims to design for water quantity management, water quality treatment, enhanced amenity, and the maintenance of biodiversity. In so doing many of the negative environmental impacts of stormwater are mitigated and some benefits may in fact be realised.

Objectives and aims

This study had the following three aims:

i) To identify and develop new and appropriate, practical and affordable alternative stormwater management technologies for South Africa in line with Water Sensitive Urban Design (WSUD) principles.

ii) To evaluate the identified technology options in terms of their ability to improve stormwater management in urban areas; i.e. reduce the impacts on receiving watercourses resulting from increased velocities and volumes of runoff and the deterioration of runoff quality.

iii) To develop practical and user-friendly guidelines for the implementation of WSUD for both retrofit and greenfield scenarios in both the economic and sub-economic sectors of South African society.

Methodology

Literature review

An extensive search was undertaken to uncover all that had been published on Sustainable Drainage Systems since 2000. The information obtained (which included books, journal papers, conference proceedings, reports and manuals) was used to compile a 405-page bibliography. The bibliography was in turn used to compile the Literature Review presented here (Chapter 2) as well as the South African Guidelines for Sustainable Drainage Systems

hereafter referred to as the South African SuDS Guidelines, or simply “the Guidelines” (separate document).

South African case studies

At the beginning of the research, a number of exploratory field trips were undertaken to assess what had been planned and implemented in South Africa with respect to SuDS. Although the case studies were limited to only three provinces (Western Cape, Gauteng, KwaZulu-Natal), these three provinces account for approximately half the population and the majority of the economic activity of South Africa. They also experience different climatic conditions from each other that roughly represent much of the country. The identified case studies were then monitored over a two year period. The eight most promising case studies were selected for further study and reporting. The wetlands and associated SuDS at Century City in Cape Town were studied in particular detail. The monitoring of these case studies did not include instrumentation or measurements of the quality or quantity outcomes of the systems, except in the case of Century City where monitoring had been undertaken by the landowner association.

The development of the South African SuDS Guidelines

In the course of the search for source material, 27 SuDS design manuals from Australia, the United Kingdom and the United States were reviewed. The South African SuDS Guidelines were then compiled by summarising the key material from these manuals in such a way as to be relevant to all professionals working with stormwater – and not just engineers. The Guidelines are not intended to be a design manual but a way of highlighting potential opportunities for better stormwater management. Initially the draft Guidelines – together with supplementary material – was compiled on a DVD and given out to delegates attending workshops in Cape Town, Johannesburg, Centurion, George and Durban. The feedback from these workshops was incorporated into the final SuDS Guidelines along with a number of further refinements.

The SuDS Economic Model (SEM)

The SuDS Economic Model (SEM) comprises Excel macro-enabled software that was developed to assist in the economic analysis of alternative approaches to stormwater management. The functioning of the model is described in Appendices D-F in the SuDS Guidelines.

The SuDS / WSUD Website

Initially it was envisaged that the output from this research project would be distributed on a DVD. This approach initially proved successful, but a number of shortcomings became evident including the fact that: it was not possible to get copyright clearance for all resources;

a DVD is difficult to update; and it requires practitioners to have a DVD drive to access the information.

As a result a decision was made to develop a website which could in time be expanded to cover other issues associated with WSUD. This approach has a number of advantages: it is possible to link references to their sources; it is possible to continuously update material and correct any errors; and it is possible to collect data on new SuDS projects from the professionals involved. The resulting website can be found at the following address: www.wsud.co.za

Project deliverables

This study set out to identify and develop new and appropriate guidelines for the use of alternative stormwater technology in South Africa. The project resulted in the development of the following deliverables:

- Sustainable Drainage Systems – report and South African case studies (this document).
- The South African Guidelines for Sustainable Drainage Systems (The South African SuDS Guidelines).
- The 'SuDS Economic Model (SEM)'.
- The 'SuDS Conceptual Design' poster.
- The 'Working Sustainable Drainage Systems into the City' poster.
- The 'Water Sensitive Urban Design: South Africa' website (www.wsud.co.za).

Review of South African case studies

A number of South African case studies were reviewed as part of the research. A summary of the findings follows:

Permeable pavements

Permeable paving is the most commonly implemented SuDS option in South Africa. This is most likely due to its promotion by the Concrete Manufacturers Association (CMA). Three case studies from across South Africa were investigated in detail. These were:

- **The Cape Town Grand Parade –** situated next to the Town Hall in the centre of Cape Town, this was the first major permeable paving scheme in the Western Cape.
- **A University of Witwatersrand parking area –** two multi-use sports fields were converted into parking areas using permeable paving to manage the stormwater runoff.
- **The Pietermaritzburg Anglican Cathedral –** the parking area was upgraded making use of permeable paving to manage the stormwater runoff.

Permeable paving systems can manage stormwater without the need to install catchpits and stormwater pipes. Sand, silt and other fine material have a destructive effect on the drainage capacity and detention volume of a permeable paving system however and should be carefully controlled.

Green roofs

Green roofs are vegetated roofs which act as excellent source controls. They are relatively easy to retrofit onto many commercial buildings in high density areas where other SuDS options would be inappropriate. Two interesting retrofit projects in Cape Town (DEADP Green Roof) and eThekwini (Green Roof Pilot Project) have been undertaken in South Africa.

The case studies highlighted the fact that people are generally drawn to well vegetated and pleasant environments as provided by green roofs. There is however a need for further research into the selection of plant types for the different regions of South Africa.

SuDS treatment trains

SuDS options should not be isolated but should be connected to form a treatment train in order to increase the resilience of the system. Two new developments in South Africa, Cotswold Downs and Hawaan forest estate, have implemented SuDS treatment trains and present interesting case studies.

The Cotswold Downs Golf Estate is situated between Hillcrest and Waterfall on the western outskirts of eThekwini. Although the development was modelled on SuDS principles from the outset, the consultants had not initially considered source controls for private properties within the development. The developers then revised and issued a second stormwater management plan focusing specifically on the provision of these type of SuDS.

Hawaan Forest Estate is an upmarket residential development, situated to the north of Stratton-on-Sea in eThekwini. Rain falling on the estate is initially detained in source controls such as roof gardens and soakaways which ‘polish’ and attenuate it before the runoff is directed over lawn into adjoining vegetated swales. The swales link to fourteen detention ponds distributed around the lower-lying eastern side of the estate and showcased by an ‘ornamental’ pond at the entrance

A number of lessons were learnt through these two case studies, including: that a SuDS approach has the potential to enhance the investment potential of a development; but operation and maintenance requires expertise which may be expensive.

Century City wetlands

First conceptualised in 1995, the last decade has seen Century City established as an upmarket development with the largest shopping centre in the Southern Hemisphere and

containing Cape Town's only theme park. Current land use zoning includes commercial and residential uses supported by large corridors of office park buildings. Century City offered one of the most integrated systems to be reviewed, with the longest management history, and thus provided an ideal case study.

This system collects stormwater runoff from Century City and neighbouring Summer Greens developments, and channels it into the adjoining Tygerhof detention pond. The Wingfield outfall, located at the north-eastern end of Century City's bounds, is the stormwater outfall for the development.

A number of lessons were learnt through this case study; most importantly that the use of treated sewage effluent to supplement water in the wetland during dry periods needs to be carefully considered and monitored; and that a wetland system of this magnitude requires on-going maintenance and monitoring.

Conclusions and recommendations for future research

Conventional stormwater management focuses largely on quantity (flow) management by collecting runoff and channeling it to the closest watercourse. This has resulted in the erosion of natural channels and pollution resulting in environmental degradation. SuDS offers an alternative approach through designing for water quantity management, water quality treatment, enhanced amenity, and the maintenance of biodiversity. The approach has been widely adopted overseas, however it was clear from the national workshops that there is still some degree of scepticism as to its effectiveness in South Africa.

During the course of this study several areas for further research were identified, including: *inter alia*; the need to determine local SuDS maintenance requirements; the development of technical decision support systems (DSSs) for South African conditions; the need to undertake long term monitoring SuDS systems in South African conditions; and the need to promote the results of this project to smaller municipalities through a series of workshops.

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