Dunedin Cycle Lanes Safety Audit

New Zealand Cycling Conference – Christchurch, September 2001

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Abstract

Transit New Zealand's Dunedin office installed cycle lanes on a pair of one way streets in Dunedin, forming part of State Highway 1, in March 2001. The lanes are used by University of Otago students and commuters to Dunedin's central city area, amongst others. These were the first cycle lanes installed on State Highways in Dunedin.

A post-implementation safety audit of the facilities was undertaken at the request of Transit. It gave strong support for the cycle lanes, particularly where innovative approaches were taken with pavement markings. The audit identified a number of details of the cycle lanes where installation varied from current practice elsewhere in New Zealand. These variations typically resulted in well-designed and effective cycle facilities, indicating that cycle lane design is still an evolving art in New Zealand, and that there is still room for innovation. Some recommendations in the audit related to adjustments which could be made to improve the safety and effectiveness of the lanes. In addition, the audit recommended the review of various national standards and procedures for roads and cycling facilities.

This paper discusses the background to the installation of the lanes and the audit findings, from both the auditor's and client's perspectives. The paper also discusses potential improvements to New Zealand's cycle lane pavement markings and general road operating practices.

1 Introduction

This paper is based on a project commissioned by Transit New Zealand's Dunedin office to evaluate the safety of two new cycle lanes it had installed on Cumberland Street and Great King Street, part of State Highway 1 through central Dunedin. The work was undertaken by Montgomery Watson New Zealand Limited (now MWH New Zealand Limited). The product of the review was a published report[1] for the client. Simon Underwood, one of the authors of this paper, was responsible for the cycle lane installation and for requesting the safety audit; Andrew Macbeth, the other author, undertook the work for the consultant.

The audit made a number of recommendations for direct consideration by the Client. Other recommendations were made for consideration by the profession as a whole with respect to further development of cycle facility design guidelines and standards in New Zealand. The design and implementation of cycling facilities is still evolving in New Zealand, and different preferences are likely to emerge among different practitioners. The presentation of this paper is intended to stimulate debate about standards and guidelines for cycle lanes, with the goal of advancing the art and science of this branch of traffic engineering.

Section 2 was written by Simon Underwood and Section 3 was written by Andrew Macbeth. Other sections were written jointly. The views expressed in this paper are those of the authors and do not necessarily reflect the views of Transit New Zealand or MWH New Zealand Ltd.

2 Background

2.1 Site Description

The route concerned is the northernmost section of Dunedin's one-way pair (SH 1), which passes through the central city area. More specifically, it was the section between Frederick Street (towards CBD) and the confluence of the one-way pair (at the base of Pine Hill), resulting in a length of 1.5 km each way. This section links the northern suburbs, university campus, and CBD areas of the city.

Great King Street (SH 1 north) and Cumberland Street (SH 1 south) are a little under 14 m wide, although both streets are of variable width on the curvilinear sections at the southern (CBD) ends of each leg. They are configured generally with parking on both sides, two central general traffic lanes[2] and the new cycle lane on the left adjacent to the general traffic lanes. Each street has a 50 km/h speed limit and carries in the vicinity of 10,000 motor vehicles and 400 to 500 cyclists per day.

2.2 Cycle Lane Demand

The primary motivation for installing cycle lanes was the safety of cyclists, who stood out as vulnerable road users in both intersection and mid-block situations. While there are alternative routes available, the one-way pair is attractive for cyclists due to its directness, its connectivity with other routes, its proximity to the University of Otago and its physical attributes (for example, its flat grade, generally smooth surface and good level of street lighting).

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[1] *Stage 4 Post Implementation Safety Audit – SH1: Dunedin One Way Pair Cycle Lanes:* Macbeth, Andrew G, Montgomery Watson New Zealand Limited – June 2001.

[2] "General traffic lanes" in this report means lanes generally used by motor vehicles, but also available to cyclists. Consequently they are not called "motor vehicle traffic lanes". Similarly, they are not called "traffic lanes" because the cycle lanes are also "traffic lanes".

2.3 Cycle Lane Design Options

The one-way pair configuration opened up options in terms of where and how the cycle lanes could be applied. The option adopted for each street of the one-way pair, however, would not necessarily be achievable or appropriate for an equivalent single, two-way corridor.

The principal goal was to provide a safer lane configuration for cyclists travelling along either the whole route, or along multiple blocks within the route, whilst also retaining the existing motor vehicle traffic operations of the corridor.

The physical objectives to achieve this goal were then simply:

- To provide wider shoulder areas for cycle use in mid-block situations, and
- To provide a dedicated lane at traffic signals for through cyclists.

These objectives were achieved by narrowing the two general traffic lanes from 3.5 m to 3.25 m. The "extra" width of 0.5 m was then allocated to the left-hand shoulder only. A range of alternative lane configurations was considered, including further narrowing of the general traffic lanes to achieve a cycle lane on both sides of each corridor. While such a configuration may be desirable on a single, two-way road, in this case, the opportunity was taken to concentrate efforts on achieving a single, wider cycle facility on one side of each corridor only. With a total road width of less than 14 m, insufficient road width existed to put cycle lanes on each side.

2.4 Form of Cycle Lanes

(a) Mid-block

The narrowing of the two general traffic lanes resulted in a left shoulder width of between 3.9 m and 4.2 m (inclusive of kerbside parking). This allowed a nominal 2.0 m for kerbside parking, 0.7 m clearance between parking and the cycle lane (for car door opening) and a 1.3 m wide cycle lane. The right hand shoulder remained unchanged at a width of 3.2 m to 3.6 m (inclusive of kerbside parking). This right shoulder width was still considered necessary to accommodate manoeuvring for kerbside parking, and to provide space for cyclists preparing to turn right at the intersection ahead.

The two general traffic lanes remained identical in terms of traffic function and general layout. Each also had an outside shoulder, except that the left shoulder was now wider than that on the right. Although marginally narrowed, the two lanes remained equivalent in layout to that of adjacent sections of the one-way pair, beyond the extent of this project. The one-way pair, as a whole, is also a heavily signalised route with each signal controlled intersection also having dedicated turn lanes.

As a consequence, no change in edge line treatment was made for the general traffic lanes. This also enabled explicit guidance to be given to motorists wishing to move from a general traffic lane into a dedicated turn lane. The recommended location for these manoeuvres was identified by using a dashed continuity line across the nominated divergence area, in a manner typical for these situations.

For continuity between intersections, an outside edge line to the cycle lane was also marked. This was intended to separate cycling from opening car door activity. In practical terms, however, due to its location beyond the marked kerbside parking stalls, as borne out by the safety audit, the functionality of this line is more subjective.

(b) Intersections

At signal controlled intersections with dedicated left turn lanes, the mid-block parking and clearance widths were sufficient to provide for the left turn lane. The cycle lane itself then slots between the turn lane and the adjacent general traffic lane, as illustrated in Photo 1 below. Cyclists wishing to turn left or right are expected to use the dedicated turn lanes respectively, along with general traffic.

During the project design phase, other intersection enhancements were considered, although not applied, as they were still under trial at sites elsewhere in New Zealand (for example pulling back limit lines on general traffic lanes to increase cyclist conspicuity; and cycle "hold boxes" ahead of the left turn lane). These treatments will be considered for future application in Dunedin, on a case-by-case basis, depending on the outcome of these trials.

Photo 1: Typical layout at signalised intersection.

2.5 Purpose of Post Implementation Safety Audit

Throughout the design, review and consultation stages of the project, several key decisions were made on the form of the cycle lanes. The post implementation safety audit was an opportunity for independent review of how effective the adopted design was in practice. It also would identify any safety concerns which might need to be addressed.

Ultimately, it is expected that the cycle lanes will be extended further south along the one-way pair. Accordingly, it was felt that the design and operation of the existing cycle lanes should be thoroughly reviewed to allow lessons learned to be applied when the cycle lanes are extended.

3 The Safety Audit

3.1 Safety audit process

Road safety "audits" are independent safety reviews of road transport projects or facilities. They can be done for existing or proposed facilities. The essential elements of road safety audits are:

- They are carried out by people who are independent of the design or construction,
- They are carried out by people with appropriate experience and training,
- They are restricted to road safety concerns, and
- The process is formally documented.

This project involved inspections of the two streets by day and by night, by car, on bicycle and on foot. Andrew Macbeth was accompanied by an experienced traffic engineer and safety auditor from MWH's Dunedin office during the driving portion of the audit and by a member of SPOKES, a Dunedin-based cycling advocacy group on the cycling portion of the audit. Observations were recorded on paper and by camera.

3.2 Safety audit findings

The overall findings of the audit were that the Dunedin State Highway 1 one-way pair cycle lanes appeared to have significantly improved safety (and comfort and convenience) for cyclists in this part of Dunedin. Transit's decision to install just one cycle lane on each street, and to locate it on the left side of the road, were endorsed. The use of a solid white edge line on the right side of the cycle lane was also supported.

The audit noted that the cycle lanes had increased the space available for cyclists by narrowing the general traffic lanes and had increased the profile of cycling on the streets by introducing dedicated cycle lanes. They also had possibly reduced the speed of motorised traffic by reducing the general traffic lane widths from about 3.5 m to about 3.25 m.

It was observed (through specific bicycle counts undertaken both before and after installation of the lanes) that cyclists had demonstrated their support for the new facilities. Most cyclists use the cycle lanes (on the left side of the road) instead of cycling on the right side or on the footpaths. On Great King Street, for example, nearly 50% of cyclists cycled on the right side of the street prior to installation of the lanes, but this reduced to about 14% two months after the lanes had been installed.

While the overall conclusion from the audit was that the cycle lanes appeared to have significantly improved cyclist safety, a number of potential improvements to the facilities were identified. In addition, a number of national issues were highlighted.

Specific recommendations dealt with items such as redundant pavement markings and raised reflective pavement markers left over from previous pavement marking designs. Some markings were missing.

Generally, it was felt that parking needed to be constrained as close to the kerb as possible (about 2.0 m) to encourage more orderly parking. Wider parking stalls tend to result in sloppier parking habits, reducing the amount of usable space for cyclists. This issue is particularly pertinent now from a national perspective as different road controlling authorities grapple with the same issue, and different solutions are being implemented. Opportunities to debate and resolve the issue, such as at this conference, should be used to full advantage.

One of the reasons car drivers parked far from the kerb appeared to be the excessive build-up of asphalt at the edge of the road. In some locations, the difference between the elevations of the edge of seal and the lip of the drainage channel exceeded 5 cm, as illustrated in Photo 2. In this case, cyclists inadvertently straying off the seal (or forced off by errant motor vehicles) might fall into the road while trying to return to the roadway.

The use of a left edge line some 2.7 m from the kerb was considered to be superfluous and potentially confusing. Instead, it was recommended that the left edge line for the cycle lanes be removed in favour of parking markings located about 2.0 m from the kerb to encourage car drivers to park close to the kerb. The need for a left edge line for the cycle lane (to define the car door opening envelope, as in Photo 3 below) was considered to be less compelling than the need to simplify the pavement marking design. In some locations, three parallel lines exist in the space of two metres (as in Photo 3). Cyclists routinely cycle alongside parked cars and appreciate the potential of winning the "door prize". In constrained traffic conditions, cyclists tend to cycle as close to the general traffic lane and as far from parked cars as possible. The widening of the space between parked cars and the general traffic lane, combined with the cycle lane's solid edge line on the right, were the design features of greatest merit for cyclists.

Excessive asphalt build-up is illustrated in Photo 2 and typical pavement markings are illustrated in Photos 3 and 4 overleaf.

Photo 2: Excessive build-up of asphalt presents a potential hazard to cyclists

Photo 3: Poor parking discipline puts cyclists at risk from opening car doors.

Photo 4: The left edge line for the cycle lane would be more useful closer to the kerb to constrain parking.

The audit recommended using coloured surfaces for the cycle lanes in locations where particular emphasis was needed, such as left-hand bends and places where the cycle lane is located between two general traffic lanes.

3.3 National Issues

The audit noted that traffic engineering practitioners in New Zealand have conflicting standards at their disposal for implementing cycle lanes. For example, MOTSAM[3] requires cycle lanes to be marked with dashed lines (a 1 m dash followed by a 5 m gap), whereas Austroads[4] specifies a solid edge line. The audit endorsed the Australian standard as opposed to the New Zealand one. Another difference between the standards is the cycle lane symbol. The Australian symbol is larger, with thicker lines, and is much more prominent than the New Zealand equivalent. Again, the Australian symbol is preferred. The purpose of a cycle lane is to create extra space for cyclists and to reinforce the presence and legitimacy of cyclists on the road. The more definitive the pavement markings, the more effective are the cycle lanes. In both cases where the Australian standard is preferred over the New Zealand equivalent, the rationale is the increased visual prominence. The audit recommended that pavement marking standards for cycle lanes be reviewed for New Zealand in the light of local and overseas best practice.

Concern was expressed in the audit for the edge of seal condition on New Zealand roads, in that no standards could be found detailing the relationship between the level of the edge of seal and an adjacent concrete channel. In Dunedin (and elsewhere in New Zealand), roads are often resealed with asphalt accumulating to significant depths (often over 5 cm) at the road edge. This can result in unsafe cycling conditions, where cyclists who stray off the asphalt might not be able to return to the roadway. In addition, where parking is authorised, some drivers seem reluctant to park close to the kerb if there is a large drop to the drainage channel. This results in parked cars encroaching into the space needed by cyclists. The audit recommended the creation of national standards for edge of seal/lip of channel transitions.

Many New Zealand roads (including portions of the streets that were the subject of the audit) have chip seal surfaces. Cyclists not only prefer smooth surfaces (such as asphalt) which take less energy to propel the bicycle, but it can be argued that smooth surfaces result in less injury to cyclists if they fall (or are knocked off) their bikes and slide on the road. The audit recommended that national policies and practices be reviewed for selecting State Highway surface materials, with a view to facilitating a gradual transition from chip seal to asphalt in urban areas and other locations with high levels of cycling activity.

4 Conclusions

The audit made a number of recommendations. Some of these were specific to the project, and will need to be considered by Transit for implementation as it deems necessary and cost-effective. Other issues are more national in scope, and may lead to the revision of national standards.

The installation of cycle lanes on Dunedin's one-way pair has provided more space for cyclists than was previously available. The lane is identified as a cycle lane, which helps legitimise cycling as a mode of travel. Cyclists appear to support the new facilities, in that the vast majority are now using the cycle lanes on the left of the roads as opposed to cycling on the right side of these roads.

The decision to install the lanes on the left side of the roads was endorsed by the audit, as was the decision to mark its right edge line with a solid white line. The audit recommended removal of the left edge line, and its replacement by markings defining the parking as close as practicable to the kerb.

The review of national standards and guidelines was advocated with respect to cycle lane pavement markings, coloured surfaces and traffic signs. In addition, road surfaces and edge of seal/lip of channel transition standards should be reviewed generally for New Zealand roads.

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[3] Manual of Traffic Signs and Markings – Transit New Zealand 1997

[4] Guide to Traffic Engineering Part 14 (Bicycles) – Austroads 1999