SUSTAINABLE URBAN DRAINAGE SYSTEM (SUDS) A NEW CONCEPT IN TOTAL STORMWATER MANAGEMENT SOLUTIONS FOR NEW DEVELOPMENTS

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Abstract

Sustainable Urban Drainage System (SUDS) is a concept that fully utilises all aspects of an urban drainage system for both hydraulic considerations as well as the local and global environmental protection. It is an extension of the Water Sensitive Urban Design (WSUD) concept, but looks at all aspects of the drainage system for maximum utilisation and peak environmental performance.

Each development must be considered to be unique, and the available SUDS tools must be considered for each individual site for both hydraulic and environmental aspects. Each tool must be used to its full potential and will result in many of the tools performing more than one function.

These tools have been readily available for many years, however they have generally not been used to their full effect. A SUDS design allows consideration of these tool's full potential. Rocla currently provide many of these tools, of which the application in a SUDS design is discussed.

Key Words: Sustainable, Rocla, SUDS, WSUD, Stormwater, Drainage, Water, Sensitive,Urban, Design

Introduction

There is a need to provide for sustainable development. Our global climate cannot maintain further development without consideration of the global environment.

There is also a need to provide this sustainable development at a cost that does not exceed the value that the community puts on the provision of this sustainability. If it does, then the community will not pay for the sustainable development.

There are two ways of achieving this. The first is to increase the value to the community through education. The other, is to provide more economically sustainable design, through ensuring the maximum utilisation of all measures in the drainage network.

The Purposes of a Drainage System.

A drainage system is far more than a pipeline designed to transport stormwater runoff. It comprises of a system of stormwater detention measures, pollutant traps, pits, pipes, swales, open channels, wetlands among others.

A stormwater drainage system is designed to form a number of functions. The first and most obvious is to transport stormwater runoff without causing localised flooding. This requires the drainage system to be designed to have capacity to transport runoff from rare large storm events, such as the 20 year Average Recurrence Interval (ARI)event. As the drainage system is designed for these large storm events, it is rarely used to its full capacity during the frequent smaller storm events. As an example a 3 month ARI storm will only fill a pipe to approximately one third of its cross sectional area.

Another function of a stormwater system is to prevent flooding downstream of the catchment. This is the principle of stormwater detention and retention.

In recent times the environmental impact of stormwater runoff has been recognised, not only due to the quantity of the runoff, but also the quality. Hence, there has been a move towards the use of pollutant traps, wetlands, swales and other stormwater treatment measures to improve the quality, and the use of detention and retention systems to control the quantity of flow.

The Evolution of Drainage Design.

Drainage design concepts have changed dramatically over the last twenty years. There has been a shift from a purely localised thinking, towards a globalised approach in drainage design.

Drainage design before the 1980's was based on the concept of get rid of any runoff from a development as quickly as possible. This was based on the concept of preventing localised flooding only.

During the 1980's it was recognised that the rapid removal of runoff from a site, in conjunction with the increased runoff from urbanisation, was leading to flooding of downstream receiving waters. From this, the concept of on-site detention was adopted to limit flows post development to approximately that predevelopment.

During the 1990's the significance of the quality of the stormwater to the ecology of the downstream receiving waters was recognised. There was now recognition that the pollutants contained in the stormwater runoff was having a detrimental effect on the environment. This led to the development of customised and proprietary stormwater treatment systems to remove much of this pollution. This concept considered the localised environment, that is within the development itself, and immediately downstreamCurrent thinking is now focusing not just on the localised environment, but also on the global environment. This is really the concept of water sensitive urban design (WSUD), where all of the concepts of preventing localised and downstream flooding and improving the quality of the stormwater runoff are still considered. Additionally we are now considering the effect of a development on the global environment and adopting a total water balance approach..

WSUD involves the consideration of maintaining both the internal environment as well as the external environment. It is also considering the maximum utilisation of all available resources. As an example, rainwater runoff is now being stored and reused so that the demand on external water reservoirs is reduced.

The common thread through each of these changes in design philosophy, is that the concept from the previous period is carried through to the next stage. Therefore in the present time, design concepts develop around consideration of the global environment, however preventing flooding within, and downstream of a development, is still just as important as it was before the 1980's.

Urban drainage design has evolved from being a hard numbers only engineering approach,to a hard numbers design, tempered by a subjective estimate of the effect that development will have on the environment.

Drivers for Change.

There have been two main drivers for these changes in design philosophy. Firstly, from a public liability point of view, with respect to flooding concerns, and secondly from a general increase in environmental awareness.

Australia is becoming increasingly litigious, and this has been in part a driver towards change in almost every aspect of life. Where in the past, a minor flood on someone's property may have led to a complaint to the council, it could now lead to a law suit against the council. Councils must now be much more stringent in their regulatory policy,so as to protect themselves against this.

Public awareness of stormwater issues and its impact on the environment has changed considerably in recent times. It could be said that the general public had little or no concept of urban drainage systems twenty years ago – they only were concerned when their "backyard flooded". There was almost no awareness of the environmental impacts of stormwater quality.

Up to ten years ago it could be said that there was environmental awareness by the public, but still to a large degree ignorance of what a stormwater system is, and certainly almost no link between stormwater and the environment.

Today there is some degree of public understanding of both what a drainage system is and its impact on the environment. There has been an amalgamation of concepts, between stormwater drainage and the environment. But additionally, it is recognised now that the public will pay some, but limited, additional costs to protect our environment.

What Does WSUD Need to Achieve?

WSUD is not just an environmental concept. It must not only consider local and global environmental issues, but also consider the age old drainage concepts adopted in the past. Flooding is as big an issue now, if not bigger, as it was twenty years ago.

There are five main objectives that WSUD must consider as follows;

1. Manage the risk of flooding both locally and downstream of the development.

2. Take an holistic approach to the environment, that is not just within the development, but also the external environment.

3. It must maximise the potential of all available natural resources to reduce the consumption of high environmental impact utilities such as dams.

4. It must make full utilisation of the assets within the development, and not have an asset that is only fully used once in twenty years.

5. It must provide controlled management and maintenance of the water cycle.

In addition to all of this, it must be cost effective.

While this sounds impossible, and we should all go back to living in caves. What it actually means is that we need to be smarter in the way we utilise assets and resources.

Stakeholders.

The key stakeholders are government authorities, designers, developers, manufacturers and the public. Each of these stakeholders has a different viewpoint on the objectives of WSUD, and how it should be achieved.

Government authorities include organisations such as councils, Environmental Protection Authority, State and Federal Government, road and water authorities among others.

Designers include engineering consultants both civil and hydraulic, landscape architects, architects and planners.

The primary role of the government authorities is to protect the public interest, which in the context of WSUD, is to minimise the public risk in relation to developments with regard to both flooding and environmental impacts. Hence government authorities play a major role in driving change as they will set the standards that must be met.

Designers have a role to both ensure that new developments meet with the requirements set by the government authorities, but also ensure that development costs do not escalate as a result. Hence consultants play a major role in developing innovations to provide for WSUD. Without these innovations there is the potential for dramatic increases in costs of developments.

Developers are also a major force in the drive for change. Developers effectively are the voice of the public, they are the measure of how much additional cost the public are willing to pay for protecting the environment,and what measures they are willing to undertake. They are the measure of the importance of the environment

Manufacturers play a role in the change in urban drainage design. If the tools are unavailable, or cost prohibitive, there will not be any changes. Hence manufacturers of various drainage products play a key role in the shaping of any changes to drainage design.

The public, as defined by the purchasers of the properties, will have the final say in any changes to drainage design. This is because any change that leads to a large increase in costs must be offset by a perception of increased value, and hence a higher sale price.. The public does place value on various aspects of drainage design, for example, a piece of land that is flood prone, will have a much lower price than land that cannot be flooded. This difference in price is the value that the public has placed on flooding issues. Twenty years ago the public would have placed very little value on environmental issues, and hence environmentally friendly developments would not have attracted any higher selling prices than that of non-environmentally friendly developments.

Today there is a much greater environmental awareness among the public, and there is some value placed on environmental issues. Hence some increase in cost can be past onto the public to achieve sustainable growth.

A Tool Box Approach.

Every catchment has different parameters. Variations in rainfall intensities, impermeable areas, topography, pollutant loads and layout among others, can dramatically change not only the flow characteristics, but also the performance of various treatment systems. Additionally, variations in treatment measures should be adopted depending on the sensitivity of the receiving waters, and of any treatment measures that may be downstream of the site.

Adopting similar stormwater treatment measures as another site does not assure that there will be adequate treatment of the stormwater. As an example, grass swales may work very well in an area where there is low flow rates, but in a location where there is high flow rates or high flow velocities, it may have very little effect in removing pollutants.

Hence a toolbox approach should be adopted, where a number of various treatment measures that could be used, are assessed for their appropriateness to a particular site. This assessment must not look at just one treatment measure alone, but rather look at all of the treatment measures in series, as the performance can vary depending on any pretreatment, or any upstream flow control. As an example, the issues of stormwater detention and stormwater treatment are often considered separately. The smart use of stormwater detention can greatly improve the performance of gross pollutant traps and wetlands.

What is Sustainable Urban Drainage Systems?

Sustainable Urban Drainage Systems (SUDS) is an extension of the concept of Water Sensitive Urban Design (WSUD). SUDS adopts the concepts of WSUD but takes it a step further in attempting to maximise the utilisation of all drainage assets.

In WSUD the emphasis is on grass swales, wetlands, stormwater reuse and infiltration, in order to minimise the use of the traditional structures. Often the traditional drainage system, that is still necessary, is treated as a target for WSUD. SUDS is a concept of looking at the whole system to maximise the utilisation of all assets, and is in fact complementary to WSUD.

Drainage pipes need to be provided to allow for peak runoff during large storm events, but they are rarely used to their full potential. In SUDS, the pipes could be used as detention storage during smaller storm events, allowing much greater performance to be achieved by any downstream treatment measures.

Not only does a SUDS approach consider maximum utilisation of drainage assets, but it should also consider maintenance aspects. Many of the ideals adopted in WSUD fail to consider both the long term cost of maintenance, but also the long term performance of some of the tools adopted. As an example, some infiltration systems work very well initially, but they require frequent maintenance to ensure they do not block and become ineffective.

What Are The Available Tools?

There are a multitude of tools available to designers, for example:

- Drainage pipes/culverts,
- Flow regulators,
- Detention basins and tanks,
- Stormwater reuse tanks,
- Infiltration,
- Grass swales,
- Gross pollutants traps,
- Oil and grit separators,
- Spill control,
- Wetlands,
- Ponds,
- Sedimentation basins,
- Overland flow,

Some of these tools are ready made proprietary products, while others are only able to be constructed on site.

Each tool has its own role to play in a drainage system, and should not be considered as just a stand alone item, but may also be considered as part of a treatment train.

Rocla Water Quality have a number of these tools available such as;

- Hydro-Brake® flow regulator,
- Rocla drainage system – pipes, culverts, and CPO® pits
- ecoRain™ rainwater utilisation system,
- Downstream Defender® oil and sediment separator,
- CleansAll® gross pollutant trap,
- ecoStop® spill control system,
- ecoSep® oil water separator
- Rocla on site detention systems,
- Rocla water level control pit,

How can they be adopted?

To provide an example of how to use these tools in a SUDS design, a typical approach for a residential subdivision has been used.

Consider a residential subdivision with a number of dwellings draining into a creek downstream of the development. Detention must be provided to ensure that the increased runoff from the site does not cause flooding of existing infrastructure assets prior to discharge to a creek. The following tools may be adopted.

Firstly at each house a Rocla ecoRain™ rainwater utilisation system can be adopted at each dwelling. This is used to plumb into the house for use in non-consumptive uses such as toilet flushing, laundry and out door uses. By adopting this the household mains water consumption can be reduced in the order of 50% thus reducing the effect of the development on water reserves and extending the life of our existing supply reserves.

The overflow from the rainwater utilisation system will then flow into a main stormwater drainage system, which also drains the roads. This drainage system will comprise of a series of stormwater pits and pipes designed, (due to the consequences of overflow), for peak 20 years ARI storm flows, but will, during more frequent storm events run only partially full.

To maximise the utilisation of this drainage system during smaller storm events, Hydro-Brake® flow regulators can be positioned at various locations along the drainage line to utilise the drainage network as a detention system. This will restrict flows during smaller storm events so that treatment measures downstream can be reduced in size, and will be more efficient at treating the stormwater. All treatment techniques will provide better pollution removal at lower flow rates. The flow regulation can be designed so that design flow rates are allowed to be discharged without surcharging upstream.

The next measure in this treatment train may be the CleansAll® gross pollutant trap, which is designed to remove gross pollutants, sediments and oils from the runoff. The CleansAll® is generally designed to treat up to a flow rate equivalent to a 3 month ARI storm event, in this case as there is flow regulation and retention upstream, a greater than normal proportion of total annual flow volume can be treated without by-pass.

The gross pollutant trap is used as a pretreatment system for a wetland pond, which, if the flow wasn't pretreated, would quickly become blocked and ineffective, due to the larger sediments and gross pollutants from upstream. The wetland is primarily used to remove nutrients from the runoff, through the use of vegetation. A Rocla level control pit can be used to control water levels within the wetland pond to the desired level, and allows adjustment to allow maintenance to occur.

Finally, a flow regulator may be required on the outlet from the wetland pond, in order to restrict final discharges to the level prior to development, and to decrease the frequency of major events in the creek downstream. In this case the wetland pond is also used as a detention basin for the rare major storm events.

In this example the principles of SUDS have been adopted to ensure each asset is used to its full potential, and in many instances most assets are used for more than one purpose.

Conclusion

Urban stormwater drainage design concepts have changed dramatically over the last twenty years. The concept has evolved from a very localised concept to now more global concerns for the environment. Drainage design used to only be about preventing localised flooding. This evolved, through the concept of on-site detention to prevention of downstream flooding, and now to global sustainability.

There have been a number of drivers for this change, but the most important driver is the change in the community thinking. People are now much more aware of the global environment and the need to provide for sustainable development. In many instances the provision for sustainability may end up as higher costs being past onto the public, however with changes in community attitudes, there is now an acceptance that thoughtful sustainability is worth paying for.

There are many tools available for the provision of sustainable development design. These tools must be considered in a treatment train approach, the effectiveness of each tool will depend on all of the other tools chosen, and how they are used in conjunction with each other.

A new concept in design needs to be adopted, that of Sustainable Urban Drainage Systems (SUDS). This is not a totally new concept but rather uses all of the currently available tools in a manner that maximises the utilisation of all available tools to ensure the viability of sustainable development. Unless this is adopted we risk the cost of sustainable development becoming too great and the value that the public places on sustainability being less than the additional cost and hence an unviable commercial option.

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