THE TREATMENT OF STORMWATER – WHAT'S THE ROLE OF THE ROADING ENGINEER?

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ABSTRACT

New Zealand is seeing the biggest change in water management legislation since the Resource Management Act became law in 1991. The National Policy Statement for Freshwater Management is setting water quality and quantity limits with a return to catchment management planning. Roading networks double as stormwater networks, due to their linear nature, roads cut across or down catchments. The roading network becomes a conveyance system for runoff not just from the road, but also adjacent land use. Roading engineers recognise that there are obvious stormwater treatment opportunities within their network; however, the treatment will go beyond just road runoff. This is where the quandary lies for the roading engineer, who should be contributing to treatment in the age of smaller budgets and increasing demands?

KEYWORDS

Catchment Management, National Policy Statement, roads, road run-off, catchment management plans

PRESENTER PROFILE

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1 INTRODUCTION

New Zealand is seeing the biggest change in water management legislation since the Resource Management Act became law in 1991. The road transport network in New Zealand is one of the nation's most significant pieces of built infrastructure. The road network and its activities generate stormwater pollutants such as heavy metals. Roads also act as conveyance systems for stormwater runoff from adjoining land uses. The proposed legislative changes are leading to an increase in stormwater treatment requirements and this paper is exploring what implications this may have, and a possible solution, for roading engineers.

This paper provides an overview to the New Zealand road network and the types of stormwater contaminates that are generated. The paper also outlines how the proposed amendments to the Resource Management Act through the National Policy Statement for Freshwater Management amendments may impact on roading activities. Finally the implications of these changes are assessed, highlighting the need for roading engineers to partake in the development of integrated catchment management plans.

2 ROAD TRANSPORT NETWORK

The road transport network in New Zealand is 94000km long and consists of 11000km of State Highways and 83000km of local roads of which 39% (32370km) are unsealed. The State Highway network is managed and operated by the Highway and Network Operations group within the NZ Transport Agency, while local roads are managed by the 61 territorial authorities and 6 unitary authorities' jurisdictions they fall within. The road network is funded through the National Land Transport Fund and local rates and is a significant public asset which enables people to get to and from work, provides a convenient and robust route for freight and connects communities (NZTA, 2013).

The roading network is required to manage stormwater quantity and stormwater quality. Stormwater quantity focuses on flooding and stream channel instability. Flooding is caused due to the increase in impervious surfaces which increases the peak rate of stormwater discharges to receiving systems (i.e. streams). This increase in flooding in a stream can cause stream instability by eroding banks and the stream bed.

Stormwater quality is impacted by the contaminants generated from vehicles using the road. The primary stormwater quality contaminants from vehicles are;

- Particulates
- Lead
- Zinc
- Iron
- Copper
- Cadmium
- Chromium
- Nickel
- Manganese

Table 1 identifies some of the sources of the vehicle related contaminants (NZTA, 2010).

Table 1: Sources of vehicle related contaminants

Contaminant	**Source**
Particulates	Pavement wear, vehicles, atmospheric, maintenance works
Lead	Tire wear (lead oxide filler), lubricating oil and grease, bearing wear
Zinc	Tire wear (filler material), motor oil (stabilising additive), grease
Iron	Rust, steel highway structures, moving engine parts
Copper	Metal plating, bearing and bushing wear, moving engine parts, brake lining wear
Cadmium	Tire wear (filler material)
Chromium	Metal plating, moving engine parts
Nickel	Diesel fuel and petrol exhaust, lubricating oil, metal plating, bushing wear
Manganese	Moving engine parts

(NZTA, 2010)

It is stormwater quality rather than quantity that the remainder of this paper will focus upon; however, many of the same issues are applicable to stormwater quantity management.

Attempting to predict road stormwater contaminant loads is difficult. An international review of transport-derived stormwater road runoff contaminant discharge models found two approaches. The US Department of Transportation model (based on 993 events at 31 sites) was mainly concerned with streams and lakes. The UK model (based on 340 events at 30 sites) considered road runoff discharge from bridges and potential spills. Both models rely on water quality data that is not available in New Zealand.

The UK model suggested treatment of discharges from sites with less than 30,000 AADT (Annual Average Daily Traffic) would not achieve measurable improvements. The US model suggests effects were not expected until 50,000 AADT was exceeded. Both models found poor correlation between AADT and contaminant discharge (< 40% variation explained) (NZTA, 2011).

The uncertainty in the link between AADT and contaminant loads has made predicting contaminant loads very difficult. The high costs involved in establishing the actual loads and the uncertainty in the models is likely to be the reason why there is the variations in approaches as to when stormwater is to be treated, and when treated, how that treatment is delivered.

3 LEGISLATIVE FRAMEWORK

The road network and the associated stormwater management has one main regulatory requirement, the Resource Management Act 1991 (RMA). The "sustainable management" purpose of the RMA requires those exercising functions, duties and powers under the RMA to manage natural and physical resources in a way that avoids, remedies or mitigates any adverse effects of activities on the environment.

In the context of the RMA, the roading network is a physical resource and is required to be sustainably managed. Further still, section 17 places a general duty to avoid, remedy or mitigate any adverse effects of activities on the environment. In principle the avoidance of effects is often more cost effective than mitigation, however, avoidance of all stormwater effects from roads is not possible.

The effects are typically controlled by provisions in the regional plan – prepared to give effect to the RMA. New Zealand has 11 regional councils and 5 unitary councils (unitary councils have the functions of both a regional council and territorial authority) whom currently have regional plans with varying rules and requirements in regards to stormwater management (Ministry of Transport, 2007). This variation is often a criticism of roading engineers, however, could be explained by the varying regional environments and environmental pressures each region faces. For example, Auckland will have more concerns with urban type pollutants such as zinc and copper compared to Southland, due to the difference in quantities generated. However, the National Policy Statement for Freshwater Management 2011 came into effect on 1 July 2011 set a nationally consistent policy framework for regional plans to be prepared in accordance with; in regards to freshwater quantity and quality.

As indicated in the current governments (John Key lead 2nd term) environmental policy paper, the government is committed to implementing the findings of the Land and Water Forum, including providing more detailed national guidance on freshwater environmental standards (New Zealand National Party, 2012). Phase two of this increasing guidance through legislative reform was released for discussion in November 2013. One of the key

aspects of the discussion document is the potential introduction of a National Objectives Framework. The Framework will set national minimum acceptable states for freshwater. The first set of minimum acceptable states to be implemented will focus on attributes associated with agriculture, however, the Framework puts in place the mechanism to add minimum acceptable states for temperature, sediment and heavy metals in 2016-2019 (Ministry for the Environment, 2013) which are all associated with road runoff.

The minimum acceptable states will not provide the national consistency that many roading engineers seek, as they are just minimum standards – what the roading engineer needs to be aware of is when these minimum standards are being set and incorporated into the regional plans, they need to be working alongside the scientists and policy makers to ensure that the minimum acceptable states can be meet through cost-effective treatment solutions and that they have the funding available for any retrofits that may be required.

4 IMPLCATIONS FOR THE ROADING ENGINEER

As set out in section two, roads through their use generate contaminants that require treatment. Over the years treatment devices have been installed alongside the roading network intentionally and unintentionally. Intentional devices commonly constructed are swales, wet ponds, dry ponds, wetlands, sand filters and propriety cartridge devices. Such devices all have differing contaminant removal efficiencies, and are typically selected in the design phase of a project to meet the required treatment needs (NZTA, 2010).

Unintentional devices are found along a large proportion of the rural road network. The grass verges that line rural roads operate as filter strips. Even though they are not designed for stormwater treatment, they can reduce contaminant concentrations and loads (NZTA, 2011).

What does get overlooked when considering road stormwater treatment, is that the roading network also receives stormwater runoff from adjoining land uses and the road becomes the conveyance system. These overland flows in urban settings are likely to contain heavy metals and other contaminants that grab samples may indicate generated from the road and its activities and not sourced from other land uses in the catchment.

An example of this was a small catch-pit sample study from Napier (RCA, 2010) where the catch-pit with only 1500 vehicles per day (site 4) contained significantly higher concentrations of total copper, lead and zinc compared to a busy roundabout with 25000 vehicles per day (Site 1) as demonstrated in table 2. In theory the samples should have shown the inverse of this relationship. The likely source of the heavy metals was from residential homes, whose roof waste water entered the same catch pit as the road run-off. If the round-a-bout with 25000 ADDT was built today, stormwater treatment would be required and yet the residential street would still unlikely require treatment, yet from an environmental outcome, the investment in treatment would be better centred on the residential street.

Table 2: Comparison of catch-pit samples and daily traffic at four Napier sites

	Site 1	Site 2	Site 3	Site 4
Total Cu (g/m3)	<0.011	<0.011	<0.011	0.40
Total Pb (g/m3)	0.047	0.051	0.022	0.70
Total Zn (g/m3)	2.6	3.3	4.2	31
TCLP Cu (mg/kg)	88	92	48	330
TCLP Pb (mg/kg)	64	190	110	720
TCLP Zn (mg/kg)	380	1300	1200	2600
PAH	560	1600	150	3600
Daily traffic	25000	7000	1000	1500
Location	SH2/SH50	Maadi Rd	Alamein Cr	Dunlop Rd

Source: Napier City Council, Environmental Management Office

Such examples as the Napier catch-pit sampling demonstrate the difficulty in predicting contaminant loads. The one thing that is certain is that there are contaminants in stormwater in the roading corridor. That the contaminants are entirely sourced from roading activities, particularly in an urban context, is unlikely. Therefore, is it time that stormwater treatment was regarded as just another service utility in the roading corridor?

The roading corridor typically contains water, sewerage, electricity and telecommunication services. Such services are funded and provided through their respective operators, either through end user payments or a component of the properties rates. Such services are additional to the main purpose of the road itself. So is it time to consider and fund stormwater treatment in the same light?

As identified previously, the roading corridor acts as a conveyance system for stormwater runoff. The effect from individual properties means it is unlikely to be cost-effective to treat stormwater within the boundaries of all properties as the individual contaminant loads would be small. However, the cumulative effects are significant. This places the road corridor as an ideal place to concentrate and treat stormwater.

What needs to be determined if the roading corridor is utilised for treating stormwater is how it is funded. It is not the purpose of the National Land Transport Fund to be bank rolling the installation of stormwater treatment for contaminants in the roading corridor that are not associated with roading activities. This is especially important at time when funding is constrained for network maintenance.

Taking into consideration the current legislative reforms and the challenges facing roading engineers, there is one approach that provides optimism in that solutions can be found; through an integrated catchment management approach.

4.1 INTERGRATED CATCHMENT MANAGEMENT APPROACH

Integrated catchment management plans are becoming more widely utilised in New Zealand as a way to get all discharges in a catchment consented. The approach recognizes the connectivity between different parts of the environment and the cumulative impacts of stormwater discharges within these catchments. Such an approach provides the means for the treatment of stormwater to be prioritised and discussions can be held to determine the cost sharing approach and who will be responsible for the design, installation and maintenance (Rodrigo & Perkins, 2012).

An example of where this approach is currently unfolding is in Tauranga. The Tauranga City Council has obtained a catchment wide stormwater discharge consent from the regulator – Bay of Plenty Regional Council. The consent requires the development of a Stormwater Catchment Management Plan which considers land use development and the quality of stormwater. A roading project within this catchment would previously seek its own individual resource consent; however, this would struggle to consider the cumulative effects. Having a catchment wide approach has resulted in the roading project working in partnership with the adjoining land owners/property developers to establish the appropriate pre-treatment requirements prior to discharging stormwater into the Tauranga City Council stormwater network (G. Stephen, personal communication, Dec 16, 2013).

A key element in the successful development of integrated catchment management plans is for roading engineers to take an interest. It is these integrated catchment management plans that will help them meet the upcoming legislative requirements. Participation by roading engineers in the development of the integrated catchment plans has the potential to alleviate the funding gaps of building, operating and maintaining stormwater treatment devices on the road network.

5 CONCLUSIONS

The legislative amendments to the National Policy Statement for Freshwater Management are seeing a renewed focus on stormwater treatment in New Zealand. Roading in New Zealand does need to treat stormwater due to the pollutants that roading activities generate. However, that treatment may not be anything more than what is already occurring, especially through the use of grass verges on rural roads. In other areas there is a clear and obvious environmental need to consider road runoff within the context of the contaminants generated by other land use activities in the catchment, as demonstrated in the Napier catch-pit sampling.

The use of integrated catchment management approaches is a tool to connect land use activities with stormwater outcomes. The use of this tool provides a method for roading engineers to address both the stormwater treatment needs of their network and that of the catchment. While integrated catchment management plans is one tool to achieving this, the key message of this paper is not in regards to the tool to be used. The key message is that roading engineers need to take this seriously and participate in the discussions regardless of whether it is an integrated catchment management plan or not; otherwise they will have to live with the decisions made regarding the design, construction and operation of stormwater treatment and how that is funded. Roading

engineers need to move their approach from being one of the roads are not a contaminant problem, to an attitude that roads are part of the solution to treating stormwater quality in New Zealand.

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