

# STOP THE MONEY FROM GURGLING AWAY – UNDERSTANDING YOUR DRAINAGE NETWORK

Ben Symmons and Riaz UI-Islam  
Asset Management Team Leader, Opus Perth (BS)  
Senior Asset Management Engineer, Opus Sydney (R U-I)

## Abstract

When considering major authority assets, stormwater drainage is often regarded as the most difficult to manage. Out of sight and often out of mind, drainage infrastructure is frequently neglected and forgotten about until something goes wrong. It all seems to work well until it really rains! This inherent lack of asset knowledge promotes poor maintenance and management practices and causes more than just water to flow down the gurgler.

With many authorities now realising the true economic and management value in knowing the location of an asset class and also its condition, how best can we go about collecting this information in a cost effective way? How can a little knowledge help reduce our long term costs? This paper presents two case studies. The first looks at the collection of drainage infrastructure using modern technology to provide high accuracy spatial locations. The project involved building a spatially referenced, digital network, for a Western Australian Council with around 3,500 drainage pits.

The second, presents a simplified way of quickly establishing drainage asset condition without the need for highly expensive pieces of equipment. This project focused on the NSW Roads and Traffic Authority's Newcastle F3 Freeway. The project's aim was to provide a flood-free zone on the freeway simply by ensuring remediation options of all drainage structures.

Once Authorities have an understanding of the location, attributes and condition of their stormwater drainage networks, then the asset's maintenance and renewal needs are not that difficult to establish. This in turn then leads to better maintenance management and level of service delivery to the customer. Ultimately over the long term, it should help

## Key Words: Stormwater Drainage Inventory Condition Risk Management

### Introduction

When we consider major State and Local Government asset classes, stormwater drainage is often regarded as one of the most difficult to manage. Out of sight and often out of mind, drainage infrastructure is frequently neglected and forgotten about until something goes wrong. It all seems to work so well until it really starts pouring!

In recent years, we have seen Authorities generally move to improve their understanding of their drainage networks, with an increasing use of spatially referenced data to help ensure that at the very least, we know where our drainage infrastructure is. The use of Geographical Information Systems (GIS), Global Positioning System (GPS) technologies and other data sets such as aerial photography have made this task somewhat easier than in days gone by. However the same can not be said when it comes to knowing the condition of our stormwater drainage infrastructure. With the traditional level of technology required to

assess condition being high, the associated costs also tend to reflect this. With methods such as remote controlled cameras often being highly expensive and labour intensive, decision makers frequently shy away from undertaking any form of condition assessment, as precious budgets are allocated to seemingly more immediate asset management needs. Indeed the belief that stormwater drainage is a long life asset, and with a relatively sparse history of major failures, one can argue that the acquisition of condition data in the present time is unnecessary.

Regardless of this, the inherent lack of asset knowledge undoubtedly promotes poor maintenance and management practices and causes more than just water to flow down the gurgler. Whilst the annual cost of maintaining a drainage network in Australia maybe considered relatively cheap for now, are we just burying our heads in the sand and ignoring the long term whole of life cost,

whilst passing the bill of future renewal to another generation?

And what of climate change? Whilst the debate over whether it exists or not still continues, we can't deny that our weather seems to be increasingly more unsettled and extreme. In May this year the southeast corner of Queensland was hit with record rainfalls causing the State Government to declare it a natural disaster zone. From the Sunshine Coast to Brisbane and the Gold Coast, falls of up to 300 mm were recorded in just 24 hours. So while the short term cost to the State Government was at least \$121 million through disaster relief, the true long term cost through reduced assets, lives and infrastructure damage caused by the flooding, will undoubtedly remain uncoded and unknown. Could better stormwater management have potentially saved millions? Although major natural disasters such as the Queensland and NSW floods may be difficult to manage and arguably beyond the intended design capacity of the vast majority of stormwater infrastructure, it should give us all a warning not to neglect this asset class. Because although neglect and poor asset management will ultimately result in higher whole of life costs, they also increase the risk to the consumers of the asset.

This risk eventuated during a mid afternoon on Friday 8 June 2007, as a family travelling on the Old Pacific Highway on the New South Wales central coast, were about to become the victims of misfortune and negligent asset management. For the family, the cost of poor asset management was about to be very high.

### **Old Pacific Highway Culvert Collapse**

On 18 September 2008 the coroner, Magistrate P MacMahon, released the findings into the events that night. The weather was very poor, with high winds and at times, torrential rain. At around 15:30 in the afternoon, several motorists along with a local building supervisor, discovered a cave in on the Old Pacific Highway. While the road continued to collapse in, several of the motorists had begun to realise the potential risk and began to position their vehicles to stop other vehicles from using the road. Despite this, the car containing two adults and three children did not see the hazard and fatally entered the void caused by the cave in.

Despite the attempts by witnesses to save them, all five passengers drowned in the river.

The Coroner's report goes on to ask the question, "Why did the road collapse"? Following the events of 8 June, engineers were appointed to provide expert advice to the Coroner as to determine the cause of the roads collapse. All the experts involved in the investigation were in agreement as to the mechanism that resulted in the failure of the road. They were that:

- The mechanism of collapse commenced with the abrasion/corrosion of the inverts of the corrugated steel pipes;
- Once the invert had been substantially perforated, the water flowing through the pipes began to wash soil out from around and beneath the pipes, causing voids around, and eventually over, the pipes;
- The ongoing loss of embankment fill material, as it was washed away by the flowing water through the culvert, progressively reduced the stability and integrity of the embankment;
- The progressive loss of embankment fill material and creation of voids caused by subsidence to occur on the road surface above the pipes; and
- The rain event on 8 June 2007 combined with the pre-existing instability and loss on integrity caused by the formation of the voids above and around the pipes, resulted in the collapse of the embankment above the culvert and subsequent complete washout of the embankment fill material.

In summary, the experts were also in agreement as to the overarching cause of the collapse of the embankment. They said that "*The cause of the collapse of the embankment above the culvert was the failure to adequately maintain the culvert*". Indeed, this was not the first time a similar culvert had failed in much the same fashion. In summary the Coroner reserved particular criticism for the way that the Council had failed to manage its asset. The Coroner further recommended that there was a very real need to implement an effective inspection regime for road assets, the identification of risk associated with such assets, the timely response to risks that are identified and the effective managerial oversight of such systems.

It is unfortunate that it often takes a tragedy to invoke change, but for one of the organisations within this paper, the need to identify and prioritise maintenance risks is very real to ensure that other tragedies are not repeated. In their own individual ways two very differing organisations are now taking the task of understanding their drainage networks into hand by actively improving both the knowledge and management capability of their asset.

The following case studies examine two recent projects undertaken by authorities who are responsible for the management of quite different stormwater drainage networks. The first is a small inner city Local Government Council in Perth, Western Australia. The second is the New South Wales Roads and Traffic Authority (RTA). Both case studies outline modern practices and techniques for managers to collect stormwater drainage inventory and condition information in a cost effective and accurate manner.

### **Case Study 1 – Inventory Data Collection**

With a total residential population of just under 30,000 and covering an area of just 17.62km<sup>2</sup>, the Town of Victoria Park manages a relatively small stormwater drainage network of around 3,500 pits. Proclaimed as the Victoria Park Roads Board on 20 July 1894, the area then attained municipality status on 30 April 1897, being declared the Municipality of Victoria Park. However on 18 November 1917 the municipality was dissolved and the area joined with the City of Perth. As a result of the Carr/Fardon Report the State Government enacted the City of Perth Restructuring Act in 1993, which saw the Town of Victoria Park, as we know it today, proclaimed on July 1 1994. With this came the transference of a range of public assets from the City of Perth. A lack of asset data transference resulted in the Town possessing only minimal knowledge of its stormwater drainage network, much of which is environmentally sensitive by discharging directly out into the Swan River. Driven by a need to improve its asset knowledge to help facilitate future hydraulic modelling, the Town began a project to collect highly accurate spatially referenced information. In mid-2008, Opus were commissioned by the Town to collect this data, which would ultimately enable the Town

to be able to undertake a range of management functions.

The required data fields were clearly defined upfront before the project commenced, as experience showed that fundamental to any similar data capture project, was the need to understand the intended final use of the data. Having a clear vision of where you want to end up, ensures that the correct data is collected on the way. This not only reduces the risk of not over scoping the project by collecting data of little or no value, but also ensures that nothing vital is missed, resulting in extra data capture need.

The project working party also wished to employ standard definitions and terminology from the start so that they would align with similar datasets of other WA Councils. To enable this, the Town adopted the terminology used by D-Spec, a specification for digital files covering stormwater drainage assets contributed by private development. Although not a member Council of the D-Spec initiative, the Town saw the clear value in this approach.

Opus began the data collection project in late 2008, using a two man inspection team and a range of tools. The team used the Sokkia 2700 ISX, a fully integrated high-performance GPS survey device, for data acquisition. The Sokkia involved the use of both a fixed base station receiver and mobile roving receiver to acquire centimetre accurate spatial locations, both in the horizontal and vertical plane. Furthermore the device also allowed electronic data entry templates to be built, which helped ensure data consistency and ease of use.

The data collection team walked each street within the Town and collected data for each pit it found, being:

- A spatial coordinate of the lid's centroid;
- The lid type (i.e. manhole, grate, side entry pit);
- The lid's construction material;
- The pit's depth;
- The pit's construction material;
- The diameter of any pipe entering the pit;
- The material of each pipe; and
- The invert of each pipe.

This process involved opening each pit using a mobile lifting device in order to inspect the pit and pipes within it. However, the team was restricted in accessing those pits which were

positioned in the road. These pits were unable to be inspected without the provision of traffic management and will need to be inspected at a future point as part of a further data collection stage.

Whilst the project was not designed to undertake a detailed condition assessment of all drainage assets, inspectors did record instances where they detected damaged and broken infrastructure. Common defects included heavily cracked and split concrete lids which could not be opened for risk of them falling into the pit, jammed pit lids which could not be opened and heavily silted and blocked pits. Several unusual items were also discovered in the bottom of pits, including a snooker cue and computer monitor!

Whilst the project is on going, it should be understood that Authorities undertaking similar data collection activities must understand that with stormwater drainage infrastructure, the process can be time consuming. Piecing together the network is much like a jig saw puzzle and requires the compilation of information from a range of sources, including historical drainage maps, where they exist.

For the Town of Victoria Park, the initial data collection sweep has provided them with a sound base inventory from which the missing pieces can be filled in over time. Ultimately, this can be carried out using different approaches. For the Town, its interest is in modelling certain catchments to identify areas requiring capacity upgrades. This will therefore require collecting all stormwater drainage information one catchment at a time.

### **Case Study 2 – NSW RTA Drainage Condition Assessment**

As our knowledge of our networks and their location and attributes improves, the next logical step in their management is to start assessing for condition. Within Australia this knowledge remains largely unacquired, with techniques for assessment being limited and often expensive. For example, remote control camera technology to inspect pipes exists, but the cost of performing this can often be prohibitive, requiring significant monetary investment.

But as demonstrated by the Old Pacific Highway culvert collapse, managers can no longer simply ignore this problem and efforts

must be made to proactively identify areas of potential future failure. The culvert collapse undoubtedly raised awareness of the issue of stormwater drainage condition, with many asset managers. As an Authority that was involved in the culvert collapse, being the original constructor and asset manager prior to the culvert's transfer to Gosford City Council, the NSW RTA realised the need arguably more than others, as to the importance of accurate condition information. Following the findings from the Coroner's report, the RTA then began to address a potentially significant problem, of a deteriorated stormwater drainage network. The first step in its task to identify the network's condition was to develop a data collection template that would ensure that all necessary asset attribute and condition information was collected correctly on the first time of inspection. As with any major asset data capture program a significant risk is that through poor planning, critical information fields are missed during data collection. This can not only hinder the effective management of the asset, but also potentially require additional capital expenditure at a later date to collect missing information.

Ultimately, the RTA's data capture template covered 4 key data areas, each of which had between 6 and 26 fields of possible data. The 4 key areas that the template covered were:

- Identification;
- Culvert Location;
- Design Data; and
- Culvert Details.

Once the data collection template had been built, the second step was to engage a Consultant's help who could provide an inspection service that would prove far more cost effective than some of the more traditional methods.

The RTA contracted Opus to locate and assess drainage assets located on the Newcastle F3 Freeway (Between Hawkesbury River Bridge and Beresfield). The aim of this project was to provide a flood-free zone on the freeway simply by ensuring remediation options of all drainage structures. To achieve this requirement, Opus was asked to discover and identify all road culverts along the F3 within RTA Hunter Region's road network. The scope of the task covered a wide range of culverts, catch pits, flumes, pipes and related drainage assets. The

collected data was then linked back to an RTA plan through our referencing system. The methodology of the project involved:

- Development of an inspection schedule for the drainage assets. This has taken account of traffic conditions, safe work methods, accessibility of culverts and the distances covered by the inspectors;
- Development of an asset identification regime which was easily interfaced with the RTA's Road Asset Management System (RAMS) programme;
- Site inspections for field capture of location information using differential GPS and physical asset conditions;
- Development of a GIS based drainage map using aerial photography, superimposed with the assessed drainage structures;
- Providing typical remedial options for assets which required further attention;
- Source and undertake a historical check of plans with RTA's Plan Management Systems; and
- Assessment of the maintenance management risks for each drainage line.

The equipment used by Opus on this project is known as the snake-eye camera and enabled operators to remotely inspect assets using remote digital video equipment.

The snake eye cameras have an articulated head, which is capable of rotating to an angle of 130 degrees. This gives the camera operator the ability to get a wide variety of photos inside drainage pits, down the barrels of pipes, behind bridge bearings, or for any other difficult to access location where viewing is required. As well as this, the snake eye cameras come equipped with white LED lights around the lens, which gives sufficient light to allow for detailed photos of any asset. When even further lighting was required, we attached a modulated LED light strip to the pole. The digital camera output continuous colour video to the operator's display. The operator selected the image desired and recorded either video or still photographs in digital format.

The locations of headwalls or pits were also accurately recorded using differential global positioning.

The camera was inserted into assets such as pits or culverts to assess their condition. The operator manipulated the pole height, rotation

and camera head angle whilst viewing the video display. The operator also adjusted for the desired view of the asset to get the best angle and optimum light, and then captured the image at the handheld display unit.

The versatility of the snake eye camera allowed the operator to examine different assets remotely, to identify the asset's condition and all visible defects. The operator did not enter confined spaces, nor was it necessary to open the covers to most grated pits.

The sample photographs here illustrate the defects identified through using our methods.



Cracking inside pits was easily seen, as were blockages and pipe joint separations. The camera provided good detail for assessing the condition of assets, upon which asset management decisions may be founded. Deficiencies such as vegetation growing inside of the pit could also be easily seen and assessed. The layout and condition of drainage systems could be viewed, assessed and recorded. Field data was directly recorded in a database and could be mapped as an overlay on any geographic information system, such as Google Earth.

### **Conclusion**

The two case studies outlined in this paper both focus on stormwater drainage data collection projects. However each set out with

quite differing outcomes in mind. One was heavily focused on the acquisition of high accuracy spatial data to facilitate future activities such as hydraulic modelling. The second was clearly designed to identify areas of risk to ensure that future infrastructure failures did not reoccur.

Whilst both demonstrate the importance of clearly understanding the outcomes you wish to achieve from a data capture exercise before commencing, the need to determine the scope of the process is also of high importance. While poor asset management will undoubtedly result in money being wasted, so too will poorly planned data collection projects. Through good project management, and by the employment of local solutions that helped to keep the cost of data capture down, both Authorities have significantly improved their asset management capability. Ultimately, with further good asset management, both organisations should be able to cost effectively manage their stormwater drainage networks to ensure that only water flows down the gurgler.

### **References**

NSW State Coroners' Court (2008). Inquest touching the death of: - Adam Holt, Roslyn Bragg, Travis Bragg, Madison Holt and Jasmine Holt.

### **Biography**

#### **Ben Symmons**

Ben.symmons@opus.com.au

Ben has 10 years experience in Local Government Asset Management, both in Australia and England, across key areas such as roads, paths, bridges, buildings, public open space and stormwater drainage.

An active member of the IPWEA, Ben sits on the WA Asset Management Committee and was the first convenor of the "Gundies", a young engineers committee.

#### **Riaz Ul-Islam**

Riaz.ulislam@opus.com.au

Riaz is a specialist in transportation and asset management systems and has published and presented research papers in many leading international journals and conferences. He has undertaken pavement performance modelling and research assignments for Land

Transport New Zealand, Transit New Zealand, Japan Highways and the World Bank.