VIASTRADA

TRAFFIC ENGINEERING AND PLANNING

LAKE ROAD CYCLE OPTIONS

Report prepared for

North Shore City Council

ViaStrada Ltd

November 2008

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Summary

Cycle lanes have been approved by North Shore City Council (NSCC) for installation on Lake Road between Esmonde Road and Hauraki Road, a distance of about 600 m. ViaStrada Ltd has been asked to develop and review options for accommodating cyclists on this 23 m road corridor carrying four lanes of motor vehicles.

Some 18 options have been developed. All options have some advantages and some disadvantages. They make tradeoffs amongst the various competing uses of road space on Lake Rd. These uses include pedestrians, cycles, cars, trucks and buses. Some design options make it easier for drivers to turn right into driveways and side streets; others restrict this facility. Some will encourage higher motor vehicle speed. Some will feel more comfortable for cyclists; some options provide for off-road cycling on cycle paths while others provide for cycling to be done on-street though cycle lanes. Some options provide more space for pedestrians.

The approved concept plan (described as Option 1 in this report) has 1.5 m wide cycle lanes on each side of Lake Rd. In our opinion, these are too narrow to satisfy the appropriate design guide and this design should not be used. We are concerned that this design would be unsafe for cyclists. Different people will prefer different options after balancing all the variables, depending on their own perspectives and experience as pedestrians, cyclists and drivers.

Our preferred option is Option 7, which consists of a 1.7 m cycle lane downhill (northwards) and a 2.0 m uphill cycle lane to accommodate overtaking manoeuvres. This is more space-efficient than providing 2.0 m cycle lanes for both directions. This option provides a 2.8 m western footpath and 2.0 m median midblock. The median can be widened to 2.5 m at side roads to accommodate turning manoeuvres by reducing the through-traffic lanes at these intersection locations to 2.9 m.

Our second choice is Option 3. This is similar to Option 7 but has both cycle lanes at 1.7 m wide, with slightly more width in the median and footpaths.

Both these options (and any others involving cycle lanes) can use textured lane markings (Option 4) to reinforce the presence of the cycle lane. We recommend that this should only be used at “stress points” (along with coloured surfacing) to discourage motorists from cutting into the cycle lanes.

We have some concerns over the existing layout at the Esmonde Rd intersection in terms of cyclist safety. We also feel that, in general, the cycle lanes at the side roads should include continuous green surfacing across the side streets to reduce the likelihood of right turning traffic from Lake Rd turning through queues of waiting traffic in the opposing direction and colliding with cyclists on the cycle lane. This was previously identified as a problem further south on Lake Rd. We recommend that this be re-visited when detailed design for Lake Rd between Esmonde Rd and Hauraki Rd is undertaken. As part of this redesign, we recommend the use of textured lane markings as a trial at the Lake Rd / Esmonde Rd intersection for the northbound to westbound cycle lane.

Once a cross-section has been selected for Lake Rd, considerable care will be needed in translating the design into a viable plan. In particular, transitions at each intersection will need to be designed to provide safe operating conditions for all road users.

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1 Introduction

Cycle lanes have been approved for installation on Lake Road between Esmonde Road and Hauraki Road, a distance of about 600 m. ViaStrada Ltd has been asked to develop and review options for accommodating cyclists in light of concern for the safety of cyclists on this road, which carries around 40,000 motor vehicles per day. The location is illustrated in Figure 1.

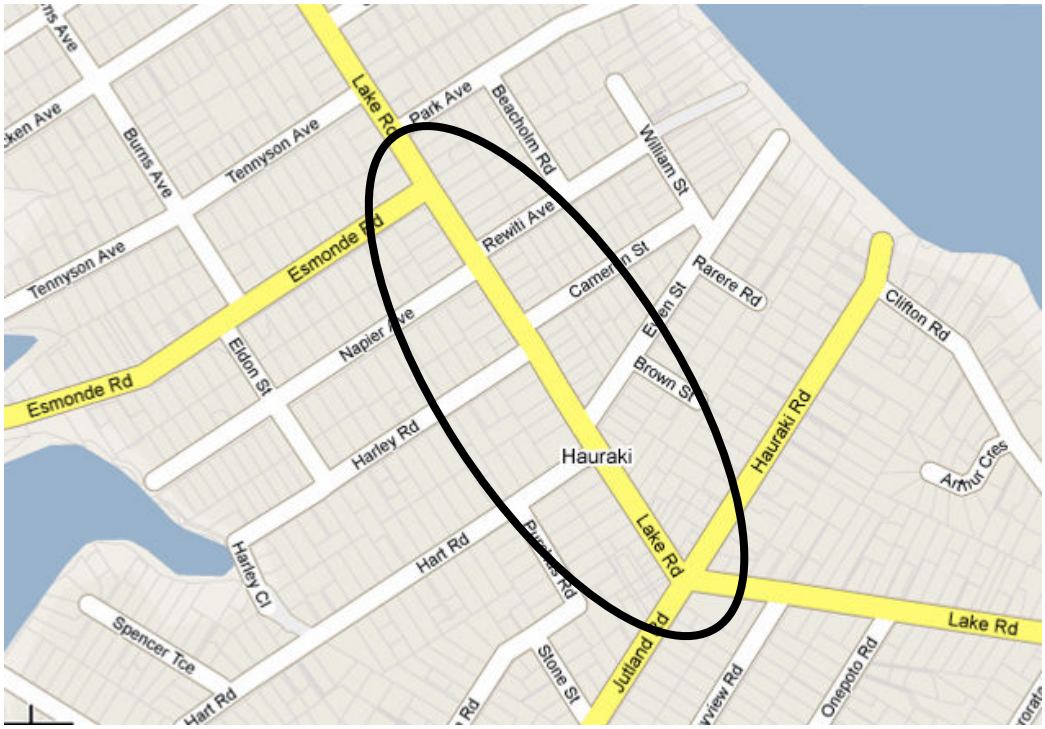


Figure 1: Location Map

Cycle lanes already exist further south on Lake Road and are proposed to connect Devonport to Takapuna in the regional cycle network, a distance of about 5 km. The current proposal for Lake Road aims to provide a significant improvement in travel amenity for both motorists and for active transport modes (walking and cycling). National targets from the NZ Transport Strategy 2008 require 30% of all urban travel to be by walking and cycling by the year 2040. Cycle traffic volumes are not expected to be 30% of motor vehicle traffic volumes, however, as cycle trips are typically shorter than motor vehicle trips. So if equal numbers of trips were done by cycle as by car, "vehicle kilometres travelled" (VKT) and consequently traffic counts, would be greater for cars than cycles. Motor vehicle traffic volumes are also likely to reduce over this time frame, as people transfer from car to public transport, walking and cycling.

On Lake Road, achievement of the national (or imminent regional) cycling targets might result in cycle traffic volumes increasing from current levels of about 400 cyclists per day to 4,000 per day or more. This would equate to approximately 200 cyclists in the peak hour in each cycle lane.

Surveys done on Lake Rd at Takapuna Grammar School show that two thirds of cyclists at that location were adults (as commuters) rather than school students and three quarters cycled on the road, as opposed to the footpath. These proportions would be higher on the Esmonde Rd to Hauraki Rd section of Lake Rd, as it is further from the school. The dominant demographic of cyclists for design purposes is thus adult commuters, although a good facility design will be likely to broaden the appeal of the route for other cyclist types.

Council staff have reported exhaustively over recent years on the Lake Road corridor upgrade project. In the agenda for the 16 October 2008 meeting of the Infrastructure and Environment Committee, a staff report of over 100 pages discusses Stage 2 of the project. Amongst other things, it discusses the need for "improved separation of the on-road cycle lanes from the traffic lanes" as follows:

> "While there is an understanding that on-road cycle lanes are acceptable in given situations, there is a need to ensure that safety has been maximised along this section of Lake Road. Officers have been looking at several options as a result of representations made to several councillors:
>
> - The possibility of creating a solid "mini-median" between the cycle-lanes and the adjacent traffic lanes has been investigated. Initial indications are that the maximum width of such a mini-median would be 300 mm (because of the current road reserve), and would be significantly broken up because of the driveways and intersections along this length of road. These narrow barriers are seen to be hazards to motorists and cyclists alike.
> - It was thought that the white line could be painted as a "rumble strip". However, some cyclists have indicated that this could be a hazard because it may cause bicycle tyres to slip.
> - There is the possibility of placing the gutter between the cycle lane and the traffic lane. There needs to be further investigation into the types of grate that might be used in these circumstances so as to avoid the creation of a hazard.
> - Officers are also looking into the practicality of creating the cycle lane from a different material than the road so that it is clear that it is an element that has a different function.
>
> These and other options will be further investigated and reported back to the Committee prior to the implementation of the Stage."

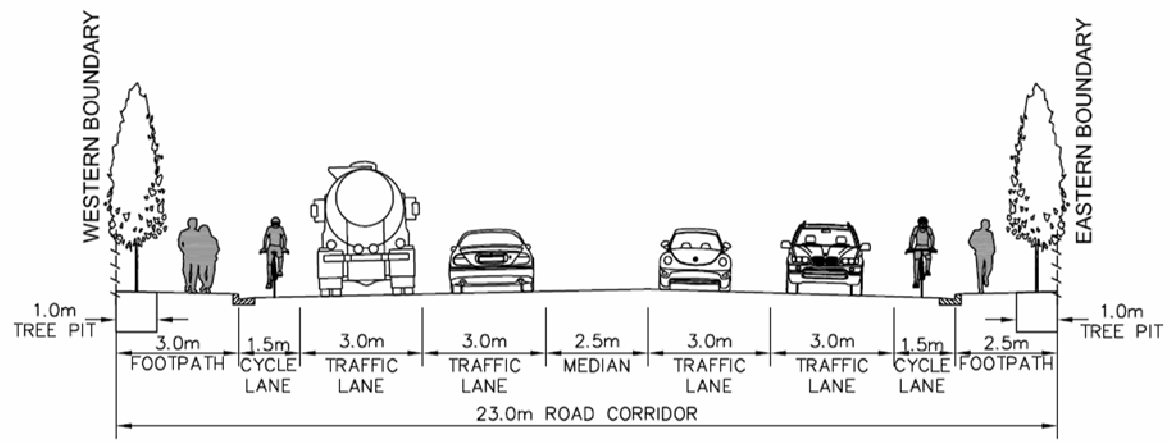
This (ViaStrada) report is intended to provide technical information and expert advice on the options to inform the decision-making process.

2 Options

The approved cross-section ("base case cycle lanes") is discussed and various other options are considered in this section of the report. Intersection designs are equally important and are discussed as they occur. Three kinds of intersections (traffic signals, side roads and driveways) all need to be considered in determining the appropriate solution for Lake Road. The best way of resolving these intersection treatment issues is at the stage when detailed design drawings are produced.

In all cross-sections discussed below, widths for footpaths, medians, cycle lanes and general traffic lanes are measured from boundary, kerb face, or centre of lane line as appropriate. Considerable care will be needed in construction to ensure that lane lines are centred according to the dimensions shown in the plans. Some contractors take dimensions from the edge of the lane lines rather than the centre, resulting in lanes at the edges of the road (typically cycle lanes) being narrower than designed and approved.

2.1 Option 1: Base Case Cycle Lanes



BASE CASE CYCLE LANES

This cross-section provides a 1.5 m wide cycle lane on each side of the road. The New Zealand Supplement to Austroads Guide to Traffic Engineering Practice Part 14 Bicycles (the NZ Supplement) notes that 1.5 m is the "desirable minimum width" for a cycle lane next to the kerb when the speed limit is 50 km/h or less. However, when the 85th percentile speed is "significantly higher" than 50 km/h, then the 85th percentile speed should be used.

The 85th percentile speed of Lake Road averaged throughout the day is currently about 55 km/h, but is over 60 km/h during times when traffic volumes are low and drivers are not impeded by other vehicles. Operating speeds are expected to increase once the four-laning is complete. Accordingly, we recommend that an 85th percentile speed of 60 km/h is used for design purposes.

With an 85th percentile speed of 60 km/h, then by interpolation from Table 4-1 of the NZ Supplement, the "desirable minimum width" of cycle lanes should be 1.7 m. Lane widths below the "desirable minimum width" (such as the 1.5 m wide cycle lanes in the base case) "should only be used in low speed environments and when it is not possible to achieve greater widths", according to the NZ Supplement.

The NZ Supplement also notes that "minimum width cycle lanes adjacent to narrow traffic lanes should be avoided". This provides another reason for rejecting cycle lanes that are 1.5 m wide.

As a general rule, cycle lanes narrower than the "desirable minimum width" should only be used for occasional "pinch points" on existing roads where cycle lanes are being retrofitted, rather than applied as a continuous width on new cycle lanes. This portion of Lake Road is a new facility (including the opportunity to define new kerb locations) and providing at least the "desirable minimum width" is strongly recommended.

The NZ Supplement also notes that "if cycle traffic flows exceed 150 in the peak hour, then additional width to accommodate overtaking manoeuvres should be considered". The Lake Road facility is expected to carry more peak hour cycle traffic than this threshold over the design life of the project, so a width of about 2.0 m would provide for this function. Cycle lanes wider than 1.5 m are discussed in other options.

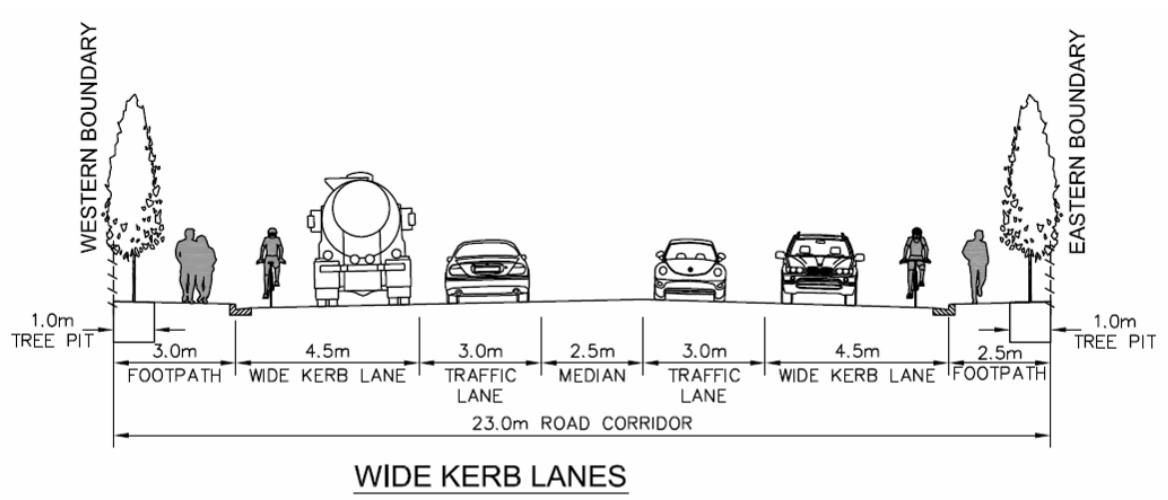
The presence of a sub-standard cycle lane would provide some benefit to cyclists in that it would encourage motorists to position their vehicles in the centre of their lane. This would create more space for cyclists, even though the cycle lane is too narrow. This treatment is not recommended, however.

If the median and footpath widths are to be retained as shown in the base case, then consideration should be given as to whether the road should be marked with cycle lanes that do not comply with the NZ Supplement, or whether the cycle lanes should be omitted in favour of wide kerb lanes. This is discussed in the next option.

It would also be possible to install an edge line 1.5 m from the kerb (but to not mark the space as a cycle lane as it does not comply with the NZ Supplement) to encourage motorists to keep away from the kerb, creating a pseudo, unmarked cycle lane. We do not recommend this sub-option as it may create a false sense of security for cyclists and would place them too close to fast-moving traffic. It also would not provide the marketing advantage of marked cycle lanes, and would not allow coloured surfacing to be used through intersections, as this should only be used in legitimate cycle lanes.

The "base case" with its 1.5 m wide cycle lanes is thus not recommended.

2.2 Option 2: Wide Kerb Lanes



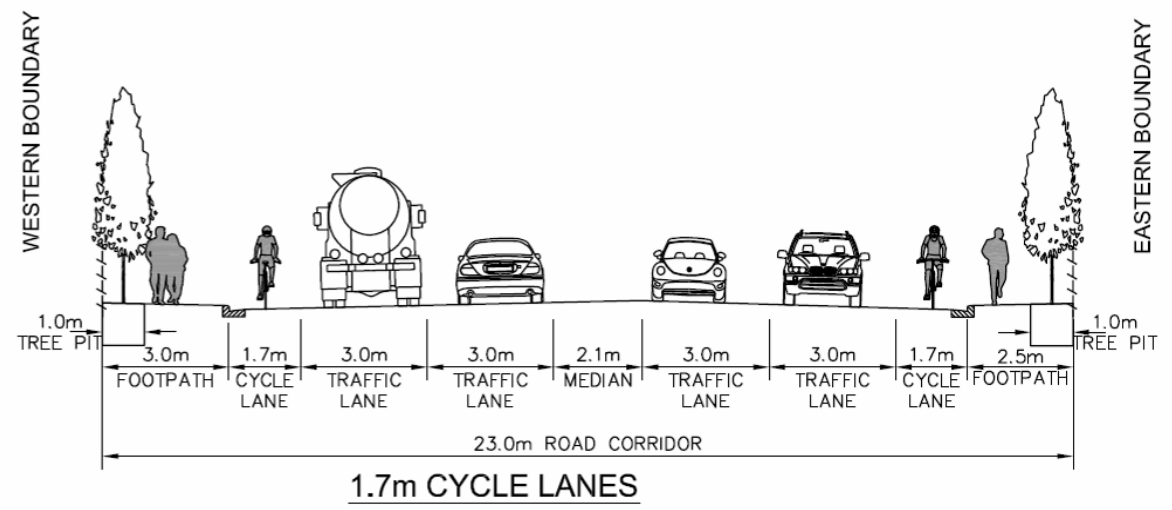
Wide kerb lanes provide additional space next to the kerb for cyclists to share with motor vehicle traffic. They are typically used only where there is insufficient width to mark conventional cycle lanes. They provide a lower level of service for cyclists and do not provide any visible indication to either motorists or cyclists that the space beside the kerb is for cyclists, thus they have no potential for marketing cycling.

In practice, motor vehicles are likely to travel further from the kerb (thus creating more space for cyclists) if there is a cycle lane marking. Conventional cycle lanes actively promote cycling by identifying to road users that cycling is supported by the road controlling authority and accommodated as part of the transport system.

Motor vehicle traffic speeds are likely to be higher in wide kerb lanes than in narrower lanes, further reducing cyclist safety. If wide kerb lanes are to be established on Lake Road, parking should be prohibited through the use of yellow "no stopping" lines, otherwise some drivers may attempt to park in a lane that feels wide enough to accommodate this.

We do not recommend the use of wide kerb lanes on Lake Road.

2.3 Option 3: Cycle Lanes 1.7 m Wide



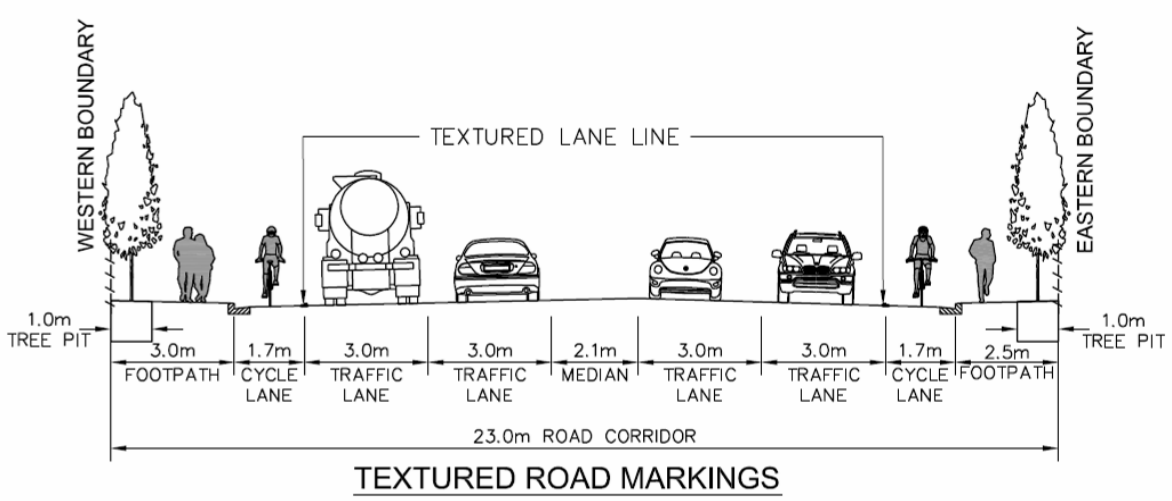
This cross-section provides 1.7 m cycle lanes instead of the 1.5 m lanes of the base case (Option 1). The cycle lane widths satisfy the requirements of the NZ Supplement.

This option can be achieved by reducing the width of the flush median to 2.1 m. This is considered to be acceptable in mid-block locations, but would be too narrow at intersections where a turning bay is required. The median can be retained at 2.5 m by either reducing the width of the four through lanes from 3.0 m to 2.9 m (just at the intersections, where lanes are often narrowed) or by reducing the width of the western footpath from 3.0 m to 2.6 m.

This option would use green surfacing at "stress points" such as the signalised intersection approaches and departures (where motor vehicle traffic merge and diverge movements are common) and across all side roads.

This is a good option in our opinion. A slight improvement on this option is discussed in Option 7.

2.4 Option 4: Textured Lane Markings



A slight improvement on the previous option could be accomplished by providing a textured lane line, such as an “audible textured edge line”, “profile line marking” or “vibraline” sometimes used on rural state highways. These lines create noise and vibration inside the vehicle and help alert drowsy drivers who may stray off the road.

Textured line markings have been successfully installed on inside curves on State Highway 1 in urban Dunedin to reinforce the presence of cycle lanes and discourage motor vehicles from encroaching into the lanes. The markings have been in place for about two years.

They are normally 7 mm high, but for these Dunedin installations they have been reduced in height to 4 mm to minimise the potential impact on cyclists and to reduce traffic noise for adjacent properties. A Dunedin installation of a textured lane marking defining a cycle lane alongside left bends where there has been a history of motor vehicle encroachment into the cycle lane is illustrated on the left of Figure 2. A more conventional rural installation (with a 7 mm lane thickness) is shown on the right.

Figure 2 : Textured road marking in Dunedin; 4mm urban (left) and 7 mm rural (right)

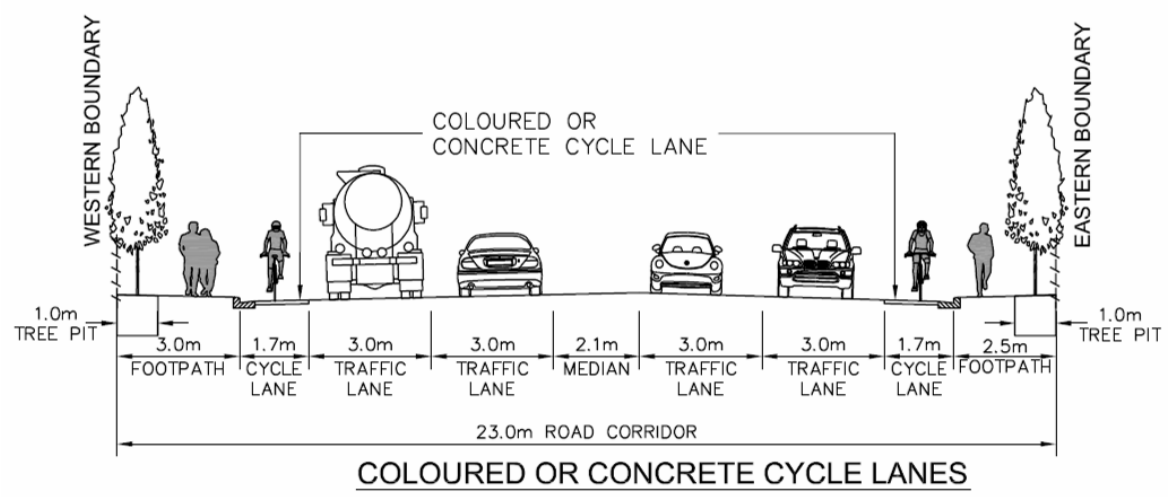
Low (4 mm) textured road markings may be a useful treatment for the insides of curves to support the cycle lanes. The cycle lane from Lake Road (northbound) to Esmonde Rd (westbound) is one location where this treatment is recommended for trial, as motor vehicle encroachment into the cycle lane is common. This location is illustrated in Figure 3.

Figure 3: Motor vehicle encroachment into cycle lane from Lake Rd to Esmonde Rd

If textured road markings were used to mark the cycle lane on straight sections of road, we recommend that the cycle lane should be at least 1.7 m wide and preferably 2.0 m wide so that cyclists do not need to cross the line when overtaking other cyclists.

We recommend their use as a trial initially at the Lake Road / Esmonde Road intersection, as illustrated. We do not recommend this as a continuous treatment along Lake Road, however, until the treatment has been tested on the Lake Rd / Esmonde Rd curve.

2.5 Option 5: Coloured or Concrete Cycle Lanes



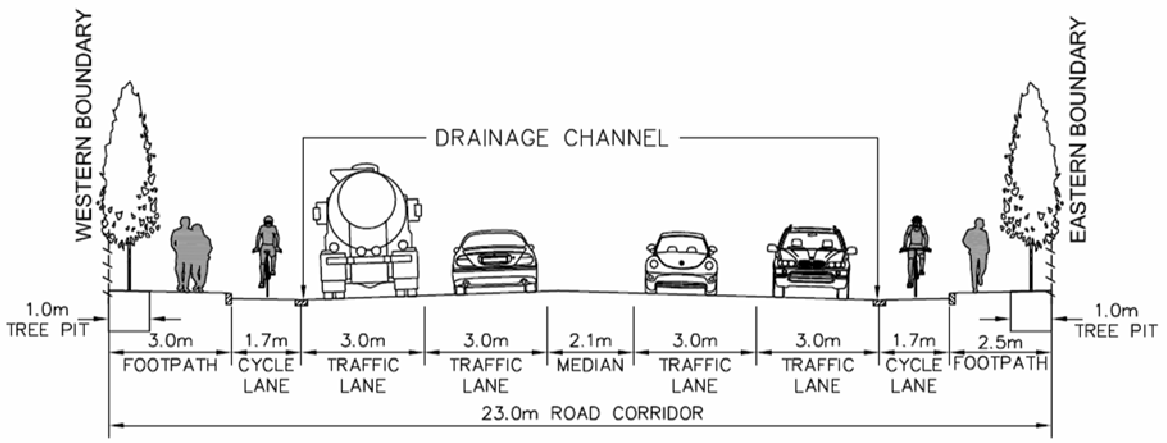
Surfacing the cycle lane in concrete (rather than asphalt) or colouring the lane green would help distinguish the cycle lane from the adjacent general traffic lane and may result in less motor vehicle intrusion into the cycle lane. It is felt that the difference would be rather subtle, however. Coloured surfacing is usually reserved for particular "stress points" such as at intersection approaches where motor vehicles are frequently crossing the cycle lane to accomplish left turns, or on the inside of left curves, where motorists often encroach into the cycle lane.

Concrete is less pronounced visually than a green surface treatment, is probably more expensive, and may result in differential settlement at the interface between the lane and the adjacent road, which would be potentially hazardous for cyclists.

The concrete surface would also have to vary at intersections and transitions to conform with best practice (green surfacing). This would mean that there will be three surface colours (concrete, green surfaced asphalt and regular asphalt) for drivers and cyclists to interpret, complicating the driving or cycling task. Another disadvantage of concrete would be that as these lanes would occasionally be travelled on by heavy vehicles (inadvertently straying into the lanes, turning or accessing driveways), they would need to be reinforced with steel, increasing their cost relative to asphalt. They would also complicate maintenance of the considerable number of underground services located in Lake Road.

We do not recommend the use of concrete cycle lanes. Green surfacing should be used to draw attention to "stress points" on the cycle lanes at curves and intersections, but not continuously throughout the cycle lanes.

2.6 Option 6: Drainage Channel Separators



DRAINAGE CHANNEL SEPARATOR

Aesthetically and from a safety view point this appears to be an attractive option, with a flat-profile or shallow V-channel (between 400 mm and 600 mm wide) separating cyclists and passing motor vehicles. It also sees the cycle lane rising from the low-point of the road up towards the footpath, and thus is likely to reduce the impact of driveways on the continuity of the longitudinal grade of both the footpath and the cycle lane. At minor road intersections, the channel could be carried through the junction, necessitating the alignment of the crown of the side road with the channel grade. This may not be desirable in some situations and is likely to complicate road drainage.

This section of Lake Road has a distinct longitudinal gradient (downhill in the northwards direction), and stormwater runoff from the road, cycle lane and footpath will accumulate in the V-channel. Compared with conventional kerb and flat channel, the V-channel will carry a relatively low volume of run-off before the water in the channel spreads out into the carriageway and cycle lane, creating a wide stream when rainfall is heavy. As this stream expands in width, the tyres of motor vehicles will be likely to spray large curtains of water into the cycle lane and even the footpath, over any cyclists and pedestrians alongside.

Increased frequency of flat-grate sumps (suitably aligned to not trap cycle wheels) along the channel run could help reduce the "stream" effect, but this concept is never likely to be as satisfactory for cyclists as if drainage is in the conventional location.

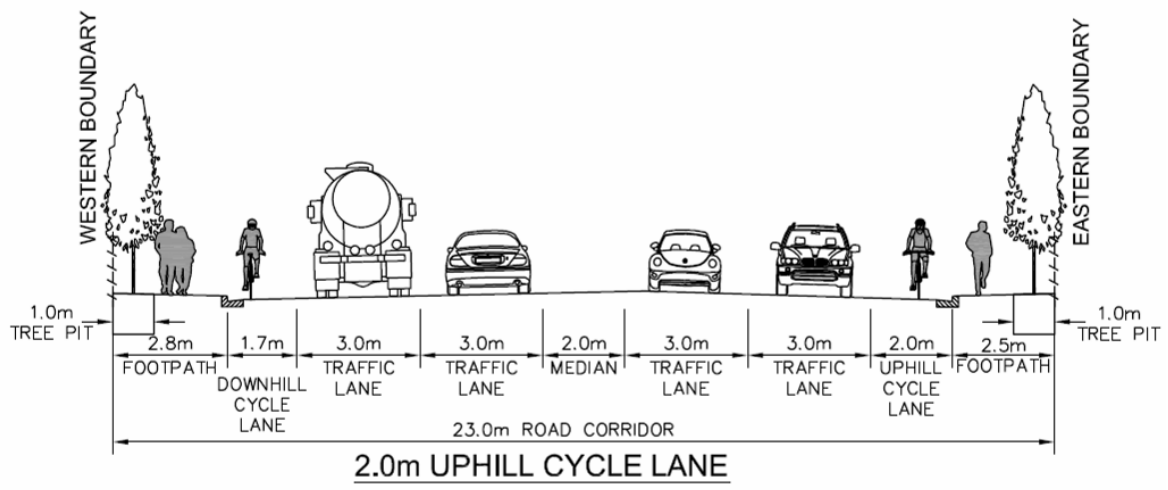
This concept is likely to increase the scale and cost of stormwater construction, and also street- and drain-cleaning maintenance operations. In detail, the stormwater sumps along the channel would protrude into both the cycle lane and the adjacent general traffic lane, placing obstacles in the path of motor vehicle and cycle wheels.

A better concept than a V-channel might be a continuous concrete slot drain. Holes or slots in the concrete cover would need to be small enough to not present a hazard for cyclists. Steel covers (as sometimes used for open-air pedestrian malls) are not recommended as they are likely to be slippery for cyclists in wet weather. Storm intensities are expected to increase through climate change in the foreseeable future and thus the stormwater design would need to provide ample capacity.

The use of a concrete slot drainage system or V-channel close to the line of motor vehicle travel is likely to be difficult to implement robustly, as the flexible pavement either side will be prone to "pumping" beside the relatively stable channel and sump structures. This would be likely to promote early failure of the road's water-tightness in the critical point beside the channel, resulting in pothole formation at the most sensitive area beside the cycle lane. Piecemeal repair efforts frequently do not restore the high-quality running surface required by cyclists. This practical issue further reduces the viability of this option.

There may be design difficulties with drainage from adjacent low-lying properties, as the invert of the drainage system would be lower than with a more conventional kerb design. Accordingly, we do not recommend this option.

2.7 Option 7: 2.0 m Uphill Cycle Lane



This option establishes a cycle lane wider than the "desirable minimum width" of 1.7 m, but just in the uphill direction (east side) where the speed differential amongst cyclists is likely to be higher than in the downhill direction. Space is at a premium on Lake Road and creating both cycle lanes 2.0 m wide, while ideal from a cycling perspective, may not be justified in terms of competing demands for road and footpath space.

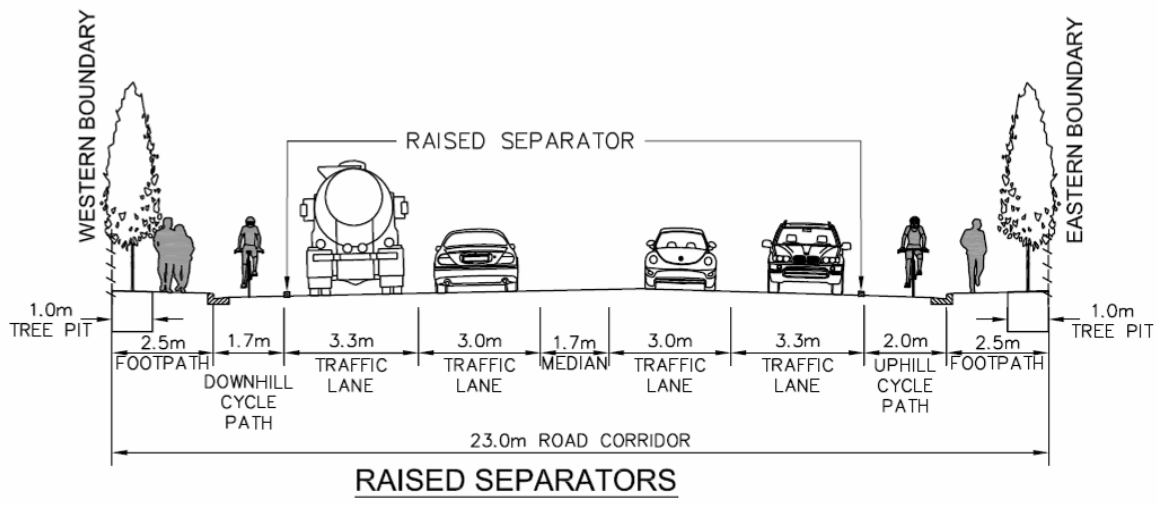
A 2.0 m uphill cycle lane would provide the opportunity for faster cyclists to overtake slower cyclists without leaving the lane, a feature that is likely to be increasingly valued in future as cycle traffic volumes increase. It also would increase the separation between motor vehicles and cyclists, improving the comfort and safety of both drivers and cyclists.

This cross-section requires the narrowing of the west footpath to 2.8 m and median to 2.0 m. The uphill cycle lane could narrowed to 1.9 m and the four through lanes could be narrowed to 2.9 m at each right turn pocket at the side streets, to allow for a 2.5 m turn lane. The uphill lane should also be reduced to 1.7 m at the Hauraki Rd signalised intersection to discourage car drivers from using the cycle lane as a "queue jump" lane.

This option provides a better level of service for cycling than Option 3 (1.7 m cycle lanes in both directions) and would accommodate the subsequent use of textured lane markings if they prove satisfactory in trials recommended in Option 4.

Accordingly, Option 7 is our preferred option, retaining as much functionality and safety for all road users as possible in this constrained corridor.

2.8 Option 8: Raised Separators



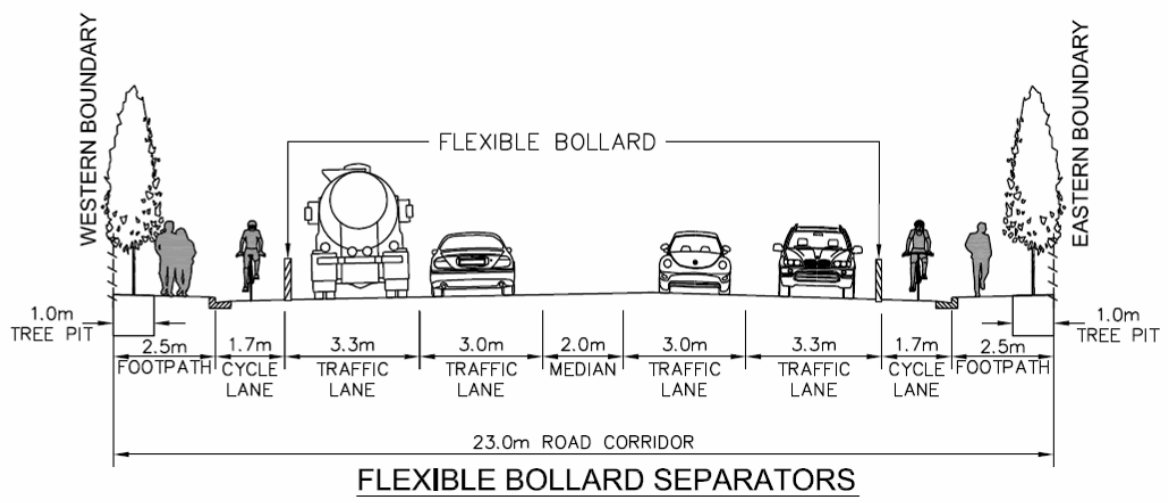
A raised separator could consist of a low kerb (say 100 mm high and a similar width), a low-profile rubber judder bar mounted longitudinally in the road, or raised reflective pavement markers (RRPMs). They all would present hazards to cyclists to a lesser or greater degree. If cyclists stray onto them, they run the risk of overbalancing and falling into the adjacent traffic lane with consequential safety risks. This risk would be exacerbated as the height of the separator increases. The separators might be more difficult for cyclists to observe and negotiate in wet weather or at night.

If such a concept is to be implemented, the adjacent cycle lane would need to be wider than otherwise, so that cyclists could overtake other cyclists without having to cross the separator. A minimum lane width of 2.0 m is recommended. A kerb separator would require a “shy space” for drivers too, increasing the required motor vehicle lane width by about 0.3 m. This additional space is not available without reducing the width of the flush median. An example of separators (for trams, rather than cycle lanes) in Melbourne is illustrated in Figure 4.

Figure 4: Raised separators (Melbourne)

The kerb separators would be significantly broken up because of driveways and intersections along this length of road. The separators would pose trip hazards for pedestrians crossing mid-block, although this practice would not be recommended. We do not recommend this option.

2.9 Option 9: Flexible Bollard Separators



This option provides a more positive separation between cyclists and motor vehicles than a simple cycle lane marking, and would feel safer to cyclists. The space requirements would be significant, with the cycle lane ideally needing to be 2.0 m to accommodate overtaking and to provide a "shy space" for cyclists, although 1.7 m would provide a barely satisfactory width if overtaking were not accommodated.

Flexible bollards (in Silverdale) are illustrated in Figure 5.

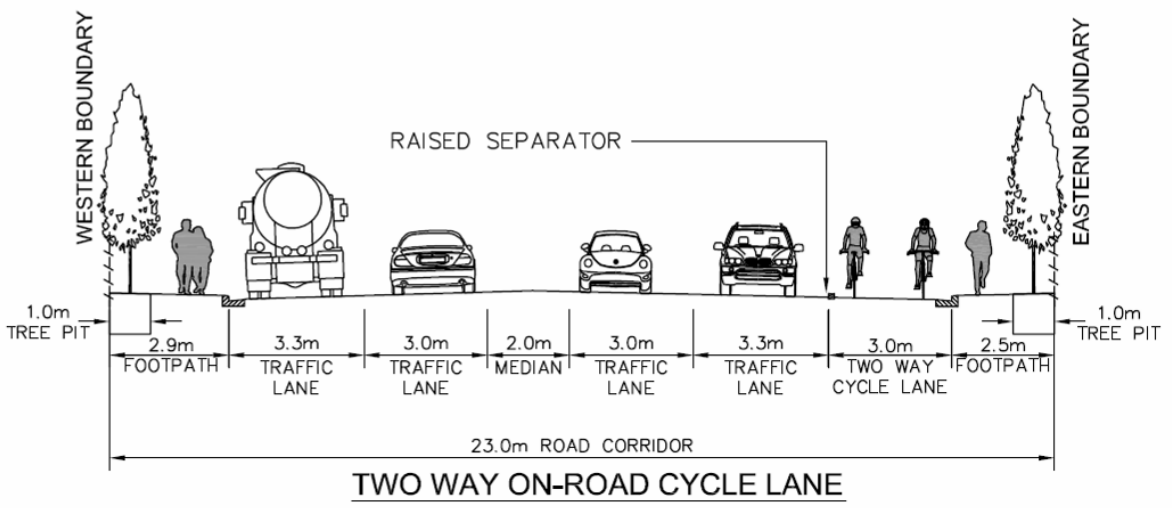
Figure 5: Flexible bollards (Silverdale)

The adjacent general traffic lane would also need to be wider than if it were adjacent to a conventional cycle lane – 3.3 m is recommended, including the width of the bollard itself (approximately 0.1 m). To accommodate this feature in the 23 m road corridor, the flush median would need to be reduced to about 2.0 m wide and the west footpath to 2.5 m.

The flexible bollards would need to be able to survive being driven over by motor vehicles. This might become a recreational pursuit for some drivers, presenting a noise problem for residents late at night and potentially resulting in the need for expensive repairs to the bollards. Street sweeping of the cycle lane and drainage channel would be more difficult with this option.

We do not recommend this option.

2.10 Option 10: Two-way On-road Cycle Lane



The two-way cycle lane in this option would need a physical separator to separate northbound cycle traffic from southbound motor vehicles. The lane would need to be 3.0 m wide to accommodate two-way cycle traffic and would put cyclists in a counter-intuitive position and direction for motorists emerging from driveways and intersections. Motorists would be looking right to find a gap in approaching traffic, and might not notice cyclists coming from the other direction.

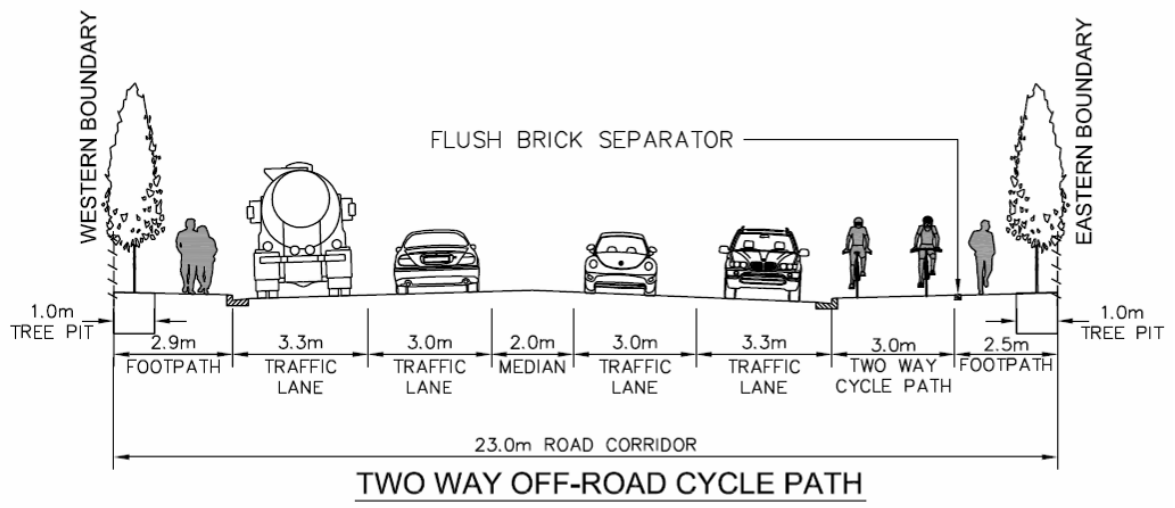
Another disadvantage of this concept is that northbound cyclists would be required to cross the road twice to use (and leave) the facility at its ends. In practice, many cyclists would not do this, with the result that they would be at greater risk in the general traffic lane on the west side of the road. This option would thus present a discontinuous cycle route for many cyclists and would discourage cycling along Lake Road.

The separators would pose trip hazards for pedestrians crossing mid-block, although this practice would not be recommended.

The kerb lane on the west side would need to be at least 3.3 m wide to accommodate motor vehicle traffic next to the kerb. Narrowing of the west footpath by 0.1 m to 2.9 m and the median by 0.5 m to 2.0 m would be needed to accommodate this.

The inconsistency of this layout in the context of the overall route configuration along Lake Road makes this a poor level of service for users. Even if the concept were to be introduced all the way between Devonport and Takapuna, the additional safety concerns at intersections and driveways prevent us from recommending this option.

2.11 Option 11: Two-way Off-road Cycle Path

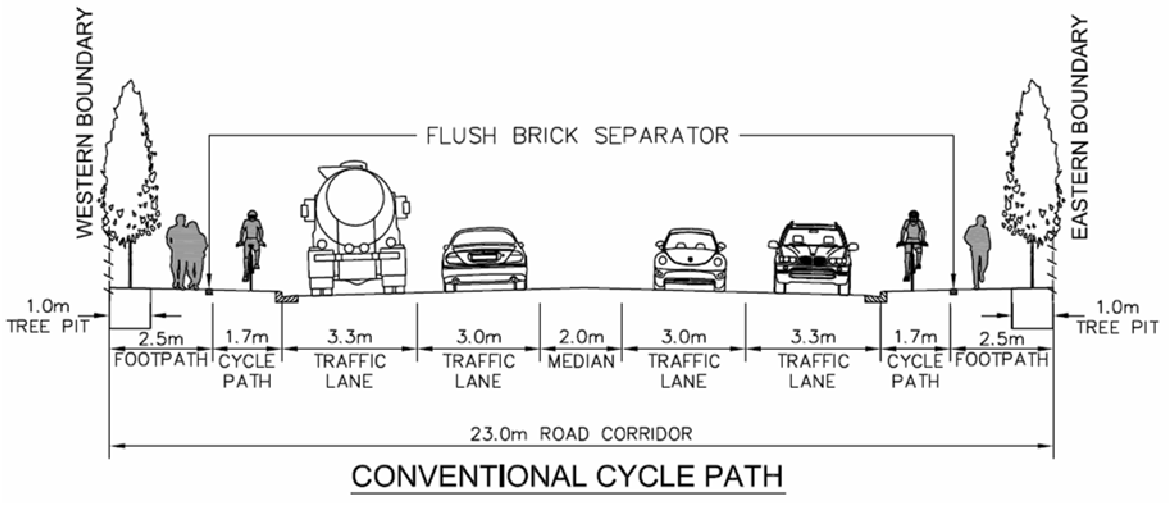


Both this two-way off-road path and the previous option, the two-way on-road cycle lane, present an unusual issue for drivers at side roads and driveways, as they have to search for gaps in two separate two-way traffic streams – on the east side path/lane and then the road itself. When suitable gaps in the passing motor vehicle stream are infrequent (as will be the case on busy Lake Road) there is a high risk that drivers will fail to do a good job of simultaneously recognising adequate gaps in the less significant two-way cycle stream. This applies to Options 10 and 11.

This cross-section also suffers the same disadvantages as the previous option of lack of continuity at the ends of this relatively short section of Lake Road, which will take most cyclists only about two minutes to traverse. If northbound cyclists (who need to cross the road to access the facility) have to wait one minute on average at each end to gain access to the facility, they will have spent twice as long on this section as if they had just continued cycling on the road. Despite the increased risk of cycling in the narrow northbound kerb lane, many cyclists will choose this more direct but less safe option.

Off-road cycle paths alongside private property are often compromised in their effectiveness for cycling by rubbish and recycling containers being left at the road edge for collection. We do not recommend this option.

2.12 Option 12: Conventional Cycle Paths



Placing a cycle path adjacent to the footpath has an intuitive appeal for cyclists and motorists, but would reduce the pedestrian amenity on footpaths, with the increased proximity of cyclists. Cyclists would be separated from motor vehicles by a standard kerb. The walking and cycling facilities could be separated by bricks laid flush to the surface.

This option would not be ideal for pedestrians with limited visibility, as they would not want cyclists on the footpath. Cyclists would be likely to encroach into the footpath area when overtaking other cyclists or simply to increase their separation from motor vehicles.

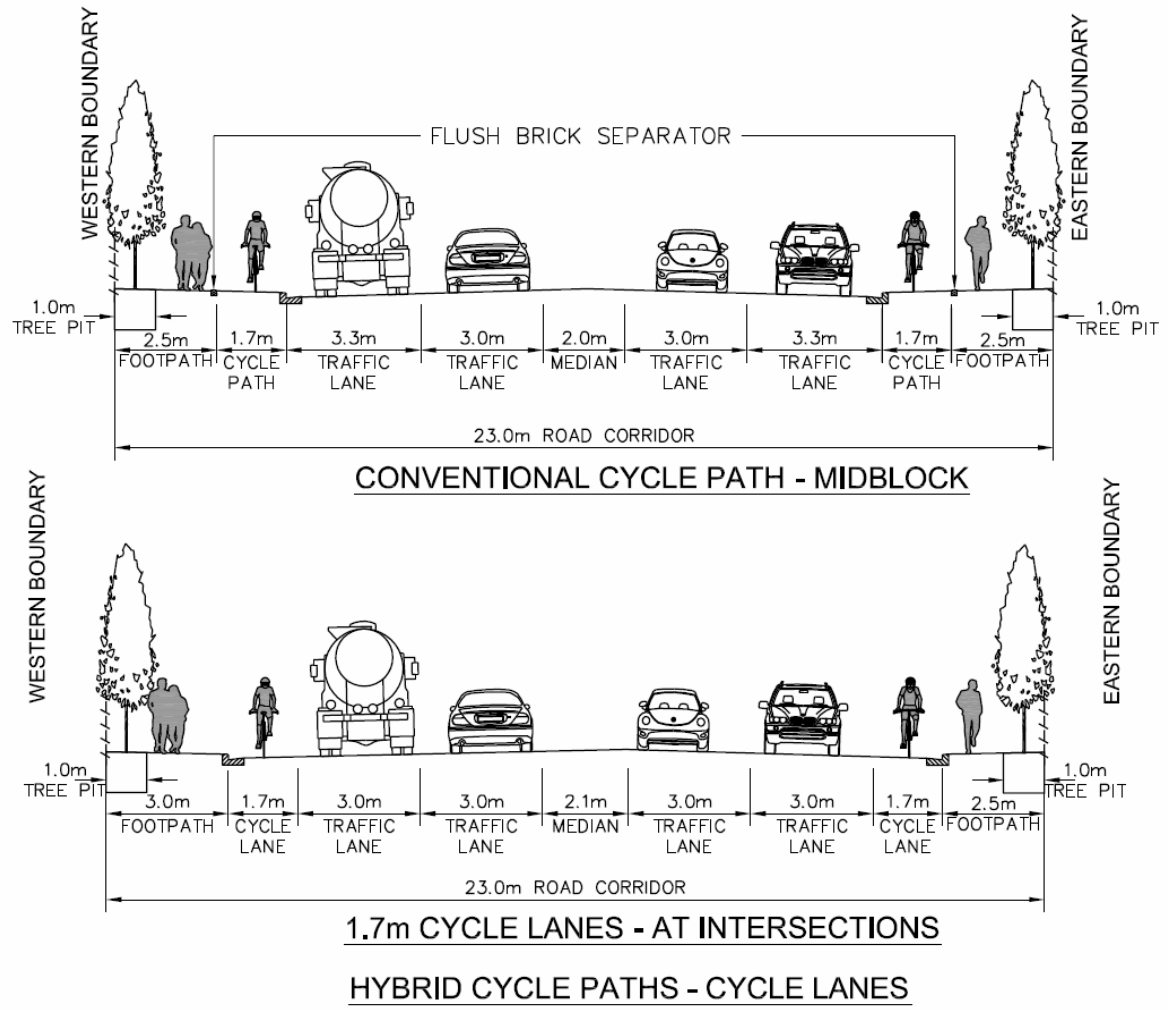
Cyclists would also be at risk from motor vehicles emerging from driveways. Motorists usually drive out to the kerb line to wait for a gap in traffic before joining the road. Pedestrians (who travel relatively slowly) are easily noticed, but cyclists, likely to be travelling at up to 30 km/h or more (especially downhill, or northbound), would be easily overlooked.

With this option, driveway ramps would be needed at each driveway (as is typical for footpaths). These provide an uneven riding surface for cycling. Some cyclists (especially faster ones) would be likely to ride on the road instead, reducing their safety and making the road less comfortable for drivers. The kerb lane for general traffic is too narrow (3.3 m) for safe sharing between cyclists and motor vehicles.

Another issue with this cross-section is that cyclists on Lake Road would not have priority over side road traffic. This legal situation is not well understood by either cyclists or motorists and is likely to result in increased crash risk. Some commuter cyclists, routinely confronted by motorists on side roads not giving way to them as they leave the cycle path, will eventually give up using the path and use the road instead, despite it not being designed to accommodate them. Others may simply give up cycling.

Off-road cycle paths alongside private property are often compromised in their effectiveness for cycling by rubbish and recycling containers being left at the road edge for collection. We do not recommend this option.

2.13 Option 13: Hybrid Cycle Paths – Cycle Lanes



This option is a hybrid of midblock cycle paths (Option 12) and cycle lanes through the intersections (Option 3) and would provide the increased separation of cycle paths mid-block with the priority of cycle lanes through intersections. A similar solution exists in Christchurch's Tennyson Street, constructed in 2001 (although the dimensions are different). This facility is illustrated in Figure 6.

Figure 6: Hybrid cycle path / cycle lane (Christchurch)

This option provides the separation from motor vehicles of an off-road path at midblock locations but ensures that cyclists have priority over side road traffic and traffic turning from Lake Road into the side roads, which cycle paths otherwise do not have.

The 4.2 m wide footpath plus cycle path provides a long platform for drivers exiting properties, assisting with break-over angles at the transitions to property and the carriageway. The combined width would allow cyclists to use the footpath as an escape route for obstacles or other path users, or overtaking. Considerable care would be needed in design and construction to ensure that the gradient changes from one location to the other are "seamless" and that cyclists do not experience a change in level from the off-road path to the on-road lane at each transition.

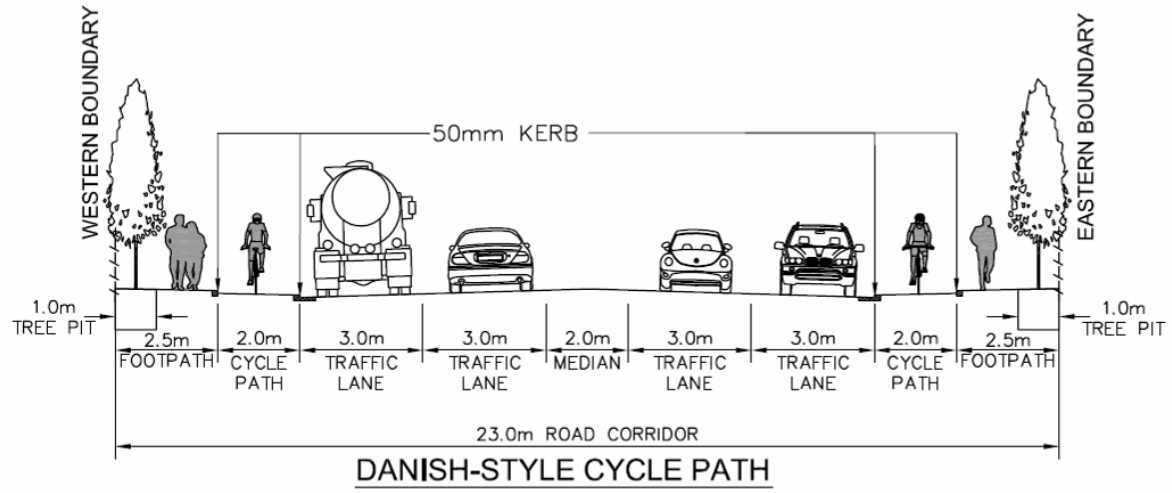
The effectiveness of off-road cycle paths alongside private property is often compromised, however, by rubbish and recycling containers being left at the road edge for collection.

Another drawback with this design is that cyclists would be closer to driveways (and hence vulnerable to emerging motor vehicles). This will mean that in practice cyclists will need to travel more slowly than if they are on the road. The safe operating speed would be only about 10 km/h to 15 km/h.

This option would provide a satisfactory level of service for less experienced or less competent cyclists, including most school students, family groups and older people. Most existing cyclists on Lake Road are probably regular commuter cyclists or training cyclists who are more comfortable on cycle lanes and who would expect to travel more quickly than this option would allow. Some of them would ride on the road, despite the existence of the special facility and the poor level of service and safety that the 3.3 m kerb lane would provide. Cycling in the carriageway of Lake Road would be less safe and comfortable than it is now.

Accordingly, this option is not recommended as it does not cater well for existing cyclists.

2.14 Option 14: Danish-style Cycle Paths



Copenhagen is known for its cycle paths located, and built at an intermediate level, between the footpath and the road. The levels are separated by low kerbs. Typically these "Danish-style" cycle paths are located in central business district areas where there are few or no driveways to property and where motor vehicle operating speeds are low (around 30 km/h). In this situation they provide pedestrians, cyclists and motorists with their own clearly-identifiable facilities.

A Danish style cycle path is illustrated in Figure 7.

Figure 7: Danish cycle path

Their use on Lake Road would be more problematic. The path should be about 2.0 m wide to accommodate overtaking manoeuvres and to provide "shy space" from the kerbs. Cyclists will not be able to get back up to the path if they have to cross into the traffic lane for any reason until the next driveway or side road. Likewise, they will not be able to readily mount the left kerb (in the direction of travel) to use the footpath if they need to take evasive action on the path. The two low kerbs present the sort of fall hazards for cyclists found in Christchurch on roads with tram tracks. To cross tram tracks or low kerbs safely on a cycle, the rider should approach the obstacle at somewhere between a 45° and 90° angle. This will be difficult to do from the kerbside lane of Lake Road, requiring the cyclist to occupy the majority of the travel lane on the approach to the kerb.

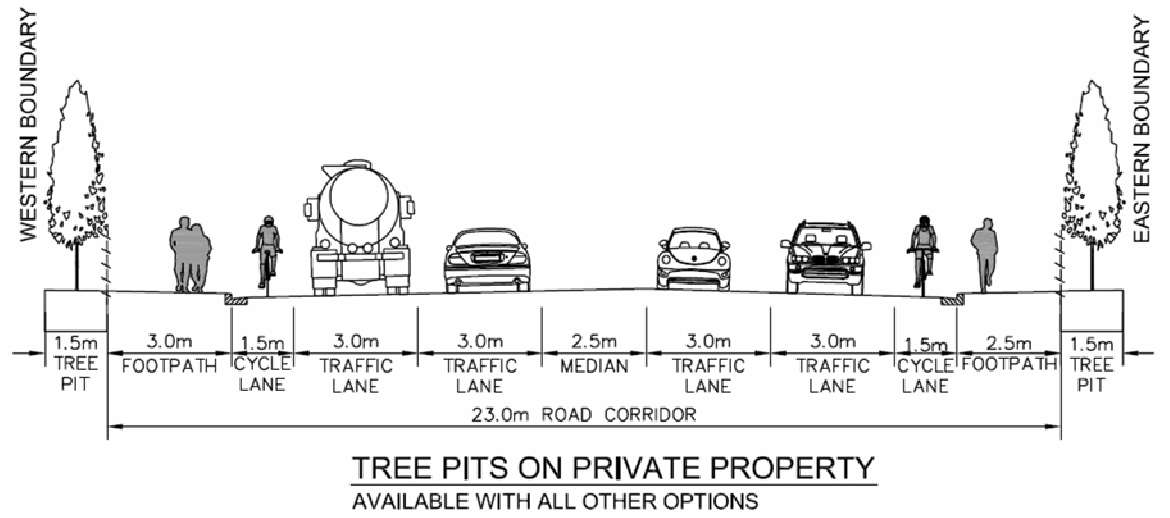
The low kerbs are likely to represent trip hazards for pedestrians too. The kerb between the road and the cycle path is the main drainage kerb, but it will be much less effective than a standard-height (125 mm) kerb. Flooding of the path is likely in intense rainfall. The side-entry drainage sumps typical on Lake Road help optimise the use of road width by not placing drainage grates next to the kerb where they can present a hazard for cyclists. This style of drainage structure will not be feasible with a low kerb height.

A "rollover" mountable kerb between the footpath and cycle path may allow cyclists to traverse between one surface and the other safely, but introduce another hazard for pedestrians with poor vision.

The design of the kerbs and cycle path will be difficult at each driveway, with the path ideally maintaining a steady drive grade (as would the adjacent road). If the path level rises and falls at each driveway as do footpaths, many cyclists would find this level of service unacceptable and would ride in the road, despite the narrow width of the kerb lane (3.3 m).

This option is not recommended from a safety perspective.

2.15 Option 15: Tree Pits on Private Property



Space is at a premium on Lake Road within its 23 m corridor. If some elements of a preferred cross-section (such as a footpath or the median) are considered too narrow, an option would be to negotiate with land-owners to see whether street trees (whether in tree pits or not) could be located in private property. This would not need to be a consistent approach throughout the street, but could be applied site by site depending on circumstances. So if a 2.5 m footpath was deemed to be too narrow to accommodate a 1.0 m tree pit, the tree could be eliminated from the plan or relocated to private property behind the property boundary.

2.16 Option 16: Solid Medians

This option would help the viability of other options by reducing the amount of right turning from Lake Road. Most major arterial roads have solid medians preventing right turns into and out of property and even some side roads. The introduction of a solid median would require less width than a flush median (1.0 m or 1.5 m would be sufficient), instead of the 2.0 m or 2.5 m in most of the options discussed. A solid median would also increase pedestrian safety for any pedestrians who choose to cross mid-block, by providing a pedestrian refuge.

There are six side roads intersecting Lake Road on this section. It may be possible to provide only one median gap (at Cameron St / Harley Rd) to accommodate all right turn manoeuvres. We realise that this would require extensive public consultation and is therefore not feasible in the time available without affecting the overall work programme, however.

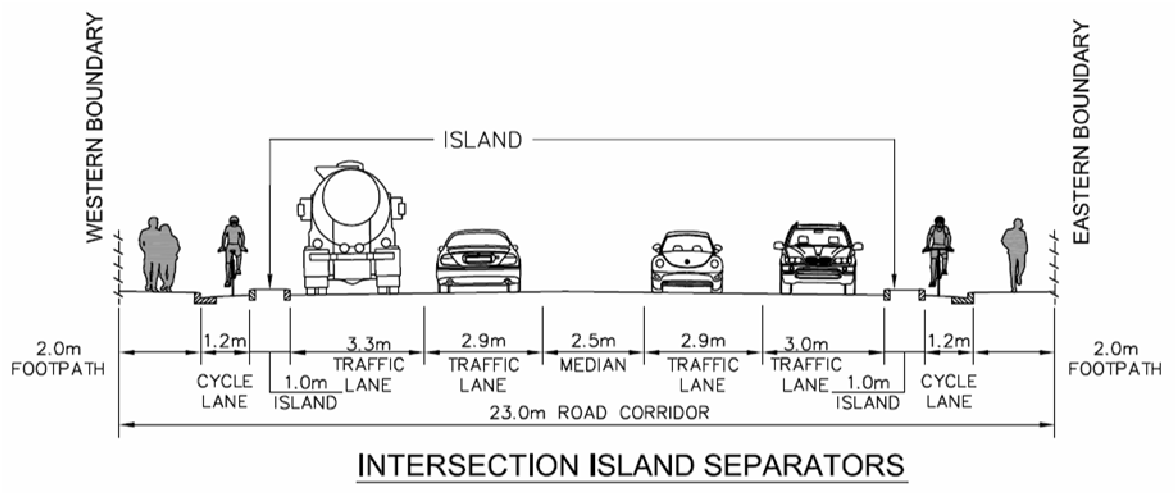
If median gaps were left at all side roads, the most affected parties would be property owners on Lake Road itself who would not be able to turn right into or out of their properties. This would reduce the consultation task, but would probably still jeopardise the timetable for the work.

This option could be introduced in future after suitable consideration and consultation. It will be important to get the main design (especially the kerb locations) right now so that this option is still available in future. A regular cycle lane design (such as Options 3 or 7) best retains this future flexibility.

2.17 Option 17: Reversible Three-lane Cross-section

This option too would require extensive consultation and thus would not be feasible. If one motor vehicle lane could be eliminated, all the remaining lanes and footpaths could be more generously proportioned. Three-lane (or five-lane) reversible roads work if there is a strong "tidal" flow on a road. This, however, is not the case on Lake Road, where flows in the peak hours are similar in each direction. The concept would also require the elimination of the flush median. We do not recommend this option.

2.18 Option 18: Intersection Island Separators



The objective of this detail is to place a physical island between cyclists and motor vehicles at the side road intersections to reinforce their "ownership" of the cycle lane. An island at each intersection would provide regular physical separation between motor vehicles and cycles. This may be considered as a "one (or two) bollard per block" option.

The island's width must be found from a reduction in the width of both the cycle lane and the footpath. This may not be desirable at the intersection, where storage (particularly for pedestrians) may be an issue.

As detailed (Figure 8), the right-of-way of on-road cyclists is unambiguous for drivers on the side road. The island location design will need to accommodate carefully the swept paths of departing left-turning vehicles to avoid forcing those vehicles entering the left-hand through traffic lane into the right lane.

A disadvantage of this option is the difficulty that would be experienced by mechanical street sweepers. The 1.2 m cycle lane between the island and the kerb would be too narrow for mechanical street sweeping so would be likely to accumulate broken glass, gravel and other road debris. Cycles are more susceptible to such surface impediments than motor vehicles.

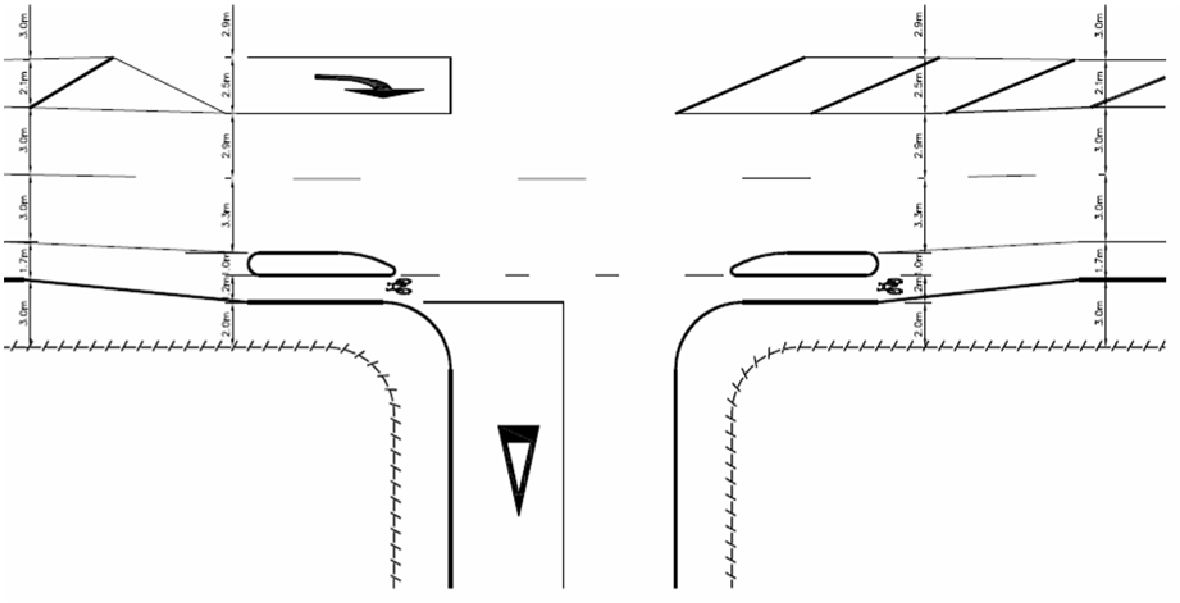


Figure 8: Plan of Intersection Island Separators

The island down-stream of the intersection should not be configured in a way that suggests that it is a pedestrian refuge, because this would encourage pedestrians to cross at the right turn lane, an intrinsically unsafe proposition.

There is a risk with this design that the islands will be struck by motor vehicles. This happens frequently with small islands in roadways. If these islands are frequently struck, there are likely to be demands to remove the islands altogether. If this eventuates, the design would revert to similar designs with 1.7 m cycle lanes, but the footpaths will be unnecessarily narrowed at the intersections because of the (former) islands and the cycle lanes or traffic lanes would be undesirably wide at these locations.

We do not recommend this option.

3 Conclusions

Some 18 options have been developed. All options have some advantages and some disadvantages. They make tradeoffs amongst the various competing uses of road space on Lake Rd. These uses include pedestrians, cycles, cars, trucks and buses. Some design options make it easier for drivers to turn right into driveways and side streets; others restrict this facility. Some will encourage higher motor vehicle speed. Some will feel more comfortable for cyclists; some options provide for off-road cycling on cycle paths while others provide for cycling to be done on-street though cycle lanes. Some options provide more space for pedestrians.

The approved concept plan (Option 1) has 1.5 m wide cycle lanes on each side of Lake Rd. In our opinion, these are too narrow to satisfy the appropriate design guide and this design should not be used. We are concerned that this design would be unsafe for cyclists. Different people will prefer different options after balancing all the variables, depending on their own perspectives and experience as pedestrians, cyclists and drivers.

Our preferred option is Option 7, which consists of a 1.7 m cycle lane downhill (northwards) and a 2.0 m uphill cycle lane to accommodate overtaking manoeuvres. This is more space-efficient than providing 2.0 m cycle lanes for both directions. This option provides a 2.8 m western footpath and 2.0 m median midblock. The median can be widened to 2.5 m at side roads to accommodate turning manoeuvres by reducing the through-traffic lanes at these intersection locations to 2.9 m.

Our second choice is Option 3. This is similar to Option 7 but has both cycle lanes at 1.7 m wide, with slightly more width in the median and footpaths.

Both these options (and any others involving cycle lanes) can use textured lane markings (Option 4) to reinforce the presence of the cycle lane. We recommend that this should only be used at “stress points” (along with coloured surfacing) to discourage motorists from cutting into the cycle lanes.

We have some concerns over the existing layout at the Esmonde Rd intersection in terms of cyclist safety. We also feel that, in general, the cycle lanes at the side roads should include continuous green surfacing across the side streets to reduce the likelihood of right turning traffic from Lake Rd turning through queues of waiting traffic in the opposing direction and colliding with cyclists on the cycle lane. This was previously identified as a problem further south on Lake Rd. We recommend that this be re-visited when detailed design for Lake Rd between Esmonde Rd and Hauraki Rd is undertaken. As part of this redesign, we recommend the use of textured lane markings as a trial at the Lake Rd / Esmonde Rd intersection for the northbound to westbound cycle lane.

Once a cross-section has been selected for Lake Rd, considerable care will be needed in translating the design into a viable plan. In particular, transitions at each intersection will need to be designed to provide safe operating conditions for all road users.