# Integrating stormwater treatment into road design

*The extension of a street in the Melbourne suburb of Broadmeadows has incorporated innovative treatment of stormwater run-off.*

Located in Broadmeadows, 15 km north of the Melbourne CBD, the project is a new road construction, extending the existing Main Street between Dimboola Rd and Pearcedale Parade.

The new road is part of the development of the Broadmeadows Central Activities District (CAD). Other local developments surrounding the project site include the redevelopment of the Broadmeadows Town Park as a high-class venue, the newly completed Global Learning Centre and forecourt plus the extension of the basketball stadium and car park.

The construction of a new road in a high public access urban environment provided the ideal opportunity to innovate and improve on outdated methods.

Traditional road construction meant the road was constructed along an elevated centreline where water is directed to kerb and channel on the outside of the road.

With this project that design was turned on its head - the crown was inverted so it was depressed in the middle and collected stormwater centrally. An inverted crown created the opportunity to centralise water quality treatment in one long linear primary treatment asset.

A great majority of the central median hosts a linear bioretention system flanked by the concrete arms forming a roadway based swale. The surface treatment along its length varies between a gravel mulched garden bed and permeable pavement.

The high volume of expected pedestrian movements motivated the need to prioritise pedestrian traffic over vehicular movements without compromising the safety of either.

The design needed to exhibit a hard wearing yet polished surface treatment but still facilitate water quality improvements within a tight road reserve. The project team identified the benefits permeable pavements could bring to the project very early on.

All water was directed into the centre of the roadway in the same area where a pedestrian refuge was designated - by using permeable pavers we had conveyance without wet feet. Water is quickly filtered through the pavers, through their bedding layers and on to the filter media that formed the linear bioretention swale.

To reduce the harshness of a large expanse of hard surfaces a dense green canopy was a must for this new road with trees planted along the central spine and footpath.

The pavers were used as primary drainage asset which ensured water was continuously directed down into the root zone where it is most needed. The pavers also differentiated the central median from the vehicle paths through colour and form that subtly highlighted the safe refuge between vehicle lanes.

Creative raised edge strip elements were designed by Outlines Landscape Architects to prevent vehicles from crossing the permeable pavement refuge.

No catchment area was left unused in this project with the large expanse of footpaths being directed into adjacent vegetation for passive watering and minor infiltration back into the landscape.

Heavy and reactive clays restricted the use of infiltration more globally throughout the project but Ag-drains were used to adequately drain trees removing the chance of water logging. This meant

that only one set of centralised drainage infrastructure was required - a significant contrast to traditional design where drainage was duplicated on both sides of the road.

There is a move in the industry towards distributed systems whereby stormwater is treated at the source before it even hits our sensitive waterways. This project showcases distributed systems within its own boundaries.

Almost every minor catchment along the new road length is redirected into garden beds and trees before overflows and the bulk of the road catchment is directed into the tree lined central swale.

The stormwater's primary goal on this project is to passively water vegetation, creating a green spine and localised cooler micro-climate to counter heat island effects of urban environments. This creates a more pleasant environment with filtered light through a green canopy and lower summer temperatures.

Without the green and lush vegetation, the harshness of such a large expanse of hard concrete surfaces would be almost unbearable in summer.

The previous site condition exhibited a park environment with few trees and plenty of grass. Almost the entire road reserve now exhibits hard surfaces that would have normally translated into increased flows to local drainage and eventually to the local creek.

Capturing this water and re-using it at the source has lowered the overall increase of flows to the creek and therefore reduced the impact of this development on local waterways.

All excess water is filtered through a linear bioretention system that also slowed the progression of water, lowering peak flow events. This means 5.25 kg of nitrogen each year is used by the site vegetation, never reaching our waterways.

The extended detention depth in this project was hidden amongst permeable pavers and mulch to lower potential for trip hazards.

Mulch on garden beds was thickened, as was the bedding of the permeable pavers to ensure the storage volume required for treatment were not reduced. This meant water quality treatment was happening beneath the feet of pedestrians without them getting wet.

The roadway was laid out and designed so that it followed the basic form of the overland 1 in 100 year flow path. The road still needed to convey in a full 1 in 100 year event without compromise. As an added complexity, to slow the progression of traffic and increase disabled access, a portion of the road was raised forming a flush and seamless section (almost reflecting a long speed hump). This further restricted the available surface flow area for higher events.

The road was designed such that the central crown still facilitated a controlled flooding route and computations confirmed the area was capable of containing the 1 in 100 year flow.

Grated pits within the central median were selectively placed to ensure water still had an opportunity for treatment before overflowing to traditional drainage.

There is currently no legislative requirement for water quality improvement on capital works or a pure roadway construction project. This project team insisted on incorporating water quality treatment into the design which has resulted in a great outcome for both council and local waterways.

When comparing this project against current best practice for new residential developments (i.e. Clause 56.07) the guidelines are well exceeded.

## The location

Upon first visiting Broadmeadows you are presented with a very dry, dusty and windy locale. Adding another area of hard surfaces to that would only amplify those characteristics.

This project sought to understand and facilitate the need for all those hard surfaces but also looked to utilise the subsequent stormwater runoff in a fashion that softens the look, feel and function.

It holds stormwater back in the catchment and sustains new vegetation in a way that facilitates an improved micro-climate.

Dense canopy foliage and lush lower groundcovers provide visitors and users with shade and moisture which in turn lower temperatures. On the face of the passive watering elements alone, significant benefits are prevalent.

On this project, the need for council to visit the trees for watering is dramatically diminished even over the summer periods with short rain burst providing regular sustenance and nutrients. This will in turn lower council's dependence on the potable water supply system which lowers costs associated with visiting each tree.

With any new road project, hard surfaces are essential and normally result in increased peak stormwater flows and volumes to local waterways. In this project the potential peak flow rate off the site has been reduced as water filters through permeable pavements and bioretention systems before overflowing to the outlet drainage. Peak flow volumes are also reduced as water is captured and held back for absorption and transpiration.

Without these treatment and water re-use systems, the project would have dramatically increased peak flows and volumes to the local creek causing significant deterioration.

In recent research by Chris Walsh (C.J Walsh - CRC Freshwater Ecology), it was found that an increase of effective impermeable surfaces to 0.1 could lead to deterioration in waterway health.

The key to this project is that it combines all these benefits without isolation. The project ticks all the boxes for council including pedestrian amenity, vehicle control and parking atop the benefits already listed for stormwater.

## Bioretention

Bioretention systems are becoming more common-place in developments throughout Australia. However, in this project their placement in a pedestrian refuge median under permeable pavement in the middle of a roadway sets them well beyond the scope of normality.

The entire road reserve is shaped so that in cross-section it all falls toward central median. This allows for one central treatment rather than a scattering across the project.

One key benefit of this is maintenance. It is one continuous system that council does not need to hunt for and it is the same over its entire length. Two surface treatments are used, permeable pavements and a garden bed. The garden bed surface is mulched and planted out similarly to standard bioretention systems, however, the mulch is filled to the top to prevent a potential trip hazard (a concern of council). This means there is no clear or visible depression to encourage ponding.

It is the pore spaces between the mulch layer that facilitate ponding and the extended detention depth.

When using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC), considerations had to be made to ensure the analysis did not overestimate the nutrient reductions.

Note that HydroCon permeable pavement was specified as the surface and that these provide enhanced nutrient trapping ability in their cement compounds which provide ionic treatment targeting phosphorus.

As with the mulch, the pore spaces in the pavers together with pore spaces amongst the crushed rock bedding facilitate the extended detention ponding depth of the system. Again, pedestrian wet feet did not result as the water is captured within pore spaces and slowly filtered through the filter media.

Pavers were chosen instead of a constant pour permeable surface. This enables easier maintenance for council in the long-term. Should any pavers angle up due to root growth or settle differentially, maintenance crews can easily pick up a paver, backfill and level out before replacing it.


The pavers are easily maintained regularly using a street sweeper to remove captured sediment. If they become clogged, they are easily pried up for cleaning or replacement.

The project team communicated well, which enabled the water sensitive urban design to be completely integrated into the project rather than tacked on as an afterthought. In fact, the water sensitive urban design drove a greater amount of the project design, i.e. the inverted crown.

## Project completion

The final product showcases a very refined and polished finish. The development is in keeping with the surrounding colours and theme of the area while meeting the targets for pedestrian and vehicular movements as outlined by council.

While the real test will come when the new school opens later this year, the completed sustainable roadway will stand up to the test. The vegetation is thriving which is a key indicator of how well the system is operating.

During construction, the designers assisted by attending meetings with the contractor to explain the key elements and to ensure the design intent was realised. The contractor understood site instructions and constructed with all materials within specification avoiding the need to compromise (which would have impacted on environment performance).

Council has provided some anecdotal reports that during high flow events water was conveyed down the central median and through the permeable pavers without problems. All pavers have been finished flush with adjacent concrete surfaces to avoid trip hazards or sharp edges.

The colouring of treatments like permeable pavements and gravel mulch fit in with the colouring of unit pavers as chosen by the landscape architects. Tonal colour changes in the design enable users to subtly define vehicle and pedestrian zones.

Council demonstrated how satisfied it was with the finished product by hosting a launch party at the site and invited the Planning Minister to officially open the new road. Even the suppliers such as Hydrocon (the permeable paver supplier) were so impressed with the result they asked to use it in their marketing materials.

Hume City Council is working hard to improve the quality of council assets throughout its municipality. The Main Street Extension project is just one of those endeavours. Environmentally, the project has reduced peak flow rates and volumes to the local creek. It has also improved the quality of water flowing to the creek as it is filtered through a bioretention system or infiltrated through ground water. This is well beyond the expectation or requirements from any guidelines.

Economically, the project has a slightly higher capital investment for long-term gain. Passive tree and vegetation watering will certainly improve the overall economics of tree watering for council.

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# Qld pipeline boosts water supply reliability

*Highly commended at the 2010 IPWEAQ Awards, the Rockhampton to Yeppoon pipeline project featured a range of innovations and helped deliver a more reliable water supply to the region.*

This $49.4 million project provides a link between the Rockhampton and Capricorn Coast water supply networks.

The project has received Australian and Queensland Government funding and will supplement the existing Waterpark Creek source for the Capricorn Coast.

It involved approximately 42km of 600mm and 750mm diameter Ductile Iron Cement Lined pipeline as well as a pump station and a 10ML reservoir.

The project was developed and project managed by Livingstone Shire Council and post-amalgamation by Fitzroy River Water.

Design was carried out by Cardno and pipe/fittings supply was by Tyco. Separate construction contracts were used for:

- Major pipeline construction
- Pipe underbores

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If council were to implement a tree strategy that enforced passive watering like this, their tree watering days per year would be reduced to almost nothing. While permeable pavements are still at a premium price, more application and streamlined use will lower their cost.

Socially, this sustainable and environmental project is located in a prime educational and leisure precinct. With a school abutting the development there is ample opportunity to educate as new pupils file in and out of the school.

They will have cutting edge technology right at their doorstep without the need to put together an excursion. Council will also place educational signage on how each system operates to showcase that this street is innovative and special.

In the long term, tree canopies will filter the light and heat from a harsh summer sun while transpiration cools the local micro-climate. The landscape architects have placed a variety of seating elements throughout the precinct to ensure groups can chat and mingle.

Stakeholder consultation was extensive in this project. Council was the primary stakeholder whose project managers scheduled regular meetings with their internal stakeholders like the events team, maintenance crew, engineering, urban design, community engagement team, and councillors.

External stakeholders involved in the project meetings were Colonial First State (the adjacent shopping centre), Kangan Batman Tafe, the Department of Education and the Historical Society.

The project design team included Outlines Landscape Architects who were the project lead working directly for council. STORM was engaged through Melbourne Water to work with Outlines on the project.

With so many stakeholders there were a multitude of opinions and requirements. Every comment was analysed and considered at each step to ensure the team was not compromising on an important design aspect. It is an important fact that early concept designs were presented by council to the team for the road with a traditionally raised crown shape. Stakeholder collaboration and consideration resulted in the significant design change towards an inverted crown.

It was highlighted that a traditional crowned road and limited road reserve really restricted the ability to achieve best practice in water quality. It was through this intense collaborative stakeholder process that we were able to innovate and really showcase new design opportunities for Hume City Council.

The Main St Extension project was completed early 2010 with an inverted crowned roadway that showcased how to use every ounce of available space to improve water quality, safety and living.

- **Article contributed by STORM_CONSULTING.**