INFRASTRUCTURE, TRANSPORT AND ENVIRONMENT COMMITTEE SUPPLEMENTARY AGENDA

THURSDAY 5 MARCH 2015

AT 8.30AM

IN COMMITTEE ROOM 1, CIVIC OFFICES, 53 HEREFORD STREET

Committee: Councillor Phil Clearwater (Chairperson)
Councillors Pauline Cotter (Deputy Chairperson), Vicki Buck, David East and Tim Scandrett

Principal Advisers

Chief Operating Officer
Jane Parfitt
Telephone: 941-6798

Director, Council Facilities and Infrastructure
David Adamson
Telephone: 941-8149

Committee Adviser
Lucy Halsall
Telephone: 941-6227

PART A - MATTERS REQUIRING A COUNCIL DECISION
PART B - REPORTS FOR INFORMATION
PART C - DELEGATED DECISIONS

INDEX

8. RESOLUTION TO BE PASSED - SUPPLEMENTARY REPORTS

Approval is sought to submit the following reports to the meeting of the Infrastructure, Transport and Environment Committee on 5 March 2015:

- **MAJOR CYCLEWAY ROUTES NETWORK BUSINESS CASE**

The reason, in terms of section 46A(7) of the Local Government Official Information and Meetings Act 1987, why the reports were not included on the main agenda is that they were not available at the time the agenda was prepared.

It is appropriate that the Infrastructure, Transport and Environment Committee receive the reports at the current meeting.

RECOMMENDATION

That the reports be received and considered at the meeting of the Infrastructure, Transport and Environment Committee on 5 March 2015.

9. MAJOR CYCLEWAY ROUTES NETWORK BUSINESS CASE

		Contact	Contact Details
Executive Leadership Team Member responsible:	Chief Operations Officer, Operations Group	N	
Officer responsible:	Unit Manager, Assets and Networks	N	
Author:	Michael Ferigo, Transport Planner – Sustainable Transport	Y	DDI 941 8925

1. PURPOSE AND ORIGIN OF REPORT

1.1 At the Council's 29 January 2015 meeting under item 13. Major Cycleway Routes (MCR) Programme – Delivery Programme and Design Guides - it resolved;

1.2 7.10 "Request the Chief Executive to provide a report to the Council on the current estimates for each route of the cycle route programme along with any potential contributions from New Zealand Transport Agency (NZTA) and Ministry of Transport (MOT). This report is to contain a regulatory impact analysis to support the business case to assist the Council's consideration of the 2015-25 LTP."

2. EXECUTIVE SUMMARY

2.1 This report summarises the programme business case for the delivery of the thirteen Major Cycleway Routes – along with their programme costs and the overall forecast benefits, based on the current predicted scenario for the future developments in Christchurch.

2.2 The amount of the contributions from the NZTA and MOT is difficult to pre-determine prior to applications being lodged for individual routes. However, this report gives evidence of a high level of benefit/cost ratios for the programme within its economic assessment. This will give Councils future funding applications a high degree of confidence in securing significant funding assistance.

2.3 On Friday 13 February, staff and some Councillors received a briefing from the NZTA National Cycling Manager who indicated that approximately $15-25 million had been 'earmarked' for the Christchurch programme from the Urban Cycleway Fund (UCF) over the next three years. The balance of funding would then be assessed for funding from the National Land Transport Fund (NLTF) through NZTA. Eligible projects would be funded through NZTA at our assistance rate of approximately 50 percent. It is likely that $20M – $40M could be expected to be secured from this fund.

2.4 Funding from the UCF beyond three years is uncertain as it is a new fund introduced by Government that covers three years. There would still be ongoing opportunities for funding assistance from the NLTF.

2.5 The regulatory impact analysis intention is covered within the content of this report notably being consistent with the Christchurch Transport Strategy Plan and the public consultation - there is no expectation that any regulations will need amendment or change.

3. THE THIRTEEN MAJOR CYCLEWAY ROUTES - BUSINESS CASE

Transport Vision and Goals

3.1 The Christchurch Transport Strategic Plan, adopted in 2012, covers all transport modes with the Council's overriding vision being to; 'Keep Christchurch moving forward by providing transport choices to connect people and places.'

3.2 To achieve the vision the Plan focuses on four goals; to improve access and choice; create safe, healthy and liveable communities; support economic vitality; and create opportunities for environmental enhancements. Cycling is identified as a key component in achieving the Plan's goals. The actions identified in the Plan make a strong statement about the importance of cycling for the city's recovery and future prospects.

9 Cont'd

3.3 The Council has resolved that a connected cycleway network around the city will be developed (made up of major, local and recreational cycleways). This will offer a safer cycling experience that encourages more people to cycle more often.

3.4 Research shows that almost a third of people in Christchurch not currently cycling would seriously consider doing so if they could travel safely. Research and case studies also show the main safety issues can be addressed by providing effective separation from motor vehicles. Cycling numbers will increase significantly if improvements in cycling infrastructure are implemented to address safety, with dedicated cycling routes, separate from other road users, and safe intersection crossings, along with convenience and connectivity with key origins and destinations. By creating a connected cycle network that makes cycling a more attractive transport option the Council is supporting health and wellbeing benefits for the community as well as recognising that a safer system contributes to network transport efficiency. These factors are what support the business case.

Forecasting use and establishing the Benefit/Cost Ratio

3.5 This programme business case is an assessment of the overall MCR programme prepared by QTP to support a strategic business case to support funding applications to the UCF and NZTA. As the design for each route is finalised a project business case will be prepared based upon the detailed cost estimates and project benefits. This project business case will be used to support funding applications for the project and to inform Council in its approval process through the Infrastructure, Transport and Environment Committee.

3.6 The following report sections give a summary from the economic assessment undertaken by QTP and peer reviewed by Flow Transportation (refer **Attachment 1**). Forecasting use and establishing the Benefit Cost Ratio is described below.

3.7 Modelling work was undertaken to forecast the quantified additional use of the network with the delivery of the MCR programme. This work was focussed primarily to support applications for potential funding assistance from NZTA and provide robust, nationally recognised methods to establish the benefit / cost assessments.

3.8 The Christchurch Strategic Cycle Model (2012), in combination with the Christchurch Assignment and Simulation Traffic Model (CAST) was used as a basis for this assessment. The Cycle Model, developed to forecast average daily utility-purpose cycle use, was modified to reflect planned MCR routes. The latest Urban Development Strategy UDS and the Land Use Recovery Plan LURP along with agreed land use and future transport assumptions were incorporated, as were plans for An Accessible City, the Coastal Pathway and other expected significant developments.

3.9 As a result of the current MCR and cycleways programme for Christchurch, in 2031 the overall cycling levels are projected to increase by 138 percent from the 2006 levels. In actual trip numbers the predicted increase will take the 18 million trips per year in 2006 to 31 million trips per year in 2031. Added to this the length of average cycle trip is also predicted to rise from its 2006 average distance of 3.1 kilometres to 4.4 kilometres as more people cycle more often and further.

3.10 Recreational cycling trips have longer average distances than commuting and thus will increase the above average distances cycled when considered along with any trending to electric assisted cycling in the market to a wider participation.

3.11 Several investment package scenarios were investigated to predict usage and identify relative benefits for the forecast years 2021, 2031 and 2041. Examples are shown in the figures below of comparative city demand maps for the planned MCR ‘Full Network’ and for the ‘Do minimum’ in the years 2021 and 2041.

9 Cont'd

3.12 The 'Full Package' covers the 13 MCRs including significant current proposed plans such as the "An Accessible City"(AAC), Christchurch Coastal Pathway (CCP) (per Appendix A in attachment 1). The "Do Minimum Package" (Pages 5 - 7 of Attachment 1) uses no new MCRs but includes many current planned cycle improvements provided by other projects. Both include an assumed 40 percent increase in fuel costs and a 30 percent "trader factor" along with the same demographic predictions.

3.13 The line widths in the maps below represent (to scale) the numbers of people cycling on the network and detail the assessed variation between "Do Minimum" and "Full MCR Network". For example if a line width in Map 1A increases in Map 1B to twice as thick then this represents a doubling in the number of people cycling on that route.

Figure 1A: Daily Cycle Demand for 'Do-Minimum' – 2021

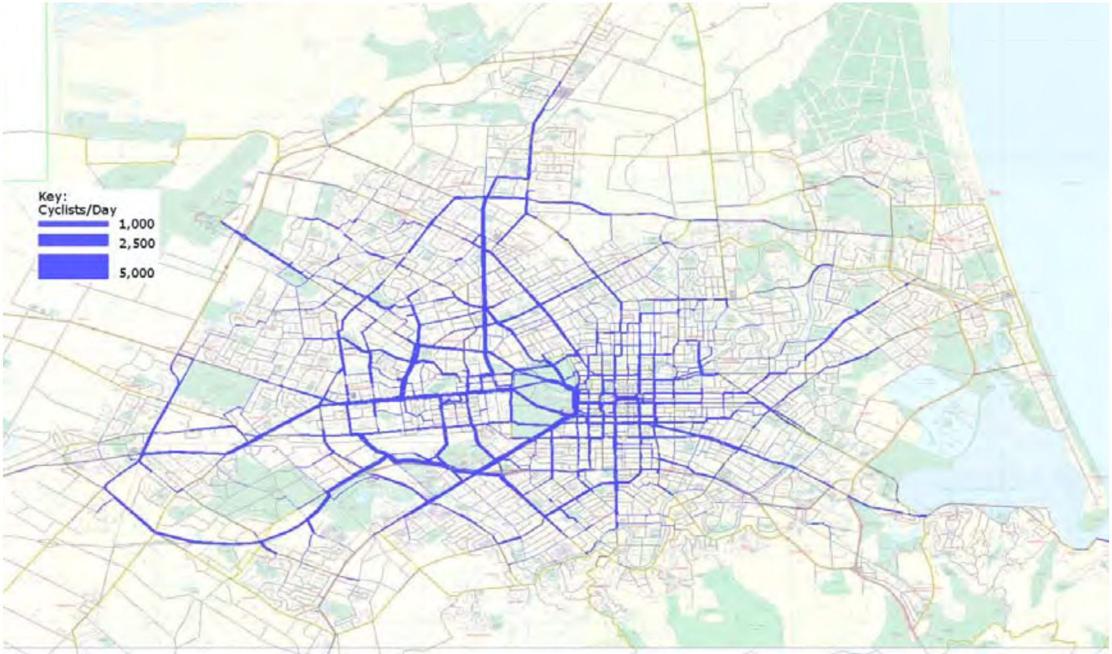


Figure 1B: Daily Cycle Demand for Full MCR Network - 2021

9 Cont'd

Figure 2A: Daily Cycle Demand for 'Do-Minimum' -2041

Figure 2B: Daily Cycle Demand for 'Full MCR Network' - 2041

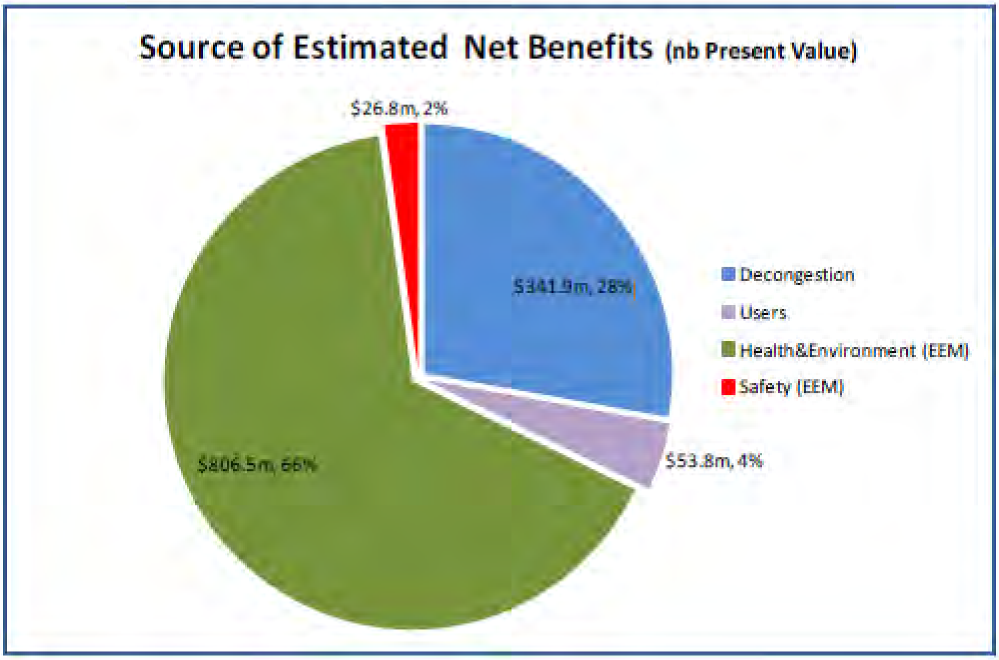
3.14 The comparative demand maps illustrate that the proposed cycleway network delivers (and continues to deliver) usage outcomes significantly higher than the Do Minimum scenario.

9 Cont'd

Predicted benefits to cyclists and non cyclists

3.15 In broad terms, the combined present value of benefits of the proposed MCR package (in combination with AAC and CCP projects) is estimated to be very substantial, totalling over **$1,200 million over a period of 40 years**, as summarised below:

Figure 3 Source of estimated net benefits



3.16 It should be noted that this $1200 million estimate of benefits derived is conservative. The process and purpose of the benefit capture is aligned with the NZTA funding assistance programme. This evaluation excludes recreational purpose cycling trips and therefore the potential total benefits to the community are, in practice, likely to be higher than the results from the assessment and its peer review.

3.17 Health and Environment contributes the major proportion of benefits. The rise in participation is expected to be the principal contributor to the Health and Environment benefits predicted. This prediction represents New Zealand Transport Agency's recognised process and standards. This relates to benefits accruing, principally to users through use of separated cycleways, such as improved health from reduced morbidity and mortality.

3.18 The second largest and still substantial contributor is predicted to be benefits to non-users i.e. non-cyclists, through decongestion on the transport network. Essentially this package of planned works is predicted to free up and avoid further congestion on the transport network for motorists, freight and public transport to have reduced delays on their journeys.

Benefit Costs Ratio

3.19 Due to the significance of the proposed programme a detailed assessment process was considered appropriate and has been applied to determine the potential benefits. The Christchurch Major Cycleway Route – Updated Funding Assessment 2015 (refer **Attachment 1**) provides the detail of the assessment process and the peer review.

3.20 The proposed investment programme potentially has very wide-ranging benefits along with costs for the Council, however there is opportunity for significant potential funding assistance. The period of the investment (delivery) being considered for the purposes of the economic assessment is a seven and a half year programme.

3.21 The NZTA categorises both Strategic Fit and Effectiveness into Low, Medium and High. Those projects that achieve a high categorisation levels must provide a Cost/Benefit ratio of five or more – in other words for every dollar invested in the project it must return five dollars or more in benefits.

3.22 Benefit/Cost Sensitivity Testing was conducted over the current Major Cycleway Routes programme and the Benefit Cost Ratio has been estimated to be in the order of 8. The independent peer review of the current Cycleway programme concurred that the assessment was sound in it's prediction of a ratio of over five being achieved – placing the programme within the High categorisation threshold for NZTA.

3.23 This Benefit/Cost ratio is high compared to many other transport projects that have received funding assistance from NZTA. This assessment provides a high level of confidence in reinforcing the expectation that the cycleways programme will contribute significant improvements to the transport needs and well being of the community. It also obviously bodes well for the 13 MCR projects funding assistance applications to NZTA over the course of the programme.

Preliminary Scheme Design Costs

3.24 The estimated programme costs have been calculated by using the estimates from the sections of the routes that have undergone preliminary scheme design to date. This includes sections from five routes. The averaged costs determined for these sections have been used to establish a Typical Link Treatment Cost and Intersection Cost that has been applied to similar sections of the remaining routes to derive an overall estimate.

3.25 The Link Treatments required for each of the thirteen routes has been identified based upon assessment of the likely route (refer **Attachment 2**). The confidence in this process is linked to the level of planning development on each route, some routes are nearing final draft stages with identified treatment types nearing consultation; through to a few routes where confirmation of the route alignment is required to confirm treatment types.

3.26 Table 1 below shows examples of the Typical Link Treatment costs that have been applied to the routes that have yet to be designed. Collectively this process has resulted in the total costs for the programme of Major Cycleway Routes summarised in Table 2 below.

TABLE 1 TYPICAL COSTED LINK TREATMENTS

	$Cost/m
3.0 metre bike path with 2 metre footpath	621
3 metre Path no K+C one side of road - semi rural	500
3 metre shared path	500
4 metre shared Path	779
3 metre Shared Path - Greenspace	455
4 metre Shared Path - Greenspace	495
Neighbourhood Greenway – existing narrow road (slow street)	469
Neighbourhood Greenway – existing wide road (slow street)	3,500
No Kerb Changes but traffic calming	113
Separated Cycle Path Typical Section – existing 14 metre Kerb to Kerb	666
Separated 2 way Cycle Path Typical Section – existing 14 metre Kerb to Kerb	2,775
Separated Cycle Path Typical Section - existing 14 metre Kerb to Kerb - painted lines only	150
Separated Cycle Path Typical Section – existing 14 metre Kerb to Kerb – widened to 15m	1,159

9 Cont'd

TABLE 2 MAJOR CYCLEWAY ROUTES -TOTAL COST SUMMARY

Route	Rough Order Cost	Latest Estimate
Avon Otakaro Route	$ 4,200,000	$ 20,682,681
Heathcote Expressway	$ 7,800,000	$ 12,032,568
Little River Link	$ 2,400,000	$ 4,696,637
Northern Line Cycleway	$ 6,700,000	$ 7,474,282
Nor'West Arc	$ 8,600,000	$ 19,340,573
Opawaho River Route	$ 3,000,000	$ 15,913,495
Papanui Parallel	$ 3,000,000	$ 10,010,292
Quarryman's Trail	$ 4,200,000	$ 16,684,658
Rapanui Shag Rock Cycleway	$ 6,700,000	$ 19,330,914
South Express	$ 12,600,000	$ 7,082,555
Southern Lights	$ 2,900,000	$ 2,122,489
Uni-Cycle	$ 1,900,000	$ 9,292,796
Wheels to Wings	$ 4,300,000	$ 11,336,060
Total	**$ 68,300,000**	**$ 156,000,000**

4. CONCLUSION

4.1 The Major Cycleway Routes Programme for Christchurch has been subject to a rational and robust economic assessment. The assessment has considered and compared a number of delivery scenarios alongside the current MCR programme of works and has been peer reviewed. The assessed Benefit/Cost ratio for investment is calculated as 8.

4.2 A detailed, thorough and open process has been followed in developing the forecasting for the higher level of cycle provision envisaged by the Christchurch Transport Strategic Plan. Such a process has been enabled by the development and application of the Christchurch Strategic Cycle Model in combination with the Christchurch Assignment and Simulation Traffic (CAST) Model and the CAST Safety Interface. The process to reach the results via the economic assessment has been supported through an independent peer review.

4.3 The benefits from the $156 million investment have been calculated as $1229 million. A significant proportion of the benefits are spread not only to the people cycling but also to non cyclists primarily through general traffic decongestion benefits. The health and environmental benefits are the largest proportion (66 percent) followed by decongestion at 28 percent. The benefits gained by an increase in people taking up more recreational cycling on the network have not been included in the economic assessment as the assessment is focussed on the NZTA prime interests in commuting and utility transport.

4.4 Collectively the benefits alongside the costs show a high return on investment for the community. The Benefit Cost ratio also ensures a high rating within the New Zealand Transport Agency funding assistance programme giving confidence of assistance along with a high probability of accessing the Urban Cycleways Programme funding.

4.5 For every dollar invested in the programme the returns are calculated to be between $5 and $8 – this compares very favourably against many other transport projects and indeed provides an opportunity to the Council following the Earthquakes to transform the way the transport system is balanced to move into the future. Prudent planning and investment into this area of the transport system will ensure the long term value and benefits of a sustainable and well performed city transport network for all the community.

9 Cont'd

5. **FINANCIAL IMPLICATIONS**

5.1 The financial implications are to be considered as part of the draft 2015-25 Long Term Plan.

6. **STAFF RECOMMENDATION**

That the Infrastructure, Transport and Environment Committee recommend that the Council receive the report.

Quality Transport Planning

Christchurch Major Cycleway Routes

Updated Funding Assessment

(Final Issue)

February 2015

This page is intentionally blank for double-sided printing.

Document Issue Record

Version No	Prepared By	Description	Date
00a	Paul Roberts	First draft.	16 June 2014
01a	Paul Roberts	Draft issue, for Client comment	17 June 2014
01b	Paul Roberts	Final issue, incorporating Client comment	4 July 2014
02a	Paul Roberts	Draft Update incorporating revised Cost estimates and recommendations from Peer Review of Preliminary Assessment (June 2014)	12 January 2015
02b	Paul Roberts	Final issue, incorporating Updated Peer Review	4th February 2015

Document Verification

Role	Name	Signature	Date
Preparation	Paul Roberts		17 June 2014
Reviewer	John Falconer		26 June 2014
Approval	Paul Roberts		4 July 2014

This page is intentionally blank for double-sided printing.

Contents

Appendices

Abbreviations and Acronyms

AAC	An Accessible City (chapter of CCRP)
AUD	Australian Dollars
BC(R)	Benefit Cost (Ratio)
CAST	Christchurch Assignment and Simulation Model
CCC	Christchurch City Council
CCP	Christchurch Coastal Pathway
CCRP	Central City Recovery Plan
CERA	Canterbury Earthquake Recovery Authority
CSCM	Christchurch Strategic Cycle Model
CTM	Christchurch Transport Model
EEM	Economic Evaluation Manual
HBE	Home-based Education purpose
HBR	Home-based Remainder purpose
HBW	Home-based Work purpose
HIS	Household Interview Survey
hr	hour
HTS	Household Travel Survey
km	kilometres
kph	kilometres per hour
LURP	Land Use Recovery Plan
m	million
MCR	Major Cycle Route(s)
MoE	Ministry of Education
NHB	Non Home-based purpose
NZD	New Zealand Dollars
NZTA	New Zealand Transport Agency
OD	Origin-Destination
PA	Production-Attraction
PV	Present Value
RA	Relative Attractiveness
RR	Research Report (NZTA)
Sc	Scenario
SP	Simplified Procedures (per NZTA EEM)
SPPWF	Single Payment Present Worth Factor
UDS	Urban Development Strategy
VOC	Vehicle Operating Cost
vpd	Vehicles Per Day

Pre-amble to Updated Assessment

In June 2014 QTP Ltd prepared a Preliminary Funding Assessment on behalf of Christchurch City Council (CCC) which quantified the potential use and benefits of CCC's proposed Major Cycleway Route (MCR) programme. This Assessment was subject to an independent Peer Review, prepared by Flow Transportation Specialists Ltd.

Since preparation of the above reports, CCC has continued to progress investigation of the proposed MCR's, including more detailed scheme design, cost estimation and programming. This Update has therefore been prepared at the request of CCC and in essence incorporates:

- Updated Scheme Cost estimates; and
- Suggestions made by the Peer Review of the Preliminary Assessment; and
- A response to other comments made by the Peer Review of the Preliminary Assessment, where this is considered helpful.

Given a substantial rise in the estimate of anticipated total MCR capital costs from a total of around $70m adopted for our June 2014 assessment, to around $156m following the more refined design and cost estimation conducted by CCC in the interim (and incorporation of estimated net maintenance costs), the Benefit-Cost Ratio of the Base Scenario test has now been assessed at around 8. This compares with an estimated Ratio of around 15 in the Preliminary Assessment reported in June 2014. While much reduced compared with that Preliminary Assessment, clearly this ratio of benefits to costs remains very high compared to many other transport projects - given that around $8 of benefits can be expected for each dollar of investment required to achieve those benefits.

This Updated Assessment incorporates the following principal changes:

(i) All tests incorporate updated capital cost estimates, that are also based on a revised anticipated investigation, design and construction programme. Note that, conservatively for the MCR projects, the anticipated programme is based upon a potential 'delayed' completion date that for each stage is some 2 months beyond that currently anticipated.

(ii) Two sensitivity tests are provided which assume a slower uptake of benefits or rate of increase in cycling arising from the proposed projects (ie a lag in achieving full benefits).

(iii) (Net) maintenance costs have now been included for each scenario;

(iv) Back calculations have been provided to indicate the potential reduction in assessed benefits that could be accommodated at differing levels of purely-economic justification- noting that they are still likely to be justified under other funding criteria. These calculations (along with the sensitivity tests noted at (ii) above) provide an indication of the potential effects of various impediments to cycling, beyond the major cycleway routes, which might dampen down the predicted increases in the demand for cycling.

(v) While the Peer Reviewer also suggested that consideration should be given to using a more conservative assumption to derive annual average daily demands from weekday demands during school term times, having done so we are satisfied that the approach adopted is appropriate.

A summary of the Preliminary Assessment Peer Review and our responses have been collated for ease of reference, in Appendix J. The Preliminary Assessment Peer Review itself has now also been provided in full here for completeness as Appendix K.

Finally, the draft Updated Assessment (version 02a) was subject to an updated independent Peer Review by Flow Transportation Specialists Ltd., which has also been attached herein for completeness, as Appendix L.

The analyst has accepted this Updated Peer Review, except insofar as there is one area where the we do 'agree to disagree' with the updated Review. This is where the respective parties disagree on the precise methodology for calculation of decongestion benefits. However, as the Peer Reviewer (correctly) points out, this difference of opinion is not (or rather "may not be overly critical". This is because of the relatively high efficiency of the proposed project and the relative lack of sensitivity to potential variability in the contribution of these benefits to this efficiency (rating).

The principal finding of the updated Peer Review is that the Benefit-Cost Ratio (BCR) of the proposed MCR project can "reasonably be assessed as 5 or more, which would justify a High priority ranking" (under NZTA's current investment criteria).

We also note the recent change in Investment Profile criteria (requiring a BC of 5 rather than the previous 4[1] to justify a High Priority under 'Benefit and Cost Appraisal' (formerly 'Efficiency' criteria) in NZTA's 2015-18 NLTP Investment Assessment Framework.

We finally note that the proposed MCR project still exceeds this revised NZTA threshold - and thus, in combination with the MCR Strategic Fit and Effectiveness priority ratings of 'HH', suggests that the MCR project can be justified for inclusion in the 'Priority 1' band for the 2015-18 NLTP.

[1] Several references to the former NZTA criteria ('High' Efficiency=BC>4) at the time of preparation of this initial draft report have however been retained to avoid confusion with the appended Review.

Executive Summary

QTP Ltd has been commissioned by Christchurch City Council (CCC) to quantify, where possible, the potential benefits of CCC's proposed Major Cycleway Route (MCR) programme.

CCC required a rational and robust assessment to support their discussions for potential funding assistance with the New Zealand Transport Agency NZTA. Specifically, this study therefore reports QTP's preliminary estimate of the economic Efficiency made to help inform Strategic Fit and Effectiveness assessments (by Council), in compliance with NZTA's investment assessment framework.

Given the potential wide-ranging impacts of the proposed project package, the level of investment being countenanced (around $156m over a package of potentially up to 13 potential major project elements) and the NZTA limits for application of 'Simplified Procedures' (being an undiscounted capital cost ≤ $5 million), a (more) detailed assessment process was considered appropriate and has been applied to determine these potential benefits.

Such a process has been enabled by the application of the Christchurch Strategic Cycle Model (CSCM), in combination with the Christchurch Assignment and Simulation Traffic (CAST) model and the CAST Safety interface.

For the purposes of this assessment, the CSCM model has been updated since its conception in 2012, to reflect current planned routes in the proposed MCR programme and align these within a modelling framework which reflects the latest UDS/LURP agreed land use and future transport network assumptions ('v6' CTM/CAST transport models, October 2013).

The basis for the future Do-Minimum and Option cycle networks is the anticipated road network adopted by the UDS partners for each of this study's assessment years (2021, 2031 and 2041) - along with other links not available to motor vehicles (e.g. the MCR projects).

CCC's proposed Major Cycleway Route (MCR), in combination with the proposed Central City Recovery Plan cycle projects and the Christchurch Coastal Pathway represent the main package of improvements assessed ('Scenario 1'). This has been compared to a 'do-minimum' level of improvement (Scenario 0').

This package of potential investment has been estimated by this study to have a Benefit-Cost Ratio (BCR) of around 8 (using base assumptions). Overall therefore, the benefits of the proposed improved cycle infrastructure investment are clearly potentially substantial.

To determine this estimate, the CSCM has been used to forecast the future demand and user travel benefits on the cycle network for each forecast year, with differentiation within these as required to reflect key potential variables and therefore benefits.

For example, the CSCM forecasts demand for different cycle trip purposes, because the cycling trip generation, distribution, assignment – and resulting potential benefits of particular cycling infrastructure projects - will vary between each.

Use of either matrix or assignment-based methods has also been utilised as appropriate; This has enabled, for example, benefits to either 'existing' and 'new' cycle users to be identified, as well as disaggregation to specifically identify cycle use on proposed Major Cycleways compared to other elements of the available network – Both being required to allow economic assessment per NZTA's requirements.

Daily cycle demand forecasts have also been disaggregated to peak periods in each forecast year. This enables consistent modelling of the performance of motorised vehicles using the road network and thus estimates of potential decongestion ('non-user') benefits of attracting more cycling trips through investment in improved cycling infrastructure - via application and assessment using the relevant CAST road network models.

Health and environmental benefits have been assessed and quantified, at this stage adopting rates in the Economic Evaluation Manual (EEM) Simplified Procedures. Estimates have been made of the potential change in road crash costs using both the CAST Safety Interface and additional research-based assumptions regarding the potential for 'safety-in-numbers' improvements in crash rates.

Simple extrapolation and interpolation of demand forecasts and resulting benefits is considered appropriate at this stage and has been applied for intermediate years, and where facilities are operational and considered within the economic efficiency evaluation before 2021 and up to 2041. After this year (given the required 40 year evaluation period), we have taken a conservative approach and 'capped' projected benefits to the levels projected for 2041.

Whilst it will be appreciated that our best efforts have been made to ensure the likely accuracy of the demand forecasting (and resulting benefit assessment), it must also be acknowledged that cycle modelling is inherently subject to (considerably) more difficulty than traditional vehicle-based transport modelling. This arises not only by virtue of the relatively low availability and high potential variability in data on existing use (compared to that available for vehicle models) but also some uncertainty over the disparate potential motivators for use between individuals – and their response in practice (locally) to the availability of the significant-improvements in transport infrastructure that the proposals undoubtedly represent.

These levels of uncertainty will naturally be reflected in the level of confidence in trip-making scale and assignment predictions and resulting benefits. For this reason therefore, appropriate sensitivity testing is of particularly high importance, to inform the potential variation in projected benefits (or costs) to potentially critical parameters and assumptions.

What we can conclude with some confidence from the sensitivity tests conducted, is that while there is a potential range in parameters that could be expected to affect projected usage and therefore benefits, the overall economic Efficiency case for the MCR programme appears to be relatively insensitive - with a 'High' Efficiency rating being likely justified in almost all conceivable circumstances.

1 Introduction

1.1.1 QTP Ltd has been commissioned by Christchurch City Council (CCC) to quantify, where possible, the potential use and benefits of CCC's proposed Major Cycleway Route (MCR) programme.

1.1.2 The brief called for a rational and robust assessment to support CCC's discussions for potential funding assistance with the New Zealand Transport Agency NZTA, assist option selection and potentially optimise the funded package.

1.1.3 Specifically, this study is required to provide Council with the necessary information to make a preliminary estimate of the economic efficiency inputs and help inform Strategic Fit and Effectiveness assessments (by Council), in compliance with NZTA's investment assessment framework.

1.1.4 Given the potential wide-ranging impacts of the proposed project package, the level of investment being countenanced (now assessed as being around $156m for a package of potentially up to 13 potential major project elements) and the NZTA limits for application of 'Simplified Procedures' (being an undiscounted capital cost ≤ $5 million), a (more) detailed assessment process is appropriate and has been applied to determine potential benefits.

1.1.5 Such a process has been enabled by the application of the Christchurch Strategic Cycle Model (CSCM), in combination with the Christchurch Assignment and Simulation Traffic (CAST) model.

1.1.6 For the purposes of this assessment, the CSCM model has been updated since its original conception in 2012, to reflect current planned routes in the proposed MCR programme and align these within a modelling framework which, apart from the exception described below, reflects the latest UDS/LURP agreed land use and future transport network assumptions ('v6' CTM/CAST transport models, October 2013).

1.1.7 The single exception to complete consistency with the land use (and road network assumptions) in CTM/CAST 'v6' (October 2013) is that school rolls adopted for this 'v6' Cycle Model now also reflect the latest Ministry of Education (MoE) announcements on future school merges and closures - including those made in December 2013.

1.1.8 This departure was considered warranted, as one of the key desired objectives of the MCR programme is to offer facilities that will attract less-confident potential cyclists (including school children): Education trips are known to have a very different pattern of cycling to other trips (and this varies too by age). To enable the most accurate estimation we can currently make of future potential use of cycle networks (Do-minimum or Do-Something), the adoption of the MoE's latest proposals was necessary to ensure any future potential use of any particular cycle network package reflects the scale and distribution of potential education-purpose cycle trips to existing (and future) schools - accounting for location, school type, roll, any prevailing catchments and anticipated population/age cohort shifts of contributing households and their relationship to proposed package projects.

1.1.9 The basis for the future Do-Minimum and Option cycle networks examined is the anticipated road network currently adopted by the UDS partners, for each of this study's main assessment years (2021, 2031 and 2041) - along with other links available not available to motor vehicles.

1.1.10 The updated CSCM has been used to forecast the future cycle demand and user travel benefits on these cycle networks for each forecast year, with differentiation within these as required to reflect key potential variables (and therefore benefits). Our assessment of benefits has been informed not only by these projections of user statistics, but also through associated and consistent application of the CAST traffic model, to inform potential non-user benefits.

1.1.11 Following this Introduction, subsequent sections of this report in turn:

- summarise the main tool used for assessment (CSCM), including updates made for this study;
- identify the Option(s) assessed, including costs;
- forecast cycle demand, outlining relevant key assumptions;
- describe our assessment of benefits;
- summarise Benefit-Cost Ratio estimates (BCR)/Incremental BCRs;
- test potential Sensitivity (and any implications for rating); and finally
- present our Conclusions.

1.1.12 Lay readers should note that we have not attempted to explain all the terms and processes used in 'non-technical' language within this report: Its purpose is to summarise and supplement our technical work (including model data and calculation spreadsheets), and to support and facilitate technical peer review of the principal findings.

2 The Christchurch Strategic Cycle Model (CSCM)

2.1.1 The principal tool used as the basis for this investigation is the Christchurch Strategic Cycle Model (CSCM). This model was first developed by QTP for CCC in 2012 and is described more fully in two reports, which are available on request to CCC:

- Strategic Cycle Model - Non-Technical Summary (QTP, August 2012); and
- Christchurch Strategic Cycle Model Background report (QTP, August 2012).

2.1.2 The application of the model for this study essentially follows similar processes as described in detail within the above technical Background Report. These processes have therefore not repeated in full here, except where the original processes have been extended or modified to cater for the specific needs of this investigation. However, to ensure context, the key features have been summarised below:

2.1.3 The CSCM was set up to make forecasts of daily[2] utility-purpose cycle use, by trip purpose. The model includes stages which account for cycle trip generation, distribution, mode-split and assignment.

2.1.4 The cycle demand forecasts made by the model depend (mainly) upon:

- Demographic land use scale and distribution (e.g. population, jobs, school places);
- Accessibility and Attractiveness (via the available cycle network); and
- Relative (changes in) attractiveness of travel via cycle and private vehicle over time.

2.1.5 It should be emphasised that the CSCM is an entirely 'synthetic' transport model, by design: It does not rely upon matrix estimation at any stage. The rationale for this design choice is covered in more depth in the above Background Report, but essentially revolves around the potential reliability and variability of available cycle count information, coupled with a requirement to develop a model suitably responsive to potential future 'sea-changes' (including the infrastructure under assessment).

2.1.6 The CSCM is based upon the CAST (Christchurch Assignment and Simulation Traffic) model, with additional enhancement to reflect the cycle network - and cyclist choices.

2.1.7 The CAST model is a fine-grained network traffic model that could be readily adapted to enable relevant information for cycle modelling, such as inclusion of existing or potential cycle-only links, the ability to apply alternative assignment methods for different target cycle users and of course to incorporate accurate information on traffic volumes and delays, where this might affect potential cycle use.

2.1.8 Both CAST and thus the CSCM model divide the greater Christchurch ('UDS') area up in to around 1,400 discrete smaller areas (model zones). The CSCM estimates the potential cycle demand between each pair of these zones – as well as the likely route(s)

2 Note that unless specified, the term 'Daily' is used within this report to described estimates adjusted to reflect use over an average weekday (Monday-Friday) within an (average) term-time. Flows can be expected to be higher or lower at times, e.g. due to seasonal variation, on wet days or in school holidays. Where quoted, AADT or annual estimates reflect adjustment for such variations, totalled over 365 days (ie 7 days a week accounting for all terms and holidays).

taken between each pair - by different types of user.

2.1.9 The fine division offered by this zone system (compared to, say, Census Area Units or the parent strategic CTM) was necessary to capture potential cycle effects because:

- Whilst Census Journey to Work data is highly useful, (home-based) commuting trips are estimated to (currently) account for 'only' around 30% of all term-time weekday utility trip-making by cycle; In other words, 70% of (existing) cycling is likely to have different drivers of scale (trip generation) and patterns.
- Indeed, a range of sources[3] confirm that trip-making generation and distribution for other cycle trip purposes differ markedly from for commuting (cycling) – e.g. different trip length profiles compared to commuting cycling trips.[4]
- CAU and CTM areas (on the whole) were determined to be too large to reflect a significant portion of potential cycle use - particularly for some purposes and at an assignment level appropriate for determining potential benefits.

2.1.10 The CSCM takes account of key forecast demographic demand variables in each area when making projections of a 'base' level of potential cycle trip-making, and therefore ensures that the potential impacts (over time) of anticipated (post-earthquake) changes in population, employment and school locations and rolls on potential cycle demands are incorporated.

2.1.11 The model also takes account of planned future transport network changes (e.g. the Central City Recovery Plan 'AAC'[5] roading network and new roading schemes elsewhere - as well as potential rise in future congestion, fuel prices etc.

2.1.12 Projections of cycling demand take account of perceived *utility* of cycling for different trip purposes[6] (commuting, education level (5 types), other home-based and non-home based cycling). The perceived utility for travel (by cycle) between a particlat pair of zones takes account, (weighted by purpose) of the proportions using diifferent routes and therefore different 'types' (standards) of cycle links – ranging from from the high-standard segregated facilities, to on-street cycle lanes – to streets with no speciic cycle facilites. The (change in) potential utility for a cycle trip is compared to the alternative of a trip by car to determine the potential change in future mode-split.

2.1.13 The ability for different potential cycle network improvement packages to attract more or less demand is therefore reflected by this mode-split adjustment element of the model.

2.1.14 The original model has been further developed for this study to disaggregate daily forecasts for each of the main travel hours (AM peak hour =0800-0900, an average Interpeak hour (0900-1600) and the PM Peak hour = 1630-1730). This has been done to facilitate an accurate estimate of potential non-user (decongestion) benefits.

---

3 E.g. CTM Household Interview Surveys and National Travel Survey data.

4 E.g. for 'Education' purposes, the trip length profile depends not only on the level of education (student age) but also on the location and catchment policies of individual schools. The CSCM takes account of such factors.

5 An Accessible City Chapter of the Central City Recovery Plan, CERA, October 2013

6 As noted above, the estimates of use for purely-recreational cycling are NOT included.

3 Improvement Scenarios Assessed

3.1.1 The analysis presented within this report considers several alternative cycle network improvement strategies including:

- Scenario 0 – A Do Minimum Cycle Network improvement strategy;
- Scenario 1 – The principal 'Option' or 'Do-something' Strategy. On completion this would represent a package including additional potential major cycle network improvements:
  - b) The MCR programme (13 projects as currently envisaged), and
  - c) The Central City Recovery Plan (AAC) Cycle projects; and
  - d) The Christchurch Coastal Pathway (CCP);
- Scenario 2– As Scenario 1 above, but with approximately 25% less (by length) of the currently proposed MCR project (sections).

3.1.2 The term 'scenario' has been deliberately adopted throughout this report to describe what are, in effect, alternative investment package options. This is because the benefits of each are likely to ***also*** be dependent upon a range of other factors, beyond assumed cycle infrastructure. Such factors are described more fully in Section 4.1.

3.1.3 Each Scenario has been investigated to predict usage and identify consequential potential relative benefits, in 2021, 2031 and 2041. The basis for each of the cycle networks reflected in the above scenarios is therefore the road network anticipated for each of these assessment years - plus of course any cycle-only links enabled (in that relevant assessment year) within the package under consideration.

3.2 Do-Minimum Cycle Networks ('Scenario 0')

3.2.1 It may be noted that several significant updates have been made to the single (2026) do-minimum scenario network prepared for the *original* (2012) cycle model-build, as described in the original Background Report. For each of the 3 future modelled years we have prepared updated Do-Minimum cycle networks for this study which:

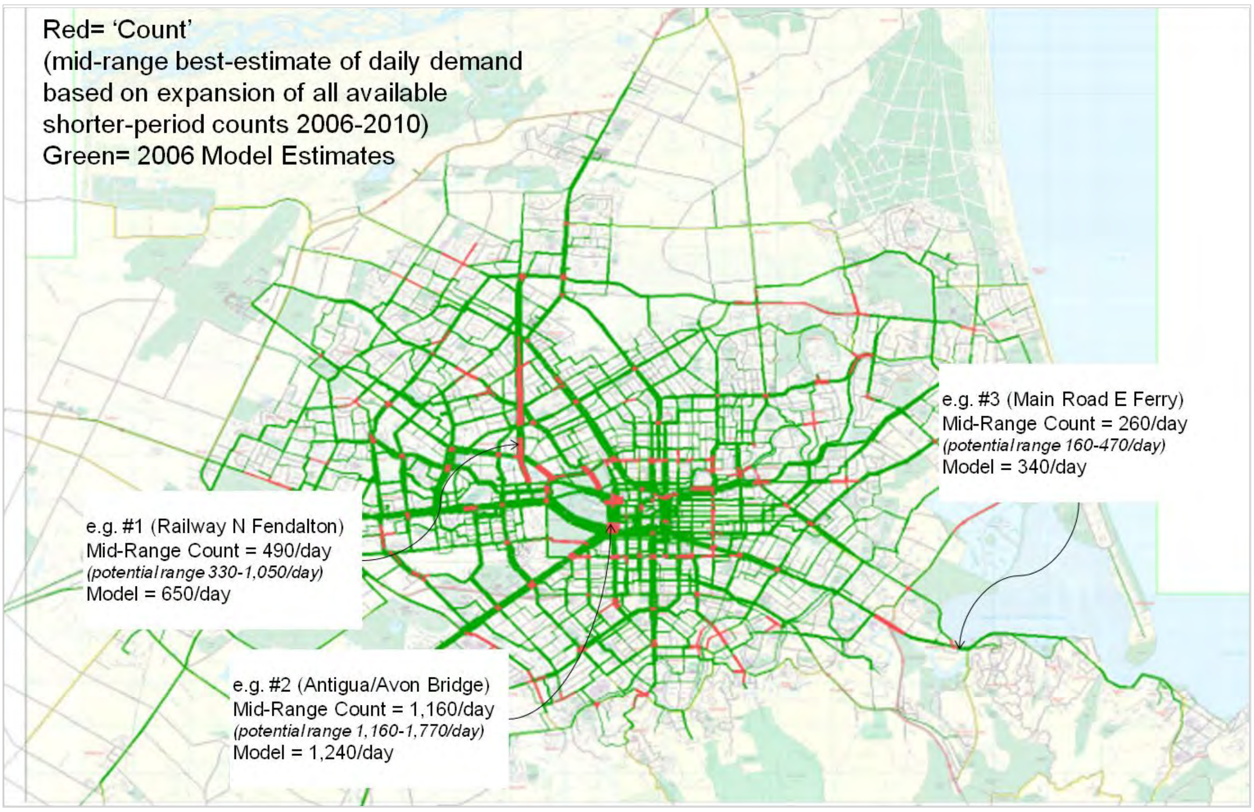
- Update the overall v5 road-based cycle networks to reflect the current ('v6') CAST vehicle networks, for each of the new assessment years of 2021, 2031 & 2041;
- Updates do-minimum improvements to reflect the detail of fully-or partially completed cycle projects (e.g. Southern Motorway Cycleway, Tuckers extension of Northern Railway cycleway, as well as several additional cycle-only river crossings not incorporated previously); and
- Now incorporates consideration of the principal on-road cycle lanes (to account for perceived utility differences between no facilities, segregated cycle paths ***and*** on-road cycle lanes in both Do-Minimum and Do-Something network assessments).

3.2.2 The 'parent' transport model changes - including both assumed land use and 'road network' supply (including public transport), are described in the following two reports:

- CTM V06 Update Report V01b.pdf (QTP Ltd., October 2013); and
- CAST v06 Model Update Report v02a.pdf (QTP Ltd., October 2013).

3.2.3 Given that we wished to enhance the CSCM to incorporate relative consideration of the proposed segregated cycle path projects to a network also incorporating many (existing) on-road cycle *lanes*, this has also necessitated updating the (2006) v5-based CSCM, to incorporate the latter[7]. The updated v6-based 2006 CSCM model estimates of daily cycle demand patterns are illustrated (and compared to available 'actual' count estimates[8]) below:

Figure 3-1: v6 CSCM 2006 Estimated Daily Cycle Demand



3.2.4 Each of the revised future v6 Do-Minimum cycle networks therefore have also been updated to ensure consistency, where relevant, with the physical and operational management assumptions within the v6 *vehicle* models (e.g. new subdivision roads, updated AAC schemes, revised traffic signal timings, etc.).

3.2.5 For the purposes of this assessment, the future assumed 'Do-Minimum' networks (one for each of the 3 future assessment years of 2021, 2031 and 2041) therefore include:

- The current road and cycle-specific network (restored per pre-quake);

7 The original CSCM was developed on a very contrained budget that precluded inclusion of all desirable features: It therefore only sought to illustrate the potential difference between segregated paths and 'existing' cycle infrastructure (on-road lanes and no facilities not being differentiated).

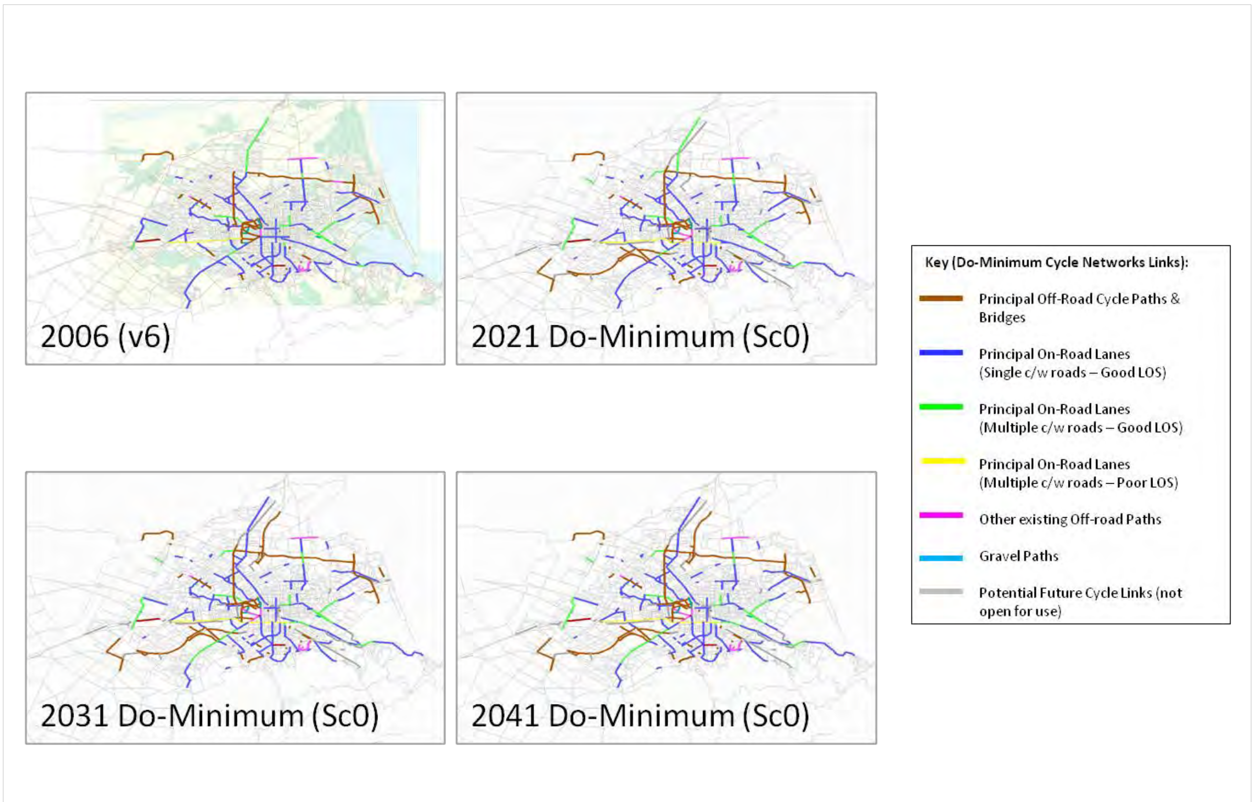
8 It is accurate to describe these 'counts' as 'estimates' too: They reflect the expansion of (all) shorter-period observed counts (typically gathered over 1.5hr periods) using expansion factors detailed in NZTAs National Cycle and Route Planning Guide to thus provide an *estimate* of daily 'actual' demand.

- Road improvements and additions anticipated to be added by the appropriate time e.g. through anticipated growth area sub-division.
- Specific off-road cycle paths (currently) proposed to be provided in association with approved or publicly-notified major transport projects (e.g. the Northern Arterial (NZTA), and Wigram-Magdala Link, Northcote Road 4-Laning and Northern Arterial Extension (CCC).
- The following major potential cycle infrastructure improvement projects have not been included in the assumed Do-Minimum networks, given potential funding uncertainty - but have instead been incorporated as part of (all) assumed integrated 'Do-Something' (Option) cycle network packages:
  a) The CCRP (An Accessible City - AAC) cycle path projects; and
  b) The Christchurch Coastal Pathway (CCP), which runs between the Ferrymead Bridge and Sumner

3.2.6 In addition, all v6 cycle networks (including the Do-minimums) also reflect, where required, the predicted *performance* or the v6 vehicle networks, requiring interrogation of vehicle networks to extract and update the relevant updated (cycle) turning penalties for the appropriate year/period – as some of these depend upon (revised) traffic movements and delays.

3.2.7 The Do-Minimum network assumptions are broadly summarised on Figure 3-2 below:

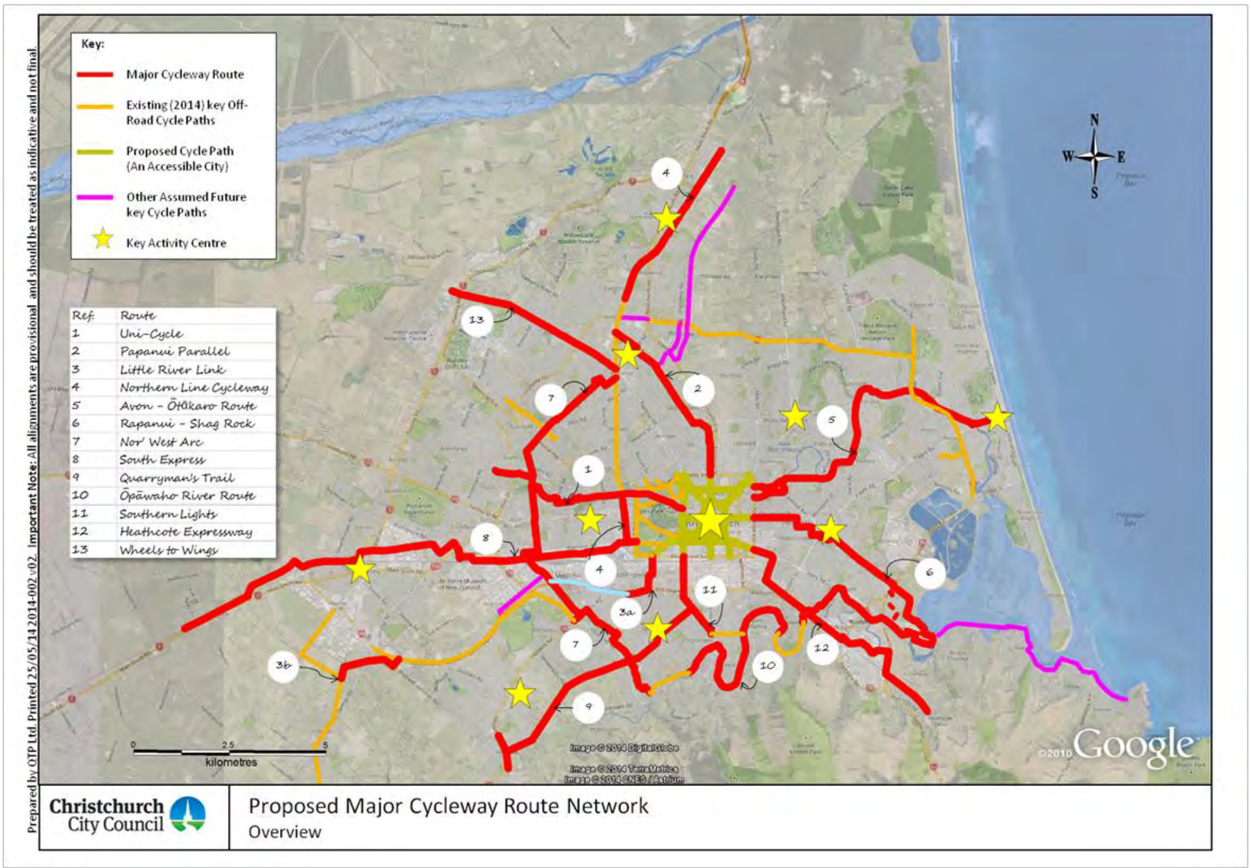
Figure 3-2: Revised Do-Minimum Cycle Networks (CSCMv6)



3.3 Scenario 1 Cycle Network

3.3.1 The key Option network scenario adopted for the purposes of this assessment is the current assumed MCR programme for segregated off-road cycle paths, as shown below in Figure 3-3.

Figure 3-3: MCR Assumed Future Cycle Network[9]



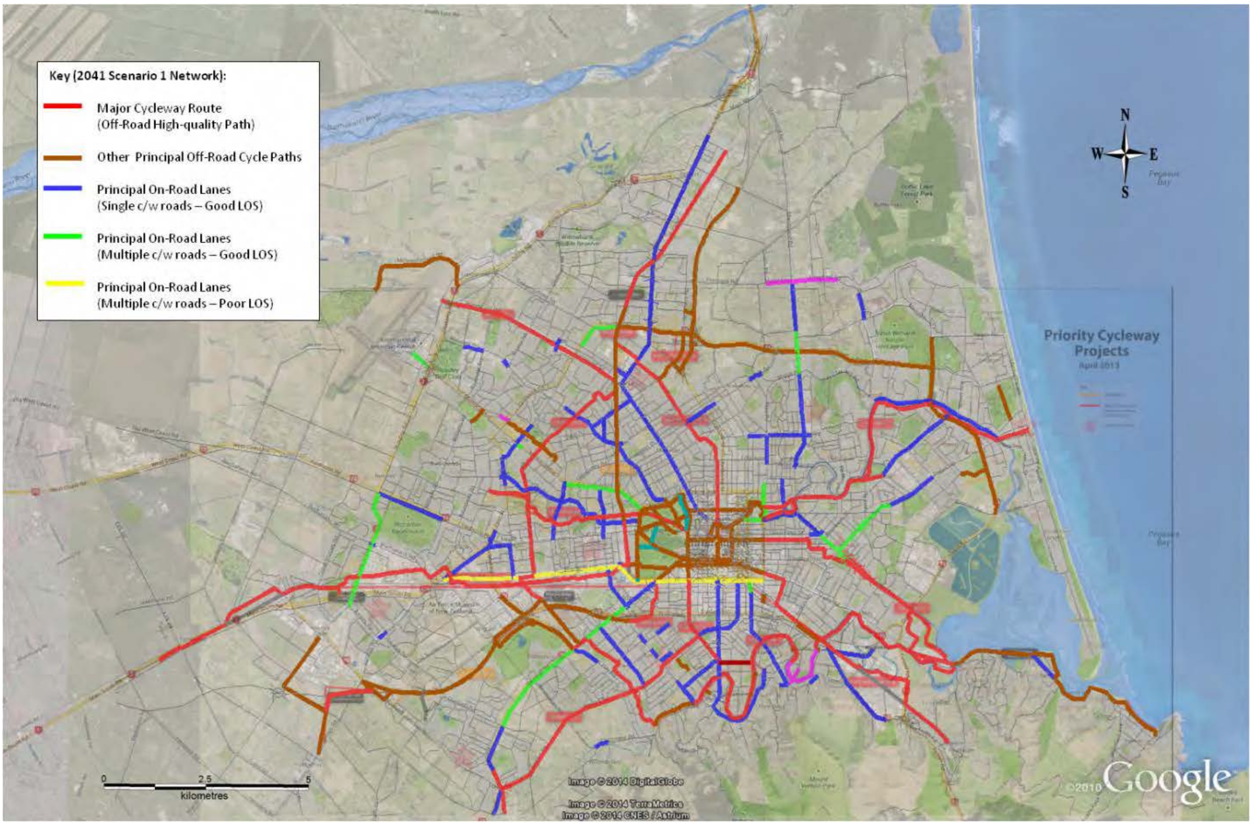
3.3.2 The above MCR alignments represent, in some cases, slight amendment to the provisional alignments shown in CCC's April 2013 Priority Cycleway Project plan and follow further investigation by the Council's project team since that time. Appendix 1 identifies and describes the principal differences from this earlier plan.

3.3.3 It is important to note however that detailed design for project alignments shown above will continue to be progressed and therefore the alignments shown should still not be taken as definitive until such time as they are approved as such by the Council and other relevant agencies.

9 The network shown here is for 'Scenario 1' (Full implementation of MCR)

3.3.4 In terms of representation of the infrastructure capacity of this package within the CSCM, this may be summarised by showing the assumed model 'link' coding assumptions, shown in Figure 3-4 and Figure 3-5.

Figure 3-4: Model Coding[10] Example: 2041 Scenario 1 Future Cycle Model Network



3.3.5 Essentially (for mode-split) purposes, the 'utility' of each potential cycle link within the network is allocated into one of only 3 categories, being:

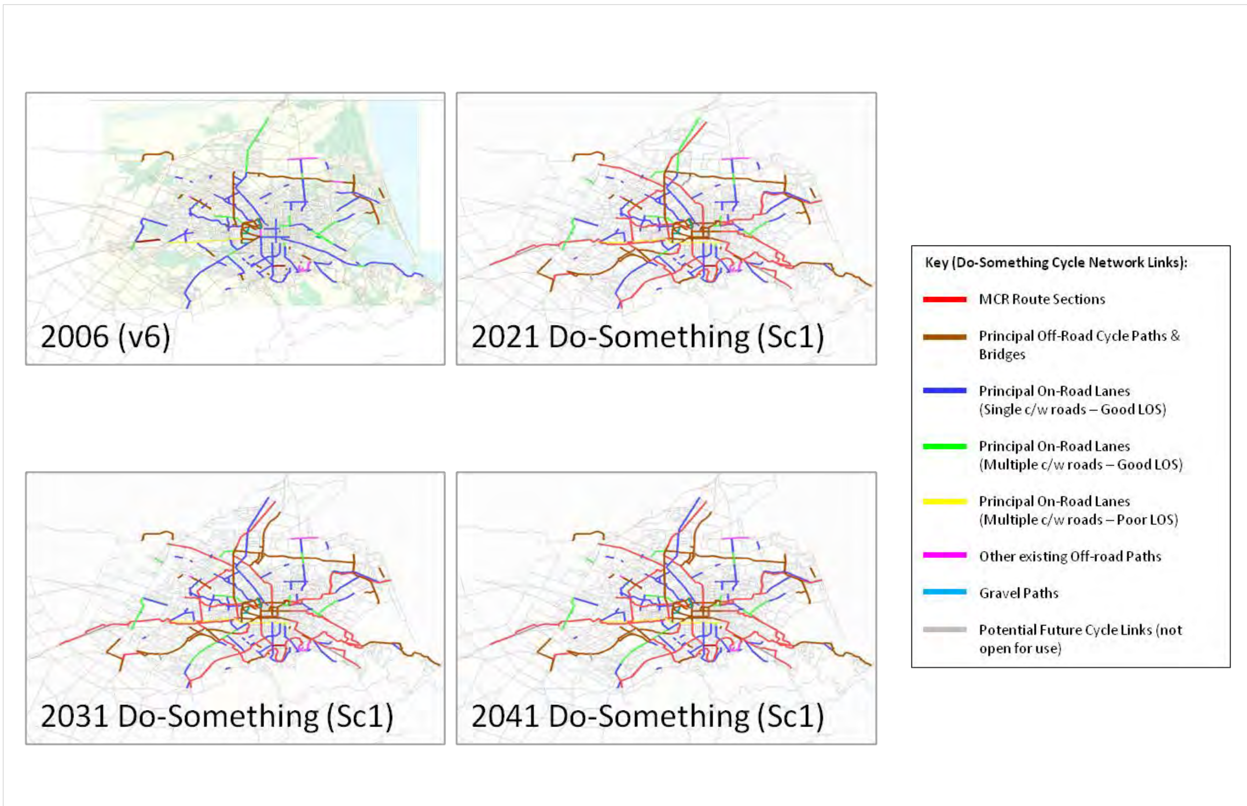
a) On-Street (no facilities)

b) On-Street (with Cycle lanes); or

c) Off-Street Cycle Paths

10 Several residual minor *model* differences may be noted in detail, when compared to Figure 3-3:– e.g. final AAC cycleway omissions on original April 2013 CCC plan are still omitted in the above networks (i.e. as modelled) e.g. Colombo & Barbadoes (Moorhouse-St Asaph); Minor routeing change near Eastgate etc. None are considered likely to be significant in terms of the strategic modelling.

Figure 3-5: Model Coding Summary[11] of all Scenario 1 Cycle Model Networks



3.3.6 It can be seen from the above figure that, for all future year scenarios the MCR routes are assumed to have all been completed by 2021.

3.3.7 The current assumptions regarding a potential construction profile for this package are shown overleaf. These are necessary to determine the present value of costs for economic assessment purposes.

3.3.8 This capital cost profile, will of course be subject to potential change – both as designs and cost-estimation are progressed to a greater level of detail, and decisions are developed and made by Council and partner agencies over funding and optimum sequencing.

11 This Summary cannot possibly show all coded differences (e.g. at the intersection level, the assumed form of traffic control may differ, signal timings are anticipated to change etc. etc.)

Table 3-1: Draft Major Cycleway Route Programme - Funding Cash flow *(Updated)*

Draft Major Cycleway Route Programme - Current Assumed Funding Cashflow

Route	Name	Previous Working Name	Approx. Route Length (km) - As model defn.	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	Total $	Approx. $/km
1	Uni-Cycle	University	5.6	$318,000	$1,593,000	$2,706,000	$3,900,000						$8,517,000	$1,521,000
2	Papanui Parallel	Grassmere	4.9	$515,000	$986,000	$4,074,000	$1,678,000	$2,206,000					$9,459,000	$1,941,000
3	Little River Link	Little River	3.0	$42,000	$446,000	$3,194,000							$3,682,000	$1,244,000
4	Northern Line Cycleway	Northern Railway	5.6				$634,000	$314,000	$4,792,000				$5,740,000	$1,018,000
5	Avon - Ōtākaro Route	Avon River	10.4					$2,006,000	$371,000	$12,990,000	$4,179,000		$19,546,000	$1,873,000
6	Rapanui - Shag Rock Cycleway	Ferrymead	8.9		$1,035,000	$710,000	$1,412,000	$13,977,000	$1,134,000				$18,268,000	$2,055,000
7	Nor' West Arc	Western Orbital	10.5				$175,000	$1,968,000	$6,778,000	$9,355,000			$18,276,000	$1,734,000
8	South Express	Hornby	13.3				$1,955,000	$1,017,000	$14,958,000	$570,000			$18,500,000	$1,390,000
9	Quarryman's Trail	Halswell	8.6		$1,227,000	$740,000	$8,026,000	$5,773,000					$15,766,000	$1,837,000
10	Ōpāwaho River Route	Heathcote River	10.8						$1,562,000	$456,000	$11,092,000	$1,664,000	$14,774,000	$1,365,000
11	Southern Lights	South-City	0.9					$59,000	$221,000	$1,347,000			$1,627,000	$1,898,000
12	Heathcote Expressway	Heathcote Rail	7.1			$884,000	$868,000	$9,619,000					$11,371,000	$1,595,000
13	Wheels to Wings	Airport-City	4.6					$1,209,000	$740,000	$8,764,000			$10,713,000	$2,348,000
Total Draft MCR Programme (Capital)			**94.2**	**$875,000**	**$5,287,000**	**$12,308,000**	**$18,648,000**	**$38,148,000**	**$30,556,000**	**$33,482,000**	**$15,271,000**	**$1,664,000**	**$156,239,000**	**$1,659,000**

(Data provided by CCC and current 08/1/2015 . Note lengths of Routes 9 and 11 have changed since Preliminary Assessment - with a portion of Route 11 now being incorporated into Route 9.

3.3.9 We consider that much of the anticipated MCR programme expenditure shown for the financial year 2013/14 are likely represent sunk costs for design and investigation. These costs have non-saleable value and would normally be omitted from economic assessment (and thereby reducing the net expenditure of the proposed package, compared to the assumed Do-Minimum). However, to realise a conservative assessment, the full current (capital) cost estimates provided above by CCC have been allowed for, at this stage.

3.3.10 As noted above, two other potential major projects have been assumed as additional (to the MCR programme) in an integrated 'Do-Something' (Option) cycle network package:

- An Accessible City cycle path projects; and
- The Coastal Pathway, which runs between the Ferrymead Bridge and Sumner.

3.3.11 For the purposes of this assessment, revised estimates for these projects have been adopted, being a total of $15m now being allowed for An Accessible City (AAC) cycle projects (down from $18m adopted in the Preliminary Assessment) and $17.75m now allowed for the Christchurch Coastal Pathway (up from $10m).

3.3.12 Note that capital costs of cycle improvements associated with future major roading schemes, eg Wigram-Madala, Northern Arterial) have *not* been included – These costs will be incurred in Do-Minimum and the net cost (c.f. Do-Something) is therefore zero.

3.3.13 Detailed discounting calculations for costs (and benefits) are provided within the spreadsheets that accompany and support this report –and these are summarised in Appendices F and G.

3.3.14 The assumed capital cost profile has however been summarised graphically, as shown in Figure 3-6 overleaf - while Table 3-2 supplies the key figures relevant to the central Benefit-Cost assessment scenario.

Figure 3-6: Assumed Capital Expenditure Profile for Scenario 1 *(updated)*

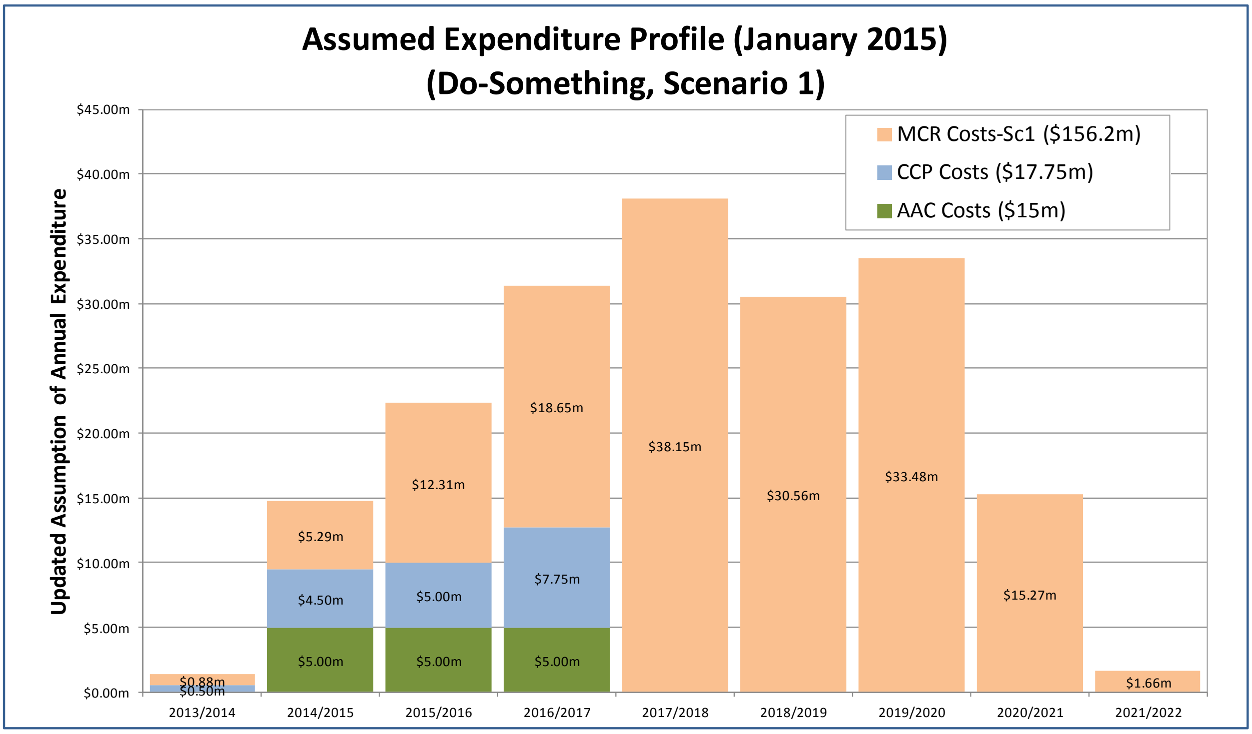


Table 3-2: Scenario 1 Capital Cost Assumptions – Summary *(updated)*

Package Element	Undiscounted Total Cost	Present Value of Costs (6% Discount Rate)
13 MCR Routes	$156.2m	$120.3m
An Accessible City Routes	$15.0m	$13.4m
Christchurch Coastal Pathway	$17.75m	$15.7m
Scenario 1 Total	$189.0m	$149.4m

3.3.15 This Update also now makes allowance for the (net) maintenance of the improved cycleway network infrastructure: This was not known when the Preliminary Assessment was made but has since been assessed by CCC (for the MCR network), allowing for the particular type of cycle facilities now proposed and their anticipated recurrent and periodic maintenance[12] requirements. We have applied average net rates from these projects to also estimate a net maintenance allowance for the AAC and CCP projects.

3.3.16 Overall the net maintenance on completion of all projects is expected to be +$240,000 annually (compared to the Do-Minimum), amounting to an undiscounted net total of around $9m over the assessment period and a discounted total (Present Value) of $3m. The latter amounts to around 2% of the Updated Capital Costs.

12 Periodic maintenance has however been incorporated by CCC on a % basis i.e. as a recurrent (annual) maintenaance allowance. While this is not strictly correct when discounting, we have retained these values for simplicity.

3.4 Scenario 2 Cycle Network

3.4.1 To examine the potential for cost savings (and resulting reduction in benefits) a second scenario is described here, which reflects the assumed omission (or 'indefinite deferment') of some sections of the full (Scenario 1) MCR network. The sections selected to omit for this illustrative scenario represent a total of approximately 25% (by length) of the full MCR network and are highlighted in Figure 3-7.

Figure 3-7: MCR Sections assumed to be omitted/deferred for Scenario 2

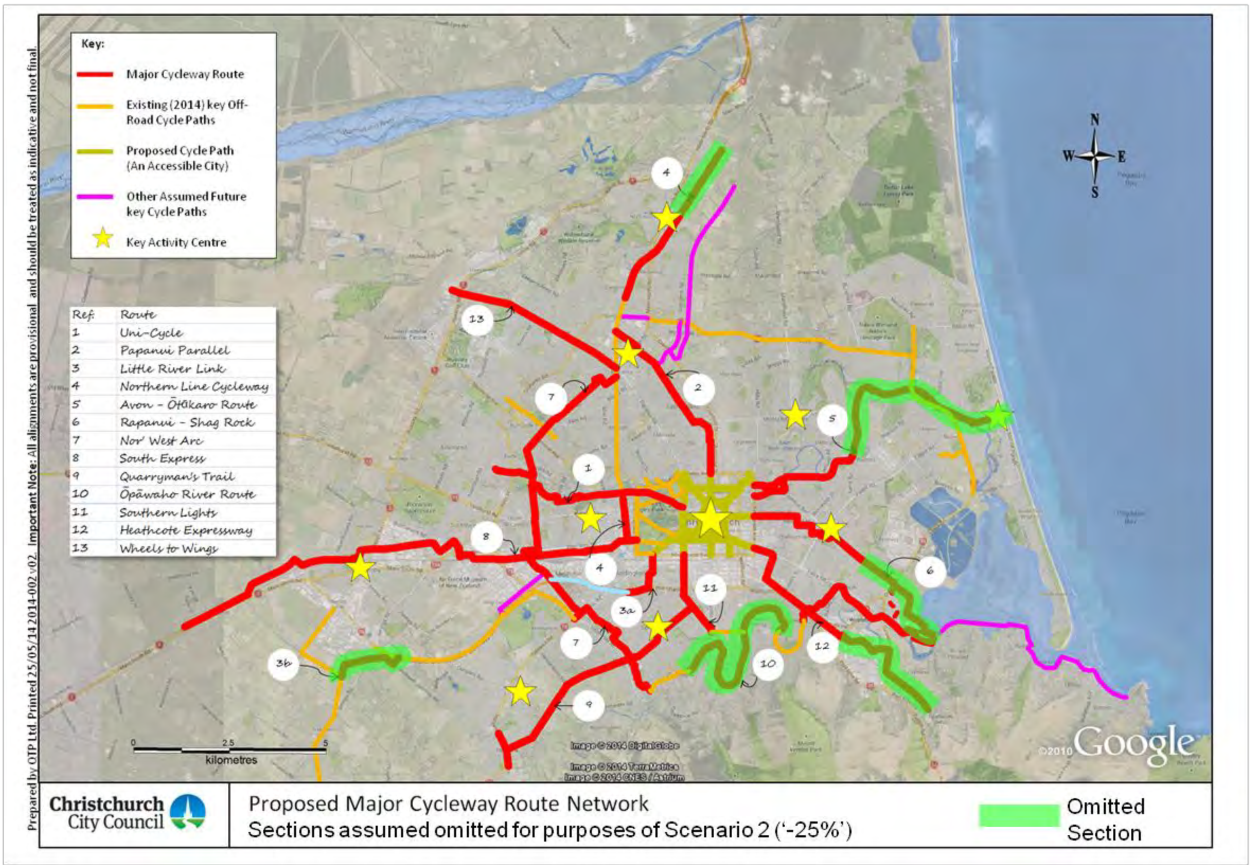


Table 3-3: Scenario 2 Capital Cost Summary *(updated)*

Package Element	Undiscounted Total Cost	Present Value of Costs (6% Discount Rate)
13 MCR Routes	$117.3m	$91.1m
An Accessible City Routes	$15.0m	$13.4m
Christchurch Coastal Pathway	$17.75m	$15.7m
Scenario 2 Total	$150.1m	$120.1m

3.4.2 Given these assumptions, when net maintenance is also included, the **present value of total Scenario 2 costs** might be reduced by -20%, compared with the cost estimates adopted for Scenario 1.

3.4.4 Note that total of MCR element costs does not reduce in direct proportion to the length reduction (-25%), because of the particular route sections omitted.: Costs for each route are reduced pro-rata in the absence of more detailed information and the PV is determined according to the profile in Table 3-1.

Table 3-4: Scenario 2: Undiscounted Cost Assumptions *(updated)*

Route	Name	Full Length (Sc1) km	Reduced Length (Sc2) km	Assumed Sc2 $
1	Uni-Cycle	5.60	5.60	$8,517,000
2	Papanui Parallel	4.87	4.87	$9,459,000
3	Little River Link	2.96	1.49	$1,858,415
4	Northern Line Cycleway	5.64	3.54	$3,600,092
5	Avon - Ōtākaro Route	10.44	4.37	$8,179,912
6	Rapanui - Shag Rock Cycleway	8.89	3.74	$7,684,974
7	Nor' West Arc	10.54	10.54	$18,276,000
8	South Express	13.31	13.31	$18,500,000
9	Quarryman's Trail	8.58	8.58	$15,766,000
10	Ōpāwaho River Route	10.83	5.30	$7,231,441
11	Southern Lights	0.86	0.86	$1,627,000
12	Heathcote Expressway	7.13	3.70	$5,907,241
13	Wheels to Wings	4.56	4.56	$10,713,000
All MCRs		**94.21**	**70.47**	**$117,320,075**

Routes with sections omitted for illustrative Scenario 2

4 Forecast Cycle Demands

4.1 Key Assumptions

4.1.1 For our base forecasts a consistent assumption (applied within both the Do-Minimum and Do-Something Scenarios) is that by 2041, a rise in the real-terms price of fuel of some 40% (over 2006 values) *might* occur – allowing for potential peak-oil effects[13]. Such an increase can, naturally, be anticipated to make alternatives to private car use (including cycling) somewhat more attractive by comparison, for some travellers. Given the uncertainty around the potential scale and timeing of any such rise however, a sensitivity test has however also been conducted *without* this increase - i.e.fuel costs being assumed to remain at 2006 values in real terms, for all 3 assessment years.

4.1.2 One of the other key assumptions relating to potential future year cycle demand, is how many car users (drivers or passengers) actually *would* choose cycling as a viable alternative, given suitable improvements. Existing research suggests significantly differing figures for this 'trader-factor', depending on the context and method of research. Figures range from up to about 80% (applied in a recent study into potential cycle use within the Inner Sydney area[14)] down to 9% (from a hierarchical elimination study undertaken in 1992 in Brisbane[15)].

4.1.3 One of the key cautions when transferring relationships, particularly those derived from 'Stated-Preference' studies, is not only the potentially different context and the detail of original survey method – but also the difference between what people *say* they might do (in a hypothetical situation) and what they actually *would* do, in reality. There may be a significant gap between the subset of the population that say they are prepared to consider cycling as an alternative mode or might be considered potential cyclists – illustrated by very significant cycle ownership levels – and those that actually would realistically choose to cycle (on a regular basis).

4.1.4 For our base forecasts however, we have adopted an estimated figure of 30% as this (maximum) 'trader-factor' (from car). Whilst this is based on a dated hierarchical elimination study, undertaken in 1982 in Germany[16], which itself was based on commuting trips only and also may not reflect the attractiveness of more modern designs of segregated facilities, in the absence of more detailed local investigation, in our opinion this is likely to provide a more realistic (and still aspirational) figure for Christchurch, compared with the figure of 80% recently adopted for Inner Sydney[17.]

13 2021 and 2031 values (per vehicle-km) have been applied, through simple interpolation between 2006 and 2041.

14 Aecom Australia Pty Ltd. (2010) Inner Sydney Regional Bike Network: Demand Assessment and Economic Appraisal.

15 Morgan-Thomas, E. (1992). Why Don't You Commute by Bicycle? Ausbike 92-Cyclist Behaviour and Planning, Melbourne.

16 Brög, W. (1982). The acceptance of polices to encourage cycling. Transportation Research Board, Washington, Socialdata, Muenchen, Germany.

17 It is perhaps also worth noting that surveys and analysis by Parkman et al. estimated a maximum

4.1.5 Put another way, respecting local factors, for the purposes of our base estimates on average around 70% of car users are assumed to consider themselves – and be considered - to be 'captive' to the car.

4.1.6 How this is reflected in our (base) estimates is that whilst the CSCM mode-split module might predict a rise of say x% in the proportion of person trips made by cycle (based on relative changes in utility of both cycle and car travel), for a particular zone pair, the proportional (difference) that is actually taken forward as the estimate of travel by cycle is factored by the assumed 'trader' proportion – in the base case this being a factor of 0.3x.

4.1.7 However a sensitivity test has *also* been conducted to examine 'what-if' this 'trader' proportion might conceivably be even lower? –The assumption being made for the purposes of this test that the proportion might be around 15%, compared to the 30% of car users assumed for the base tests.

4.1.8 Naturally, the figure may perhaps equally be argued as potentially higher – and people's propensity to change modes can naturally be expected vary over time as the relative attractiveness changes – e.g. people stating they would be in the "no-way, no-how" category currently may have a different stated preference, were their circumstances to change substantially.

4.1.9 Notwithstanding this uncertainty, we note that NZTA RR449 (Kingham, Koorey et al.) cites a 2005 survey by Opinions Market Research that "27% of (Christchurch) non-cyclists were keen to cycle"[18]. This may suggest that about 30% is likely to represent a realistic, if possibly conservative, value – unless, for example, parking availability and costs and /or real-terms fuel costs were to change by an order or magnitude in the future.

4.1.10 The other thing perhaps worth noting here is that the relative utility discussed above (between no facilities, on-street facilities and segregated paths) is only applied within the mode-choice module of the CSCM (i.e. to determine the relative probability of using a cycle for a trip for a particular purpose between a particular origin and destination). When it comes to assignment, the relativity between facility types is based on a different perceived value (i.e. that segregated facility (links) may allow travel perceived to be around 25kph rather than 20kph assumed as an average with no of on-road facilities (note intersections delays are calculated in addition – also note that for the purpose of modelling the relative valuation of time and distance is also assumed to vary by cycle travel by trip purpose).

trader factor of 60% based on a large RP/SP study in the UK, and in another UK SP study estimated a 'saturation level' or maximum possible uptake of 43% See John Parkin & Mark Wardman & Matthew Page, 2008: "Estimation of the determinants of bicycle mode share for the journey to work using census data," Transportation, Springer, vol. 35(1), pages 93-109, January.

18 Reference may also be made to LTNZ RR294 (Sullivan & O'Fallon)

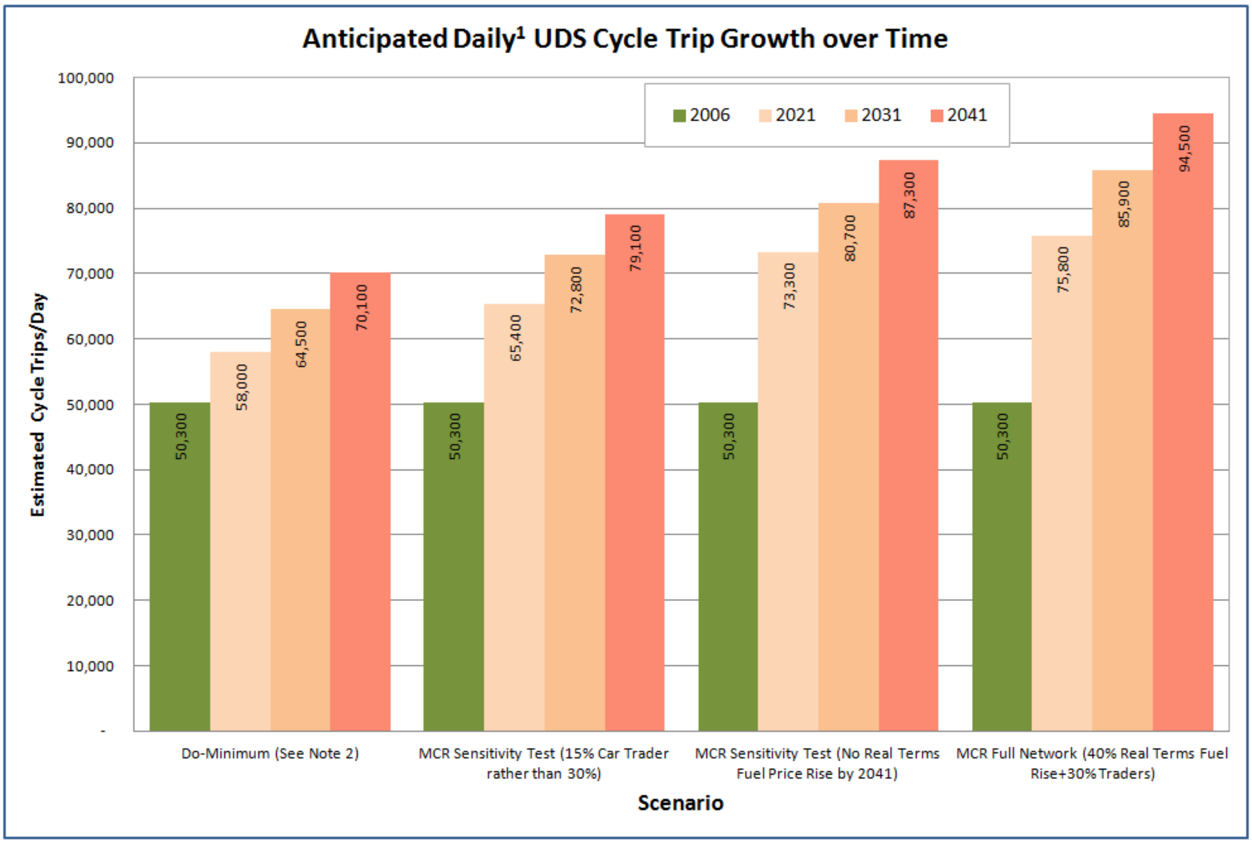
4.2 Forecast Growth in Daily Cycle Trips

4.2.1 Application of the v6 CSCM to the Do-Minimum and Do-Something networks (and the principal sensitivity tests noted above) yield the daily cycle trips summarised in Table 4-1 and shown in Figure 4-1 below.

Table 4-1: UDS-wide Total Daily Cycle Trips (Average weekday in term-time)

Year	Do-Minimum	Full Network test 1-3 (15% traders not 30)%	Full Network test 1-2 (0% fuel price rise not 40%)	Scenario 1 (MCR+ACC+ CCP)	Scenario 2 (Scenario 1 -25%) *(not shown on graph)*
2006	50,339	50,339	50,339	50,339	50,339
2021	57,994	65,362	73,324	75,757	74,365
2031	64,513	72,838	80,686	85,939	84,455
2041	70,052	79,145	87,295	94,541	92,827

Figure 4-1: Estimated Daily Cycle Trip Demand over time



4.2.2 The above analysis confirms that the principal Do-Something option (Scenario 1) is predicted to generate around 71% more cycle trips by 2031, compared to 2006 – and nearly 90% more at 2041.

4.3 Predicted Changes in Daily Cycle Travel Patterns

4.3.1 This growth is not predicted to be consistent across the whole greater Christchurch area: Rather, the number of cycle trips between particular areas is predicted to be affected by anticipated population shifts, employment opportunities and relationships between pupils and schools, not only at an absolute level but also as these changes may influence travel distances.

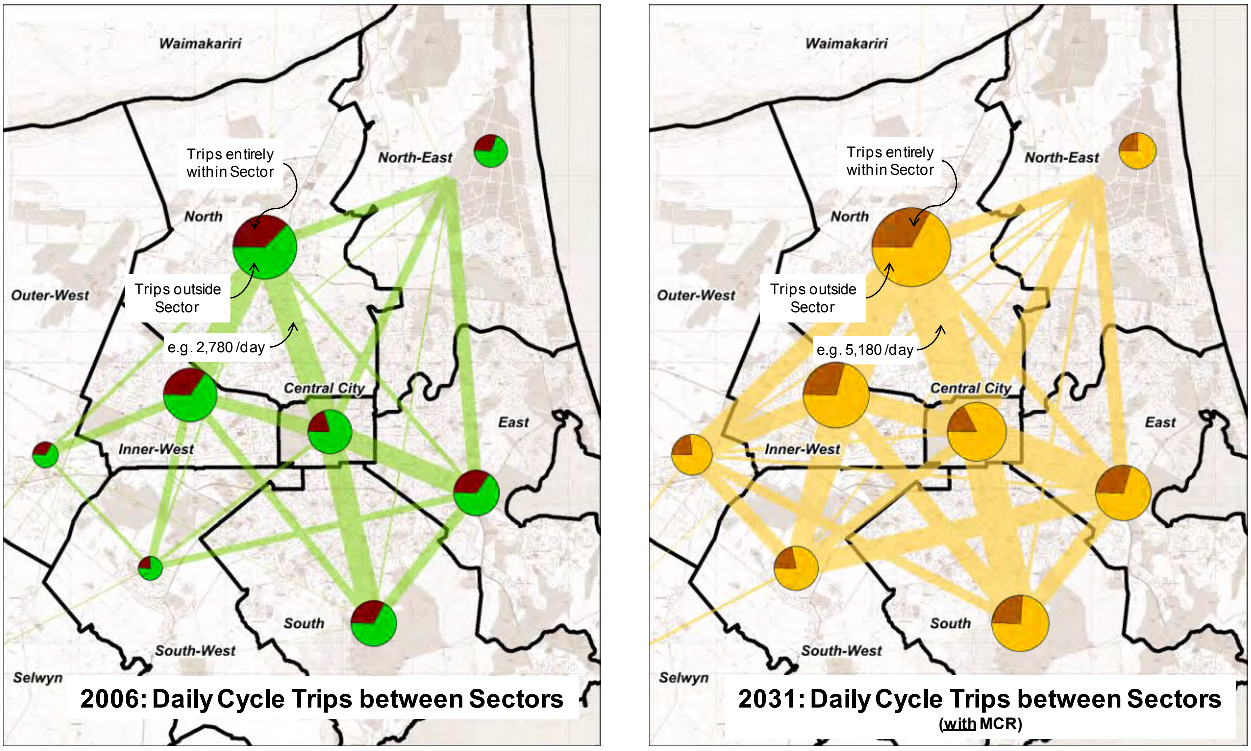
4.3.2 Furthermore (and perhaps obviously) the level of cycle trip growth between particular areas is predicted to be affected by the relationship to the major infrastructure improvements proposed, with demand between origins and destinations well-served by the improvements predicted to grow to a greater degree than in areas less well-served.

4.3.3 As an indicator of this, the overall growth (to 2031) in Cycle travel predicted between and within the UDS partners' "Improvement Sectors" is presented and compared to pre-quake patterns in n Figure 4-2 below.

4.3.4 This comparison, for example, shows that a high level of growth is anticipated within the "South-West" sector - but almost negligible growth in the "North-East". The latter is partially because the sectors represent an aggregation of many individual smaller zones that make up each sector: The "North-East". sector not only includes areas where growth in cycle trips is certainly anticipated (e.g. Prestons) but also areas where cycle trips are predicted to reduce (e.g. a reasonable proportion of residential red-zoned areas).

4.3.5 It also demonstrates that a slight rise in the proportion of *inter*-sector trips is anticipated – i.e. longer distance cycle trips, facilitated not only by more dispersed origins and destinations but also a proposed cycle network that better serves these more dispersed generators.

Figure 4-2: Inter-Sector and Intra-Sector Daily Cycle Trips

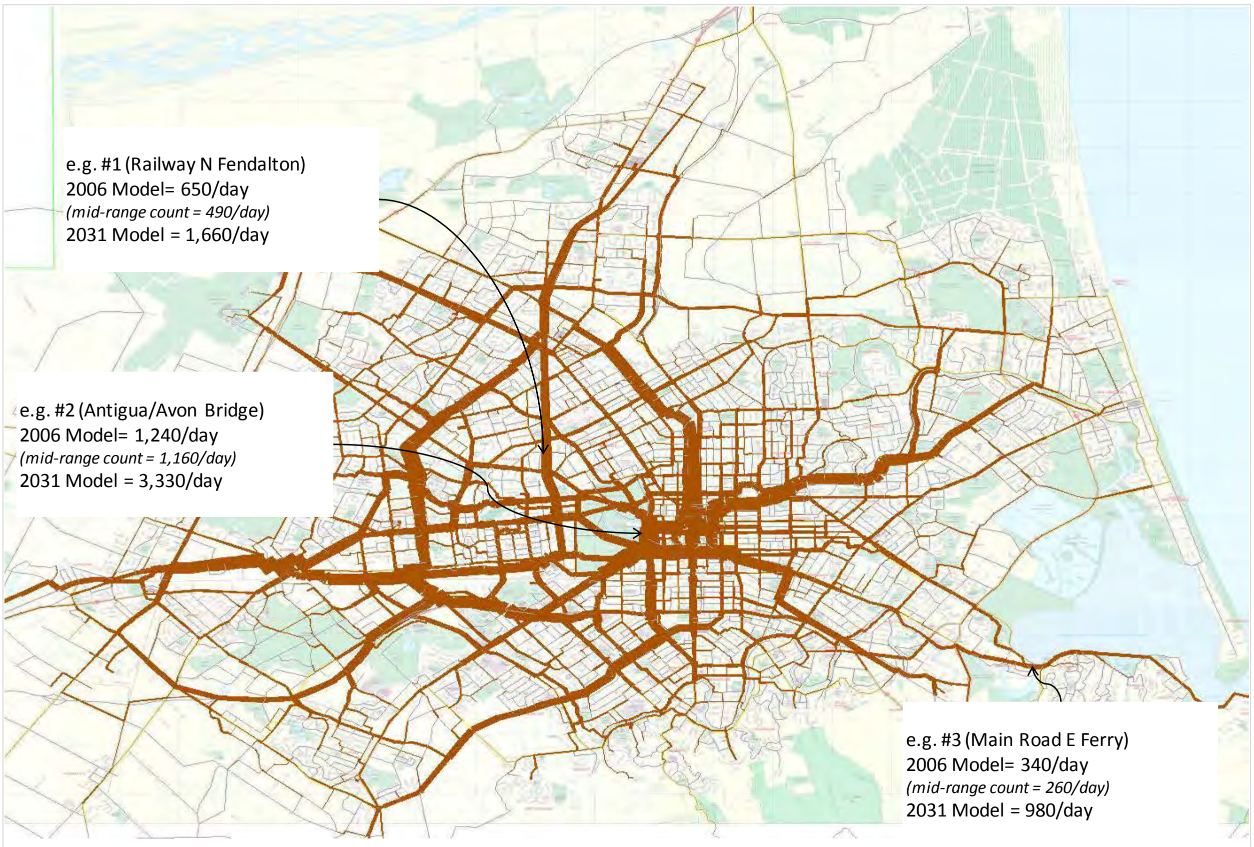


4.4 Daily Cycle Travel Assignments

4.4.1 The predicted cycle demand (matrices) have been assigned, individually for each of the 4 main cycle trip purposes, to the relevant cycle scenario networks. This is because each purpose is assumed to have different assignment parameters e.g. a greater emphasis on directness for commuters, compared to all other cycle trips. Each purpose assignment is then added together to enable an illustration of predicted **total** daily volumes on each link of the cycle network for a particular scenario/ year.

4.4.2 Figure 4-3 shows, as an example, the anticipated use in 2031, under Scenario 1 (where the cycle network represents that proposed)

Figure 4-3: Predicted Daily Cycle Assignment Example (Scenario 1 network, 2031)



4.4.3 The relationship to the proposed MCR network will be apparent, as may be the significant predicted level of growth, compared to 2006 (as shown by Figure 3-1). The ratio of growth in 'assigned' trips is predicted to be so substantial – and exceeds the proportional change in the number of trips - because 'observed' trips are a product of both the *number* ***and*** the *distance* of each trip.

4.4.4 In the future the improved network (along with demographic shifts) can be expected to facilitate & encourage longer trips by cycle – the overall average (weighted by purpose) being predicted to rise from 3.1km (2006) to 3.4km (2031 Do-Min) but 4.4km with Scenario 1 (ie +40%). 'Observed' trips (as reflected by cycle-km) are therefore projected to increase by **138%** from 2006 levels by 2031 (+70% more trips averaging +40% longer [as 1.7.x1.4=2.38])

4.5 Use of Cycle Network

4.5.1 In order to make many of the calculations required for the assessment of benefits, the amount of travel being conducted on particular parts of the network was required to be estimated. This was not only to disaggregate by standard for overall benefit assessment (e.g. no facilities, on-road cycle lanes or segregated paths), but also determine the 'average' use[19] along individual MCR projects to assist prioritisation. Statistics for these purposes have been extracted from the cycle model(s) by using the ability to identify and sum demand, time (including intersection delays) and distance by 'link-type'.

4.5.2 For example, 'x' cycle trips/day (x varying for *each* of the 4 main cycle trip purposes!) might be predicted by between zones 'a' and 'b'. However each of these trips may be predicted (by the assignment module) to take different routes between 'a' and 'b'[20]. Obviously the cycle trips observed on the network reflect the sum (assigned) over all routes, and all purposes, between all zone pairs. However, by extracting network-wide statistics on number of cyclists on each and every element of the network, the cycle-km on each element (type) of interest could thus be predicted.

4.5.3 An example of this are the figures shown overleaf. Figure 4-4 summarises the approximate lengths of segregated and other cycle facilites.

4.5.4 This shows that only about 2.3% of the 'pre-quake' (2006) network available for cycling was formed by segregated cycle paths, with an additonal 6% or so being main roads that had reasonably contiguous on-road (cycle lane) facilities. The remainder - and vast majority of this network – are roads without any explicit continuous cycle facilities.

4.5.5 With the proposed improvements however, this proportion would rise, such that on completion of the full MCR network (along with the AAC and CCP projects), cycle paths would form around 8.5% of the total road & cycle network.

4.5.6 These proportions can be compared to projected **use** by facility type over time, in Figure 4-5.

4.5.7 This demonstrates that despite comprising a relatively modest proportion of the total available network (all cycle 'paths' comprising around 8.5% of all potential cycle routes), by 2041 the 'paths' are predicted to cater for nearly half of all cycle-km travelled,. Thus, as well as providing essential inputs to enable economic assessment (e.g. use of segregated portions of the network is required to be identified for EEM processes), this also serves to confirm that, in large measure, the MCR (and other proposed cycle path routes) appear to be reasonably well-positioned to meet peoples' (future) travel needs - and fulfill a strategic objective to attract (more) use of (more of) such facilities.

4.5.8 Appendix C tabulates these key network-wide cycle user summary statistics, by purpose.

19 A 'route' may consist of many individual links, each with varying use

20 As a matter of further detail it might also be noted that the CSCM does not use an 'all-or-nothing' approach (i.e. assigning all cycle trips to a single route) - but rather reflects a spread of perceptions regarding what might constitute the most-attractive route(s), using a 'stochastic' assignment technique (with a lower spread assumed for commuting purposes).

Figure 4-4: Assumed Proportions of Cycle Infrastructure Provision

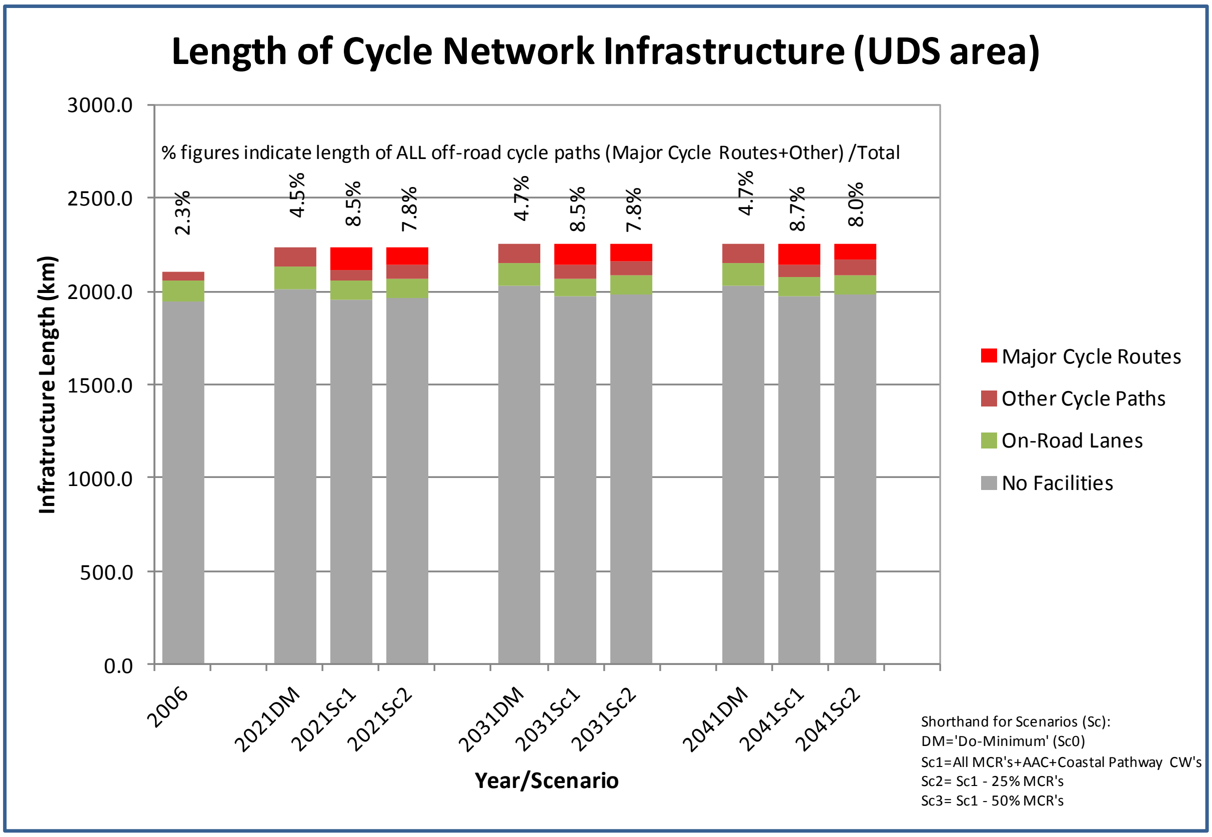
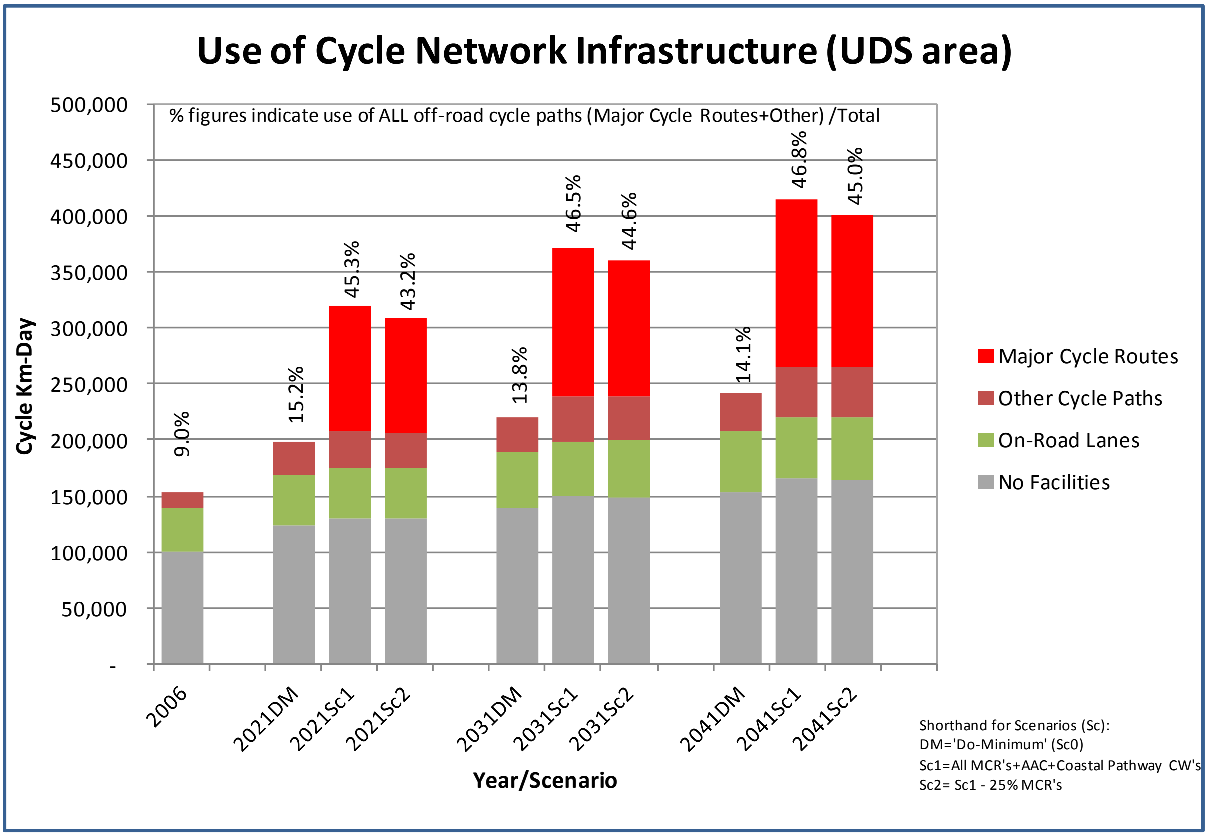


Figure 4-5: Modelled Use of Cycle Infrastructure



4.6 **Summary of Demand Projections**

4.6.1 By 2031, the number of daily cycle trips is predicted *to* rise by about +28% compared to 2006 - *even without major additional cycle infrastructure investment.*

4.6.2 This increase arises due not only to to demographic changes - e.g. *a* population increase of +21% is anticipated between 2006 and 2031 – but also the effects of increased congestion and the real-terms increase in fuel cost of using private cars assumed for our base scenarios.

4.6.3 However, the added investment of Scenario 1 (i.e. the Full MCR network along with AAC & CCP projects), is forecast to increase the number of daily cycle trips by +70% (by 2031).

4.6.4 If not *more* importantly, an improved network (along with demographic shifts) can be expected to facilitate & encourage longer trips by cycle – the overall average (weighted by purpose) rising from 3.1km (2006) to 3.4km (2031 Do-Min) - but to 4.4km with MCR (2031 with MCR) (ie +40%).

4.6.5 The combination of these factors means that 'observed' cycle travel (km-by-cycle) could be expected to actually increase by **138%** from 2006 levels (+70% more trips averaging +40% longer[21]) and this has the potential for major benefits to both users - and non-users, as identified in the following section.

21 1.7.x1.4=2.38

5 Benefit Assessment

5.1 Introduction

5.1.1 Benefits for users (cyclists) and non-users (car drivers) have been determined for each scenario in each of the principal forecast years (2021, 2031 and 2041).

5.1.2 Benefits to society include those travel 'cost' benefits perceived by new users, attracted to use the new, (more) attractive facilities. They include benefits from reduced mortality and morbidity – with reduced absenteeism and improved productivity as a result of improved health. Society also benefits from reduced congestion on the roads as a result of avoided vehicle-trips, leading to relatively better travel times, reduced vehicle operating costs, lower emissions, noise and community-severance etc.

5.1.3 The social costs of road crashes are also potentially reduced - although in practice this is likely to be heavily dependent upon the details of scheme design: There is also the potential for some net increase.

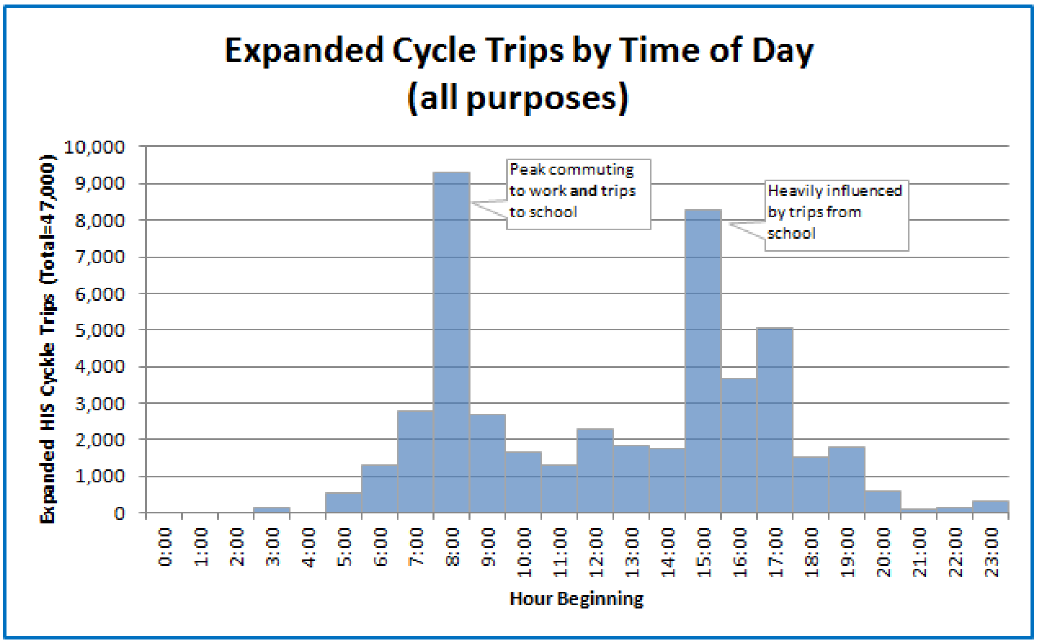
5.1.4 This section explains the rationale behind the calculation of these values, with detailed results being tabulated in the Appendices and calculations provided in associated spreadsheets.

5.2 Decongestion

5.2.1 In order to determine non-user benefits through congestion-relief, the daily-based projections of cycle numbers have to be converted to the equivalent (private-vehicle) trips avoided.

5.2.2 This estimate has been done for specific periods (and for each trip purpose), given the differing profiles and likely vehicle occupancy, *were potential cycle users to travel* – and to use other modes to do so.

Figure 5-1: Cycle Trip-making by Time of Day



5.2.3 The resulting vehicle matrices (that is the vehicle demand scale and pattern *if the projected level of cycling was not undertaken*) have then been assigned to the CAST vehicle network for the relevant year. By comparison of output statistics to the 'base' estimate of vehicle demand, the relative benefit of cycling, in terms of congestion costs avoided (travel time and vehicle operating costs), can be estimated.

Figure 5-2: Cycle Trip Purpose Proportions Assumed within Key Periods

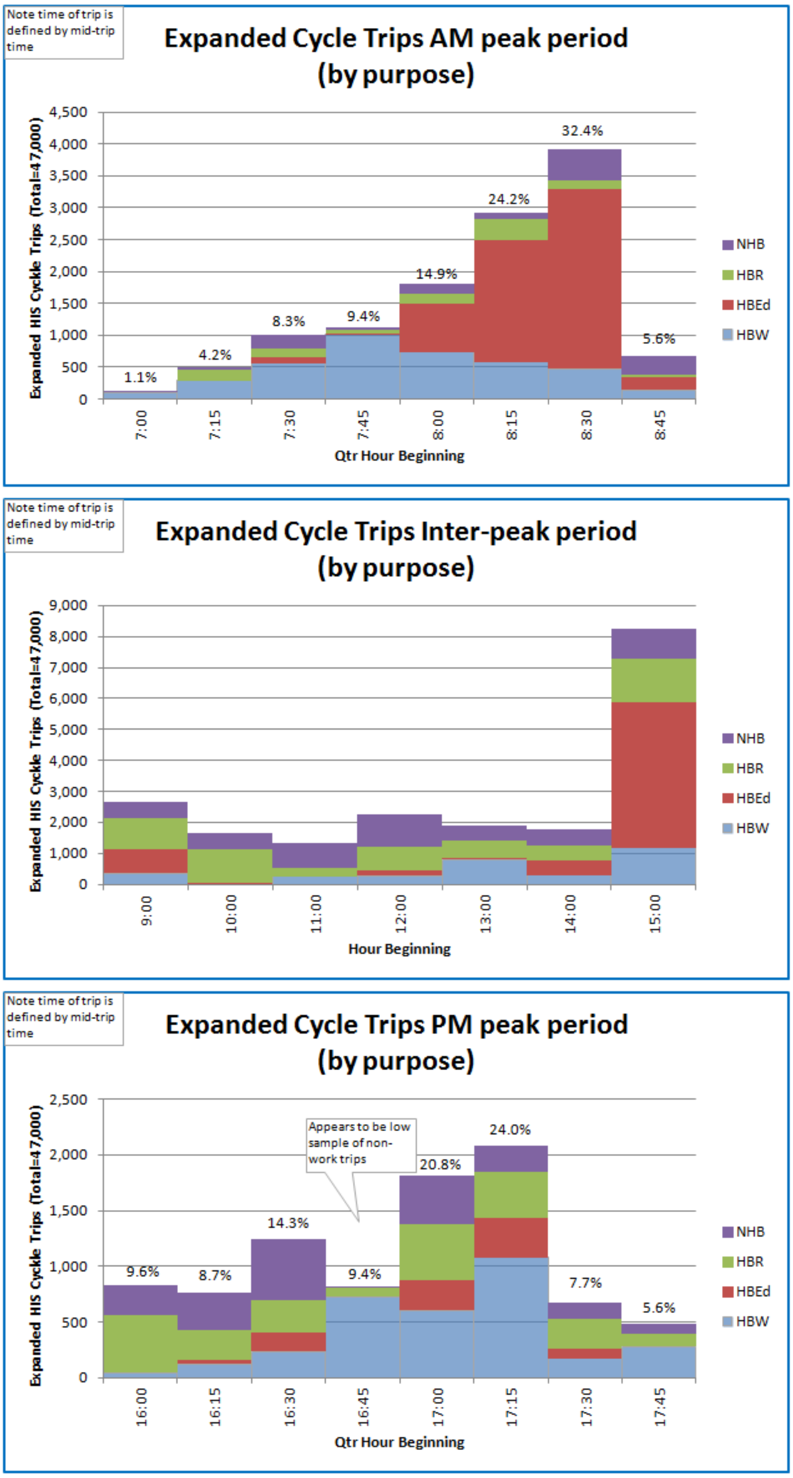


Table 5-1: Derivation of Factors applied to Daily Production-Attractions by Purpose to obtain Modelled Hour Cycle Origin-Destination Matrices

Expanded HIS Cycle Trips, by Period						
From Home		AM	IP	PM	ON	Total
HBW	a	3,763	1,288	273	1,498	6,821
HBE	b	5,706	982	-	27	6,715
HBR	c	976	2,864	1,168	690	5,698
NHB	d	683	2,428	1,127	132	4,370
Total		**11,129**	**7,562**	**2,567**	**2,347**	**23,605**

Expanded HIS Cycle Trip Proportions, by Period						
From Home		AM	IP	PM	ON	Total
HBW	a	0.552	0.189	0.040	0.220	1.000
HBE	b	0.850	0.146	-	0.004	1.000
HBR	c	0.171	0.503	0.205	0.121	1.000
NHB	d	0.156	0.556	0.258	0.030	1.000
Total		**0.471**	**0.320**	**0.109**	**0.099**	**1.000**

Expanded HIS Cycle Trips, by Period						
To Home		AM	IP	PM	ON	Total
HBW	a	135	1,837	3,679	1,164	6,815
HBE	b	84	5,241	998	95	6,418
HBR	c	52	2,739	1,811	1,273	5,875
NHB	d	683	2,428	1,127	132	4,370
Total		**955**	**12,244**	**7,614**	**2,664**	23,477

Expanded HIS Cycle Trip Proportions, by Period						
To Home		AM	IP	PM	ON	Total
HBW	a	0.020	0.269	0.540	0.171	1.000
HBE	b	0.013	0.817	0.156	0.015	1.000
HBR	c	0.009	0.466	0.308	0.217	1.000
NHB	d	0.156	0.556	0.258	0.030	1.000
Total		**0.041**	**0.522**	**0.324**	**0.113**	**1.000**

Expanded HIS Cycle Trips, by Period						
Total		AM	IP	PM	ON	Total
HBW	a	3,898	3,124	3,952	2,661	13,636
HBE	b	5,791	6,223	998	122	13,133
HBR	c	1,028	5,603	2,978	1,963	11,573
NHB	d	1,367	4,855	2,253	264	8,740
Total		**12,083**	**19,806**	**10,182**	**5,011**	**47,082**

Expanded HIS Cycle Trip Proportions, by Period						
Total		AM	IP	PM	ON	Total
HBW	a	0.286	0.229	0.290	0.195	1.000
HBE	b	0.441	0.474	0.076	0.009	1.000
HBR	c	0.089	0.484	0.257	0.170	1.000
NHB	d	0.156	0.556	0.258	0.030	1.000
Total		**0.257**	**0.421**	**0.216**	**0.106**	**1.000**

'Observed' (Expanded HIS) Totals for Modelled Hours:

Expanded HIS Cycle Trips, by Hour					
Total		AM	IP	PM	ON
HBW	a	2,890	446	2,648	205
HBE	b	2,766	889	800	9
HBR	c	654	800	1,280	151
NHB	d	1,037	694	1,334	20
Total		**7,348**	**2,829**	**6,062**	**385**
		15.6%	6.0%	12.9%	0.8%

Proportions of Period for Modelled Hours:

Expanded HIS Cycle Trips, by Hour					
Total		AM	IP	PM	ON
HBW	a	0.741	0.143	0.670	0.077
HBE	b	0.478	0.143	0.802	0.077
HBR	c	0.636	0.143	0.430	0.077
NHB	d	0.759	0.143	0.592	0.077
Total		0.608	0.143	0.595	0.077

Expanded HIS Cycle Trip Proportions, by Hour				
From Home		AM	IP	PM
HBW	a	0.409	0.027	0.027
HBE	b	0.406	0.021	-
HBR	c	0.109	0.072	0.088
NHB	d	0.119	0.079	0.153
Total		0.287	0.046	0.065

Expanded HIS Cycle Trip Proportions, by Hour				
To Home		AM	IP	PM
HBW	a	0.015	0.038	0.362
HBE	b	0.006	0.117	0.125
HBR	c	0.006	0.067	0.133
NHB	d	0.119	0.079	0.153
Total		0.025	0.075	0.193

Note that modelled Interpeak represents average Interpeak hour (0900-1600)

5.2.4 The above factors are applied to the daily cycle Production-Attraction (and Attraction-Production) demand matrices, to determine cycle use for hours that the road network is modelled.

5.2.5 These figures then also have had to be converted the equivalent vehicle numbers (to determine vehicle-trips potentially avoided).

5.2.6 In the absence of any other information, it is assumed that vehicle occupancy of cycle users, should they use a vehicle instead, would be similar to that of current CTM light vehicle trips - **but also that 'only' 75% of such trips would actually be made (by car)**.

5.2.7 This means that, (over a whole day), on average each new cycle trip generated is assumed to avoid approximately 0.6-0.65 potential car trips.

Table 5-2: Assumed Vehicle Occupancy of avoided Car Trips

Period	Trip Purpose[22]		
	HBW	HBE	HBR/NHB
AM Peak	1.14	2.25	1.57
Interpeak	1.40	2.00	1.61
PM Peak	1.15	2.25	1.63

5.2.8 Appendix D details the results of the vehicle demand analysis, by modelled period, but the relative impact *over an average weekday (in term-time)* is summarised below:

Table 5-3: Vehicle trips avoided due to cycling (average weekday)

Scenario	2021		2031		2041	
Base Vehicles	1,539,294		1,660,354		1,762,888	
Sc0 - (Do-Min)	36,440	2.37%	41,093	2.47%	45,032	2.55%
Sc1: (Full MCR+AAC+CPW)	48,801	3.17%	56,101	3.38%	62,293	3.53%
Sc2: (Sc1 - 25% MCR)	47,817	3.11%	55,056	3.32%	61,078	3.46%
Sc1b: (As Sc1 but no Fuel Increase)	47,115	3.06%	52,427	3.16%	57,205	3.24%
Sc1c: (As Sc1 but 15% Traders)	41,599	2.70%	46,962	2.83%	51,501	2.92%

(note totals shown are for assigned vehicles and therefore vehicles making intra-zone trips are excluded)

(2006 cycle use was estimated to avoid 31,630 or 2.38% of 1,331,200 daily vehicle trips)

5.2.9 Appendix D also indicates the calculations that give rise to our estimate of the annual value of cycling) towards lowering the costs (travel time and VOC) for vehicles. It should be noted that this might be considered conservative – we have not actually attempted to calculate and allow for *additional* EEM rates allowing for congested flow, but rather applied only the standard EEM rate for Urban Other roads across the time and distance for road vehicles (with cycling use as appropriate), predicted by CAST.

5.2.10 Adjustment is however made using EEM Update factors accounting for the fact that usual EEM TT Update Factor is from July $2002 (FP). Factors used are from EEM 2010 Edition (1.22 Factor for 2002-2009) and EEM 2013 Edition (1.40 Factor for 2002-2013)

5.2.11 In broad terms, the current (or actually 2006) level of cycle use is estimated to save around $10m of cost (travel time and vehicle operating costs) to car users annually. This benefit is however expected to rise substantially in the future, totalling nearly $50m annually by 2041 - *even were there to be no substantial additional investment in cycle infrastructure*. Virtually all these decongestion benefits are due to peak-period travel, with cycling predicted to offering minimal or limited decongestion benefits in (most) inter-peak hours. However, given the potential investment proposed in a more comprehensive cycle system, cycling can give rise to potentially even higher decongestion benefits, estimated to rise to around $90m annually by 2041.

22 HBW=Home-based Work; HBE=Home-based Education; HBR=Home-based Remainder; NHB=Non Home-based; See Background Report for more-detailed descriptions of each.

5.3 Safety

5.3.1 The potential safety impacts of a more comprehensive cycle network have to acknowledged as (somewhat) uncertain. One of the key drivers for implementing such a network is the perception of users that they are safer – and the relative increase in attractiveness that this will yield. However, there is conflicting advice about whether indeed 'off-road' cycle paths are indeed actually safer (in terms of crashes per cycle-km) - with some international and local research potentially suggesting otherwise[23]. It appears that the frequency of driveways and the specific treatment of the cycle paths (and profile of users) may be the major factors governing performance in practice. We note that Aecom Pty., in their recent study of an Inner Sydney cycleway network, also expressed similar reservations and elected to retain existing cycle crash rates to make 'initial' estimates of cycle crashes. We have adopted a similar approach for this assessment

5.3.2 However, both Aecom Pty in Sydney, and ourselves in Christchurch subsequently modify these 'initial assessments' made on a pro-rata basis, because what does appear to be beyond dispute, is the potential for a 'safety in numbers' effect: That is, the more cyclists around, the less their crash risk. This is not to say however that there could *not* be an overall increase in total cycle crashes, given large rises in the number of cyclists - or more accurately their exposure, as expressed in terms of cycle-km.

5.3.3 For the purposes of our 'base estimate' of benefits, we have however adopted the NZTA's EEM values for safety, which suggests an overall net safety benefit of $0.05 per cycle-km, applicable *to both new and existing users* (*using new facilities*)[24]. This is determined by extracting the level of use, in terms of cycle-km, across all of the assumed new (segregated) facilities.

5.3.4 However, we have also identified additional benefits, being a combination of:

- The *potential* benefits in terms of general road crashes, from having fewer vehicles on the road; and
- (Dis)benefits in terms of additional cycle crashes from higher cycle use - adjusted for 'safety-in-numbers' effects.

5.3.5 To estimate the first element we have used the CAST Safety Interface, which uses comprehensive and locally-calibrated crash-prediction models. We applied this interface to estimate the increase in crash-costs of current cyclists were to travel by private vehicle (and thus relative benefits if they were to cycle), applying these benefits pro-rata to other future scenarios, based on the level of anticipated vehicle-trip relief.

5.3.6 To estimate the second element, we have adopted the 'existing' cycle crash-risk in Christchurch (or to be accurate the annual average for 2006-2010), adjusted in the future for 'safety in numbers'. Data on this analysis is given below:

---

23 E.g. refer NZTA Research report RR359 (Genter et al, 2008)

24 Economic Evaluation Manual Part 2, Simplified Procedures SP11-9. This is actually the 2008$ value (EEM Table A20.4). Our assessment applies the specified update factor of 1.12, to reflect 2013$.

Table 5-4: Existing Christchurch Cycle Crash Risk/Costs (annual average 2006-10)

	Fatal	Serious	Minor	Non-Injury	Total
No Reported Crashes	1.60	30.84	100.99	27.21	160.64
with EEM Allowance for Cycle-crash under-reporting	1.60	105.82	590.60	209.26	907.28
Value ($m)	4.968	34.396	9.656	0.232	49.252
% of all road crash costs	8.6%	26.1%	16.5%	0.7%	17.7%
Reported Crash rate/m cycle km	0.0335	0.6449	2.1120	0.5690	3.3595
Crash Rate with Underreporting/m cycle km	0.0335	2.2130	12.3515	4.3764	18.9744
Cost/Crash	3,100,000	325,054	16,349	1,107	54,285
Initial Cost/Cycle km					$ 1.03003
Initial Cost/Cycle km if no allowance for under-reporting					$ 0.18

(Note crash costs are individually set, depending on crash type, vehicle involvement, speed environment etc. The above data represents totals and averages when these are summed across the UDS network)

5.3.7 It can be seen that, given the current involvement of cyclists in crashes (particularly serious crashes), the average social cost are estimated to be significant, averaging around $49m annually – out of a total annual road crash cost which averages around $284m across the UDS area.

5.3.8 For a conservative approach, we have however adopted this 'current' cycle crash-cost rate (approx $1.04/cycle-km, in $2008), and applied this to the forecasts of cycle-km. – but this is also subsequently adjusted, to account for the 'safety-in-numbers' effect.

5.3.9 The 'safety-in-numbers' ratio our assessment has adopted is 0.4: That is, a 100% increase in cyclist trip numbers is expected to yield (only) a 40% increase in total cycle crashes. This figure accords with research by Jacobsen[25] adopted in the Inner Sydney cycle network study by Aecom Pty - and also aligns closely with more local research, reported by Turner et al.[26]:

Figure 5-3: Safety-in Numbers: Mid-block Crashes (extract from RR 259)

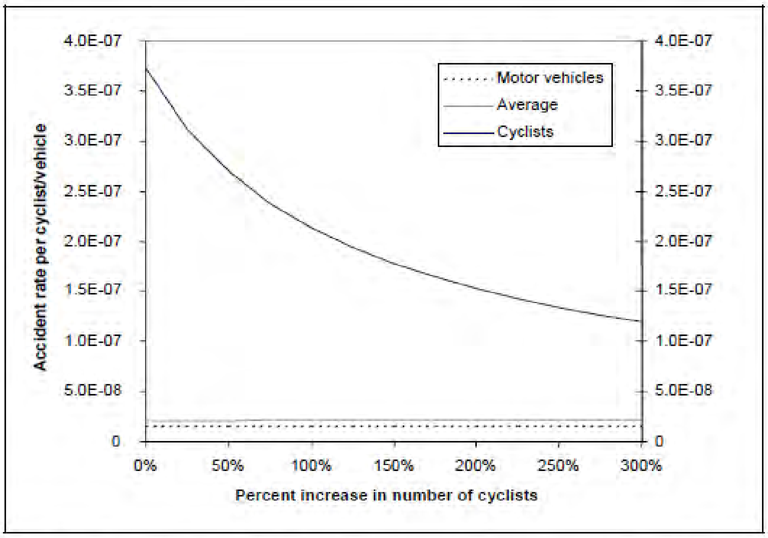


Figure 7.13 Cyclist and motor-vehicle accident rates along commercial mid-block sections in Christchurch.

25 Jacobsen, P. Safety in numbers: More walkers and bicyclists, safer walking and bicycling. Injury Prevention 9, no. 3: 205–209

26 See NZTA Research reports RR 289 (Turner et al.), and RR 359 (Genter et al.)

5.3.10 It can be readily deduced from the above model that an increase from 100% to 200% (i.e. +100%) would yield an increase in *total crashes* of +44%, whilst an increase from 200% to 300% (i.e. +50%) would yield an increase in total crashes of +19%. Models developed for signalised and roundabouts intersections follow a similar pattern.

5.3.11 When applied to the projected cycle numbers (and cycle-km), for example, by 2041 the do-minimum cycle network is expected to accommodate 21.2m cycle trips/year (up from 15.2m in 2006), travelling 74.0m cycle-km (up from 47.3m in 2006). Using the existing cycle crash-rate therefore, we might expect the social cost of cycle crashes to rise to $76.3m/year (from around $49.3m). However, adjusting for cyclist numbers – applying the 'safety-in-numbers' correction, the rise is expected to be less, totalling some $57.0m/year.

5.3.12 By 2041 the more comprehensive improved cycle network in Scenario 1 is however expected to accommodate 28.5m cycle trips/year, travelling a total of 126.2m cycle-km. Using the existing cycle crash-rate therefore, we might expect the social cost of cycle crashes to rise up to $129.9m/year - but applying the 'safety-in-numbers' correction, the rise is expected to be substantially less, totalling some $66.6m/year (i.e. a +35% rise in crash costs over 2006 for an 88% rise in trips)

5.4 User Benefits

5.4.1 The EEM (Simplified Procedures) suggest that the value to users of new facilities may be estimated by applying standard values of time for these users, and adjusting the resulting totals that reflect a perceived relative attractiveness.

5.4.2 This is a rather more simple approach than using consumer-surplus methodology (with a 'rule-of-half' being applied for new trips), but one we have adopted for the purposes of this study.

5.4.3 The user benefits are thus estimated by totalling the annual cycle-km on new facilities, converting this to time (using an average cycle speed of 22.5kph), applying the 'Urban Other' EEM value of $22.74/hr[27] to obtain total actual time value, and modifying this by dividing by the relative attractiveness[28].

5.4.4 For a 'conservative' approach, we have applied the applicable EEM factors (Table SP11.1) between segregated facilities – 'Off-street Cycle Path' (2.0) and 'On-street with parking, marked cycle lane'. (1.8), giving a relative attractiveness RA of 2.0/1.8= 1.11. This yields a *substantially* lower user benefit than say, moving from 'On-street with parking, no marked cycle lane' (1.0), where, effectively half the travel time is assumed

[27] 2013$ [19.31*1.4/(((1.22-1)*6/7)+1)=$22.74/hr] .Note this value is considered potentially conservative: $19.31 is the value used in Simplified Procedures for Urban Other roads and is actually in July $2008- Compare with Urban Arterial value at $19.36. Adjustment shown is made using EEM Update factors accounting for the fact that usual EEM Travel Time Update Factor is from July $2002 (FP). Factors used are from EEM 2010 Edition (1.22 Factor for 2002-2009) and EEM 2013 Edition (1.40 Factor for 2002-2013).

[28] In fact the calculation requires multiplying by RA-1, to obtain net benefits - the difference from the Do-Minimum. Thus, effectively 11% of total travel time value on the new facility is assumed to be the (perceived) benefit, compared with 50% for RA=2.0.

captured as a benefit (RA=2.0/1.0). Put another way, user benefits (strictly using EEM procedures) could be up to 4.5 times higher than we have assumed, if an off-road cycle path were to replace on-street cycle use with parking and no cycle lanes.

5.5 Health and Environmental Benefits

5.5.1 The EEM (Simplified Procedures, SP11-11 & A20.4) suggest that a value of $1.45/ cycle-km can be applied to reflect the *total* health and environment benefits that will accrue from attracting *additional* cycle trips. Whilst somewhat crude, this is the value that we have adopted in our base analysis.

5.5.2 Aecom Pty. in their recent study for Inner Sydney adopted a more sophisticated approach, disaggregating such benefits. Whilst initially we considered following a similar line, comparison revealed that the more-simple EEM approach yielded similar total rates (when decongestion was included) and indeed our 'hybrid' approach (adopting EEM simplified procedures for combined health and environment benefits whilst conducting a more-sophisticated congestion-relief valuation) results in the use of higher benefit values, particularly when considering the relative congestion between Christchurch and Sydney. This comparison is tabulated below:

Table 5-5: Comparison of Health and Environment Rates applied in Sydney to EEM

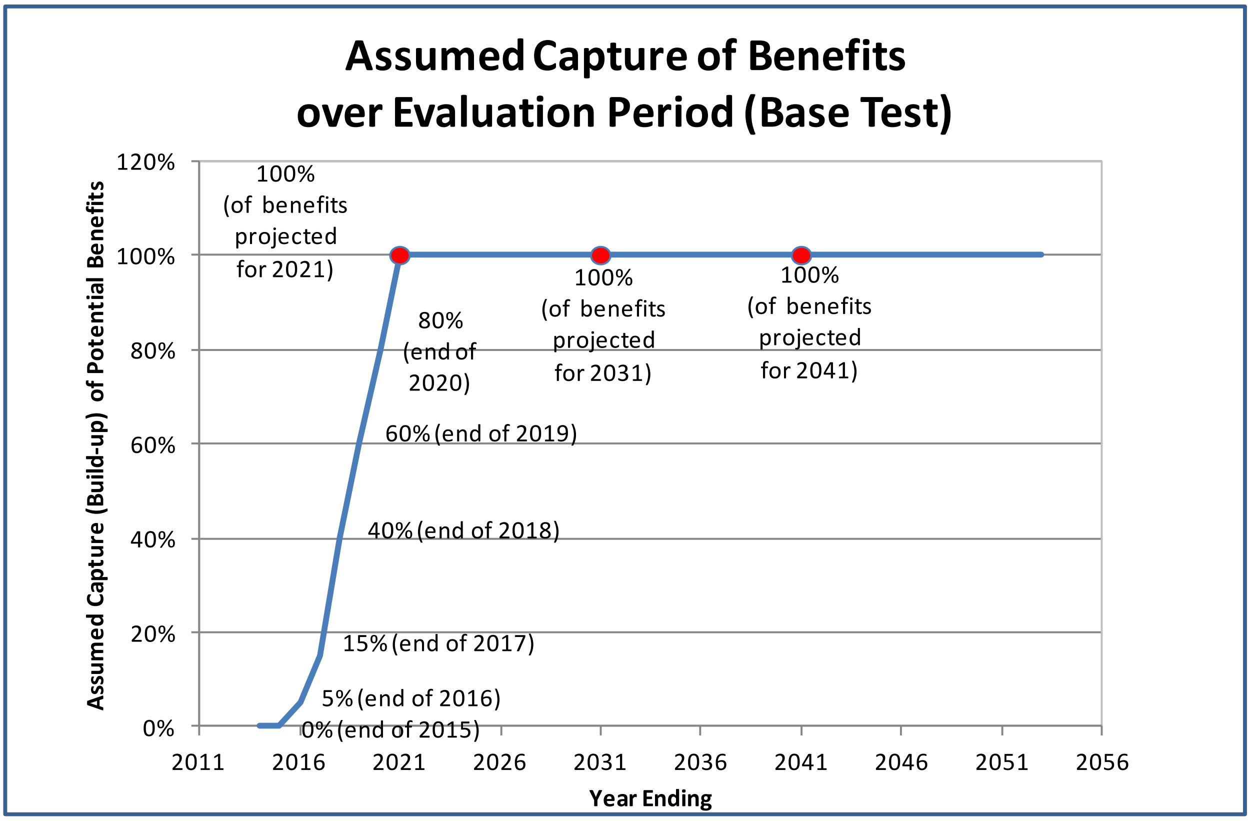
		1.2629	(Exchange rate conversion)			
Aecom Study (Inner Sydney)	$AUD	$NZ				
Reduced Mortality	$0.060	$0.08				
Reduced Morbidity (sensitivity test)	$0.460	$0.58				
Reduced Absenteeism/Improved Productivity	$0.167	$0.21				
Ambiance (net over cycle lane)	$0.028	$0.03				
Per Cycle km (on segregated network)	**$0.715**	**$0.902**	**A**			
Per avoided vehicle-km (cycle assumed same as car):						
Externalities:	$AUD	$NZ				
Air Pollution	$0.028	$0.03				
Greenhouse Gases	$0.022	$0.03				
Noise	$0.009	$0.01				
Water	$0.004	$0.01				
Urban Seperation	$0.006	$0.01				
Infrastructure	$0.037	$0.05			Compare EEM*:	
	$0.106	**$0.134**	**B**			
	$0.821	$1.037	**A+B**	vs	$1.40	nb $2008
	$AUD	$NZ				
Crash Costs	$0.091	$0.11	**C**		$0.05	nb $2008
			including crash costs:			
	$0.91	$1.15	**A+B+C**	vs	$1.45	nb $2008
	$AUD	$NZ				
Decongestion (time value)	$0.271	$0.34				
Vehicle Operating Costs	$0.319	$0.40			Compare calculation using CAST:	
	$0.590	**$0.745**	**D**		$0.53-$0.95	**B**
	$AUD	$NZ			min	max
	$1.50	$1.90	**A+B+C+D**	vs	$2.07	$2.55
					(2021)	(2041)
2021-01				2041-01		
Decongestion value	38.61			Decongestion value		91.75
mLV Trips avoided:	14.73			mLV Trips avoided:		18.80
av length (cycle)	4.26			av length (cycle)		4.42
LV m km avoided	62.71			LV m km avoided		83.10
decongestion value/km	0.62			decongestion value/km		1.10
(Note these differ from values tabulated abiove as the altter are adjusted to $2010 for comparison)						
* SP11. nb $July 2008 and includes $1.30 for 'Health' and $0.10 for 'Road Traffic Reduction'.						

5.6 Totalled Benefits

5.6.1 The calculated (net) benefits of each of the above elements (tabulated in Appendix F) has been combined and converted to a Net Present Value, using NZTA's standard 40 year evaluation period and discount rate of 6%.

5.6.2 To determine the present value of benefits, a build-up has been assumed, to those projected (for a full completed Do-Something network) at 2021: Although an updated construction programme has been adopted for the purposes of determining the PV of costs, the precise potential capture of benefits of partial completion (over the whole network) has not been determined for each year preceding 2021. Instead the total benefits (predicted at 2021) are assumed to be captured on a proportional basis, as shown in Figure 5-4. This approach not only provides for some flexibility in element programming, but also recognises the potential for variability and lag in benefit capture, in a practical fashion.

Figure 5-4: Assumed Capture of Benefits *(updated[29])*

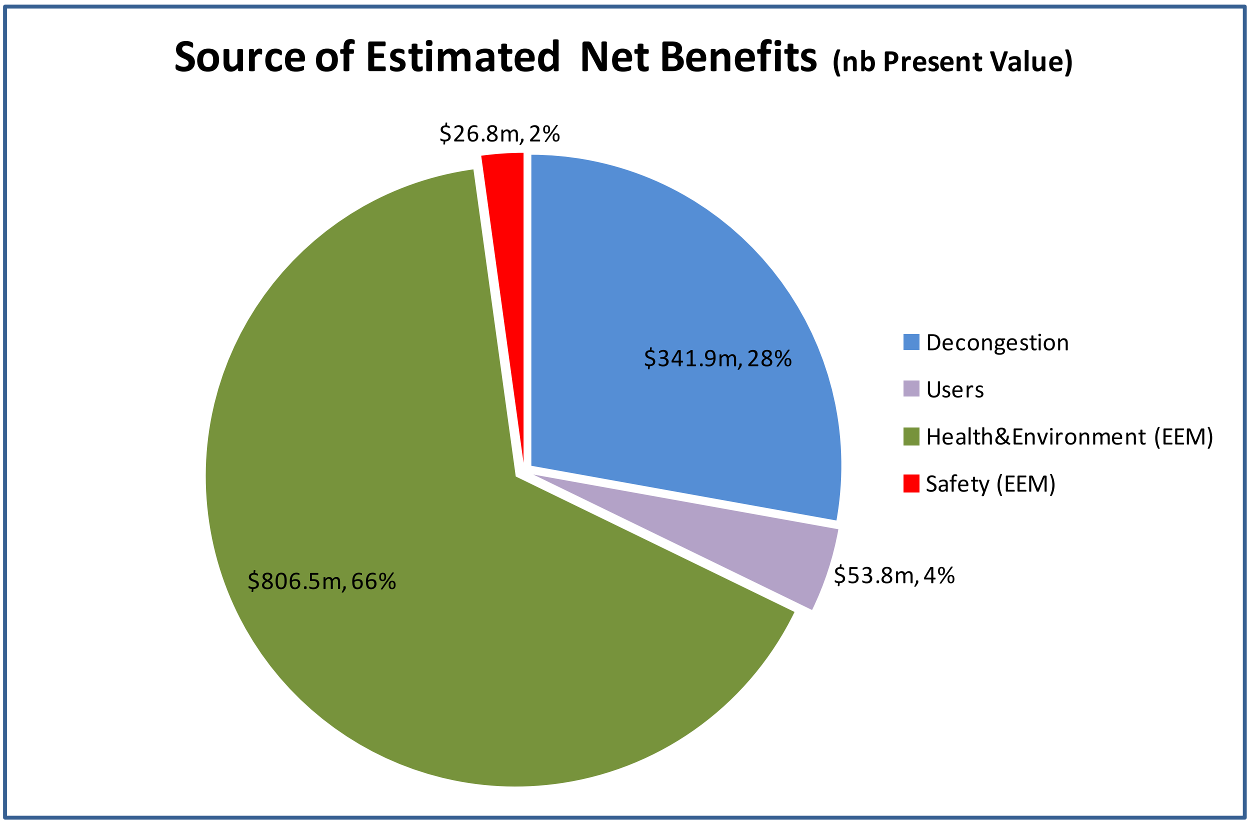


5.6.3 It may also be noted from Appendix F that we have made an assumption that benefits should be capped from 2041. This is likely to realise a (slightly) conservative assessment of the present value of benefits. The effect on PV is not large, because of discounting: With capping the resulting PV is around 2% lower than if benefits are assumed to continue to growth linearly beyond 2041 at the 2031-41 annual rate of increase.

29 Please refer to (new) Appendix H, which provides both the basis for these 'Base Case' assumptions – being the proportional build up of MCR network km. Also shown is the basis for two sensitivity tests suggested by the Peer Reviewer (Sc1b and Sc1c) that adopt alternative assumptions regarding the potential 'lag' in benefits compared to investment.

5.6.4 In broad terms, the combined present value of benefits of the proposed MCR package (in combination with AAC and CCP projects) is estimated to be very substantial indeed, totalling over $1.2b over a period of 40 years, as summarised by Figure 5-5 below):

Figure 5-5: Scenario 1 Benefit Sources



5.6.5 By 2041, given the proposed investment, UDS-wide participation in cycling (for utility purposes alone) is predicted to rise from an average of around 115km per person/per year (in 2006) to 230km per person/per year by 2041. This rise in participation is expected to be the principal contributor to the benefits predicted (being the component dubbed (for convenience) 'health and environment' in the diagram above). In fact this component actually represents NZTA's current 'standard' allowance of $1.40 for a number of elements applied to each predicted additional cycle-km – and actually relates to benefits accruing (principally) to users – and thereby society - through use of segregated cycleways, such as improved health (reduced morbidity, mortality) but also health-related economic benefits such as reduced absenteeism/improved productivity.

5.6.6 It should be noted that this estimate of health benefits excludes any purely recreational cycling trips and therefore the potential health benefits to the community are, in practice, likely to be higher than assessed.

5.6.7 The second-biggest and still substantial contributor is however predicted to be benefits to <u>non-users</u> – i.e. non-cyclists, through decongestion. The (net) benefits from this source alone are predicted to total over $300m. Cyclists are estimated to deliver benefits to car users that could rise from the equivalent of a relatively modest $1 per cycle trip (do-minimum cycle improvements by 2021) to over $3 per cycle trip (proposed package cycle improvements by 2041)[30].

5.6.8 By contrast, 'direct' traditional evaluation benefits to *users* (e.g. travel time) are expected to be very modest and indeed arguably negligible in the context of the wider benefit assessment.

5.6.9 Likewise, safety benefits are likely to form a relatively modest proportion of overall benefits (if EEM values are adopted, as assumed and shown above, for our base case). Even if potential disbenefits in absolute terms (of the scale anticipated using our more detailed analysis) were to eventuate, the scale of (negative) benefit for this component is predicted to be modest, compared to other sources of benefit. Again it is emphasised that any *absolute* rise in crash costs is likely to arise because of the significant rise in absolute numbers participating and resulting overall exposure– but that overall the safety of cycling is likely to improve dramatically: The social crash cost/cycle-km is predicted to fall by approx 50% from $1.04/km in 2006 to $0.52/km by 2041.

30 It may be noted that the decongestion benefits estimated using the detailed CAST approach substantially exceed the approximate $0.10 ($2008) per cycle-km allowed within the EEM (Table A20.4) for 'Road Traffic Reduction'. We do not consider this to represent double-counting - the EEM allowance of 10c/km is assumed to represent environmental benefits (CO2 etc) due to decongestion, rather than travel time and VOC benefits for vehicle users.

6 Benefit-Cost Summary (including Sensitivity Testing)

6.1.1 The combination of net cost and benefits (expressed as present values) naturally leads to an estimated benefit-cost ratio (BCR), for a particular scenario (test). These are summarised below in Table 6-1 for the 'base' Scenarios (Do-Something Scenarios 1 and 2).

6.1.2 Under our updated assumptions, the BCR for Scenario 1 has now been estimated to be 8.0:

Table 6-1: BCR and Sensitivity Analysis Summary ($m, 2013)

(Updated January 2015 - Subject to review)

Ref	Scenario	PV Costs	PV Benefits	BCR
Base Options:				
Sc1	Full MCR Network + ACC + CPW	**152.3**	**1219.2**	**8.0**
Sc2	Full MCR Network Less 25% + ACC + CPW	122.4	1098.8	9.0
Sensitivity Tests (on Preferred Option Sc1)				
Sc1b	***Sc1 with delayed Capture of Benefits (Test 1)***	***152.3***	***967.4***	***6.4***
Sc1c	***Sc1 with delayed Capture of Benefits (Test 2)***	***152.3***	***745.1***	***4.9***
Sc1-2 (Sc4)	Sc1 with No real-terms Fuel Price Increase	152.3	910.0	6.0
Sc1-3 (Sc5)	Sc1 with 15% Car Trader Assumption (compared to 30% in Base Scenario Sc1)	152.3	488.2	3.2
Sc1-4	Costs +20% (All Cycle Projects ie MCR+AAC+CCP)	182.7	1219.2	6.7
Sc1-5	Costs +20% (All Cycle Projects ie MCR+AAC+CCP) and halve ALL projected benefits	182.7	609.6	3.3
Sc1-6	Costs +20% (MCR +AAC+CCP) AND assume ONLY Decongestion (Non-User) TT/VOC benefits[4]	182.7	340.0	1.9
Sc1-7	Assume 4% Discount rate (cf Standard 6%) AND Increase All Costs +20%	195.6	1743.4	8.9
Sc1-8	Assume 8% Discount rate (cf Standard 6%) AND Increase All Costs +20%	169.2	885.9	5.2
Sc1-9	As Sc1-4 (Increase all Costs +20%) but assume 'True' Crash Costs[5] rather than adopt EEM rates	182.7	1127.9	6.2

(Note Scenarios 1b and 1c have been added to those in Preliminary Assessment)

Notes:

1. A 40 year evaluation period, 6% discount rate and progressive build up to a full benefit stream from 2021 is assumed for all scenario tests - except for sensitivity test scenarios Sc1-7 (reflecting a 4% discount rate) and Sc1-8 (reflecting a 8% discount rate).
2. All tests cap projected annual benefits in post-2041 period to 2041 estimated values
3. Net maintenance costs have now been included in the assessment.
4. This particular test therefore ignores ALL potential benefits to users (including health) and the wider environment
5. This test substitutes the EEM 'safety' values for additional cycling (5c/km in $2008 for each new user as Cycle Safety benefit - see EEM Table A20.4), adopted for all other tests, with a revised estimate that acknowledges potential for an absolute increase in cycle crash (costs) –despite an anticipated reduction in rates (cycle crashes/cycle-km). See below for more detail.

6.1.3 Scenario 2 (constructing around 25% less of the full MCR network) obviously would have lower costs and ostensibly a (marginally) higher BCR than Scenario 1. However, as detailed in Section 6.3 which follows, an incremental BCR assessment demonstrates that additional benefits of the full MCR network (Scenario 1) would easily outweigh the additional costs, compared to Scenario 2 and therefore represent the preferred option (on efficiency grounds alone), according to EEM procedures.

6.2 Sensitivity Tests

6.2.1 It will be noted that Table 6-1 above also summarises, for comparison, the results of a range of sensitivity tests. These are described in turn below:

Potential Lag in Benefit Capture (Scenarios Tests 1b and 1c)

These tests have been added to those in our Preliminary Assessment at the suggestion of the Peer Reviewer: While the Base Scenario is based up capture of the predicted benefits as assessed in the model prediction years (2021, 2031 and 2041) as shown in Figure 5.4 (with capture before 2021 broadly in line with the km of the MCR network completed, as shown in Appendix H, Figure H-1), two alternative tests have been conducted:

- Test 1b assumes an approximate 5 year lag may occur, such that the predicted benefits for 2021 may not be fully captured until 2026, those predicted at 2031 may not be fully captured until 2036 and those predicted at 2041 may not be fully captured until 2041. With such a scenario, this could reduce the revised base BCR down from 8.0 to 6.4.
- Test 1c assumes an even longer initial lag in the potential capture of benefits, with a 10 year initial lag (following full completion of the MCR network) i.e. the predicted benefits for 2021 are assumed not to be fully captured until 2031, with a slower build up to this point (as illustrated in Appendix H, Figure H2). With these assumptions, this Sensitivity Test would reduce the revised base BCR down from 8.0 to 4.9.

Private Vehicle Fuel-Price Rise (Scenario 1-2)

6.2.2 As explained in Section 4.1, our base tests, (applied to the Do-Minimum, Scenario 1 and Scenario 2) each have a consistent assumption that, by 2041, a rise in the real-terms price of fuel of some 40% over 2006 values *might* occur - allowing for peak-oil effects[31]. Such an increase can, naturally, be anticipated to make alternatives to private car use (including cycling) somewhat more attractive by comparison, for some travellers.

6.2.3 The timing and scale of potential real-terms price rises is uncertain – although the fact is that peak oil will occur within 10-15 years appears to be beyond dispute[32].

6.2.4 Test Sc1-2 involves a full run of all model processes[33] (for the 3 assessment years) assuming **no real-terms fuel price increase.** This confirms that the BCR would be reduced, from 8.0 with a 40% increase to 6.0 with a 0% increase, primarily because of a reduction in decongestion benefits (e.g. these are predicted to fall from $44m p.a. at 2041 for Scenario 1 to $25m p.a. with Scenario 1-2)

6.2.5 In the face of the widely-accepted likelihood that peak-oil effects *will*, over time, lead to

[31] 2021 and 2031 values (per vehicle-km) have been applied through simple interpolation between 2006 and 2041.

[32] NZTA RR496. Travel adaptive capacity assessment for particular geographic, demographic and activity cohorts, Krumdieck et al., (NZTA, 2012)

[33] Hence it might be noted that these runs are referred to as Scenario 4 in the associated model files and spreadsheets because, this test required the same full model processes as the base scenarios to generate the required results to determine a Benefit assessment

potentially (substantial) rises in fuel prices, it might reasonably be argued that a scenario of zero (real-terms) price rise over the next 25 years is quite simply untenable. However, what the test does serve to demonstrate is that, even with this very conservative assumption, clearly the benefits of the proposed investment in cycle infrastructure are predicted to be still substantial.

Proportion of 'Traders' (Scenario 1-3)

6.2.6 The base tests, (applied to the Do-Minimum, Scenario 1 and Scenario 2) each have a consistent assumption that 'only' 30% of car users may form the potential 'trader' market. – That is, the proportion that is assumed would actually seriously consider switching to cycling, on a regular basis. Put another way, respecting local factors, for the purposes of our base estimates on average around 70% of car users are assumed to consider themselves – and be considered - to be 'captive' to the car.

6.2.7 Sensitivity Test Sc1-3 however examines 'what-if' this 'trader' proportion might conceivably be even lower? The assumption for the purposes of this test is therefore that the proportion of car users as potential 'traders' to cycle use might be around 15%, rather than the 30% of car users assumed for the base tests.

6.2.8 Again, because these the initial and therefore final proportional mode-shares can be expected to vary by zone-zone pair, this test also required a full run of all model processes[34] (for the 3 assessment years).

6.2.9 This test does demonstrate that this (assumed) proportion does have a potentially significant impact on projected package benefits, primarily through projected lower projected demand and (car) transfer and therefore projected lower user (health) and non-user (decongestion) benefits: The BCR is estimated to fall from around 8, to just over 3.2.

6.2.10 It could, of course, perhaps equally be argued that the trader proportion *might* be *higher* rather than lower - which would naturally increase even further an efficiency assessment of significant cycle infrastructure investment.

Construction Costs

6.2.11 Planning of the proposed MCR (and indeed AAC) cycle network improvements has progressed from the Preliminary Assessment prepared in June 2014. Given the more detailed design and cost estimation conducted in the interim by CCC, more confidence can now be placed in current budget allowances. The current total programme estimate of just over $156m (for the MCR projects alone) obviously does represent a substantial increase over CCC's Preliminary Estimate – but we are advised that there is also now a commensurate increase in the level of confidence of this estimate. Thus, while our Preliminary Assessment included sensitivity tests based on a potential doubling (of MCR costs), in this Update we consider it appropriate that this now is reduced to +20%. This in

34 These runs are therefore referred to as Scenario 5 in the associated model files and spreadsheets.

itself may be considered conservative, as, given the substantial cost increase and more refined cost estimation, we understand that CCC are confident that the programme will be achieved *within* their revised total estimate.

6.2.12 Nevertheless, for the remaining sensitivity tests (denoted as Scenario 1-4 to 1-9 in Table 6-1) each examines various 'what-if' scenarios for Scenario 1 - while assuming that the capital and maintenance costs (for all projects – i.e. MCR, AAC and CCP) might, potentially, be **+20%** on the revised base estimates (for the sake of illustration).

6.2.13 Even with such a substantial potential variation in costs (which effectively would represent a $37m contingency in total), it can be seen that the BCR for Scenario 1 (which includes the full MCR network) is still predicted to exceed 4.0 (the currently-recommended threshold for a 'High' efficiency rating) - in all but extremely pessimistic scenarios.

6.2.14 The only case where the projected BCR falls below 2 is our test 1-6, which considers a scenario if capital and net maintenance costs were to be 20% higher than the current best-estimates in practice – but that **also** ONLY road decongestion (time) benefits are considered (i.e. NO benefits to those attracted to cycle are valued, including benefits to their health).

6.2.15 Whilst a consumer surplus approach might be argued that (more) people will only cycle if they consider it to their (own) benefit to do so – and that- for example, any time benefits might be negligible (or even negative), we consider it almost beyond argument (and in accordance with EEM allowances) that substantial health (and environmental) benefits would still accrue to society through improved cycle participation rates.

6.2.16 However, even taking such an (arguably) extreme scenario, the resulting BCR is *still* projected to be around 1.9. While this is lower than the current recommendation of 4.0 for a 'High' rating efficiency, it still clearly represents significant value for money, particularly when compared to funding other potential transport infrastructure projects.

Discount Rates

6.2.17 Scenario Tests 1-7 and 1-8 are presented in accordance with the requirements of the EEM, demonstrating the potential impact of alternative discount rates to the current standard 6%, of 4% and 8%. Note however that these tests *also* include a potential +20% increase in all costs – so the BCRs (5.2 and 8.9 for 4% and 8% respectively) actually need to be compared to Scenario 1-4 (All costs +20% at 6% discount rate) – which projected a BCR of 6.7: It is clear that the lowest resulting BCR (5.2) still easily exceeds the current recommendation of 4.0 for a 'High' rating efficiency.

Safety

6.2.18 This test (Sc1-9) reflects that EEM 'safety' values for additional cycling (5c/km in $2008 for each new user as Cycle Safety *benefit* - see EEM Table A20.4), adopted for all other tests, is considered highly likely to underplay the potential for additional crashes (and costs), given many more cyclists using the network. This test therefore uses results derived by application of the CAST Safety interface - **with adjustment for 'Safety in**

Numbers' reduction in cycle crash rates. Even with this adjustment, overall a (relatively small) safety disbenefit is projected, given that with these assumptions (including all costs being +20% higher than the current best-estimates), the resulting BCR is still well above 4 (falling from 8.0 to 6.2), this test provides a rational basis for concluding that overall the proposed Activity is still likely to be easily beneficial overall. (i.e. any small safety disbenefit is outweighed significantly by e.g. public health benefits of increased exercise by users, along with decongestion benefits to non-users).

Back-Calculation of Uptake Required

6.2.19 The Peer Review of the Preliminary Assessment included a suggestion that "consideration be given to the potential effects of various impediments to cycling, beyond the major cycleway routes, which could dampen down the predicted increases in the demand for cycling. This could be achieved simply by back calculating the increase in cycling needed for the cycleway routes still to be justified economically, noting that they are still likely to be justified under other funding criteria".

6.2.20 The precise back-calculation of uptake required would take significant modelling resources (given for example the inter-relationship between decongestion and particular demand scale and patterns – which are affected differently around the City. However, a broad indication can be suggested by the relative benefits required to achieve alternate Benefit-Cost Ratios. This is shown in Table I-1 (Appendix I): Assuming also a potential delay in benefit capture in line with our Scenario1b (see Figure H-2). This shows that the modelled benefits (even under this lagged capture scenario) could be reduced by a further 37% and still a benefit-cost ratio of 4.0 would be achieved. Similarly a reduction of nearly 70% could be accommodated and still the benefits would outweigh the (updated) costs by a factor of 2. Finally, even if the (total) benefits are only around 15% of those actually predicted (under this lagged scenario), the benefits would still be broadly in line with the costs.

6.2.21 As we have noted, there is unlikely to be an absolutely direct correlation (in proportional terms) between the benefits and the absolute level of uptake – but it is likely to be close and we therefore consider this to be a reasonable indicator of the (low) level of risk of achieving a positive benefit-cost ratio for the proposed programme of investment.

6.3 Incremental Benefit-Cost Analysis

6.3.1 As shown by Table 6-1, a package consisting of fewer elements could (obviously) reduce costs - and even generate a marginally higher BCR: For example, with consistent assumptions applied to both scenarios, for Scenario 2 (-25% of MCR routes) the BCR is predicted at 9.0, compared to a BCR of 8.0 predicted for the full MCR package Scenario 1).

6.3.2 The EEM however addresses whether the additional benefits of a more-expensive option generated could outweigh the additional costs, through a process known as Incremental Benefit-Cost Analysis[35].

[35] This is a purely 'economic' assessment – There may be other non-monetised benefits, costs or considerations that might warrant an alternative preferred option.

6.3.3 The worksheets showing this Incremental comparison are provided in Appendix G. These demonstrate that the choice of the full package as the most[36] economically-efficient (i.e. that the additional benefits generated would easily outweigh the additional costs) can be supported, as the Incremental BC easily exceeds the currently-target incremental BCR threshold of 5 (given that the BC of the options is greater than 4).

6.3.4 This conclusion would not be affected even in the event that package costs were to increase by+20% *and* only half of the projected benefits were to be captured: The incremental BCR analysis presented in Appendix G still confirms Scenario 1 as the preferred package (on purely economic grounds) for such a sensitivity test.

[36] Of those examined – We *cannot* claim that the proposed package is the most 'efficient' of any potential cycle investment. However we note that the elements of this proposed package (i.e. individual routes and specific alignments of each) have been determined through a process that considers a wide range of factors beyond 'efficiency' as measured in simple economic terms.

7 Conclusions

7.1 This study seeks to provide a rational and robust estimate of the potential benefits of the major programme of investment proposed for cycle infrastructure in Christchurch. Its principal purpose is to help inform Strategic Fit and Effectiveness assessments (by Council), in compliance with NZTA's investment assessment framework and assist with subsequent detailed planning and prioritisation of the Council's investment.

7.2 Given the potential wide-ranging potential impacts of the proposed project package, and the significant level of investment being countenanced, a detailed assessment process was considered warranted and has been applied to determine these potential benefits.

7.3 The approach adopted relies significantly on the Christchurch Strategic Cycle Model (CSCM) as the principal tool to determine potential cycle use (and thus user benefits) - in combination with the Christchurch Assignment and Simulation Traffic (CAST) model to estimate potential non-user benefits (decongestion and safety).

7.4 CCC's proposed Major Cycleway Routes (MCR), in combination with the proposed Central City Recovery Plan cycle projects and the Christchurch Coastal Pathway represent the main package of improvements assessed ('Scenario 1') and this has been compared to a do-minimum level of improvement. This proposed package of investment has now been estimated to have a BCR of around 8 (using updated base assumptions).

7.5 A package consisting of fewer elements could (obviously) reduce costs - and even generate a marginally higher BCR. However, incremental BCR assessments support the choice of the full package as the most[37] economically-efficient (i.e. that the additional benefits generated would easily outweigh the additional costs).

7.6 Arguably the CSCM represents a world-leading tool and the state-of-the-art. However it should also be acknowledged that cycle modelling is inherently subject to (considerably) more difficulty and uncertainty than traditional vehicle-based transport modelling. These levels of uncertainty will naturally be reflected in the level of confidence in trip-making scale and assignment predictions - and resulting benefits. For this reason therefore, appropriate sensitivity testing is of particularly high importance, to inform the potential variation in projected benefits (or costs) to potentially critical parameters and assumptions.

7.7 What we can conclude from this sensitivity testing, with some confidence, is that while the potential variation in these parameters could be expected to affect projected usage and therefore benefits, the overall economic Efficiency case for the MCR programme appears relatively insensitive - with a 'High' Efficiency rating being likely to be justified in almost all conceivable circumstances.

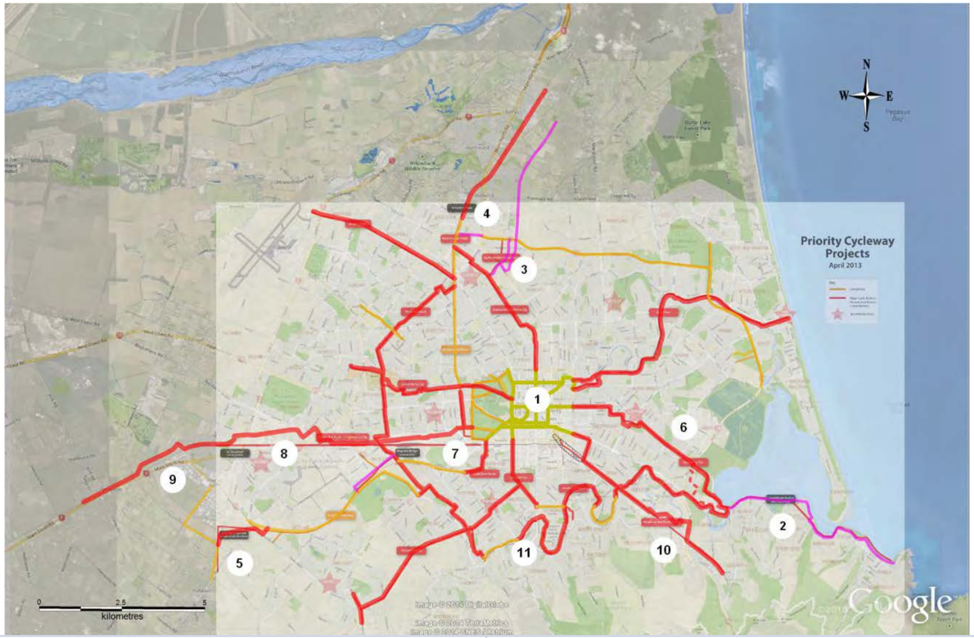
---

37 Of those examined – We *cannot* claim that the proposed package is the most 'efficient' of any potential cycle investment. However we note that the elements of this proposed package (i.e. individual routes and specific alignments of each) have been determined through a process that considers a wide range of factors beyond 'efficiency' as measured in simple economic terms.

This page is intentionally blank for double-sided printing.

Appendix A – Network Alignment Development from April 2013 Priority Cycleway Project Plan

This page is intentionally blank for double-sided printing.



Adjustments to Proposed MCR Routes from April 2013 CCC Plan	
1. An Accessible City cycle routes added (Salisbury St and adjacent Avon River)	7. Realignment of Hornby Rail Route ("South Express") to use transmission corridor and Foster Street to avoid rail sidings.
2. Christchurch Coastal Pathway route modified (off-road path routed along Beachville Road rather than Main Road)	8. Realignment of Hornby Rail Route ("South Express") to cross Main Sth Road and use Greenhurst St/Waterloo Road to Kyle Park to avoid rail sidings.
3. Addition of Northern Connections in line with notified designation plans for Northern Arterial (NZTA) and Northern Arterial Extension (CCC)	9. Realignment of Hornby Rail Route ("South Express") to use proposed Collector Road through Waterloo Business Park (PC19) to avoid potential future rail sidings.
4. Assumption that Off-Road path would be provided in association with proposed Northcote 4-Laning (CCC) to ensure connectivity between existing QE2 Drive path and Northern Railway cycleway.	10. Realignment of Heathcote Rail Route to City ("Heathcote Expressway") to use Cumnor Tce to avoid potential future rail sidings between Tunnel Rd and Curries Rd. Deletion of former proposal to provide route past sidings to Waltham Rd.
5. Minor alignment adjustment for Little River Link to reflect approved CSM2 and that a cycle path now already provided along former railway between Marshs Road and Prebbleton.	11. Assumption that slightly more of existing Heathcote River path ("Ōpāwaho River Route") may require upgrade to MCR standard. Deletion of drafting error indicating route on Burnbrae St.
6. Minor adjustment for Sumner-City Route ("Rapanui-Shag Rock Cycleway") to reflect addition of nighttime route via Charlesworth St & Te Rakau Drive	12. Recognise that existing Railway Cycleway extends to Kilmarnock and remove MCR route S Blenheim to Lester Lane.

This page is intentionally blank for double-sided printing.

Appendix B – Cycle Model Forecast Demands

This page is intentionally blank for double-sided printing.

Figure B1: Daily Cycle Demand for Scenario 0 'Do-Minimum' - 2021

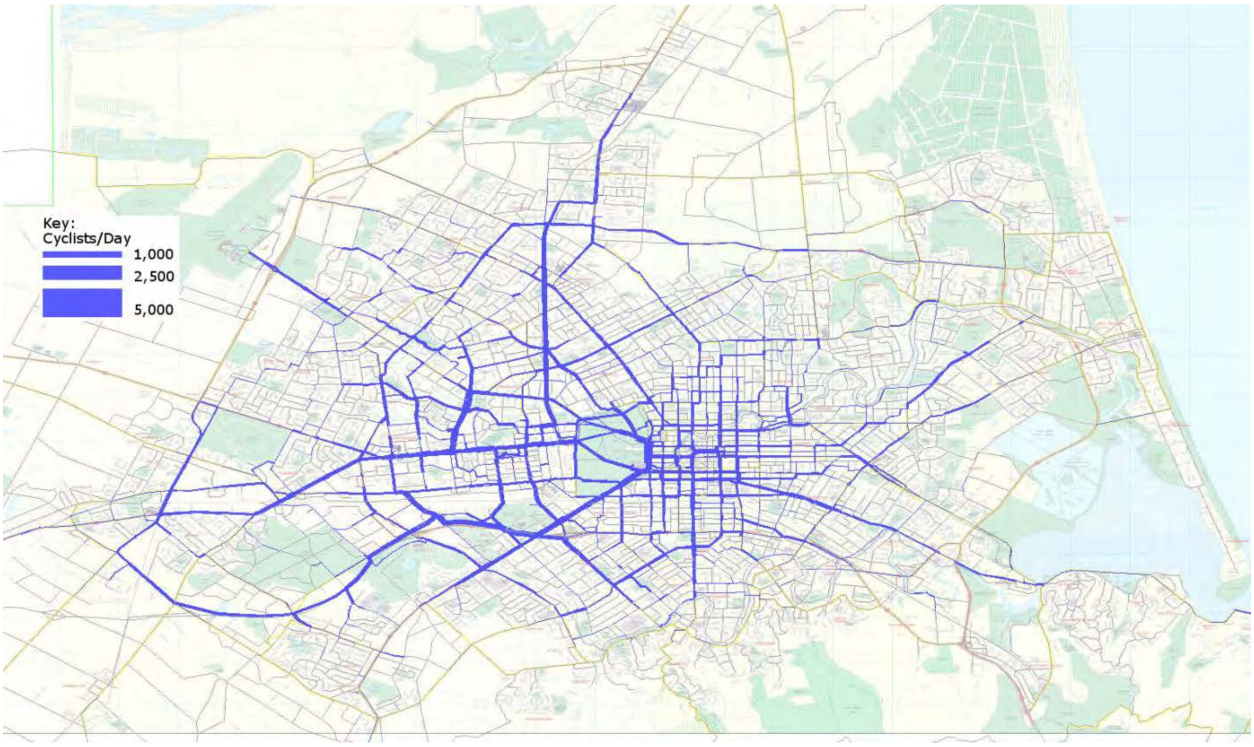


Figure B2: Daily Cycle Demand for Scenario 1 'Full Network' - 2021

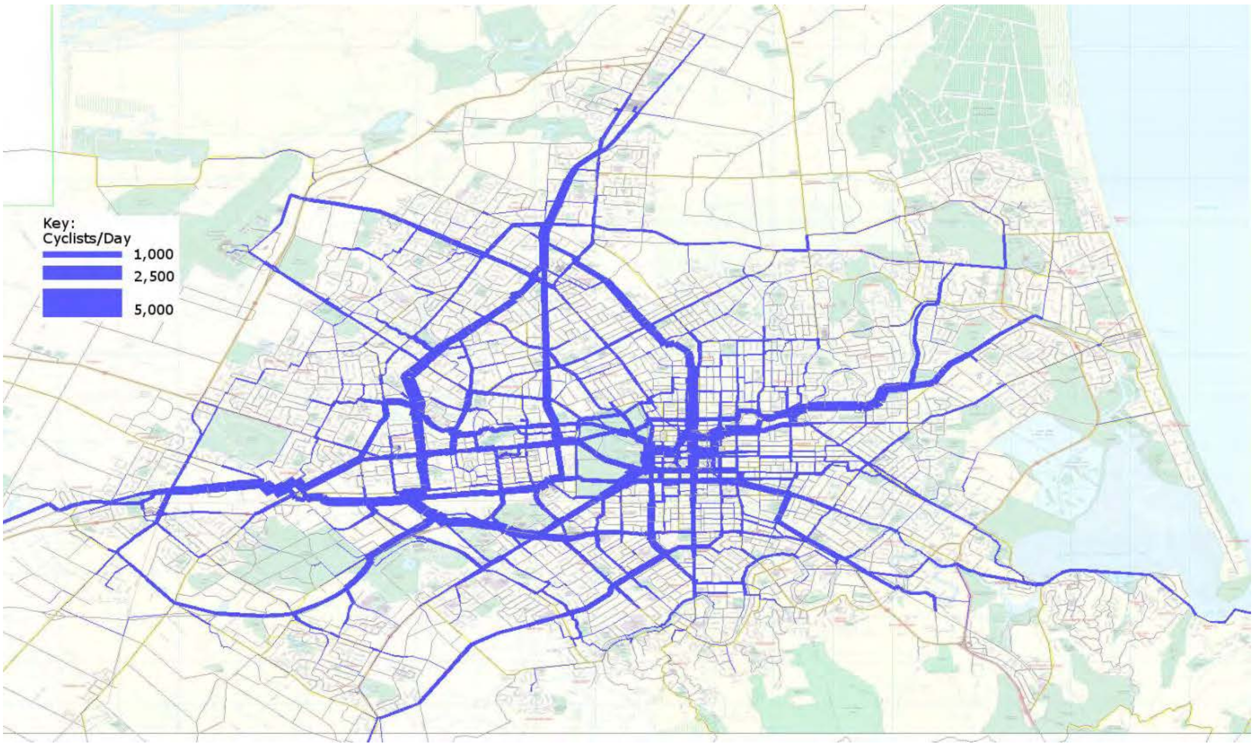


Figure B3: Daily Cycle Demand for Scenario 0 'Do-Minimum' - 2031

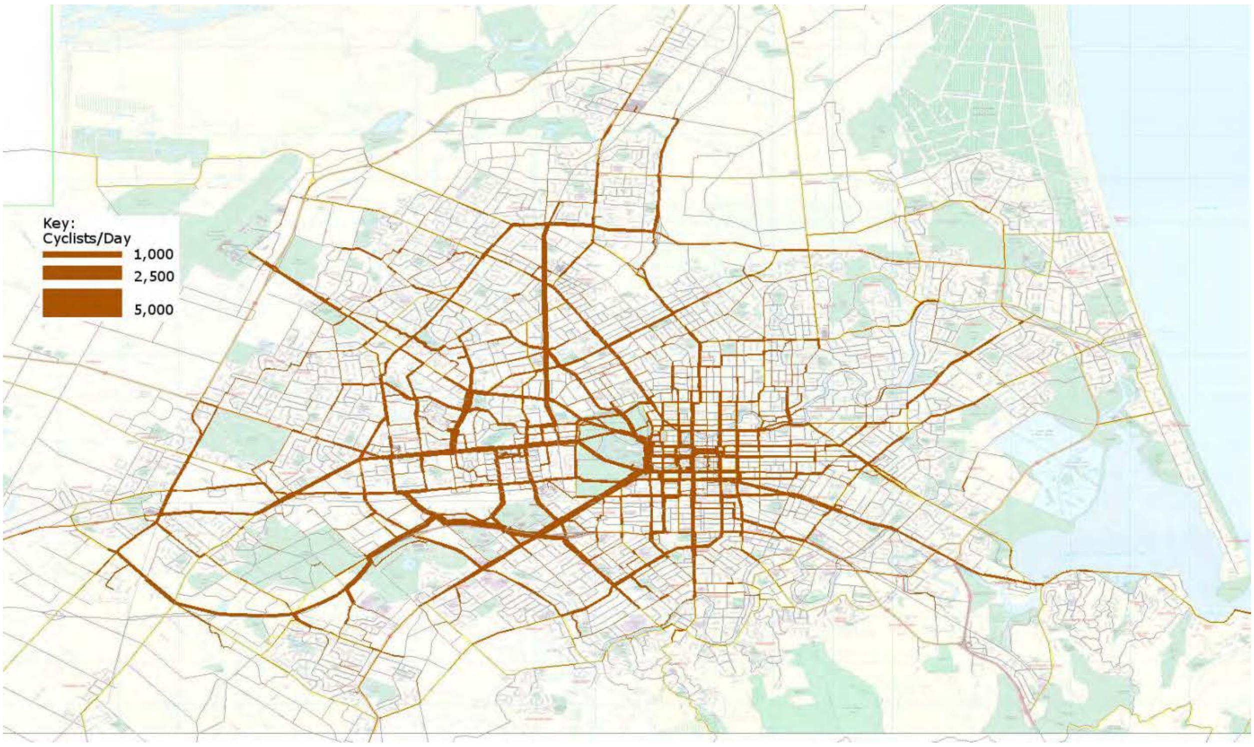


Figure B4: Daily Cycle Demand for Scenario 1 'Full Network' - 2031

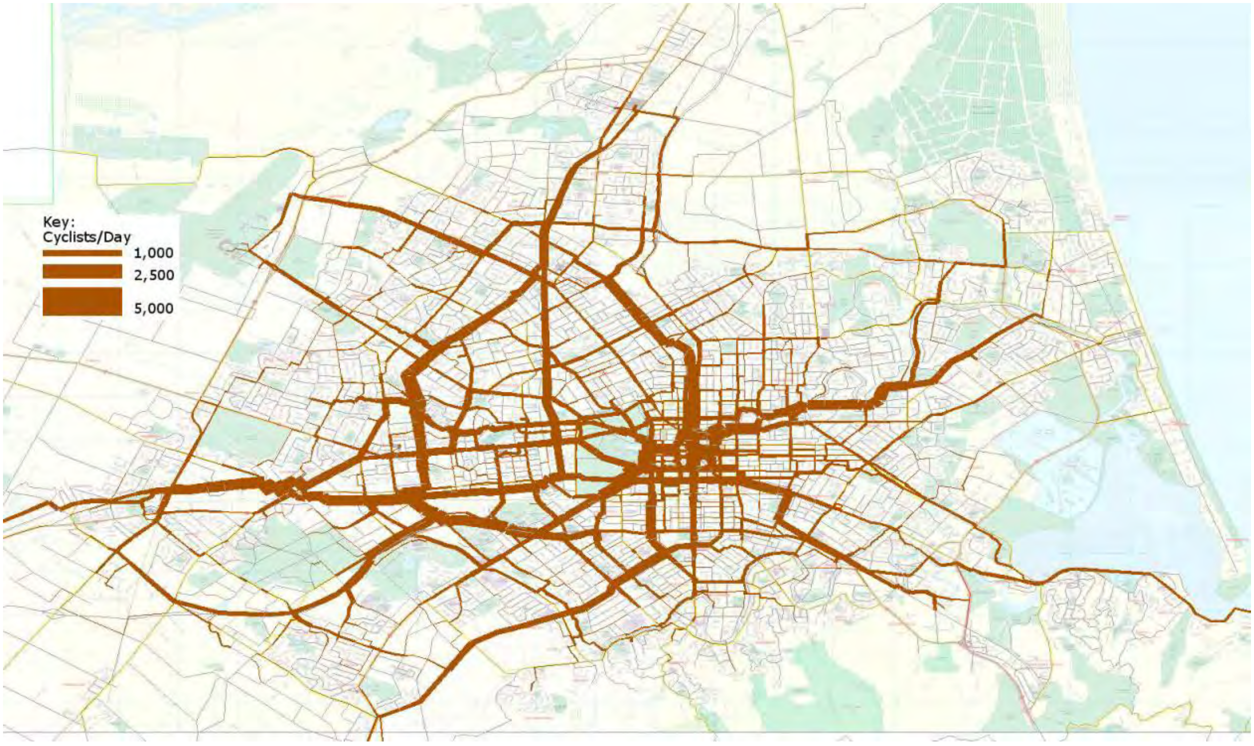


Figure B5: Daily Cycle Demand for Scenario 0 'Do-Minimum' -2041

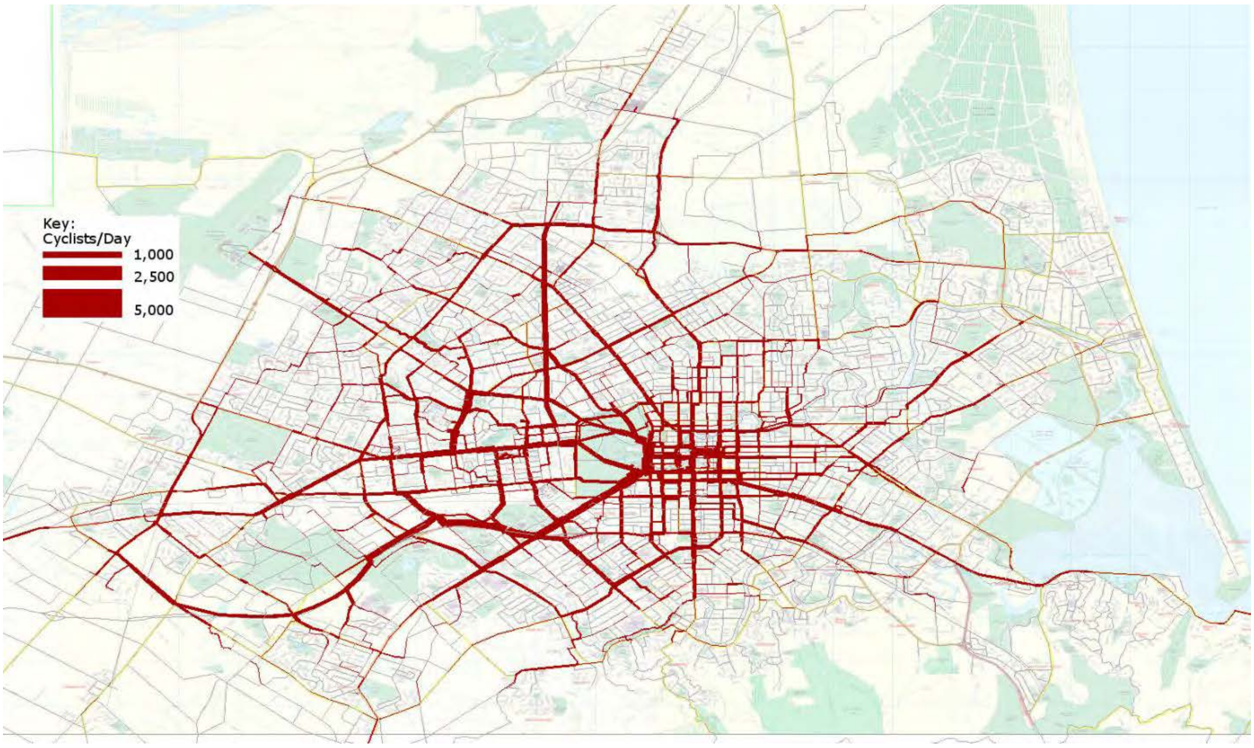
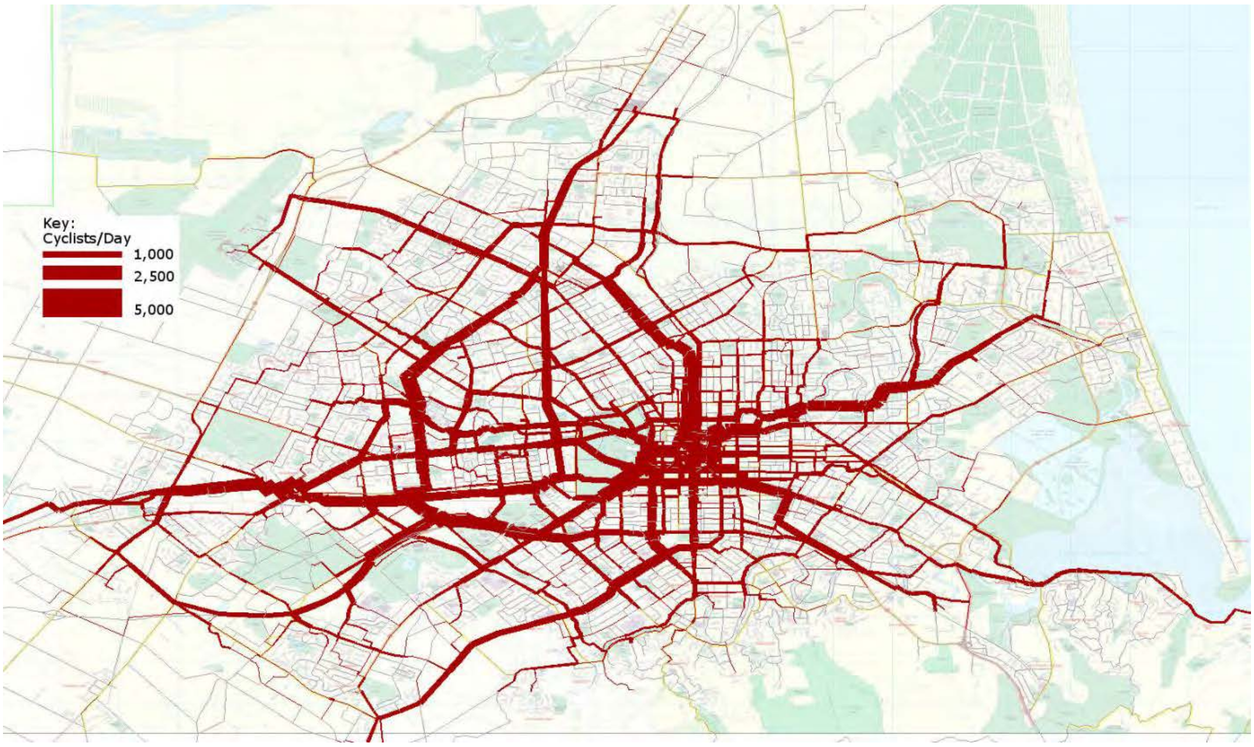


Figure B6: Daily Cycle Demand for Scenario 1 'Full Network' - 2041



This page is intentionally blank for double-sided printing.

Appendix C – Cyclist Demand Summary by Purpose

This page is intentionally blank for double-sided printing.

Table C1: Daily and Annual Predicted Cycle Demand, Time and Distance (by Purpose)

0.827 Factor Average weekday in term-time to 7 day AADT
365 Days in year Note factor above used to modify term-time flows)
$0.38 Base Road Safety Crash Benefit/cycle km 47816209.33
$1.57 New User Health & Environmental Benefits/cycle km Based on $1.40 at 1/07/2008 (EEM Table A20.4)
$0.06 Existing and New User Safety Benefits/cycle km Based on $0.05 at 1/07/2008 (EEM Table A20.4)
1.401249462
(Updated to July 2013 values above)

2006-00

	HBW	HBE	HBR	NHB	Daily	Annual (m)	Annual (m) corrected for intras	
Time (hrs)	333.8	193.0	200.1	135.8	8,627.0	2.604	2.653	
Dist (km)	5,937.6	3,489.1	3,567.9	2,384.0	153,786.0	46.421	47.300	3.11
Assigned Trips	1,487.8	1,219.0	1,218.2	885.6	48,106.0	14.521	15.195	
Intras	27.6	65.4	63.3	67.0	2,233.0	0.674		
	1,515.4	1,284.4	1,281.5	952.6	50,339.0			
				Segregatec	13,798.6	Annual (m)	4.244	

	HBW	HBE	HBR	NHB	Daily	Annual (m)		
2006	1,487.8	1,219.0	1,218.2	885.6	48,106.0	14.5		
2031	3,571.1	1,599.0	1,855.2	1,311.1	83,364.0	25.2		2.4
	140%	31%	52%	48%	73%	73%		
2006	4.0	2.9	2.9	2.7	3.2	Annual (m)		2.42
2031	5.6	3.6	3.8	3.4	4.5	(m-km/year)		
	39%	27%	29%	27%	39%	#VALUE!		

2021-00

	HBW	HBE	HBR	NHB	Daily	Annual (m)	Annual (m) corrected for intras
Time (hrs)	481.7	212.1	226.2	152.2	10,722.0	3.236	3.290
Dist (km)	8,671.9	3,847.6	4,082.8	2,708.4	193,107.0	58.290	59.260
Assigned Trips	1,985.1	1,284.4	1,330.5	953.0	55,530.0	16.762	17.506
Intras	33.2	67.6	69.0	76.6	2,464.0	0.744	
	2,018.3	1,352.0	1,399.5	1,029.6	57,994.0		
				Segegated	30,239.6	(m-km/year)	5.036
	4.4	3.0	3.1	2.8	3.5		

2031-00

		HBW	HBE	HBR	NHB	Daily	Annual (m)	Annual (m) corrected for intras
	Time (hrs)	579.6	223.2	253.1	167.7	12,236.0	3.693	3.750
3.39	Dist (km)	10,415.5	4,038.2	4,556.5	2,972.1	219,823.0	66.355	67.368
	Assigned Trips	2,366.5	1,329.4	1,459.7	1,038.2	61,938.0	18.696	19.474
	Intras	36.7	68.0	72.4	80.4	2,575.0	0.777	
		2,403.2	1,397.4	1,532.1	1,118.6	64,513.0		
					Segregatec	30,262.1	(m-km/year)	5.030

2041-00

		HBW	HBE	HBR	NHB	Daily	Annual (m)	Annual (m) corrected for intras	
	Time (hrs)	664.8	236.3	270.3	177.5	13,489.0	4.072	4.131	
3.46	Dist (km)	11,914.6	4,273.4	4,851.5	3,134.3	241,738.0	72.970	74.030	3.50
	Assigned Trips	2,698.4	1,393.2	1,546.9	1,097.2	67,357.0	20.332	21.146	
	Intras	38.9	71.0	75.9	83.7	2,695.0	0.813		
		2,737.3	1,464.2	1,622.8	1,180.9	70,052.0			
					Segregatec	33,978.1	(m-km/year)	6.161	
		4.4	3.1	3.1	2.9	3.6			

2021-01

	HBW	HBE	HBR	NHB	Daily	Annual	Annual (m) corrected for intras
Time (hrs)	856.4	281.9	318.5	210.0	16,668.0	5.031	5.082
Assigned Trips	2,880.4	1,513.7	1,630.8	1,165.1	71,900.0	21.703	22.447
Intras	33.1	67.6	69.1	76.7	2,465.0	0.744	
	2,913.5	1,581.3	1,699.9	1,241.8	74,365.0		
				Segegated	133,286.8	(m-km/year)	36.409
	5.5	3.5	3.6	3.3	4.3		

2031-01

2,575.0

	HBW	HBE	HBR	NHB	Daily	Annual	Annual (m) corrected for intras
Time (hrs)	1,038.1	302.0	364.8	236.7	19,416.0	5.861	5.914
Assigned Trips	3,485.8	1,587.4	1,823.2	1,291.7	81,881.0	24.716	25.493
Intras	36.5	68.0	72.4	80.5	2,574.0	0.777	
	3,522.3	1,655.4	1,895.6	1,372.2	84,455.0		
				Segregatec	160,301.1	(m-km/year)	44.595
	19.1	19.1	19.0	18.9	19.0		

2041-01

	HBW	HBE	HBR	NHB	Daily	Annual	Annual (m) corrected for intras
Time (hrs)	1,197.3	323.5	395.2	255.4	21,714.0	6.554	6.610
Assigned Trips	4,005.2	1,672.8	1,953.0	1,382.2	90,132.0	27.207	28.020
Intras	38.7	71.0	76.0	83.8	2,695.0	0.813	
	4,043.9	1,743.8	2,029.0	1,466.0	92,827.0		
				Segregatec	180,128.2	(m-km/year)	50.605
	5.5	3.6	3.7	3.4	4.4		

2021-04 (No Fuel Price Increase Sensitivity Test)

	HBW	HBE	HBR	NHB	Daily	Annual	Annual (m) corrected for intras
Time (hrs)	799.4	271.8	303.5	200.9	15,756.0	4.756	4.807
Dist (km)	15,309.3	5,211.6	5,810.2	3,815.5	301,466.0	90.999	91.968
Assigned Trips	2,827.4	1,493.7	1,612.7	1,152.2	70,860.0	21.389	22.133
Intras	33.0	67.6	69.1	76.7	2,464.0	0.744	
	2,860.4	1,561.3	1,681.8	1,228.9	73,324.0		
				Segegated	134,981.9	(m-km/year)	36.935

2031-04 (No Fuel Price Increase Sensitivity Test)

		HBW	HBE	HBR	NHB	Daily	Annual	Annual (m) corrected for intras
	Time (hrs)	913.0	281.3	332.6	217.4	17,443.0	5.265	5.318
4.16	Dist (km)	17,445.0	5,390.6	6,350.0	4,116.7	333,023.0	100.525	101.538
	Assigned Trips	3,276.5	1,534.8	1,754.1	1,245.6	78,110.0	23.578	24.355
	Intras	36.5	68.0	72.5	80.6	2,576.0	0.778	
		3,313.0	1,602.8	1,826.6	1,326.2	80,686.0		
					Segregatec	151,438.4	(m-km/year)	41.929

2041-04 (No Fuel Price Increase Sensitivity Test)

		HBW	HBE	HBR	NHB	Daily	Annual	Annual (m) corrected for intras	
	Time (hrs)	1,023.4	295.5	351.8	229.2	18,999.0	5.735	5.791	
4.17	Dist (km)	19,478.2	5,657.3	6,693.3	4,327.5	361,563.0	109.140	110.199	4.18
	Assigned Trips	3,692.5	1,599.9	1,852.2	1,315.5	84,601.0	25.537	26.350	
	Intras	38.6	71.0	76.0	83.8	2,694.0	0.813		
		3,731.1	1,670.9	1,928.2	1,399.3	87,295.0			
					Segregatec	164,863.4	(m-km/year)	46.004	

2021-05 (Reduction to 15% Car Trader Sensitivity Test)

	HBW	HBE	HBR	NHB	Daily	Annual	Annual (m) corrected for intras
Time (hrs)	633.4	236.4	259.2	172.9	13,019.0	3.930	3.981
Dist (km)	12,053.1	4,511.5	4,927.4	3,258.7	247,507.0	74.711	75.681
Assigned Trips	2,397.5	1,380.9	1,462.9	1,048.5	62,898.0	18.986	19.730
Intras	33.0	67.6	69.1	76.7	2,464.0	0.744	
	2,430.5	1,448.5	1,532.0	1,125.2	65,362.0		
				Segegated	101,029.9	(m-km/year)	26.648

2031-05 (Reduction to 15% Car Trader Sensitivity Test)

		HBW	HBE	HBR	NHB	Daily	Annual	Annual (m) corrected for intras
	Time (hrs)	754.1	248.4	290.5	191.0	14,840.0	4.480	4.533
3.84	Dist (km)	14,334.6	4,738.6	5,513.3	3,592.9	281,794.0	85.061	86.074
	Assigned Trips	2,845.0	1,428.8	1,607.9	1,144.5	70,262.0	21.209	21.987
	Intras	36.5	68.0	72.5	80.6	2,576.0	0.778	
		2,881.5	1,496.8	1,680.4	1,225.1	72,838.0		
					Segregatec	118,331.6	(m-km/year)	31.901

2041-05 (Reduction to 15% Car Trader Sensitivity Test)

		HBW	HBE	HBR	NHB	Daily	Annual	Annual (m) corrected for intras	
	Time (hrs)	861.4	262.5	310.3	202.9	16,371.0	4.942	4.998	
3.91	Dist (km)	16,329.3	5,003.3	5,872.2	3,806.9	310,117.0	93.610	94.670	3.96
	Assigned Trips	3,237.1	1,493.8	1,703.3	1,210.9	76,451.0	23.077	23.890	
	Intras	38.6	71.0	76.0	83.8	2,694.0	0.813		
		3,275.7	1,564.8	1,779.3	1,294.7	79,145.0			
					Segregates	131,336.7	(m-km/year)	35.849	

This page is intentionally blank for double-sided printing.

Appendix D – Model Result Summary for Road Networks (Decongestion calculations)

This page is intentionally blank for double-sided printing.

QTP

Table D1: Decongestion Calculations for Principal Scenarios

0.827 Factor Average weekday in term-time to 7 day AADT
365 Days in year

AM	2.61	
IP	8.48	
PM	2.61	
$/veh-km	$0.31	Based on July 2008 Values updated to July 2013
$/veh-hr	$22.74	Based on July 2002 Values updated to July 2013

NOTE THAT THE TIME, DISTANCE AND REPORTED COST TOTALS BELOW RELATE **ONLY** TO THE BASE TRIPS, not the assigned trips for "No Cycling" Scenarios

2021-00

AM peak	Base	No Cycling	% Difference	
Dist (km)	939,990	941,105	0.1%	
Time (hrs)	24,449	24,885	1.8%	
Vehicle Trips	115,112	119,818	4.1%	4,706
Speed	38.45	37.82	-1.6%	
Interpeak	Base	No Cycling		
Dist (km)	756,974	757,077	0.0%	
Time (hrs)	18,087	18,124	0.2%	
Vehicle Trips	104,600	106,134	1.5%	1,534
Speed	41.85	41.77	-0.2%	
PM Peak	Base	No Cycling		
Dist (km)	1,100,981	1,102,281	0.1%	
Time (hrs)	29,718	30,177	1.5%	
Vehicle Trips	135,088	139,372	3.2%	4,284
Speed	37.05	36.53	-1.4%	
Weekday	Base	No Cycling		
Dist (km)	11,739,825	11,746,992	0.1%	
Time (hrs)	294,583	297,229	0.9%	
Vehicle Trips	1,539,294	1,575,734	2.4%	36,440
Speed	39.85	39.52	-0.8%	
Annual	Base	No Cycling		
Dist (m.km)	3,543.7	3,545.9	0.1%	
Time (m.hrs)	88.9	89.7	0.9%	
Vehicle Trips	464.6	475.6	2.4%	
Cost ($m)	3134.39	3153.24	0.6%	
Net Cost ($m)		18.85		
		0.63		

2021-01

AM peak	Base	No Cycling	% Difference	
Dist (km)	939,990	941,993	0.2%	
Time (hrs)	24,449	25,226	3.2%	
Vehicle Trips	115,112	121,570	5.6%	6,458
Speed	38.45	37.34	-2.9%	
Interpeak	Base	No Cycling		
Dist (km)	756,974	757,128	0.0%	
Time (hrs)	18,087	18,149	0.3%	
Vehicle Trips	104,600	106,558	1.9%	1,958
Speed	41.85	41.72	-0.3%	
PM Peak	Base	No Cycling		
Dist (km)	1,100,981	1,108,287	0.7%	
Time (hrs)	29,718	30,762	3.5%	
Vehicle Trips	135,088	140,983	4.4%	5,895
Speed	37.05	36.03	-2.8%	
Weekday	Base	No Cycling		
Dist (km)	11,739,825	11,765,399	0.2%	
Time (hrs)	294,583	299,854	1.8%	
Vehicle Trips	1,539,294	1,588,095	3.2%	48,801
Speed	39.85	39.24	-1.5%	
Annual	Base	No Cycling		
Dist (m.km)	3,543.7	3,551.4	0.2%	
Time (m.hrs)	88.9	90.5	1.8%	
Vehicle Trips	464.6	479.4	3.2%	
Cost ($m)	3134.39	3173.00	1.2%	
Net Cost ($m)		38.61		

2021-02

AM peak	Base	No Cycling	% Difference	
Dist (km)	939,990	941,922	0.2%	
Time (hrs)	24,449	25,199	3.1%	
Vehicle Trips	115,112	121,433	5.5%	6,321
Speed	38.45	37.38	-2.8%	
Interpeak	Base	No Cycling		
Dist (km)	756,974	757,117	0.0%	
Time (hrs)	18,087	18,147	0.3%	
Vehicle Trips	104,600	106,575	1.8%	1,975
Speed	41.85	41.72	-0.3%	
PM Peak	Base	No Cycling		
Dist (km)	1,100,981	1,103,115	0.2%	
Time (hrs)	29,718	30,543	2.8%	
Vehicle Trips	135,088	140,850	4.3%	5,762
Speed	37.05	36.12	-2.5%	
Weekday	Base	No Cycling		
Dist (km)	11,739,825	11,751,634	0.1%	
Time (hrs)	294,583	299,196	1.6%	
Vehicle Trips	1,539,294	1,587,111	3.1%	47,817
Speed	39.85	39.28	-1.4%	
Annual	Base	No Cycling		
Dist (m.km)	3,543.7	3,547.3	0.1%	
Time (m.hrs)	88.9	90.3	1.6%	
Vehicle Trips	464.6	479.1	3.1%	
Cost ($m)	3134.39	3167.18	1.0%	
Net Cost ($m)		32.79		

2031-00

AM peak	Base	No Cycling	% Difference	
Dist (km)	1,036,113	1,037,658	0.1%	
Time (hrs)	27,198	27,781	2.1%	
Vehicle Trips	123,730	129,086	4.3%	5,356
Speed	38.10	37.35	-2.0%	
Interpeak	Base	No Cycling		
Dist (km)	836,833	836,970	0.0%	
Time (hrs)	20,010	20,059	0.2%	
Vehicle Trips	112,802	114,491	1.5%	1,689
Speed	41.82	41.73	-0.2%	
PM Peak	Base	No Cycling		
Dist (km)	1,225,813	1,228,718	0.2%	
Time (hrs)	33,622	34,362	2.2%	
Vehicle Trips	146,227	151,142	3.4%	4,915
Speed	36.46	35.76	-1.9%	
Weekday	Base	No Cycling		
Dist (km)	12,993,040	13,005,799	0.1%	
Time (hrs)	328,232	332,096	1.2%	
Vehicle Trips	1,660,354	1,701,448	2.5%	41,093
Speed	39.58	39.16	-1.1%	
Annual	Base	No Cycling		
Dist (m.km)	3,922.0	3,925.9	0.1%	
Time (m.hrs)	99.1	100.2	1.2%	
Vehicle Trips	501.2	513.6	2.5%	
Cost ($m)	3484.11	3511.84	0.8%	
Net Cost ($m)		27.73		

2031-01

AM peak	Base	No Cycling	% Difference	
Dist (km)	1,036,113	1,043,958	0.8%	
Time (hrs)	27,198	28,544	4.9%	
Vehicle Trips	123,730	131,205	6.0%	7,475
Speed	38.10	36.57	-4.0%	
Interpeak	Base	No Cycling		
Dist (km)	836,833	837,067	0.0%	
Time (hrs)	20,010	20,097	0.4%	
Vehicle Trips	112,802	115,000	1.9%	2,198
Speed	41.82	41.65	-0.4%	
PM Peak	Base	No Cycling		
Dist (km)	1,225,813	1,231,378	0.5%	
Time (hrs)	33,622	35,049	4.2%	
Vehicle Trips	146,227	153,125	4.7%	6,898
Speed	36.46	35.13	-3.6%	
Weekday	Base	No Cycling		
Dist (km)	12,993,040	13,029,972	0.3%	
Time (hrs)	328,232	336,197	2.4%	
Vehicle Trips	1,660,354	1,716,455	3.4%	56,101
Speed	39.58	38.76	-2.1%	
Annual	Base	No Cycling		
Dist (m.km)	3,922.0	3,933.2	0.3%	
Time (m.hrs)	99.1	101.5	2.4%	
Vehicle Trips	501.2	518.1	3.4%	
Cost ($m)	3484.11	3542.29	1.7%	
Net Cost ($m)		58.18		

2031-02

AM peak	Base	No Cycling	% Difference	
Dist (km)	1,036,113	1,043,757	0.7%	
Time (hrs)	27,198	28,508	4.8%	
Vehicle Trips	123,730	131,057	5.9%	7,327
Speed	38.10	36.61	-3.9%	
Interpeak	Base	No Cycling		
Dist (km)	836,833	837,074	0.0%	
Time (hrs)	20,010	20,094	0.4%	
Vehicle Trips	112,802	114,965	1.9%	2,163
Speed	41.82	41.66	-0.4%	
PM Peak	Base	No Cycling		
Dist (km)	1,225,813	1,230,682	0.4%	
Time (hrs)	33,622	34,976	4.0%	
Vehicle Trips	146,227	152,986	4.6%	6,759
Speed	36.46	35.19	-3.5%	
Weekday	Base	No Cycling		
Dist (km)	12,993,040	13,027,693	0.3%	
Time (hrs)	328,232	335,887	2.3%	
Vehicle Trips	1,660,354	1,715,410	3.3%	55,056
Speed	39.58	38.79	-2.0%	
Annual	Base	No Cycling		
Dist (m.km)	3,922.0	3,932.5	0.3%	
Time (m.hrs)	99.1	101.4	2.3%	
Vehicle Trips	501.2	517.8	3.3%	
Cost ($m)	3484.11	3539.95	1.6%	
Net Cost ($m)		55.84		

2041-00

AM peak	Base	No Cycling	% Difference	
Dist (km)	1,112,249	1,117,445	0.5%	
Time (hrs)	30,356	31,525	3.9%	
Vehicle Trips	130,725	136,648	4.5%	5,923
Speed	36.64	35.45	3.3%	
Interpeak	Base	No Cycling		
Dist (km)	896,085	896,265	0.0%	
Time (hrs)	21,770	21,856	0.4%	
Vehicle Trips	119,971	121,787	1.5%	1,816
Speed	41.16	41.01	0.4%	
PM Peak	Base	No Cycling		
Dist (km)	1,318,616	1,323,211	0.3%	
Time (hrs)	37,941	39,031	2.9%	
Vehicle Trips	155,242	160,688	3.5%	5,446
Speed	34.75	33.90	2.5%	
Weekday	Base	No Cycling		
Dist (km)	13,935,902	13,962,944	0.2%	
Time (hrs)	362,647	369,263	1.8%	
Vehicle Trips	1,762,888	1,807,919	2.6%	45,032
Speed	38.43	37.81	-1.6%	
Annual	Base	No Cycling		
Dist (m.km)	4,206.6	4,214.8	0.2%	
Time (m.hrs)	109.5	111.5	1.8%	
Vehicle Trips	532.1	545.7	2.6%	
Cost ($m)	3809.68	3857.67	1.3%	
Net Cost ($m)		47.99		

2041-01

AM peak	Base	No Cycling	% Difference	
Dist (km)	1,112,249	1,121,361	0.8%	
Time (hrs)	30,356	32,651	7.6%	
Vehicle Trips	130,725	139,071	6.4%	8,346
Speed	36.64	34.34	-6.3%	
Interpeak	Base	No Cycling		
Dist (km)	896,085	896,396	0.0%	
Time (hrs)	21,770	21,903	0.6%	
Vehicle Trips	119,971	122,366	2.0%	2,395
Speed	41.16	40.93	-0.6%	
PM Peak	Base	No Cycling		
Dist (km)	1,318,616	1,327,989	0.7%	
Time (hrs)	37,941	40,072	5.6%	
Vehicle Trips	155,242	163,004	5.0%	7,762
Speed	34.75	33.14	-4.6%	
Weekday	Base	No Cycling		
Dist (km)	13,935,902	13,986,712	0.4%	
Time (hrs)	362,647	375,309	3.5%	
Vehicle Trips	1,762,888	1,825,181	3.5%	62,293
Speed	38.43	37.27	-3.0%	
Annual	Base	No Cycling		
Dist (m.km)	4,206.6	4,222.0	0.4%	
Time (m.hrs)	109.5	113.3	3.5%	
Vehicle Trips	532.1	550.9	3.5%	
Cost ($m)	3809.68	3901.43	2.4%	
Net Cost ($m)		91.75		

2041-02

AM peak	Base	No Cycling	% Difference	
Dist (km)	1,112,249	1,121,931	0.9%	
Time (hrs)	30,356	32,567	7.3%	
Vehicle Trips	130,725	138,899	6.3%	8,174
Speed	36.64	34.45	6.0%	
Interpeak	Base	No Cycling		
Dist (km)	896,085	896,365	0.0%	
Time (hrs)	21,770	21,901	0.6%	
Vehicle Trips	119,971	122,326	2.0%	2,355
Speed	41.16	40.93	0.6%	
PM Peak	Base	No Cycling		
Dist (km)	1,318,616	1,327,203	0.7%	
Time (hrs)	37,941	39,972	5.4%	
Vehicle Trips	155,242	162,840	4.9%	7,598
Speed	34.75	33.20	4.5%	
Weekday	Base	No Cycling		
Dist (km)	13,935,902	13,985,886	0.4%	
Time (hrs)	362,647	374,813	3.4%	
Vehicle Trips	1,762,888	1,823,966	3.5%	61,078
Speed	38.43	37.31	-2.9%	
Annual	Base	No Cycling		
Dist (m.km)	4,206.6	4,221.7	0.4%	
Time (m.hrs)	109.5	113.1	3.4%	
Vehicle Trips	532.1	550.6	3.5%	
Cost ($m)	3809.68	3897.95	2.3%	
Net Cost ($m)		88.26		

This page is intentionally blank for double-sided printing.

Appendix E – Calculation of Annual Benefits

This page is intentionally blank for double-sided printing.

QTP

Tables E1/E2: Annual benefit calculations (Scenarios 1 and 2 vs. Do-Min)

VoT $22.74

RA 0.11

New Cycle User health & environment benefits: @140c/km Updated to July 2103 (EEM Table A20.4)

EEM Safety: @5c/km Updated to July 2013 (EEM Table A20.4)

... with 'True' Crash Costs: $/cycle km

	UDS Residents	Cycle Mode Share	Term Weekday Cycle Trips	Annual Cycle Trips (m)	New Trips (m)	New Trip km (m)	Time (m hrs)	Distance (m km)	Cycle hrs/Head (per year)	Cycle km/Head (per year)	Decongestion benefit ($m)	New Cycle User Benefits ($m)*	New Cycle User health & environment benefits ($m)	EEM Safety	Total	Base Road Crash Safety benefits ($m)	Increase in Cycle crash rate (based on no of trips)	m cycle-km/year	Cycle Crash Cost @ Base rate	Cycle Crash Cost with Safety in Numbers effect	$/cycle km	Total benefits
	2006	2.4%		15.20	3.11282			47.30										47.30		49.29	1.04	
Do-Minimum																						
2021	445,501	2.4%	57,994	17.506	2.311	11.960	3.290	59.260	7.39	133.02	18.847	0.566	18.753	0.28	38.448	6.612	6.1%	59.26	61.04	52.28	0.88	
2031	500,715	2.5%	64,513	19.474	4.278	20.068	3.750	67.368	7.49	134.54	27.733	0.565	31.467	0.28	60.047	7.356	11.3%	67.37	69.39	54.84	0.81	
2041	548,155	2.6%	70,052	21.146	5.950	26.731	4.131	74.030	7.54	135.05	47.988	0.692	41.913	0.35	90.938	7.987	15.7%	74.03	76.25	57.01	0.77	
Sc1 (Full MCR + AAC + CPW)	UDS Residents	Cycle Mode Share	Term Weekday Cycle Trips	Annual Cycle Trips (m)	New Trips (m)	New Trip km (m)	Time (m hrs)	Distance (m km)	Cycle hrs/Head (per year)	Cycle km/Head (per year)	Decongestion benefit ($m)	New Cycle User Benefits ($m)	New Cycle User health & environment benefits ($m)	EEM Safety		Base Road Crash Safety benefits ($m)	Increase in Cycle crash rate (based on no of trips)	m cycle-km/year	Cycle Crash Cost @ Base rate	Cycle Crash Cost with Safety in Numbers effect		
2021	445,501	3.2%	75,757	22.868	7.673	50.052	5.082	97.352	11.41	218.52	38.614	4.480	78.482	2.23	123.809	8.638	20.2%	97.35	100.27	59.24	0.61	
2031	500,715	3.4%	85,939	25.941	10.746	65.851	5.914	113.151	11.81	225.98	58.179	5.431	103.255	2.71	169.573	9.799	28.3%	113.15	116.55	63.23	0.56	
2041	548,155	3.5%	94,541	28.538	13.343	78.820	6.610	126.120	12.06	230.08	91.748	6.155	123.590	3.07	224.562	10.779	35.1%	126.12	129.90	66.60	0.53	
Net Benefits			Term Weekday Cycle Trips	Annual Cycle Trips (m)	New Trips (m)	New Trip km (m)	Time (m hrs)	Distance (m km)	Cycle hrs/Head (per year)	Cycle km/Head (per year)	Decongestion benefit ($m)	New Cycle User Benefits ($m)	New Cycle User health & environment benefits ($m)	EEM Safety		Base Road Crash Safety benefits ($m)				Net Benefits	Net Total Safety Benefits	Total benefits
2021		0.8%	17,763	5.362	5.362	38.092	1.792	38.092	4.022	85.50	19.77	3.91	59.729	1.95	85.361	2.025				-6.957	-4.931	78.479
2031		0.9%	21,426	6.468	6.468	45.783	2.164	45.783	4.322	91.44	30.45	4.87	71.788	2.43	109.527	2.443				-8.391	-5.948	101.152
2041		1.0%	24,489	7.392	7.392	52.090	2.479	52.090	4.523	95.03	43.76	5.46	81.676	2.72	133.624	2.792				-9.591	-6.799	124.101

... with 'True' Crash Costs:

	UDS Residents	Cycle Mode Share	Term Weekday Cycle Trips	Annual Cycle Trips (m)	New Trips (m)	New Trip km (m)	Time (m hrs)	Distance (m km)	Cycle hrs/Head (per year)	Cycle km/Head (per year)	Decongestion benefit ($m)	New Cycle User Benefits ($m)*	New Cycle User health & environment benefits ($m)	EEM Safety	Total	Base Road Crash Safety benefits ($m)	Increase in Cycle crash rate (based on no of trips)	m cycle-km/year	Cycle Crash Cost @ Base rate	Cycle Crash Cost with Safety in Numbers effect		Total benefits
Do-Minimum																						
2021	445,501	2.4%	57,994	17.506	2.311	11.960	3.290	59.260	7.39	133.02	18.847	0.566	18.753	0.28	38.448	6.612	6.1%	59.26	61.04	52.28		
2031	500,715	2.5%	64,513	19.474	4.278	20.068	3.750	67.368	7.49	134.54	27.733	0.565	31.467	0.28	60.047	7.356	11.3%	67.37	69.39	54.84		
2041	548,155	2.6%	70,052	21.146	5.950	26.731	4.131	74.030	7.54	135.05	47.988	0.692	41.913	0.35	90.938	7.987	15.7%	74.03	76.25	57.01		
Sc2 (Sc1 less 25% Full MCR)	UDS Residents	Cycle Mode Share	Term Weekday Cycle Trips	Annual Cycle Trips (m)	New Trips (m)	New Trip km (m)	Time (m hrs)	Distance (m km)	Cycle hrs/Head (per year)	Cycle km/Head (per year)	Decongestion benefit ($m)	New Cycle User Benefits ($m)	New Cycle User health & environment benefits ($m)	EEM Safety		Base Road Crash Safety benefits ($m)	Increase in Cycle crash rate (based on no of trips)	m cycle-km/year	Cycle Crash Cost @ Base rate	Cycle Crash Cost with Safety in Numbers effect		
2021	445,501	3.1%	74,365	22.447	7.252	46.733	4.934	94.033	11.08	211.07	32.793	4.089	73.277	2.04	112.198	8.479	19.1%	94.03	96.85	58.70		
2031	500,715	3.3%	84,455	25.493	10.298	62.287	5.756	109.587	11.49	218.86	55.838	5.009	97.666	2.50	161.011	9.629	27.1%	109.59	112.87	62.65		
2041	548,155	3.5%	92,827	28.020	12.825	74.668	6.422	121.968	11.72	222.51	88.261	5.684	117.080	2.83	213.858	10.584	33.8%	121.97	125.63	65.93		
Net Benefits			Term Weekday Cycle Trips	Annual Cycle Trips (m)	New Trips (m)	New Trip km (m)	Time (m hrs)	Distance (m km)	Cycle hrs/Head (per year)	Cycle km/Head (per year)	Decongestion benefit ($m)	New Cycle User Benefits ($m)	New Cycle User health & environment benefits ($m)	EEM Safety		Base Road Crash Safety benefits ($m)				Net Benefits	Net Total Safety Benefits	Total benefits
2021		0.7%	16,371	4.942	4.942	34.773	1.644	34.773	3.690	78.05	13.95	3.52	54.524	1.76	73.750	1.867				-6.411	-4.545	67.448
2031		0.8%	19,942	6.020	6.020	42.219	2.006	42.219	4.006	84.32	28.11	4.44	66.200	2.22	100.964	2.274				-7.810	-5.536	93.212
2041		0.9%	22,775	6.875	6.875	47.938	2.291	47.938	4.179	87.45	40.27	4.99	75.166	2.49	122.920	2.597				-8.919	-6.323	114.109

QTP

Tables E3/E4: Annual benefit calculations: Scenarios '4' (1-2) and '5' (1-3) vs. Do-Min

	UDS Residents	Cycle Mode Share	Term Weekday Cycle Trips	Annual Cycle Trips (m)	New Trips (m)	New Trip km (m)	Time (m hrs)	Distance (m km)	Cycle hrs/Head (per year)	Cycle km/Head (per year)	Decongestion benefit ($m)	New Cycle User Benefits ($m)*	New Cycle User health & environment benefits ($m)	EEM Safety	Total
Do-Minimum															
2021	445,501	2.4%	57,994	17.506	2.311	11.960	3.290	59.260	7.39	133.02	18.847	0.566	18.753	0.28	38.448
2031	500,715	2.5%	64,513	19.474	4.278	20.068	3.750	67.368	7.49	134.54	27.733	0.565	31.467	0.28	60.047
2041	548,155	2.6%	70,052	21.146	5.950	26.731	4.131	74.030	7.54	135.05	47.988	0.692	41.913	0.35	90.938
Sc4 (Sc1 but NO real-terms fuel increase)	UDS Residents	Cycle Mode Share	Term Weekday Cycle Trips	Annual Cycle Trips (m)	New Trips (m)	New Trip km (m)	Time (m hrs)	Distance (m km)	Cycle hrs/Head (per year)	Cycle km/Head (per year)	Decongestion benefit ($m)	New Cycle User Benefits ($m)	New Cycle User health & environment benefits ($m)	EEM Safety	
2021	445,501	3.1%	73,324	22.133	6.938	44.669	4.807	91.968	10.79	206.44	31.802	4.149	70.041	2.07	108.060
2031	500,715	3.2%	80,686	24.355	9.160	54.239	5.318	101.538	10.62	202.79	51.218	4.710	85.046	2.35	143.322
2041	548,155	3.2%	87,295	26.350	11.155	62.900	5.791	110.199	10.56	201.04	73.264	5.167	98.627	2.58	179.634
Net Benefits			Term Weekday Cycle Trips	Annual Cycle Trips (m)	New Trips (m)	New Trip km (m)	Time (m hrs)	Distance (m km)	Cycle hrs/Head (per year)	Cycle km/Head (per year)	Decongestion benefit ($m)	New Cycle User Benefits ($m)	New Cycle User health & environment benefits ($m)	EEM Safety	
2021		0.7%	15,330	4.627	4.627	32.709	1.516	32.709	3.404	73.42	12.96	3.58	51.287	1.79	69.612
2031		0.7%	16,173	4.882	4.882	34.170	1.568	34.170	3.132	68.24	23.49	4.14	53.579	2.07	83.275
2041		0.7%	17,243	5.205	5.205	36.169	1.660	36.169	3.028	65.98	25.28	4.48	56.714	2.23	88.696

... with 'True' Crash Costs:

	Base Road Crash Safety benefits ($m)	Increase in Cycle crash rate *(based on no of trips)*	m cycle-km/year	Cycle Crash Cost @ Base rate	Cycle Crash Cost with Safety in Numbers effect	Net Benefits	Net Total Safety Benefits	Total benefits
Do-Minimum								
2021	8.057	6.1%	84.59	87.13	52.28			
2031	9.105	11.3%	97.72	100.65	54.84			
2041	10.020	15.7%	109.04	112.31	57.01			
Sc4								
2021	8.360	18.3%	91.97	94.73	58.29			
2031	9.200	24.1%	101.54	104.58	61.17			
2041	9.953	29.4%	110.20	113.51	63.76			
Net Benefits								
2021	0.303					-6.004	-5.701	62.125
2031	0.095					-6.334	-6.239	74.969
2041	- 0.067					-6.753	-6.820	79.645

	UDS Residents	Cycle Mode Share	Term Weekday Cycle Trips	Annual Cycle Trips (m)	New Trips (m)	New Trip km (m)	Time (m hrs)	Distance (m km)	Cycle hrs/Head (per year)	Cycle km/Head (per year)	Decongestion benefit ($m)	New Cycle User Benefits ($m)*	New Cycle User health & environment benefits ($m)	EEM Safety	Total
Do-Minimum															
2021	445,501	2.4%	57,994	17.506	2.311	11.960	3.290	59.260	7.39	133.02	18.847	0.566	18.753	0.28	38.448
2031	500,715	2.5%	64,513	19.474	4.278	20.068	3.750	67.368	7.49	134.54	27.733	0.565	31.467	0.28	60.047
2041	548,155	2.6%	70,052	21.146	5.950	26.731	4.131	74.030	7.54	135.05	47.988	0.692	41.913	0.35	90.938
Sc5 (Sc1 but only 15% car Traders)	UDS Residents	Cycle Mode Share	Term Weekday Cycle Trips	Annual Cycle Trips (m)	New Trips (m)	New Trip km (m)	Time (m hrs)	Distance (m km)	Cycle hrs/Head (per year)	Cycle km/Head (per year)	Decongestion benefit ($m)	New Cycle User Benefits ($m)	New Cycle User health & environment benefits ($m)	EEM Safety	
2021	445,501	2.7%	65,362	19.730	4.535	28.381	3.981	75.681	8.94	169.88	24.833	2.993	44.501	1.49	73.820
2031	500,715	2.8%	72,838	21.987	6.791	38.775	4.533	86.074	9.05	171.90	38.198	3.583	60.799	1.79	104.366
2041	548,155	2.9%	79,145	23.890	8.695	47.371	4.998	94.670	9.12	172.71	61.718	4.027	74.277	2.01	142.029
Net Benefits			Term Weekday Cycle Trips	Annual Cycle Trips (m)	New Trips (m)	New Trip km (m)	Time (m hrs)	Distance (m km)	Cycle hrs/Head (per year)	Cycle km/Head (per year)	Decongestion benefit ($m)	New Cycle User Benefits ($m)	New Cycle User health & environment benefits ($m)	EEM Safety	
2021		0.3%	7,368	2.224	2.224	16.421	0.691	16.421	1.550	36.86	5.99	2.43	25.748	1.21	35.372
2031		0.4%	8,325	2.513	2.513	18.707	0.783	18.707	1.564	37.36	10.46	3.02	29.332	1.50	44.320
2041		0.4%	9,093	2.745	2.745	20.640	0.867	20.640	1.581	37.65	13.73	3.33	32.364	1.66	51.091

... with 'True' Crash Costs:

	Base Road Crash Safety benefits ($m)	Increase in Cycle crash rate *(based on no of trips)*	m cycle-km/year	Cycle Crash Cost @ Base rate	Cycle Crash Cost with Safety in Numbers effect	Net Benefits	Net Total Safety Benefits	Total benefits
Do-Minimum								
2021	8.057	6.1%	84.59	87.13	52.28			
2031	9.105	11.3%	97.72	100.65	54.84			
2041	10.020	15.7%	109.04	112.31	57.01			
Sc5								
2021	7.452	11.9%	75.68	77.95	55.17			
2031	8.305	17.9%	86.07	88.66	58.10			
2041	9.024	22.9%	94.67	97.51	60.57			
Net Benefits								
2021	- 0.605					-2.886	-3.490	30.671
2031	- 0.800					-3.260	-4.061	38.754
2041	- 0.996					-3.561	-4.557	44.872

Appendix F – Summary of Cost and Benefit Streams

This page is intentionally blank for double-sided printing.

Table F-1: Assumed Cost Stream (Scenarios 1 and 2) - ***updated***

Year	Yrs from Time Zero	6.0%		AAC Costs	CCP Costs	MCR Costs (Sc1)	Net Maintenance (Sc1)	Total Costs (Sc1)	Total Costs (Sc2)
2013	Base Date 1 July 2013	SPPWF							
2014	0	1.000	2013/2014		*$0.500m*	*$0.875m*		*$1.375m*	*$1.354m*
2015	1	0.943	2014/2015	*$5.000m*	*$4.500m*	*$5.287m*	*$0.002m*	*$14.789m*	*$13.969m*
2016	2	0.890	2015/2016	*$5.000m*	*$5.000m*	*$12.308m*	*$0.025m*	*$22.333m*	*$19.912m*
2017	3	0.840	2016/2017	*$5.000m*	*$7.750m*	*$18.648m*	*$0.058m*	*$31.456m*	*$29.981m*
2018	4	0.792	2017/2018			*$38.148m*	*$0.120m*	*$38.268m*	*$24.247m*
2019	5	0.747	2018/2019			*$30.556m*	*$0.159m*	*$30.715m*	*$27.233m*
2020	6	0.705	2019/2020			*$33.482m*	*$0.202m*	*$33.684m*	*$25.870m*
2021	7	0.665	2020/2021			*$15.271m*	*$0.239m*	*$15.510m*	*$7.370m*
2022	8	0.627	2021/2022			*$1.664m*	*$0.242m*	*$1.906m*	*$1.007m*
Undiscounted Total				*$15.0m*	*$17.8m*	*$156.2m*	*$8.6m*	*$197.5m*	*$156.9m*
Present Value Total				*$15.9m*	*$15.7m*	*$120.3m*	*$2.9m*	*$152.3m*	*$122.4m*

Table F-2: Assumed Benefit Streams (Key Scenarios) - *updated*

				Total Benefits					Scenario 1 Benefit Sources				Scenario 2 Benefit Sources				Scenario 1-8 Benefit Sources			
End Year	Base Date 1 July 2013	SPPWF (6%)	Proportion of benefits captured	Sc1	Sc2	Sc1-2 (No Fuel Price Increase vs 40%)	Sc1-3 (15% Traders vs 30%)	Sc1-8 (Revised Safety)	Decong-estion	Users	Health&Environ-ment	Safety	Decong-estion	Users	Health& Environ-ment	Safety	Decong-estion	Users	Health& Environ-ment	Safety
2014	0	1.0000	0%	68.45	54.70	60.05	29.11	62.61	12.29	3.25	51.29	1.62	4.03	2.88	46.35	1.44	12.29	3.25	51.29	-4.22
2015	1	0.9434	0%	70.86	57.42	61.41	30.00	64.87	13.36	3.34	52.49	1.67	5.45	2.97	47.52	1.48	13.36	3.34	52.49	-4.32
2016	2	0.8900	5%	73.28	60.14	62.78	30.90	67.14	14.43	3.44	53.70	1.71	6.87	3.06	48.69	1.53	14.43	3.44	53.70	-4.42
2017	3	0.8396	15%	75.70	62.86	64.15	31.79	69.41	15.50	3.53	54.90	1.76	8.28	3.16	49.85	1.57	15.50	3.53	54.90	-4.52
2018	4	0.7921	40%	78.11	65.59	65.51	32.69	71.68	16.56	3.63	56.11	1.81	9.70	3.25	51.02	1.62	16.56	3.63	56.11	-4.63
2019	5	0.7473	60%	80.53	68.31	66.88	33.58	73.94	17.63	3.72	57.32	1.86	11.11	3.34	52.19	1.67	17.63	3.72	57.32	-4.73
2020	6	0.7050	80%	82.94	71.03	68.25	34.48	76.21	18.70	3.82	58.52	1.90	12.53	3.43	53.36	1.71	18.70	3.82	58.52	-4.83
2021	7	0.6651	100%	**85.36**	**73.75**	**69.61**	**35.37**	**78.48**	**19.77**	**3.91**	**59.73**	**1.95**	**13.95**	**3.52**	**54.52**	**1.76**	**19.77**	**3.91**	**59.73**	**-4.93**
2022	8	0.6274	100%	87.78	76.47	70.98	36.27	80.75	20.84	4.01	60.93	2.00	15.36	3.62	55.69	1.80	20.84	4.01	60.93	-5.03
2023	9	0.5919	100%	90.19	79.19	72.34	37.16	83.01	21.90	4.10	62.14	2.05	16.78	3.71	56.86	1.85	21.90	4.10	62.14	-5.13
2024	10	0.5584	100%	92.61	81.91	73.71	38.06	85.28	22.97	4.20	63.35	2.09	18.19	3.80	58.03	1.89	22.97	4.20	63.35	-5.24
2025	11	0.5268	100%	95.03	84.64	75.08	38.95	87.55	24.04	4.29	64.55	2.14	19.61	3.89	59.19	1.94	24.04	4.29	64.55	-5.34
2026	12	0.4970	100%	97.44	87.36	76.44	39.85	89.82	25.11	4.39	65.76	2.19	21.03	3.98	60.36	1.99	25.11	4.39	65.76	-5.44
2027	13	0.4688	100%	99.86	90.08	77.81	40.74	92.08	26.17	4.49	66.96	2.24	22.44	4.08	61.53	2.03	26.17	4.49	66.96	-5.54
2028	14	0.4423	100%	102.28	92.80	79.18	41.64	94.35	27.24	4.58	68.17	2.28	23.86	4.17	62.70	2.08	27.24	4.58	68.17	-5.64
2029	15	0.4173	100%	104.69	95.52	80.54	42.53	96.62	28.31	4.68	69.38	2.33	25.27	4.26	63.86	2.12	28.31	4.68	69.38	-5.74
2030	16	0.3936	100%	107.11	98.24	81.91	43.42	98.88	29.38	4.77	70.58	2.38	26.69	4.35	65.03	2.17	29.38	4.77	70.58	-5.85
2031	17	0.3714	100%	**109.53**	**100.96**	**83.28**	**44.32**	**101.15**	**30.45**	**4.87**	**71.79**	**2.43**	**28.11**	**4.44**	**66.20**	**2.22**	**30.45**	**4.87**	**71.79**	**-5.95**
2032	18	0.3503	100%	111.94	103.16	83.82	45.00	103.49	31.78	4.93	72.78	2.46	29.32	4.50	67.10	2.24	31.78	4.93	72.78	-5.99
2033	19	0.3305	100%	114.35	105.36	84.36	45.67	105.84	33.11	4.99	73.77	2.49	30.54	4.55	67.99	2.27	33.11	4.99	73.77	-6.02
2034	20	0.3118	100%	116.76	107.55	84.90	46.35	108.18	34.44	5.05	74.75	2.52	31.76	4.61	68.89	2.30	34.44	5.05	74.75	-6.06
2035	21	0.2942	100%	119.17	109.75	85.44	47.03	110.52	35.77	5.11	75.74	2.55	32.97	4.66	69.79	2.32	35.77	5.11	75.74	-6.10
2036	22	0.2775	100%	121.58	111.94	85.99	47.71	112.86	37.10	5.16	76.73	2.58	34.19	4.72	70.68	2.35	37.10	5.16	76.73	-6.14
2037	23	0.2618	100%	123.98	114.14	86.53	48.38	115.21	38.43	5.22	77.72	2.60	35.41	4.77	71.58	2.38	38.43	5.22	77.72	-6.17
2038	24	0.2470	100%	126.39	116.33	87.07	49.06	117.55	39.77	5.28	78.71	2.63	36.62	4.83	72.48	2.41	39.77	5.28	78.71	-6.21
2039	25	0.2330	100%	128.80	118.53	87.61	49.74	119.89	41.10	5.34	79.70	2.66	37.84	4.88	73.37	2.43	41.10	5.34	79.70	-6.25
2040	26	0.2198	100%	131.21	120.72	88.15	50.41	122.23	42.43	5.40	80.69	2.69	39.06	4.94	74.27	2.46	42.43	5.40	80.69	-6.29
2041	27	0.2074	100%	**133.62**	**122.92**	**88.70**	**51.09**	**124.58**	**43.76**	**5.46**	**81.68**	**2.72**	**40.27**	**4.99**	**75.17**	**2.49**	**43.76**	**5.46**	**81.68**	**-6.32**
2042	28	0.1956	100%	133.62	122.92	88.70	51.09	124.58	43.76	5.46	81.68	2.72	40.27	4.99	75.17	2.49	43.76	5.46	81.68	-6.32
2043	29	0.1846	100%	133.62	122.92	88.70	51.09	124.58	43.76	5.46	81.68	2.72	40.27	4.99	75.17	2.49	43.76	5.46	81.68	-6.32
2044	30	0.1741	100%	133.62	122.92	88.70	51.09	124.58	43.76	5.46	81.68	2.72	40.27	4.99	75.17	2.49	43.76	5.46	81.68	-6.32
2045	31	0.1643	100%	133.62	122.92	88.70	51.09	124.58	43.76	5.46	81.68	2.72	40.27	4.99	75.17	2.49	43.76	5.46	81.68	-6.32
2046	32	0.1550	100%	133.62	122.92	88.70	51.09	124.58	43.76	5.46	81.68	2.72	40.27	4.99	75.17	2.49	43.76	5.46	81.68	-6.32
2047	33	0.1462	100%	133.62	122.92	88.70	51.09	124.58	43.76	5.46	81.68	2.72	40.27	4.99	75.17	2.49	43.76	5.46	81.68	-6.32
2048	34	0.1379	100%	133.62	122.92	88.70	51.09	124.58	43.76	5.46	81.68	2.72	40.27	4.99	75.17	2.49	43.76	5.46	81.68	-6.32
2049	35	0.1301	100%	133.62	122.92	88.70	51.09	124.58	43.76	5.46	81.68	2.72	40.27	4.99	75.17	2.49	43.76	5.46	81.68	-6.32
2050	36	0.1227	100%	133.62	122.92	88.70	51.09	124.58	43.76	5.46	81.68	2.72	40.27	4.99	75.17	2.49	43.76	5.46	81.68	-6.32
2051	37	0.1158	100%	133.62	122.92	88.70	51.09	124.58	43.76	5.46	81.68	2.72	40.27	4.99	75.17	2.49	43.76	5.46	81.68	-6.32
2052	38	0.1092	100%	133.62	122.92	88.70	51.09	124.58	43.76	5.46	81.68	2.72	40.27	4.99	75.17	2.49	43.76	5.46	81.68	-6.32
2053	39	0.1031	100%	133.62	122.92	88.70	51.09	124.58	43.76	5.46	81.68	2.72	40.27	4.99	75.17	2.49	43.76	5.46	81.68	-6.32
Undiscounted Total				4433.03	4006.43	3216.83	1754.39	3771.03	1287.45	190.53	2860.06	94.99	1120.51	173.27	2626.26	86.39	1287.45	190.53	2860.06	-228.92
Present Value Total				1219.19	1098.80	909.99	488.15	1127.86	340.02	53.29	799.31	26.57	292.35	48.43	733.88	24.14	340.02	53.29	799.31	-64.76
									28%	4%	66%	2%					28%	4%	66%	-5%

Highlights where Benefits assumed capped post-2041

Appendix G – Incremental Analysis Summary *(updated)*

This page is intentionally blank for double-sided printing.

Worksheet 4a: Incremental analysis (Using Base Case Costs and Benefits)

1 Target incremental BCR (from appendix A12.4) 4

Step	Option	Base option for comparison		Next higher cost option			Incremental analysis			
		Costs	Benefits	Option	Costs	Benefits	Incremental costs	Incremental benefits	Incremental BCR	Base option for next step
	(2)	(3)	(4)	(5)	(6)	(7)	(8) = (6) - (3)	(9) = (7) - (4)	(10) = (9) - (8)	(11)
1	Sc2	122.4	1098.8	Sc1	152.3	1219.2	29.81	120.4	90.6	Sc1
2										

12 Preferred project option: Sc1 (Full MCR + ACC + CPW)

13 Rationale for selection: This is the Preferred Option and exceeds target Incremental BCR requirements (for BCR >4)

14 Results of sensitivity testing of target incremental BCR: Sc1 is still preferred option using a target incremental BCR of 5

Worksheet 4b: Incremental analysis (Using Costs +20% and Halved Benefits) 50%

1 Target incremental BCR (from appendix A12.4) 4

Step	Option	Base option for comparison		Next higher cost option			Incremental analysis			
		Costs	Benefits	Option	Costs	Benefits	Incremental costs	Incremental benefits	Incremental BCR	Base option for next step
	(2)	(3)	(4)	(5)	(6)	(7)	(8) = (6) - (3)	(9) = (7) - (4)	(10) = (9) - (8)	(11)
1	Sc2-5	146.9	549.4	Sc1-5	182.7	609.6	35.78	60.2	24.4	Sc1-5
2										

12 Preferred project option: Sc1 (Full MCR + ACC + CPW)

13 Rationale for selection: This is the Preferred Option and exceeds target Incremental BCR requirements (for BCR >4)

14 Results of sensitivity testing of target incremental BCR: Sc1 is still preferred option using a target incremental BCR of 5

This page is intentionally blank for double-sided printing.

Appendix H – Potential Alternative Benefit Capture Profiles *(new to Update)*

This page is intentionally blank for double-sided printing.

Figure H-1: Basis of Base Case Assumed Benefit Capture Assumptions (Network km completed – CCC Programme as at January 2015)

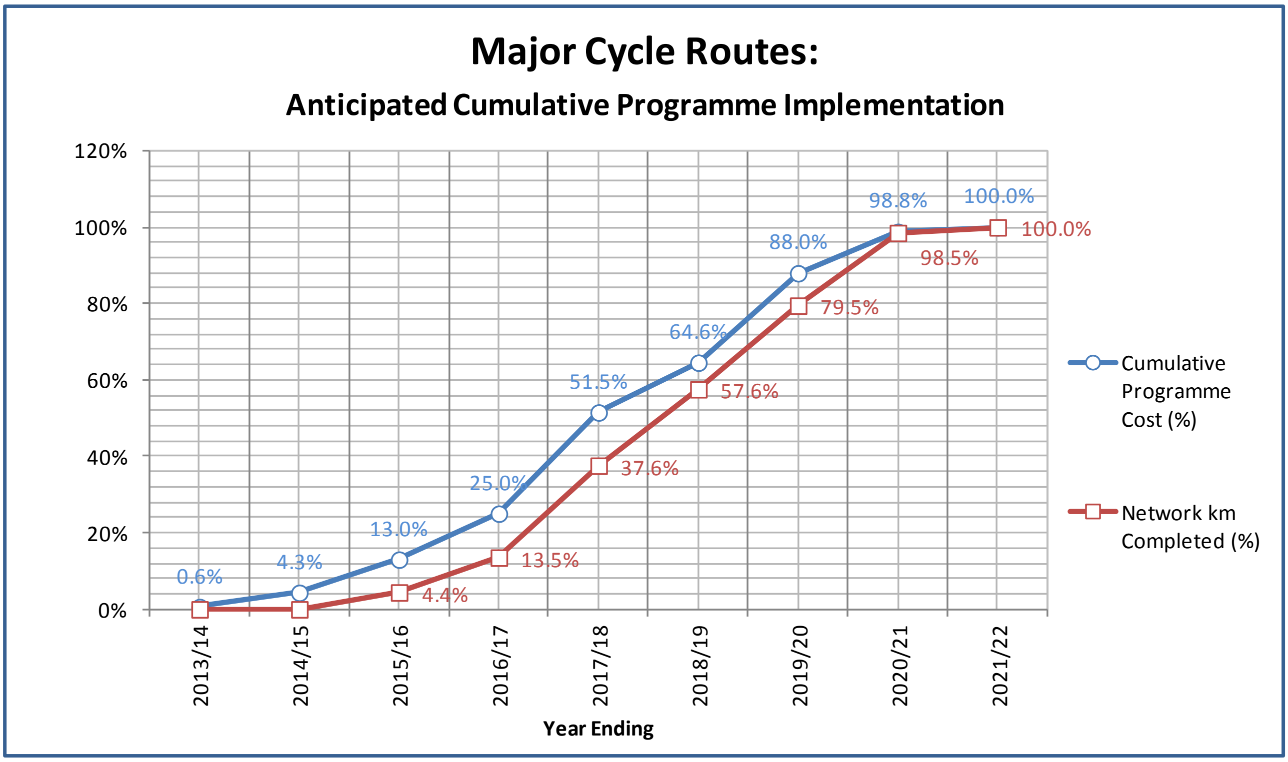
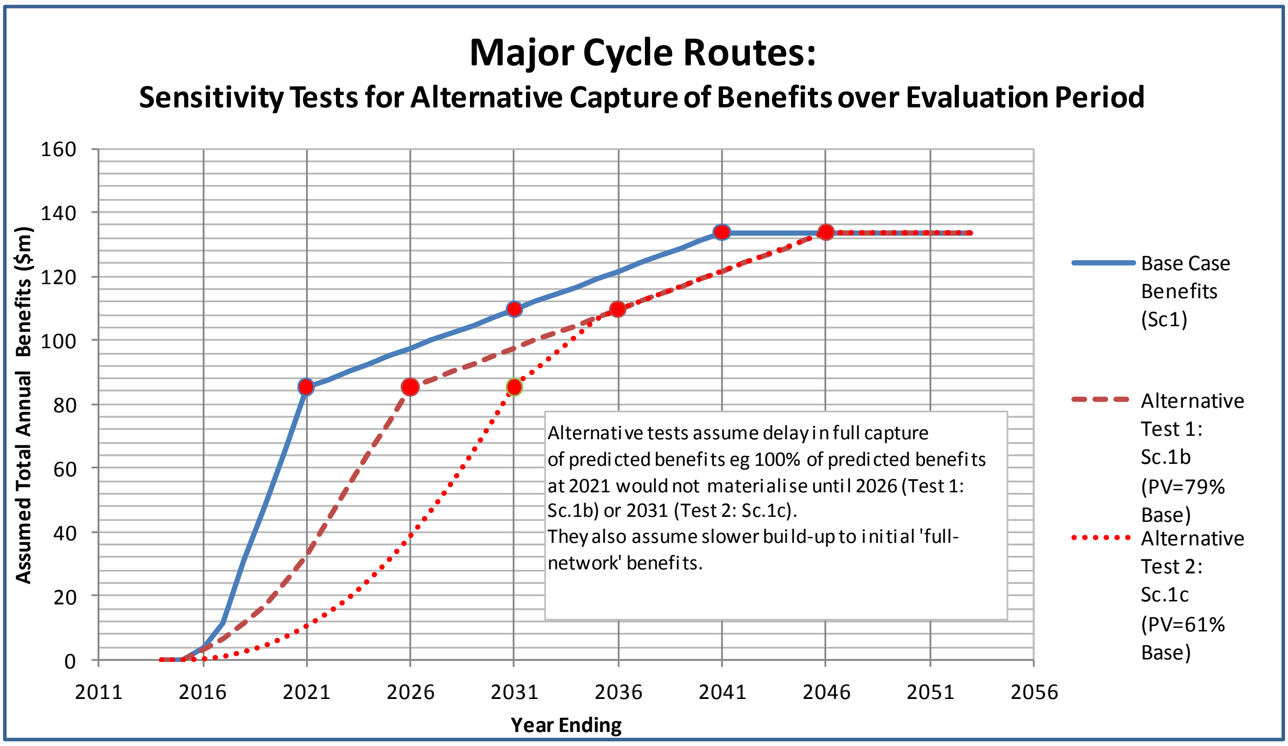


Figure H-2: Basis of Sensitivity Tests for Potential Lag in Benefit Capture



This page is intentionally blank for double-sided printing.

Appendix I – Back-Calculation of Required Benefits *(new to Update)*

This page is intentionally blank for double-sided printing.

Table I-1: Back-Calculation of Required Benefits to achieve various Benefit-Cost Ratios given updated Capital and Maintenance Cost Estimates

(Note this is a relative proportion against the benefits adopted for Test 1 shown in Figure H-1), which itself assumes potential lag in benefits behind model predictions)

End Year	Base Date 1 July 2013	SPPWF (6%)	Proportion of benefits captured	Alternative Test 1: Sc1b (PV=79% Base)	Alternative to Sc1b (Back-calculation to obtain BC=4	Alternative to Sc1b (Back-calculation to obtain BC=2	Alternative to Sc1b (Back-calculation to obtain BC=1
				Ratio of Benefits compared to Sc1b:	63.0%	31.5%	15.7%
2014	0	1.0000	0%	0.00	0.00	0.00	0.00
2015	1	0.9434	0%	0.00	0.00	0.00	0.00
2016	2	0.8900	5%	3.06	1.93	0.96	0.48
2017	3	0.8396	15%	6.36	4.00	2.00	1.00
2018	4	0.7921	40%	11.56	7.27	3.64	1.82
2019	5	0.7473	60%	17.11	10.77	5.39	2.69
2020	6	0.7050	80%	24.80	15.61	7.81	3.90
2021	7	0.6651	100%	32.98	20.76	10.38	5.19
2022	8	0.6274	100%	43.52	27.40	13.70	6.85
2023	9	0.5919	100%	54.68	34.42	17.21	8.61
2024	10	0.5584	100%	64.42	40.55	20.28	10.14
2025	11	0.5268	100%	74.65	46.99	23.50	11.75
2026	12	0.4970	100%	**85.36**	**53.74**	**26.87**	**13.43**
2027	13	0.4688	100%	87.78	55.26	27.63	13.81
2028	14	0.4423	100%	90.19	56.78	28.39	14.19
2029	15	0.4173	100%	92.61	58.30	29.15	14.57
2030	16	0.3936	100%	95.03	59.82	29.91	14.96
2031	17	0.3714	100%	97.44	61.34	30.67	15.34
2032	18	0.3503	100%	99.86	62.86	31.43	15.72
2033	19	0.3305	100%	102.28	64.38	32.19	16.10
2034	20	0.3118	100%	104.69	65.91	32.95	16.48
2035	21	0.2942	100%	107.11	67.43	33.71	16.86
2036	22	0.2775	100%	**109.53**	**68.95**	**34.47**	**17.24**
2037	23	0.2618	100%	111.94	70.46	35.23	17.62
2038	24	0.2470	100%	114.35	71.98	35.99	18.00
2039	25	0.2330	100%	116.76	73.50	36.75	18.37
2040	26	0.2198	100%	119.17	75.02	37.51	18.75
2041	27	0.2074	100%	121.58	76.53	38.27	19.13
2042	28	0.1956	100%	123.98	78.05	39.02	19.51
2043	29	0.1846	100%	126.39	79.57	39.78	19.89
2044	30	0.1741	100%	128.80	81.08	40.54	20.27
2045	31	0.1643	100%	131.21	82.60	41.30	20.65
2046	32	0.1550	100%	**133.62**	**84.12**	**42.06**	**21.03**
2047	33	0.1462	100%	133.62	84.12	42.06	21.03
2048	34	0.1379	100%	133.62	84.12	42.06	21.03
2049	35	0.1301	100%	133.62	84.12	42.06	21.03
2050	36	0.1227	100%	133.62	84.12	42.06	21.03
2051	37	0.1158	100%	133.62	84.12	42.06	21.03
2052	38	0.1092	100%	133.62	84.12	42.06	21.03
2053	39	0.1031	100%	133.62	84.12	42.06	21.03
Undiscounted Total Benefits				3568.19	2246.21	707.00	111.27
Present Value Total Benefits				967.44	609.01	304.51	152.25
Benefit-Cost Ratio (PV Costs =$152.25m				**6.4**	**4.0**	**2.0**	**1.0**

This page is intentionally blank for double-sided printing.

Appendix J – Collated Responses to Preliminary Assessment Peer Review Comments (new to Update)

This page is intentionally blank for double-sided printing.

CCC commissioned an independent Peer Review of the Preliminary Funding Assessment Report prepared by QTP in June 2014 from Flow Transportation Specialists Ltd (Flow). While supportive of the majority of the analysis, Flow made a number of recommendations and comments, each of which we have collated and provided a response to below, for ease of reference:

***Peer Review Comments (Executive Summary)*:**

(i) A sensitivity test should be undertaken assuming a slower rate of completion of the series of projects, and a slower still rate of increase in cycling (ie a lag in achieving full benefits)

> Analyst's Response: The anticipated completion schedule adopted in this Update has been prepared by CCC's project team – and takes account not only on anticipated resources but also the revised budget estimates. We have adopted their 'delayed completion' dates for each stage – which generally fall 2 months after the actual programmed date. We have now also conducted and reported 2 sensitivity tests within this Update that may reflect ta slower rate of increase in cycling than that actually modelled (ie a lag in achieving full benefits).

(ii) Consideration should be given to using a more conservative assumption to derive annual average daily demands from weekday demands during school term times

> Analyst's Response: We are comfortable that the combined factors adopted (0.827 to factor term-time weekday to AADT and 365 days in each year) represent an reasonable and appropriate means of annualisation: The 0.827 Factor is based upon analysis of all data within the CPMPG (365 days): In our view use of these factors will not therefore represent an overestimate of benefits. We do accept that the surveys on which the CNRPG factors are based do not differentiate by different types of cycle activity, there being only a generic split between 'commuting' routes and 'general' route types. The surveys and therefore derived factors for both of these types will therefore include some elements of recreational and non-recreational (including commuting and education) cycle activity, rather than purely the latter.

(iii) Consideration should be given to a few points raised in this review, concerning the derivation of decongestion benefits

> Analyst's Response: See further comments below

(iv) Consideration should be given to including maintenance costs

> Analyst's Response: See These have now been included – see pars 3.3.15-3.3.16

(v) Consideration should be given to the potential effects of various impediments to cycling, beyond the major cycleway routes, which could dampen down the predicted increases in the demand for cycling. This could be achieved simply by back calculating the increase in cycling needed for the cycleway routes still to be justified economically, noting that they are still likely to be justified under other funding criteria.

> Analyst's Response: Calculation of a broad proxy to demand needed (benefits required) has now been included (in addition to the potential 'benefit-lag' tests noted above) – See paras 6.2.19-6.2.21. Even with a 5 year lag in benefit capture, BC ratio of 4 would still be achieved even if benefits were 37% lower than anticipated. Benefits would have to be only 15% of those actually predicted for a positive benefit cost ratio (above 1.0) *not* to be achieved.

Peer Review Comment (section 2.2):

"Full completion of the projects is unlikely to coincide with 100% of the benefits of the projects being realised. A sensitivity test should be undertaken in order to understand the effect that a lag in the benefit stream would have on the BCR."

Analyst's Response: As noted above, 2 sensitivity tests have now been reported, which reflect lags in the benefit stream (compared to that predicted) – e.g. See Figure H-2. These reduce the central scenario BC from 8.0 to 6.4 (Test 1 – 5 year initial lag) or 4.9 (Test 2 – 10 year initial lag).

Peer Review Comment (section 2.3.2):

"Whilst the absolute increase cyclist numbers is large, it is not considered exceptional as the cyclist demand is predicted to increase in a large part due to population increases."

Analyst's response: We concur with this comment. Table 1 of the Review noted the omission of the residential population at 2006 (which was only included in our Background Report provided rather than the Preliminary Funding Assessment. This figure is 414,400.

Peer Review Comment (Section 2.3.3):

"A sensitivity test should be undertaken with a more conservative annual cycle demand"

The cycle demand spreadsheet sets out the procedure used to derive the annual number of cyclists from the weekday daily number of cyclists. The factor applied are:

- A factor of 0.827 to get from an average weekday in term-time to a 7-day annual average; and
- 365 days in the year

These assumptions may lead to overestimates in the case of cyclist demand estimation, as educational and work related trips form significant proportions of the weekday cycle numbers, and there are likely to be significantly lower numbers at weekends. On the other hand, while there are greater numbers of recreational cyclists at weekends, these trips are specifically excluded from the analysis. As an alternative, the weekday daily trips could be used and multiplied by 245 days of the year, representing the number of "normal" weekdays in the year. Applying this to the spreadsheets provided results in a BCR of 13.1 rather than 15.1. However, we accept that this is overly conservative, as it assumes that there are no cyclists on the weekends."

Analyst's response: We are comfortable that the combined factors adopted for our analysis represent a reasonable and appropriate means of annualisation, based as they are on analysis of all data within the CNRPG. (This spreadsheet will be provided to the Peer Reviewer). In our view use of these factors will *not* therefore represent an overestimate of benefits. We do accept that the surveys on which the CNRPG factors are based do not differentiate by different types of cycle activity, there being only a generic split between 'commuting' routes and 'general' route types. The surveys and therefore derived factors for both of these types will therefore naturally include some elements of recreational and non-recreational (including commuting and education) cycle activity, rather than purely the latter. However, the broad test conducted by the Peer Reviewer (which implies benefits could be reduced by (at most) -13% with a conservative (weekday benefits only) will still be applicable to the updated analysis – which might imply that such a conservative approach could result in a reduction in the Updated Base Scenario BCR from 8.0 to 7.0.

Peer Review Comment (Section 2.3.4):

"It is acknowledged that the model was developed with the information current at the time. However, given the significant changes in Christchurch following the recent earthquakes, it may be prudent to consider whether there are any significant long term effects that need to be accounted for."

Analyst's response: As noted by the Reviewer, we have not considered it appropriate to place significant emphasis on the 2013 Census commuting patterns and specifically those for cycle commuters. While we note that the overall level of cycling is indeed similar to the previous (pre-earthquake) 2006 Census, our principal reason for not seeking to 'recalibrate' the models to 2013 is the fact that the key destination (for commuting cyclists) which had been most significantly affected at the time of the 2013 Census was the Central City. However by around 2021 the Central City is anticipated to have returned to a similar level of (land use and transport demand) activity to that before the earthquakes. Of course, the relationships calibrated for 2006[38] are in any event applied to relevant future year expected land use variables, for prediction years of 2021, 2031 and 2041. In short we consider that the modelling approach adopted justifiably ignores short-term post-earthquake effects (albeit that post-earthquake and future anticipated shifts in population and jobs are accounted for) - but appropriately concentrates on predicting effects using methods appropriate for the longer term.

Peer Review Comment (Section 2.4):

"Consideration should be given to the significance of the above issues on the predicted decongestion effects."

Analyst's response: The issues referred to by the Peer Reviewer included the following:

Effect of '75%' assumption. The Reviewer has very slightly misinterpreted what this proportion relates to, stating that "It is assumed that 75% of vehicle trips by potential cycle users would be made by car in the Do-Minimum. This results in each new cycle trip being assumed to avoid approximately 0.6 to 0.65 potential car trips"

In fact for the Do-Minimum cycle numbers, 75% of the *person* trips that are modelled to take place by cycle are, in the absence of that mode, assumed to be made by car (at occupancy rates similar to current CTM light vehicle trips). If a cycle was not used then the balance of trips may be made by other modes (e.g. bus or walk), or not made at all – but the effects of these trips is not accounted for (in calculating potential decongestion benefits). We consider this to (likely) be a reasonable assumption. However, were the proportion to be only be, say for example, 50%, then the decongestion benefits may be reduced in proportion (being 2/3 of those assessed) – albeit ignoring the fact that we have not sought to allow for additional congestion value. A 1/3 reduction in decongestion benefit would change the Base Scenario BCR from 8.0 to 7.3.

[38] In fact the 2001 Census data was actually used to calibrate commutiing JTW relationshiops with this being validated (for distribution) using 2006 Census data.

Basis of Change in Car Demand

"One issue that should be clarified is how the change in car demands is modelled. We understand that the car trips have been added to the Do Minimum vehicle matrices, wheras it may be that the vehicle trips should have been removed from the Do Minimum. This should be clarified as in a congested network,. removing rather than adding vehicle trips may lead to smaller decongestion effects"

We do agree removing rather than adding vehicle trips may tend to lead to smaller decongestion effects. We also agree that it may appear more logical to 'remove' vehicle trips that are catered for by cycle (in the absence of that mode). However, we had considered both approaches and came to the conclusion the method adopted (addition) is indeed appropriate. This is because we are interested in the potential *net* effects (of attracting new users to cycling or more specifically when it comes to decongestion –supporting fewer car trips (and vehicle-km) through investment in cycling. This need to determine the net effects requires us to assess the performance of the road network (and its influence on all vehicle users) for both 'Do-minimum' and 'Do-Something (in this case, additional cycle investment'. If we were to pursue the 'subtraction' approach, the number of vehicle (trips) avoided by cycling would have to be removed from both Do-minimum and Do-Something networks – meaning that such a model scenario there would be fewer vehicle trips than we know that there actually is (from our calibrated base year model) or predict to be (in the case of the future Do-Minimum). Thus (applying to the present day as a more simple way of envisaging it) with a 'subtraction' approach both 'with-cycling' and 'no-cycling' scenarios would not be correctly represented – and therefore neither would be the potential difference in costs for road users. Between the two cases (which would differ for Do-Minimum and Do-Something scenarios). In contrast, by adopting an 'addition' approach to the Do-Minimum (i.e. what would be the road user cost in the absence of cycling as a mode), we correctly reflect the base case vehicle network performance (ie how many vehicles are observed on the roads and their level of congestion)

Effect on Cars

"A further matter relates to the effects of cars on cyclists and vice versa. We understand that delays likely to be incurred by cyclists, for example at intersections, are reflected in the cycle model, based on outputs from CAST. However, the effects on motorised vehicles of having more cyclists has, to our knowledge, not been taken into account. It is difficult to estimate the significance of this issue, which would occur where cyclists cross roads, or on sections of road the cycle network does not extend"

We agree with the Peer Reviewer that it is indeed difficult to assess the significance of this issue – although we consider it likely to be fairly low (i.e. not highly significant – given the (lack of) sensitivity noted above to a potential 1/3 reduction in decongestion benefits): The Reviewer is however correct in that delays incurred by cyclists are accounted for but that effects on motor vehicles of having more cyclists have not been (except for our sensitivity test that does account for potential additional safety costs for other road users including motor vehicles). In many cases, more cyclists may not have any effect on other road users (for example queuing in their own dedicated space or crossing in give-way situations via central refuges where safe to do so...as this minimises delays to both cyclists and other road users. However, it is acknowledged that there will indeed be some situations where, for example, new traffic signals or slightly changed phase timings at existing signals may be required. These could lead to some additional delays for motor vehicles, as could more vehicular (cycle) traffic at priority intersections.

Peer Review Comment (Section 2.6):

"The increase in cyclists combined with the increase in cycle trip length is a key prediction that influences the overall benefit. The predicted average cycle trip length is reasonable and is not exceptional or reason for concern. However, we wonder if the road reduction factor suggests that there is a small level of double counting with the decongestion benefits."

Analyst's response: We concur that the predicted average cycle trip length (increase) appear reasonable (given the integrated network proposed). Our understanding is that the $0.10c/km (in $2008) allowance within the EEM for 'road traffic reduction' is somewhat of a misnomer and relates to an allowance for the environmental benefits associated with road traffic reduction ()which we have not otherwise allowed for). Whilst we acknowledge that if our impression is not correct there is the possibility of some 'double-counting', in the context of the actual decongestion values (which equate to between $0.60 and $1.10 ($2010) any double-counting would form a small % and in any event is likely to be vastly outweighed by the conservative approach to other areas (i.e. no use of additional congested time values).

Peer Review Comment (Section 3.1.1):

"The report acknowledges that the costs are relatively preliminary in nature. This has been covered with a sensitivity test whereby the capital costs of the MCR projects have been doubled."

Analyst's response: Following further design and planning, this update incorporates the latest estimates for both the MCR projects as well as the AAC and CCP projects. Overall the (undiscounted) total capital costs for these elements of the upgraded cycle network have now risen to $189m with a further $9m of additional maintenance costs anticipated over a 40 year assessment period. When discounted to the present day, the total costs have indeed nearly doubled, from $81.3m in the Preliminary Assessment to $152.1m (the latter including net maintenance which comprises $2.9m or 1.9% of the total).

Peer Review Comment (Section 3.1.2):

"Consideration should be given to allowing an estimate of maintenance costs for the cycle network in the Scenarios 1 and 2 if these are now known or can be determined."

Analyst's response: As suggested, the net maintenance costs have now been incorporated in this updated analysis.

Peer Review Comment (Section 3.1.3):

"Correct the reported discounting of benefit sources for Scenario 2 in Table F2. This has no effect on the BCR of Scenario 2."

Analyst's response: The reporting mistake has been corrected in the updated Table F2

This page is intentionally blank for double-sided printing.

Appendix K – Preliminary Peer Review (Flow Transportation Consultants)

This page is intentionally blank for double-sided printing.

flow
TRANSPORTATION SPECIALISTS

Christchurch Major Cycleway Routes

Economic Assessment Peer Review

September 2014

flow TRANSPORTATION SPECIALISTS LTD
Level 1, 11 Blake Street, Ponsonby, Auckland | PO Box 47497 Ponsonby 1144 | p 09 970 3820 | f 09 970 3890 | www.flownz.com

flow
TRANSPORTATION SPECIALISTS

Project:	**Christchurch Major Cycleway Routes**
Title:	**Economic Assessment Peer Review**
Document Reference:	**S:\cccx\005\R1B140929.docx**
Prepared by:	**Harry Ormiston, Ian Clark**
Reviewed by:	**Ian Clark**

Revisions:

Date	**Status**	**Reference**	**Approved by**	**Initials**
5 September 2014	A	R1A140705	I Clark	
29 September 2014	B	R1B140929	I Clark	

EXECUTIVE SUMMARY

Christchurch City Council has engaged Flow Transportation Specialists to undertake a peer review of the economic assessment completed by Quality Transport Planning (QTP) for the proposed Christchurch Major Cycleway Routes (MCR).

The review includes the economic assessment contained within QTP's Christchurch Major Cycleway Routes Preliminary Funding Assessment dated June 2014. Predicting cycle demand is an inexact science and the report notes the budgetary constraints which governed the study, which may have limited the ability to justify all important assumptions and provide significant validation. However, the study provides clear cross referencing to the origins of several assumptions, and it states elsewhere where certain assumptions have not been fully supported by evidence, leading to sensitivity tests.

The study predicts that the cycleway routes can be justified by a high Benefit Cost Ratio (BCR) of around 15, using base assumptions. This is primarily due to the predicted health/environment and decongestion benefits, which in turn depend to a significant degree on the predicted increase in cycling as a result of the Project. The conclusion of a healthy BCR has then been supported by a series of sensitivity tests.

While supportive of the majority of the analysis, we recommend the following:

- A sensitivity test should be undertaken assuming a slower rate of completion of the series of projects, and a slower still rate of increase in cycling (ie a lag in achieving full benefits)
- Consideration should be given to using a more conservative assumption to derive annual average daily demands from weekday demands during school term times
- Consideration should be given to a few points raised in this review, concerning the derivation of decongestion benefits
- Consideration should be given to including maintenance costs
- Consideration should be given to the potential effects of various impediments to cycling, beyond the major cycleway routes, which could dampen down the predicted increases in the demand for cycling. This could be achieved simply by back calculating the increase in cycling needed for the cycleway routes still to be justified economically, noting that they are still likely to be justified under other funding criteria.

CONTENTS

1 INTRODUCTION

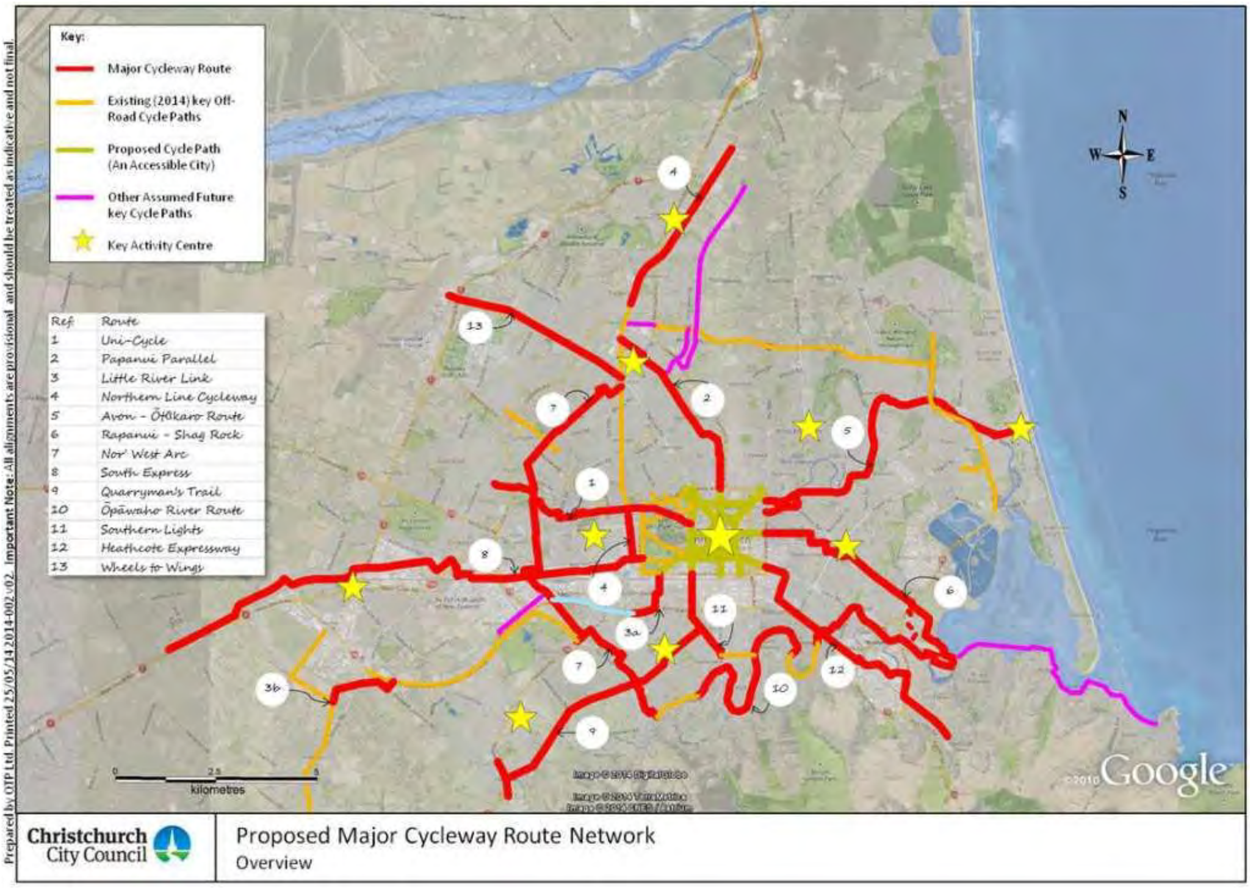
Christchurch City Council (CCC) has engaged Flow Transportation Specialists (Flow) to undertake a peer review of the economic assessment completed by Quality Transport Planning (QTP) for the proposed Christchurch Major Cycleway Routes (MCR).

The review includes the economic assessment contained within QTP's Christchurch Major Cycleway Routes Preliminary Funding Assessment dated June 2014.

1.1 Project Summary

Christchurch City Council engaged QTP to quantify the potential use and benefits of CCC's proposed MCR programme. The MCR programme incorporates 13 segregated off-road cycle paths of between 3 km and 14 km in length, as shown in Figure 1 below.

Figure 1: MCR Assumed Future Cycle Network (Full Network)



In addition, two other major projects have been included as additional to the MCR programme. These are the "An Accessible City" (ACC) cycle path projects within the City Centre (shown as yellow in Figure 1 above) and the Christchurch Coastal Pathway (CCP) between Ferrymead Bridge and Sumner (shown as one of the sections of pink in the figure above).

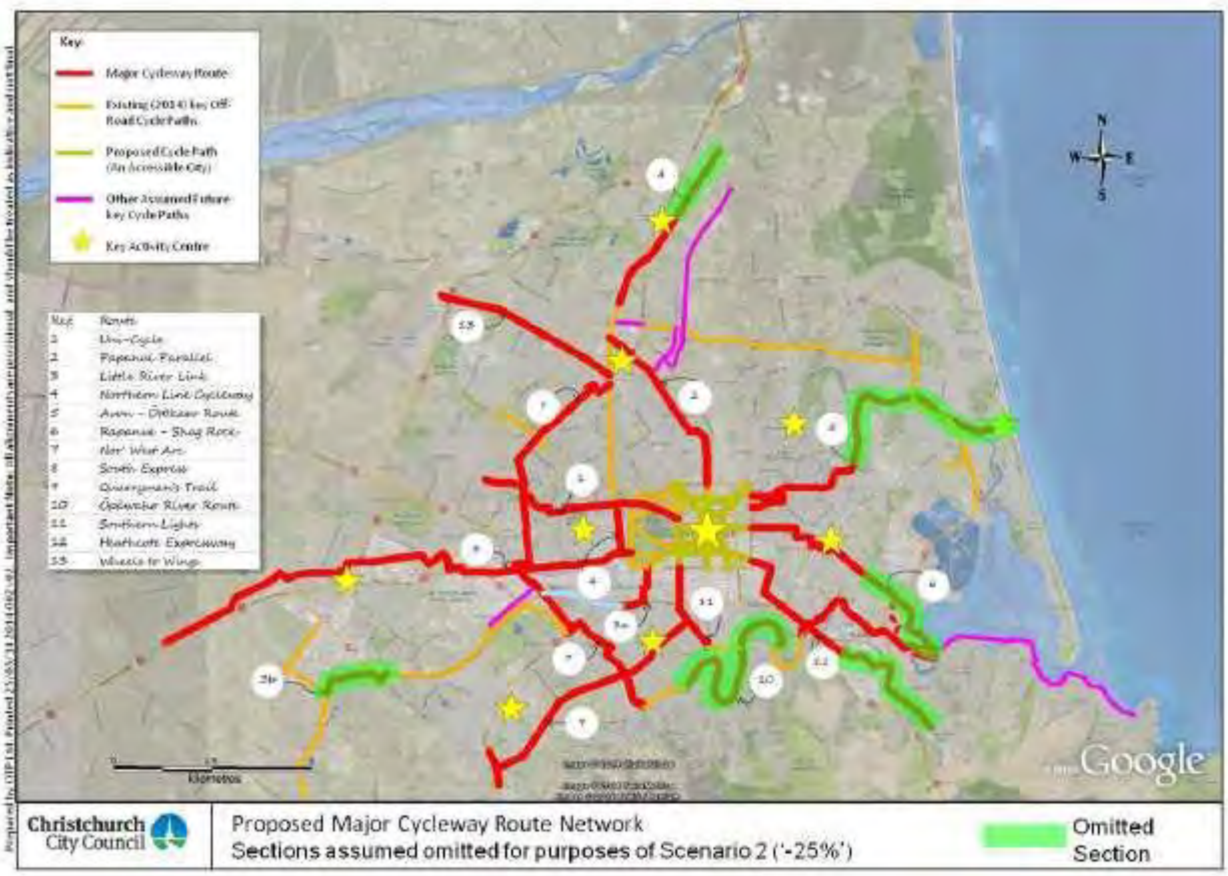
The network alignments are principally those shown in CCC's Priority Cycle Project plan (April 2013) with some amendments made since this report by Council. As discussed in the QTP report, the path alignments shown below are not final and may be subject to change until finalised by Council and other relevant agencies.

The principal tool used for the assessment is the Christchurch Strategic Cycle Model (CSCM). This model was first developed by QTP for CCC in 2012 and has been updated more recently for the purpose of this assessment.

Two scenarios have been compared against a Do Minimum scenario. These are as follows:

- Scenario 1 includes the full length of the current MCR network for segregated off-road cycle paths (as shown in Figure 1 above), including ACC and CCP routes
- Scenario 2, as Scenario 1 above but with approximately 25% reduction in length of the proposed MCR network (as shown in Figure 2 below) , including ACC and CCP routes.

Figure 2: MCR Assumed Future Cycle Network - Scenario 2



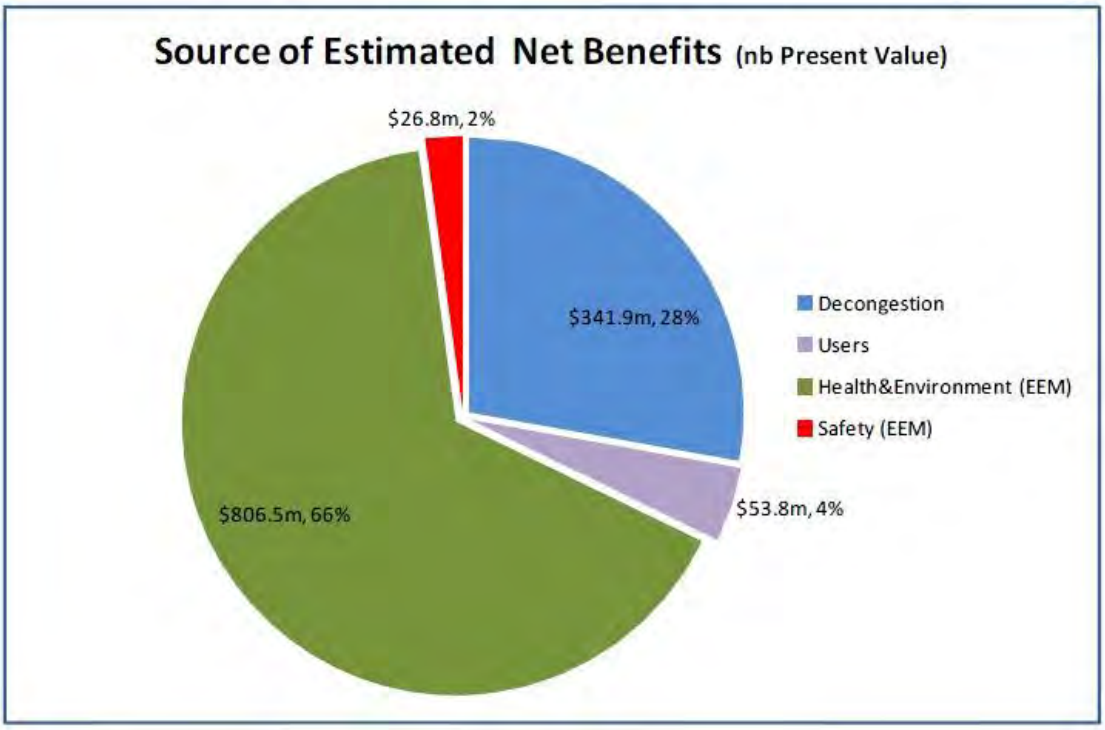
The two scenarios have been compared against a Do Minimum scenario. All three scenarios include an assumed 40% increase in fuel costs and a 30% "trader" factor. Essentially the only difference between the scenarios is the cycle network.

2 PROJECT BENEFITS

2.1 Overview

The predicted benefits of the projects (MCR and AAC and CCP projects) are very high, at some $1.2 billion over a period of 40 years. The report shows graphically the breakdown of the estimated benefits. This is reproduced in Figure 3 below.

Figure 3: Scenario 1 Benefit Sources



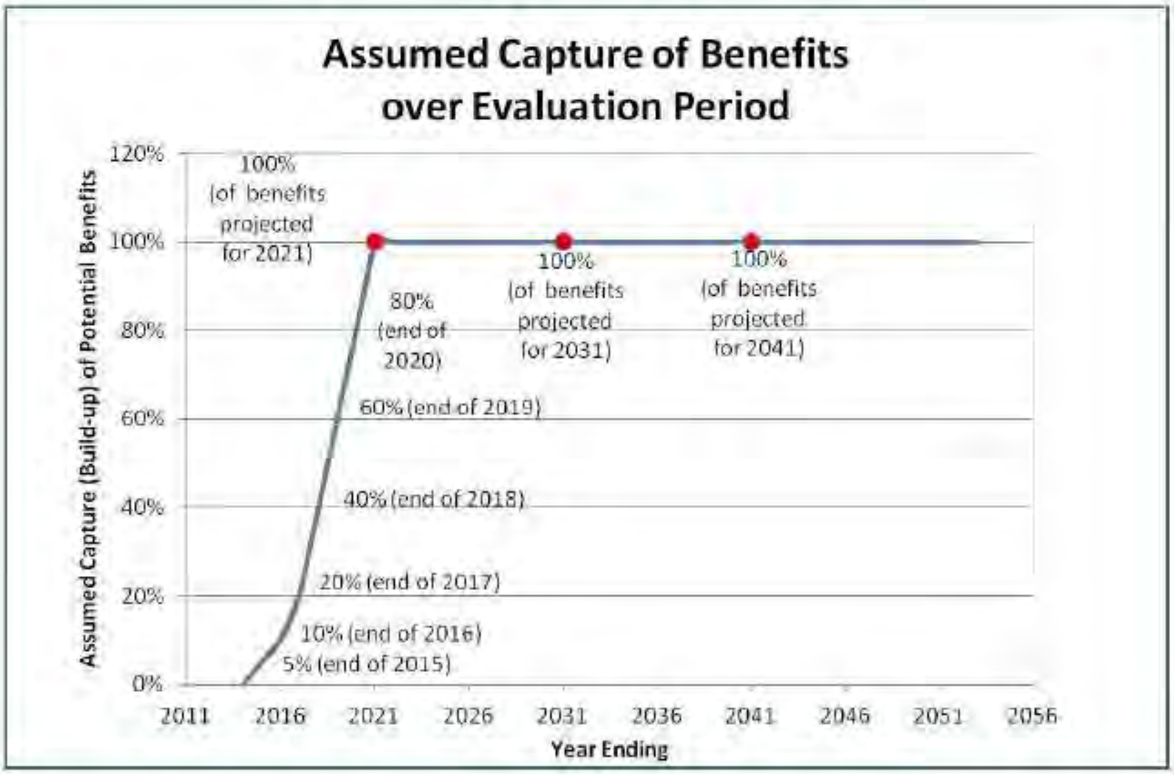
The predicted benefits of the projects are mainly due to Health and Environment (66%), and decongestion benefits (28%). We have therefore focused mainly on how these two benefit streams were derived and how the forecast cycle demand (which drives these benefits) is found.

2.2 Benefit Stream

It has been assumed that projects are all completed by 2021, based on the CCC's provisional construction programme.

The benefits from the projects have not been analysed by individual projects, or for partial completion of projects. Rather, the total benefits have been assumed to be captured on a proportional basis through the years to 2021. Figure 4 below shows the assumed capture of benefits over the evaluation period, as shown in the report.

Figure 4: Assumed Capture of Benefits over the Evaluation Period



Whilst the capital cost investment programme is reasonably specific, the assumed benefit stream is not. However, it is considered that estimating on a proportional basis is fair, as any further analysis on partial completion of projects (etc) would involve unnecessary detail, and therefore time and cost, in the overall assessment, for potentially little greater accuracy in the final result.

We do however believe that the full completion of the projects may not coincide with the full benefits of the projects. That is to say, there is likely to be some lag between the implementation of the projects and 100% of the benefits being realised. Sensitivity tests should be undertaken in order to understand the effect on the BCR, ie with capital expenditure undertaken and benefits lagging behind.

Comment: *Full completion of the projects is unlikely to coincide with 100% of the benefits of the projects being realised. A sensitivity test should be undertaken in order to understand the effect that a lag in the benefit stream would have on the BCR.*

2.3 Cycle Demand

2.3.1 Base Demands

As noted above, a large proportion of the benefits is based on the predicted increase in cycling, and the resulting health/environment and decongestion benefits. These demands have been derived from the Christchurch Strategic Cycle Model (CSCM), in conjunction with the Christchurch Assignment and Simulation Traffic (CAST) model. The CAST model is a SATURN model covering the Greater Christchurch area.

We have not undertaken a full review of the CSCM. However, we have been supplied the background reports associated with the model development in August 2012[1].

The reporting makes several references to the budget limitations that governed the model development and testing. The report sets out the methodology used to derive base predictions for cycling in Christchurch in 2006, by each cycle type:

- Home based work trips
- Home based education trips, by different age group
- Home based remainder trips
- Non home based trips.

The reporting gives detail of the data drawn on in deriving trip predictions by each type, and it notes several "sensibility checks" that were undertaken along the way. For example, it notes a Christchurch based survey which appeared to lead to an unrealistically high prediction of primary school cycle trips, and it adopted a lower, more realistic value.

While the assumptions for each cycle trip type seemed reasonable, it led to an overestimate of the total quantum of cycling, when the base "predictions" were compared against a number of counts (noting that the amount of cycle count data was fairly limited). This led to the use of a downward correction factor. It is important to note that the forecasts retain the use of this correction factor.

Checks were also made against research on cycle trips lengths, indicating a good correlation.

2.3.2 Forecast Demands

Table 1 below shows a comparison of forecast population and daily cycle trips and represents information contained within Appendix E of the QTP report.

Table 1: Comparison of Forecast Population and Daily Cycle Trips

Forecast Year	Residents	Do Minimum		Scenario 1	
		Weekday Cyclist Trips	Mode Share	Weekday Cyclist Trips	Mode Share
2006	[2]	50,339	-	[3]	-
2021	445,501	57,944	2.4%	75,757	3.2%
2031	500,715	64,513	2.5%	85,939	3.4%
2041	548,155	70,052	2.6%	94,541	3.5%

[1] Christchurch Strategic Cycle Model Background report (QTP, August 2012)
[2] Information not provided, to our knowledge
[3] Same as Do Minimum as Scenario 1 was not in place in 2006

The population increase between 2021 and 2041 is predicted to be around 23%, while the daily cycle demand forecast is to increase by some 21% in the Do Minimum and 25% in Scenario 1. It can be seen that the cyclist demand is predicted to increase in a large part due to population increases, with assumed fuel price rises and increased congestion therefore predicted to have fairly modest effects.

Scenario 1 predicts an increase in the number of cyclists and an increase in the mode share. This mode share is still not particularly high and can be considered reasonable.

Comment: *Whilst the absolute increase cyclist numbers is large, it is not considered exceptional as the cyclist demand is predicted to increase in a large part due to population increases.*

2.3.3 Annualisation

The cycle demand spreadsheet sets out the procedure used to arrive the annual number of cyclists from the weekday daily number of cyclists. The factor factors applied are:

- A factor of 0.827 to get from an average weekday in term-time to a 7-day annual average
- 365 days in the year

These assumptions may lead to overestimates in the case of cyclist demand estimation, as educational and work related trips form significant proportions of the weekday cycle numbers, and there are likely to be significantly lower numbers at weekends. On the other hand, while there are greater numbers of recreational cyclists at weekends, these trips are specifically excluded from the analysis.

As an alternative, the weekday daily trips could be used and multiplied by 245 days of the year, representing the number of “normal” weekdays in the year. Appling this to the spreadsheets provided results in a BCR of 13.1 rather than 15.1. However, we accept that this is overly conservative, as it assumes that there are no cyclists on the weekends.

Comment: *A sensitivity test should be undertaken with a more conservative annual cycle demand.*

2.3.4 2013 Census Data

The CSCM is based on 2006 and 2001 census data (calibrated to 2001 data and validated against the 2006 data). The model was originally developed in 2012 and the 2001 and 2006 data was therefore the current information that was available at that time. However, since the model development, the 2013 census data has been released.

Given the significant changes in Christchurch following the earthquakes it may be prudent to compare the home to work trip census data for 2013 against the information previously used in the development of the model. From our discussions with the author, we understand some broad comparisons have been made, and the report refers to the changes following a number of recent school closures. We understood, anecdotally that the upheaval to homes and workplaces may have led to some trips being less accessible for cycling than was previously the case, although we have received information from QTP which suggests that cycle activities overall have remained fairly constant according to the 2013 census. In any case, it may be that any earthquake related effects on cycling may be a short to medium term issue, when viewed at the macro scale, in which case the current 2021 forecasts may still be valid.

Comment: *It is acknowledged that the model was developed with the information current at the time. However, given the significant changes in Christchurch following the recent earthquakes, it may be prudent to consider whether there are any significant long term effects that need to be accounted for.*

2.3.5 Scenario 1

The changes in demands as a result of the projects included in Scenario 1 are based on the assumption of a 30% "trader factor". However, it is important to note that this factor has not been applied to all trips across the modelled area, but only to those trips in which the origins and destinations are within the area of influence of one or more of the cycle projects. In that case, the attractiveness of cycling will have been improved for those trips, in the mode split model.

2.3.6 Scenario 2

The 25% reduction associated with Scenario 2 is an assumption that has been made with the regard to the network included in this test. Discussions with the author indicate that the sections removed were the 'worst performing' routes in terms of predicted cyclist demand. The reasoning behind this is that these are the schemes that would be most likely to be cut from budgets as they have the lowest predicted returns.

The alternative to this approach would be that the routes that pose the most difficulties in terms of construction may be the routes that are not progressed, ie the routes that offer the easier wins could possibly be put in place first. However, for the purposes of this scenario and sensitivity testing the assumption adopted is reasonable.

2.3.7 Canterbury Regional Land Transport Strategy 2012 - 2042

Canterbury Regional Land Transport Strategy 2012 – 2042 (RLTS) is the strategy document prepared by the Canterbury Regional Transport Committee (February 2012). Whilst it is an aspirational document, it shows targets that the RLTS seeks to be achieved over the next 30 years. With regard to cycling the RLTS seeks to:

> *Increase the relative amount of total travel time that Christchurch City residents spend travelling by active means to 100 hours per person per year by 2024 and to 150 hours per person by 2042*

This compares with the baseline in 2009/10 when travel by active modes was around 70 hours per person per year.

Effectively this indicates a more than doubling of hours of active travel. Obviously there are other means of active travel, for instance walking, however the quantum of the increase is important. The preliminary funding assessment for the MCR predicts around 90% increase in daily cycle trips between the 2006 base and 2041 with the full cycle network in place (page 19 of the QTP report). It is reassuring to see that this increase is broadly in line with that sought by the RLTS.

Further to the above, other targets include environmental targets relating to CO_2 emissions. This seeks to return the regions' transport related CO_2 emissions to 1998 levels. Whilst personal car travel is only a part of the overall transport related emissions, cycling trips rather car based trips will help to achieve this target particularly on the scale predicted.

Comment: *While the predicted increases in cycling appear to be broadly in line with the aspirations of the RLTS, the RLTS figures presumably are a result of other initiatives, in addition to the provision of the cycle network. This issue is considered further in Section 4 below.*

2.4 Decongestion Benefits

The predicted daily cycle trips have been used to derive predicted changes in vehicle trips. The differences between a scenario with these additional vehicles on the road network and without (ie if cyclists using the cycle network) have been compared. The differences in travel times and vehicle operating costs have been compared in order to understand the estimated reductions in congestion costs.

A number of assumptions have been applied in order to arrive at the number of vehicles predicted to be taken off the roads. These include:

- Vehicle occupancy – assumed to be similar to the current CTM light vehicle trips, which is reasonable
- It is assumed that 75% of vehicle trips by potential cycle users would be made by car in the Do Minimum. This results in each new cycle trip being assumed to avoid approximately 0.6 to 0.65 potential car trips
- When calculating the dollar value of benefits, the standard value of time for an 'Urban Other' road has been applied
- Congestion relief value has not been used and it may be considered that this is conservative.

The above assumptions do not seem unreasonable. However it is acknowledged in the QTP report that the 75% figure (of vehicle trips being potential cycle users) is just an assumption. It would be good to understand if this is realistic and/or the effect on this assumption on the decongestion benefits. On the one hand it seems a bit high, in that some cycle trips may transfer from car passenger trips. On the other hand, some car passenger trips may still lead to a car trip being avoided. For example, if a child cycles to school, this may avoid the car trip to school and then the return parent trip back home.

One issue that should be clarified is how the change in car demands is modelled. We understand that the car trips have been added to the Do Minimum vehicle matrices, whereas it may be that the vehicle trips should have been removed from the Do Minimum. This should be clarified, as in a congested network, removing rather than adding vehicle trips may lead to smaller decongestion effects.

A further matter relates to the effects of cars on cyclists and vice versa. We understand that delays likely to be incurred by cyclists, for example at intersections, are reflected in the cycle model, based on outputs from CAST. However, the effects on motorised vehicles of having more cyclists has, to our knowledge, not been taken into account. It is difficult to estimate the significance of this issue, which would be encountered where cyclists cross roads, or on sections of road where the cycle network does not extend.

Comment:

Consideration should be given to the significance of the above issues on the predicted decongestion effects.

2.5 Health and Environmental Benefits

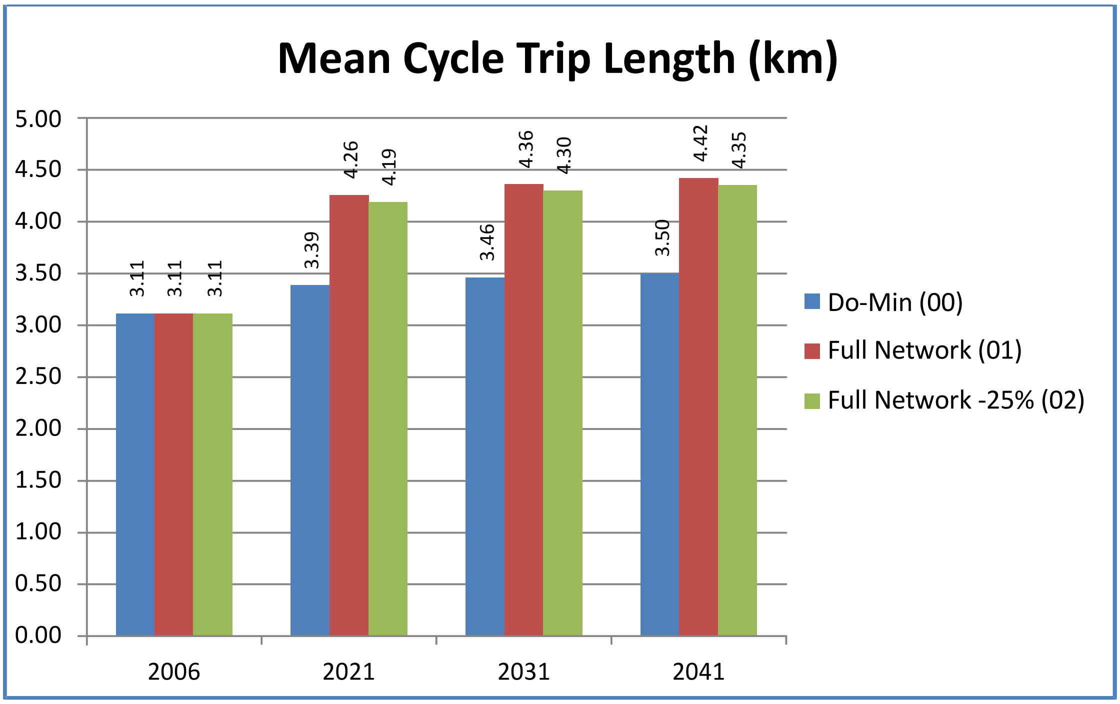
The assessment of the 'Health and Environment' benefits uses the value contained within the EEM of $1.40. This value includes $1.30 for 'health' related benefits and $0.10 for 'road traffic reduction'. It is considered appropriate to apply this to the new cyclists, although we wonder if the $0.10 road reduction factor means that the decongestion benefits include a small measure of double counting.

This is correctly applied to all **new** cyclists that use the facilities and their distances travelled, that is to say, the differences between the predicted number of new cyclist-kms for the Do Minimum and scenario rather than existing cyclist-km. The new distance travelled by each new cyclist is derived from the origin-destination cycle matrix and therefore is specific for each trip.

As mentioned in the report, the average cycle trip rises from 3.1 km (2006) to 3.5 km[4] (2031 Do Minimum) and 4.4 km (2031 with MCR projects). The spreadsheet analysis provided shows this increase graphically and this is reproduced in Figure 5 below.

4 The spreadsheet analysis shows 3.5 km rather than 3.4 km shown in the report text

Figure 5: Mean Cycle Trip Length (m)



***Comment:** The increase in cyclists combined with the increase in cycle trip length is a key prediction that influences the overall benefit. The predicted average cycle trip length is reasonable and is not exceptional or reason for concern. However, we wonder if the road reduction factor suggests that there is a small level of double counting with the decongestion benefits.*

2.6 Safety Benefits

The report outlines the safety benefits for the project which consist of the following:

- NZTA's EEM value for safety benefit of $0.05 per cycle-km
- Potential benefits in terms of general road crashes from having fewer vehicles on the road
- Benefits of having more cyclists, ie a 'safety in numbers' effect.

The EEM safety benefit value has correctly been applied to both new and existing cyclists using the new facilities.

It should be noted that the safety benefits of the projects are relatively minor in nature when compared to the other benefits derived and therefore the assumption made regarding the 'safety in numbers' effect, which may be more difficult to justify, will have only minimal impact on the total benefits.

3 PROJECT COSTS

3.1.1 Capital Costs

We have not undertaken a review of the cost estimates and these have not been provided. The QTP report acknowledges that the costs are relatively preliminary in nature.

The cost profile, prepared by CCC (May 2014), has been provided in the report. Without detailed knowledge of the construction programme or other construction projects in the region, and their priority, it is difficult to understand if this is realistic or not. However, it does seem optimistic to achieve completion of the full network of cycle schemes within 6 or 7 years in post-earthquake Christchurch.

Comment: *The report acknowledges that the costs are relatively preliminary in nature. This has been covered with a sensitivity test whereby the capital costs of the MCR projects have been doubled.*

3.1.2 Maintenance Costs

No maintenance costs have been accounted for in either the Do Minimum or scenarios. The report acknowledges that this was unable to be done at the time of writing. Whilst the net difference in maintenance cost is the key here, a reasonable cost may be regularly incurred.

We have noted in other cycle schemes that the maintenance costs can be high (as a proportion of the project) as they are equivalent to the cost of renewing line markings, cycleway symbols and greening, signs and lighting regularly over a 40 year period. Whilst these projects are segregated paths, and therefore the proportion that line markings etc represent will be smaller than on road cycle lanes, it may still be worth considering the impact of maintenance costs as part of the default scenarios rather than sensitivity tests.

Comment: *Consideration should be given to allowing an estimate of maintenance costs for the cycle network in the Scenarios 1 and 2 if these are now known or can be determined.*

3.1.3 Discounting – Timeframes

The analysis period for assessment is the 6% discount rate and the 40 year analysis period now required by the EEM. This is has been applied appropriately, with two sensitivity tests undertaken for discount rates of 4% and 8%.

The benefits have been capped at 2041 which could be considered conservative approach as cycle demands, as well as congestion, are likely to continue to rise. This assumption seems appropriate.

It appears the Table F2 Assumed Benefit Streams contained within Appendix F has the incorrect values in the benefit stream for Scenario 2. The end result is correct but the figures represented in this appendix of the report are mismatched with the actual Scenario 2 figures contained within the spreadsheets provided separately. The end calculation for Scenario 2 is unaffected by this, but it should be corrected for the reporting purposes.

Comment: *Correct the reported discounting of benefit sources for Scenario 2 in Table F2. This has no effect on the BCR of Scenario 2.*

3.1.4 Sensitivity Analysis

A number of sensitivity tests have been undertaken. This shows that the benefits are still high in all sensitivity tests, with all BCRs over 4.0 except one.

Additional sensitivity tests have been recommended through this review and are noted in the comments of each section. These should be included within this section of the updated report.

In addition, an incremental analysis has been undertaken with the results showing that Scenario 1 is the preferred scheme. No further analysis is required for this.

4 CONCLUDING COMMENTS

Section 2.3.7 above noted the consistency between the cycle demands predicted by this study and the aspirations of the RLTS. While this appears reassuring, it raises an important issue. The study assumes that the increase in cycling is entirely due to the provision of the cycleway routes, and it is necessary to consider whether there may be other impediments that may inhibit the predicted change in behaviour. These impediments could include a lack of end of trip facilities, in some cases, or there being gaps in the cycle network at one or both ends of the trips, which could leave some persons unwilling to cycle.

In saying this, it could be argued that assessments of road schemes do not include the cost of additional car parking, due to induced traffic. However, this does not appear to be a valid comparison, as the vast majority of road schemes are justified through predominantly travel time savings (ie for existing road users), whereas this package of cycleway schemes is being justified (at least for the economic analysis), primarily as a result of health benefits which relate to a significant degree to attracting new cycle trips.

It is difficult to ascertain the significance of this issue, particularly for Scenario 2, which relates to a partially completed network, and a sensible way to proceed may be to back calculate the extent of the new cycle activity that is required to still achieve a satisfactory Benefit Cost Ratio, noting that the package of cycleway projects may still be justifiable on the other funding assessment criteria.

Appendix L – Updated Peer Review (Flow Transportation Consultants)

This page is intentionally blank for double-sided printing.

flow
TRANSPORTATION SPECIALISTS

2 February 2015

Ms E. Taylor
Infrastructure Funding Manager
Asset and Network Planning
Christchurch City Council
CHRISTCHURCH

Via Email: **Emily.Taylor@ccc.govt.nz**

Dear Emily

ECONOMIC EVALUATION PEER REVIEW UPDATE - CCC MAJOR CYCLEWAYS NETWORK

Flow Transportation Specialists Limited (Flow) undertook a peer review of the economic evaluation of the Christchurch Major Cycleway Routes in September 2015[1]. Since this review, the Funding Assessment report has been updated. Flow has reviewed the updated Funding Assessment report and outlined our conclusions below.

1 INTRODUCTION

Since our peer review of the Funding Assessment report, Christchurch City Council (CCC) has continued to progress investigation of the proposed Major Cycleway Routes (MCRs), including more detailed scheme design, cost estimation and programming. The updated report incorporates:

- Updated Scheme Cost estimates
- Suggestions made in the Peer Review report relating to the Preliminary Assessment, and
- A response to other comments made in the Peer Review report.

2 UPDATES TO FUNDING ASSESSMENT REPORT

There is a substantial rise in the estimate of anticipated total MCR capital costs, from a total of around $70 million adopted for the 2014 assessment, to around $156 million following the more refined design and cost estimation conducted by CCC (and incorporation of estimated net maintenance costs). This has been carried through to all of the tests.

The Benefit Cost Ratio of the Base Scenario test has now been assessed at around 8 (compared with 15, calculated previously).

[1] Christchurch Major Cycleway Routes Economic Assessment Peer Review (R1B140929 September 2014)

Forecast cycle demand projections have not changed.

3 RESPONSE TO PEER REVIEW REPORT

The following are the recommendations and comments made by Flow and the responses from QTP as taken from Appendix J of the updated report. In addition, Flow's response as the Peer Reviewer is outlined in each case.

3.1 Peer Review Comments (Executive Summary)

3.1.1 A sensitivity test should be undertaken assuming a slower rate of completion of the series of projects, and a slower still rate of increase in cycling (ie a lag in achieving full benefits)

Analyst's Response: The anticipated completion schedule adopted in this Update has been prepared by CCC's project team – and takes account not only on anticipated resources but also the revised budget estimates. We have adopted their 'delayed completion' dates for each stage – which generally fall 2 months after the actual programmed date. We have now also conducted and reported 2 sensitivity tests within this Update that may reflect a slower rate of increase in cycling than that actually modelled (ie a lag in achieving full benefits).

Peer Reviewer's Response: The sensitivity tests assumed a lag in the benefit stream with full benefits in 2026 and 2031 rather than 2021. These result in BCRs of 6.4 or 4.9 for the two forecast years 2026 and 2031 respectively, compared with 8 for the "base test".

It is difficult to predict the uptake of cycling as a result of the MCRs, but as discussed, there is likely to be some sort of lag in the capture of benefits. The additional tests are useful as they demonstrate that the BCRs are still healthy with a 5 or 10 year lag. This adequately captures the issue, and it is likely that the true BCR may sit somewhere between 6.4 and 8 (between 0 and 5 year lag).

3.1.2 Consideration should be given to using a more conservative assumption to derive annual average daily demands from weekday demands during school term times

Analyst's Response: We are comfortable that the combined factors adopted (0.827 to factor term-time weekday to AADT and 365 days in each year) represent a reasonable and appropriate means of annualisation. The 0.827 factor is based upon analysis of all data within the CNRPG (365 days). In our view use of these factors will not therefore represent an overestimate of benefits. We do accept that the surveys on which the CNRPG factors are based do not differentiate by different types of cycle activity, there being only a generic split between 'commuting' routes and 'general' route types. The surveys and therefore derived factors for both of these types will therefore include some elements of recreational and non-recreational (including commuting and education) cycle activity, rather than purely the latter.

Peer Reviewer's Response: Flow has reviewed the information supplied with regard to the derived daily factor. The process of using count sites in Christchurch and scale factors for the day of the week from the Cycle Network and Planning Guide seems appropriate. Whilst the surveys include recreational cyclists, and the modelling does not, the effect of this on the daily factor may not be significant.

3.1.3 Consideration should be given to a few points raised in this review, concerning the derivation of decongestion benefits.

Analyst's Response: See further comments below

3.1.4 Consideration should be given to including maintenance costs

Analyst's Response: These have now been included – see pars 3.3.15 - 3.3.16

Peer Reviewer's Response: Maintenance costs are now included appropriately.

3.1.5 Consideration should be given to the potential effects of various impediments to cycling, beyond the major cycleway routes, which could dampen down the predicted increases in the demand for cycling. This could be achieved simply by back calculating the increase in cycling needed for the cycleway routes still to be justified economically, noting that they are still likely to be justified under other funding criteria.

Analyst's Response: Calculation of a broad proxy to demand needed (benefits required) has now been included (in addition to the potential 'benefit-lag' tests noted above) – See paras 6.2.19 - 6.2.21. Even with a 5 year lag in benefit capture, BC ratio of 4 would still be achieved even if benefits were 37% lower than anticipated. Benefits would have to be only 15% of those actually predicted for a positive benefit cost ratio (above 1.0) not to be achieved.

Peer Reviewer's Response: It is acknowledged that a precise back-calculation of the cycle demand required to achieve a specific result could be time consuming. The alternative used by the analyst is sufficient and shows that at one extreme if the benefits were reduced to 15 % of those calculated in the base case then a BCR of 1.0 is achieved. The conclusion that a BCR of 4 would still be achieved with a reduction in benefits of 37%, in addition to a 5 year lag, is worth noting.

3.2 Peer Review Comment (section 2.2 of the Flow report):

"Full completion of the projects is unlikely to coincide with 100% of the benefits of the projects being realised. A sensitivity test should be undertaken in order to understand the effect that a lag in the benefit stream would have on the BCR."

Analyst's Response: As noted above, two sensitivity tests have now been reported, which reflect lags in the benefit stream (compared to that predicted) – e.g. See Figure H-2. These reduce the central scenario BC from 8.0 to 6.4 (Test 1 – 5 year initial lag) or 4.9 (Test 2 – 10 year initial lag).

Peer Reviewer's Response: See response at 3.1.1 above.

3.3 Peer Review Comment (section 2.3.2):

"Whilst the absolute increase cyclist numbers is large, it is not considered exceptional as the cyclist demand is predicted to increase in a large part due to population increases."

Analyst's response: We concur with this comment. Table 1 of the Review noted the omission of the residential population at 2006 (which was only included in our Background Report provided rather than the Preliminary Funding Assessment. This figure is 414,400.

Peer Reviewer's Response: No further response required.

3.4 Peer Review Comment (Section 2.3.3):

"A sensitivity test should be undertaken with a more conservative annual cycle demand"

The cycle demand spreadsheet sets out the procedure used to derive the annual number of cyclists from the weekday daily number of cyclists. The factors applied are:

- **A factor of 0.827 to get from an average weekday in term-time to a 7-day annual average; and**
- **365 days in the year**

These assumptions may lead to overestimates in the case of cyclist demand estimation, as educational and work related trips form significant proportions of the weekday cycle numbers, and there are likely to be significantly lower numbers at weekends. On the other hand, while there are greater numbers of recreational cyclists at weekends, these trips are specifically excluded from the analysis. As an alternative, the weekday daily trips could be used and multiplied by 245 days of the year, representing the number of "normal" weekdays in the year. Applying this to the spreadsheets provided results in a BCR of 13.1 rather than 15.1. However, we accept that this is overly conservative, as it assumes that there are no cyclists on the weekends."

Analyst's response: We are comfortable that the combined factors adopted for our analysis represent a reasonable and appropriate means of annualisation, based as they are on analysis of all data within the CNRPG. (This spreadsheet will be provided to the Peer Reviewer). In our view use of these factors will *not* therefore represent an overestimate of benefits. We do accept that the surveys on which the CNRPG factors are based do not differentiate by different types of cycle activity, there being only a generic split between 'commuting' routes and 'general' route types. The surveys and therefore derived factors for both of these types will therefore naturally include some elements of recreational and non-recreational (including commuting and education) cycle activity, rather than purely the latter. However, the broad test conducted by the Peer Reviewer (which implies benefits could be reduced by (at most) -13% with a conservative (weekday benefits only) will still be applicable to the updated analysis – which might imply that such a conservative approach could result in a reduction in the Updated Base Scenario BCR from 8.0 to 7.0.

Peer Reviewer's Response: See response at section 3.1.2 above

3.5 Peer Review Comment (Section 2.3.4):

"It is acknowledged that the model was developed with the information current at the time. However, given the significant changes in Christchurch following the recent earthquakes, it may be prudent to consider whether there are any significant long term effects that need to be accounted for."

Analyst's response: As noted by the Reviewer, we have not considered it appropriate to place significant emphasis on the 2013 Census commuting patterns and specifically those for cycle commuters. While we note that the overall level of cycling is indeed similar to the previous (pre-earthquake) 2006 Census, our principal reason for not seeking to 'recalibrate' the models to 2013 is the fact that the key destination (for commuting cyclists) which had been most significantly affected at the time of the 2013 Census was the Central City. However by around 2021 the Central City is anticipated to have returned to a similar level of (land use and transport demand) activity to that before the earthquakes. Of course, the relationships calibrated for 2006 are in any event applied to relevant future year expected land use variables, for prediction years of 2021, 2031 and 2041. In short we consider that the modelling approach adopted justifiably ignores short-term post-earthquake effects (albeit that post-earthquake and future anticipated shifts in population and jobs are accounted for) - but appropriately concentrates on predicting effects using methods appropriate for the longer term.

Peer Reviewer's Response: This seems an acceptable and logical approach. The project is obviously closely tied to the rebuild of Christchurch Central City. A similar level of land use and transport demand by 2021 may or may not be realistic and is somewhat a moving target, but given the modelled years are 2021, 2031 and 2041 (relating to the regional CAST model) this is an appropriate assumption.

3.6 Peer Review Comments (Section 2.4):

"Consideration should be given to the significance of the above issues on the predicted decongestion effects."

Analyst's response: The issues referred to by the Peer Reviewer included the following:

Effect of '75%' assumption. The Reviewer has very slightly misinterpreted what this proportion relates to, stating that "It is assumed that 75% of vehicle trips by potential cycle users would be made by car in the Do-Minimum. This results in each new cycle trip being assumed to avoid approximately 0.6 to 0.65 potential car trips".

In fact for the Do-Minimum cycle numbers, 75% of the *person* trips that are modelled to take place by cycle are, in the absence of that mode, assumed to be made by car (at occupancy rates similar to current CTM light vehicle trips). If a cycle was not used then the balance of trips may be made by other modes (e.g. bus or walk), or not made at all – but the effects of these trips is not accounted for (in calculating potential decongestion benefits). We consider this to (likely) be a reasonable assumption. However, were the proportion to be only, say for example, 50%, then the decongestion benefits may be reduced in proportion (being 2/3 of those assessed) – albeit ignoring the fact that we have not sought to allow for additional congestion value. A 1/3 reduction in decongestion benefit would change the Base Scenario BCR from 8.0 to 7.3.

Peer Reviewer's Response:

The key issue here is that the assumption does not seem unreasonable, but it is difficult to substantiate that assumption. Therefore it is important to note the effects on the BCR.

Basis of Change in Car Demand

"One issue that should be clarified is how the change in car demands is modelled. We understand that the car trips have been added to the Do Minimum vehicle matrices, whereas it may be that the vehicle trips should have been removed from the Do Minimum. This should be clarified as in a congested network, removing rather than adding vehicle trips may lead to smaller decongestion effects"

We do agree removing rather than adding vehicle trips may tend to lead to smaller decongestion effects. We also agree that it may appear more logical to 'remove' vehicle trips that are catered for by cycle (in the absence of that mode). However, we had considered both approaches and came to the conclusion the method adopted (addition) is indeed appropriate. This is because we are interested in the potential *net* effects (of attracting new users to cycling or more specifically when it comes to decongestion – supporting fewer car trips (and vehicle-km) through investment in cycling. This need to determine the net effects requires us to assess the performance of the road network (and its influence on all vehicle users) for both 'Do-minimum' and 'Do-Something (in this case, additional cycle investment'. If we were to pursue the 'subtraction' approach, the number of vehicle (trips) avoided by cycling would have to be removed from both Do-minimum and Do-Something networks – meaning that such a model scenario there would be fewer vehicle trips than we know that there actually is (from our calibrated base year model) or predict to be (in the case of the future Do-Minimum). Thus (applying to the present day as a more simple way of envisaging it) with a 'subtraction' approach both 'with-cycling' and 'no-cycling' scenarios would not be correctly represented – and therefore neither would be the potential difference in costs for road users. Between the two cases (which would differ for Do-Minimum and Do-Something scenarios). In contrast, by adopting an 'addition' approach to the Do-Minimum (i.e. what would be the road user cost in the absence of cycling as a mode), we correctly reflect the base case vehicle network performance (ie how many vehicles are observed on the roads and their level of congestion)

Peer Reviewer's Response:

We do not agree with the analyst's response. If the subtraction approach were to be adopted, this would only be to the Do Something networks (in the same way that with the addition approach, the trips would only be added to the Do Minimum networks).

However, on reflection, the effects of this difference may not be overly significant. The CAST model relates to 2021 (and later), meaning that the short term effects of the current series of temporary works during the rebuild are not being taken into account. The 2021 (and later) networks can be expected to be "broadly in balance" for the most part, (ie with transport demand broadly consistent with the capacity provided), if the anticipated investment in transport materialises, suggesting that the differences between the effects of the addition and subtraction methods may not be that significant.

Effect on Cars

"A further matter relates to the effects of cars on cyclists and vice versa. We understand that delays likely to be incurred by cyclists, for example at intersections, are reflected in the cycle model, based on outputs from CAST. However, the effects on motorised vehicles of having more cyclists has, to our knowledge, not been taken into account. It is difficult to estimate the significance of this issue, which would occur where cyclists cross roads, or on sections of road the cycle network does not extend"

We agree with the Peer Reviewer that it is indeed difficult to assess the significance of this issue – although we consider it likely to be fairly low (i.e. not highly significant – given the (lack of) sensitivity noted above to a potential 1/3 reduction in decongestion benefits). The Reviewer is however correct in that delays incurred by cyclists are accounted for but that effects on motor vehicles of having more cyclists have not been (except for our sensitivity test that does account for potential additional safety costs for other road users including motor vehicles). In many cases, more cyclists may not have any effect on other road users (for example queuing in their own dedicated space or crossing in give-way situations via central refuges where safe to do so...as this minimises delays to both cyclists and other road users. However, it is acknowledged that there will indeed be some situations where, for example, new traffic signals or slightly changed phase timings at existing signals may be required. These could lead to some additional delays for motor vehicles, as could more vehicular (cycle) traffic at priority intersections.

Peer Reviewer's Response:

The issue is accepted, but, as noted, the effects are difficult to quantify.

3.7 Peer Review Comment (Section 2.6):

"The increase in cyclists combined with the increase in cycle trip length is a key prediction that influences the overall benefit. The predicted average cycle trip length is reasonable and is not exceptional or reason for concern. However, we wonder if the road reduction factor suggests that there is a small level of double counting with the decongestion benefits."

Analyst's response: We concur that the predicted average cycle trip length (increase) appears reasonable (given the integrated network proposed). Our understanding is that the $0.10c/km (in $2008) allowance within the EEM for 'road traffic reduction' is somewhat of a misnomer and relates to an allowance for the environmental benefits associated with road traffic reduction (which we have not otherwise allowed for). Whilst we acknowledge that if our impression is not correct there is the possibility of some 'double-counting', in the context of the actual decongestion values (which equate to between $0.60 and $1.10 ($2010) any double-counting would form a small % and in any event is likely to be vastly outweighed by the conservative approach to other areas (i.e. no use of additional congested time values).

Peer Reviewer's Response:

Agreed.

3.8 Peer Review Comment (Section 3.1.1):

"The report acknowledges that the costs are relatively preliminary in nature. This has been covered with a sensitivity test whereby the capital costs of the MCR projects have been doubled."

Analyst's response: Following further design and planning, this update incorporates the latest estimates for both the MCR projects as well as the AAC and CCP projects. Overall the (undiscounted) total capital costs for these elements of the upgraded cycle network have now risen to $189m with a further $9m of additional maintenance costs anticipated over a 40 year assessment period. When discounted to the present day, the total costs have indeed nearly doubled, from $81.3m in the Preliminary Assessment to $152.1m (the latter including net maintenance which comprises $2.9m or 1.9% of the total).

Peer Reviewer's Response:

The updated capital costs and associated maintenance costs appear to have been applied appropriately.

The update of the base test now includes the more detailed capital cost estimate and maintenance costs as noted above. The previous sensitivity test which tested a doubling of the previous estimates has been replaced by a 20% increase in the *updated* capital and maintenance estimates. This seems appropriate, given that the cost estimate is unlikely to double again.

Doubling of the capital costs and inclusion of maintenance costs leads to the BCR of other sensitivity tests reducing, however these are all above 2 with the exception of one.

3.9 Peer Review Comment (Section 3.1.2):

"Consideration should be given to allowing an estimate of maintenance costs for the cycle network in the Scenarios 1 and 2 if these are now known or can be determined."

Analyst's response: As suggested, the net maintenance costs have now been incorporated in this updated analysis.

Peer Reviewer's Response: Maintenance costs are now appropriately included.

3.10 Peer Review Comment (Section 3.1.3):

"Correct the reported discounting of benefit sources for Scenario 2 in Table F2. This has no effect on the BCR of Scenario 2."

Analyst's response: The reporting mistake has been corrected in the updated Table F2.

Peer Reviewer's Response: No further comment required.

4 ADDITIONAL COMMENT

New Zealand Transport Agency (NZTA) has recently updated the efficiency rating bands[2]. The report includes reference to the previous efficiency bands which placed a 'High' priority on a project with a BCR of 4 or greater. This has only been changed very recently but should be updated before a funding application is made. The new bands are shown in Figure 1 below.

Figure 1: Priority Order of Investment Profiles, NZTA PIKB

			Numeric benefit and cost appraisal			
Strategic fit	Effectiveness	Strategic fit and Effectiveness	1 to 3	3 to 5	5+	
H	H	HH	Priority 3	Priority 2	Priority 1	Activities with these profiles progress to activity business cases.
H	M	HM	Priority 4	Priority 3	Priority 2	
M	H	MH	Priority 6	Priority 5	Priority 4	
M	M	MM	Priority 7	Priority 6	Priority 5	
H	L	HL	Low strategic fit does not progress beyond strategic business case. Low effectiveness does not progress beyond programme business case.			A decision gate that integrates with the business case approach.
M	L	ML				
L	H	LH				
L	M	LM				
L	L	LL				

5 CONCLUSIONS

Flow has reviewed the demand cycle demand estimates and economics for the Major Cycleway Routes (MCRs) and found these to be robust and consistent with good practice and NZTA's Economic Evaluation Manual. The main points noted by this review are as follows:

- The cost estimates have been updated since our previous review, and maintenance costs have been included. These adjustments have reduced the Benefit Cost Ratio from 15 to 8
- The analyst has now provided an assessment of the effects of a lag in benefits being achieved (following the completion of the MCRs). A lag of 5 years would reduce the BCR from 8 to 6.4
- A sensitivity test has been provided relating to the percentage of cycle trips assumed to divert from car
- There has been some discussion about the basis of the changes in car demands, used as the basis of the decongestion benefits (whether the diversion should lead to an increase in the Do Something demands or a reduction in the Do Minimum demands). There is a difference of opinion between the analyst and the reviewer, but we suggest that this difference may not be overly critical
- There has also been discussion about the potential effects of cyclists using the MCRs on traffic; ie would the MCRs cause delays to vehicles thereby decrease the reported benefits of the MCRs. The extent and significance of this issue is unknown at this stage
- We previously noted that the benefits of the MCRs could be constrained by the various impediments to cycling beyond the MCRs. The effects have not been quantified, but it has been noted that even with a 5 year lag in benefit capture, a BCR of 4 would still be achieved even if

[2] New Zealand Transport Agency's Planning and Investment Knowledge Base (PIKB) website

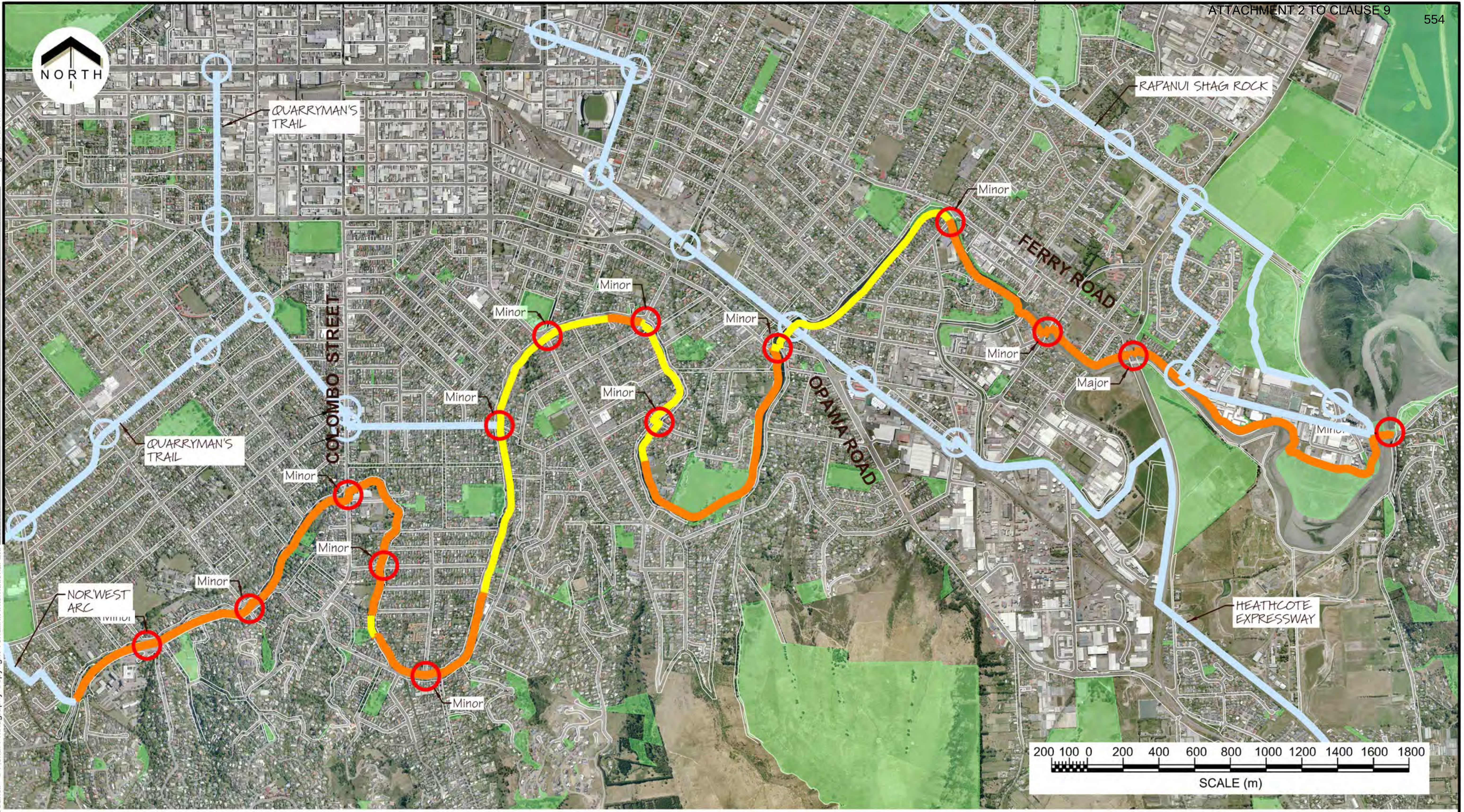
benefits were 37% lower than anticipated, due to the constraints noted. Presumably this means that a BCR of 5 would be achieved with a reduction of benefits of around 22% (this value of 5 now being required to justify a high priority rating (according to the categories as recently redefined).

As a result, we conclude that the Benefit Cost Ratio can reasonably be assessed as 5 or more, which would justify a high priority rating.

Yours sincerely

Ian Clark
DIRECTOR

Reference S:\cccx\005\L1A150202.docx - Harry Ormiston



KEY

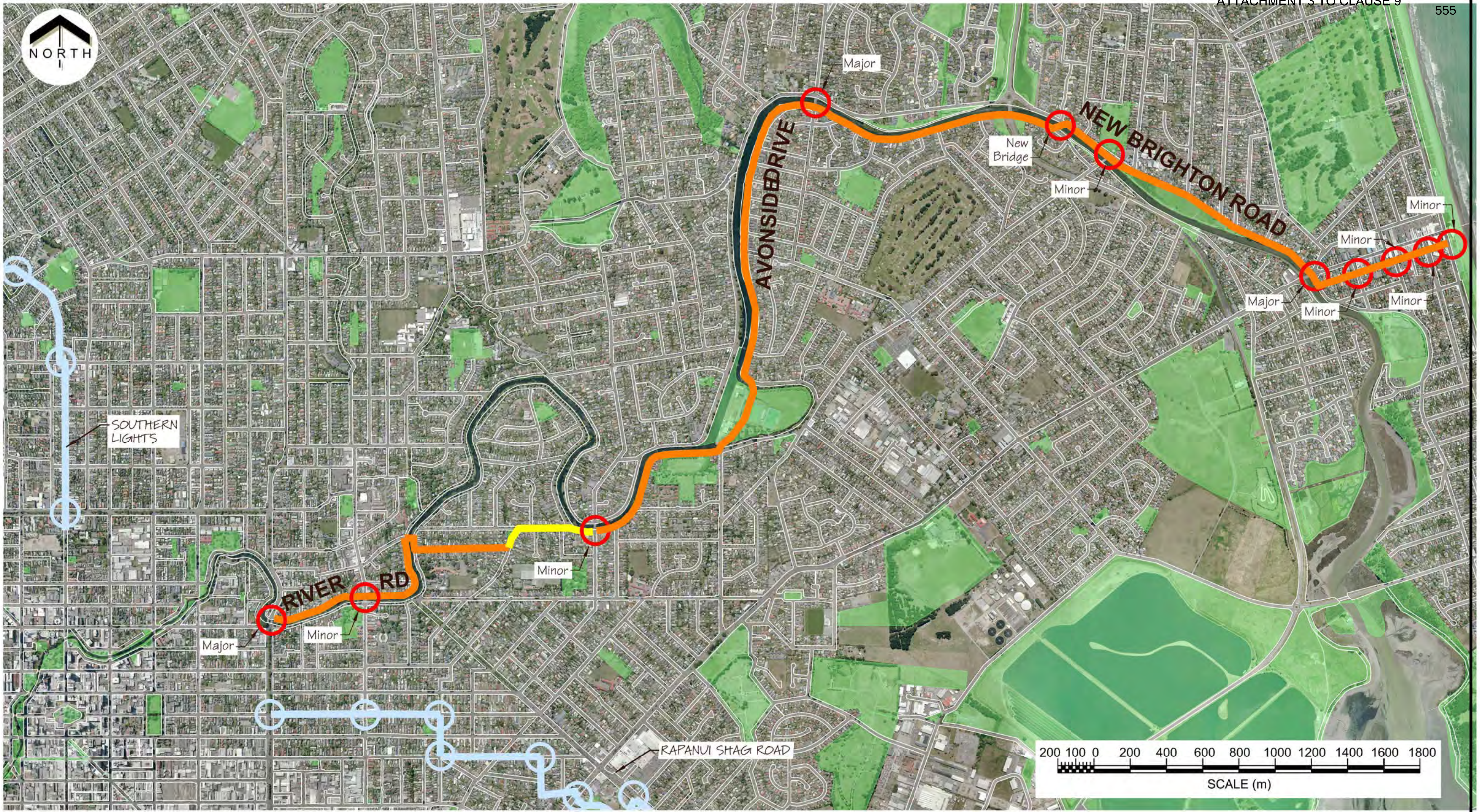
- Off Road Path (shared or separate)
- Neighbourhood Greenway (Quiet Street)
- Cycle Crossing Improvements
- Major Cycleway Routes

Christchurch City Council

Major Cycleways - Opawaho River

Route Alignment Overview Plan

Original Plan Size: A3
ISSUE. 1 03/02/2015
RD340301 VMI CP501963/06



Original size mm

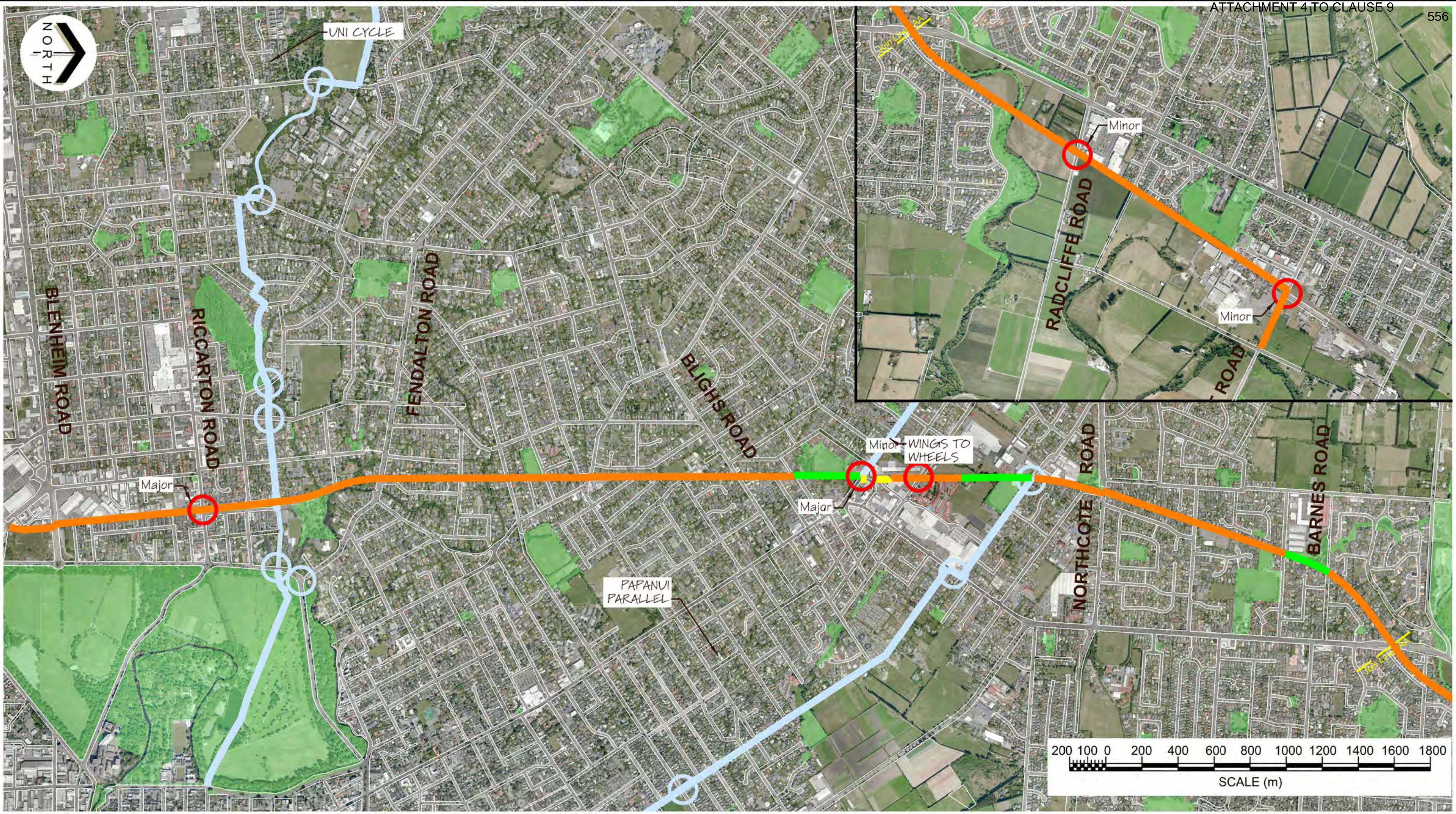
KEY

- Off Road Path (shared or separate)
- Neighbourhood Greenway (Quiet Street)
- Cycle Crossing Improvements
- Major Cycleway Routes

Christchurch City Council

Major Cycleways - Otakaro
Route Alignment Overview Plan

Original Plan Size: A3
ISSUE. 1 03/02/2015
RD340401 VMI CP501963/02



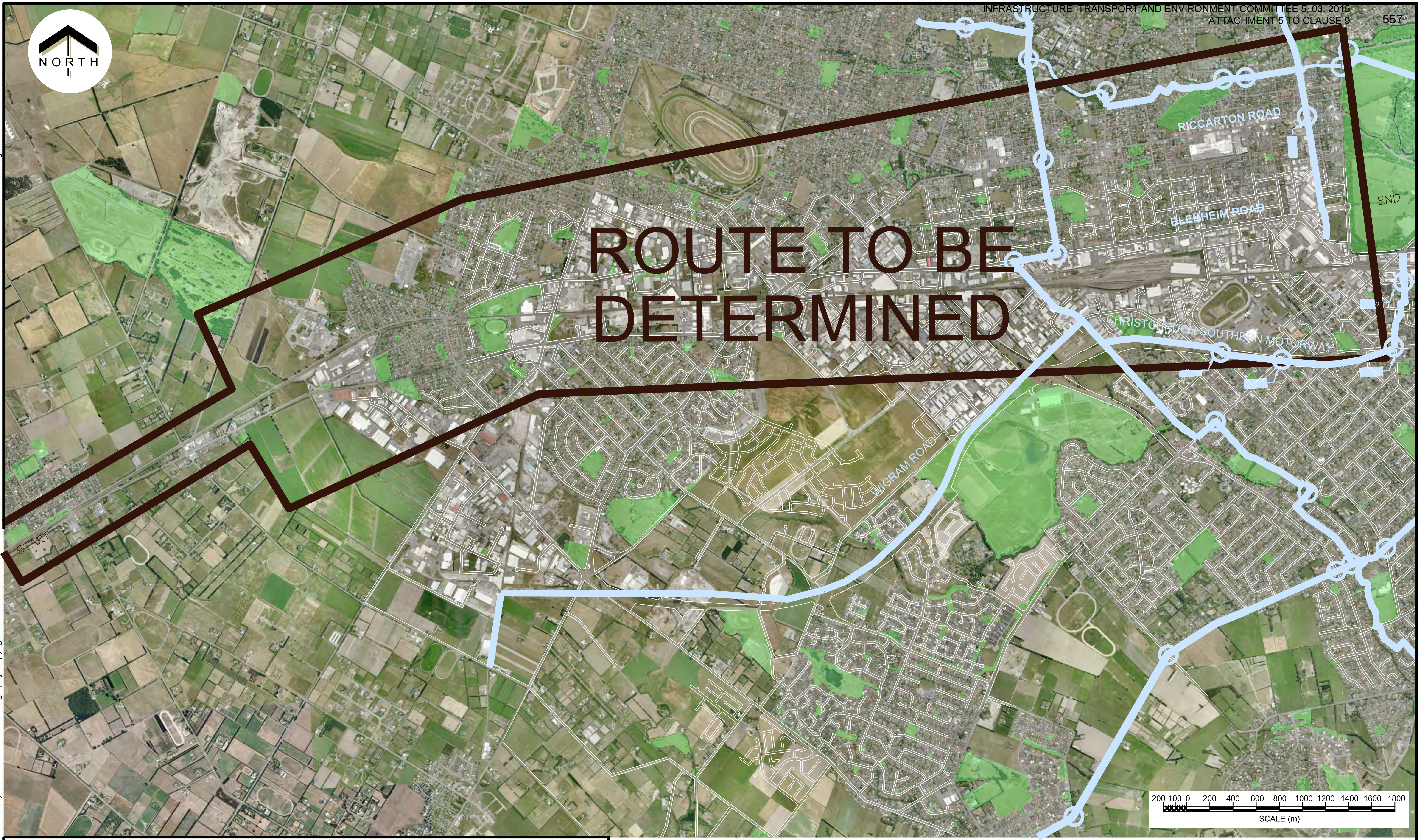
KEY

- Off Road Path (shared or separate)
- Slow Street - No Separation
- Cycle Crossing Improvements
- Shared Path - Parks - Generally 2 way
- Major Cycleway Routes

Christchurch City Council

Major Cycleways - Northern Line
Route Alignment Overview Plan

Original Plan Size: A3
ISSUE. 1 03/02/2015
rd340501 VMI CP501963/09



KEY

- Off Road Path (shared or separate)
- Separated Cycle Path - two way on Street
- Cycle Crossing Improvements
- Shared Path - Parks - Generally 2 way
- Major Cycleway Routes

Christchurch City Council

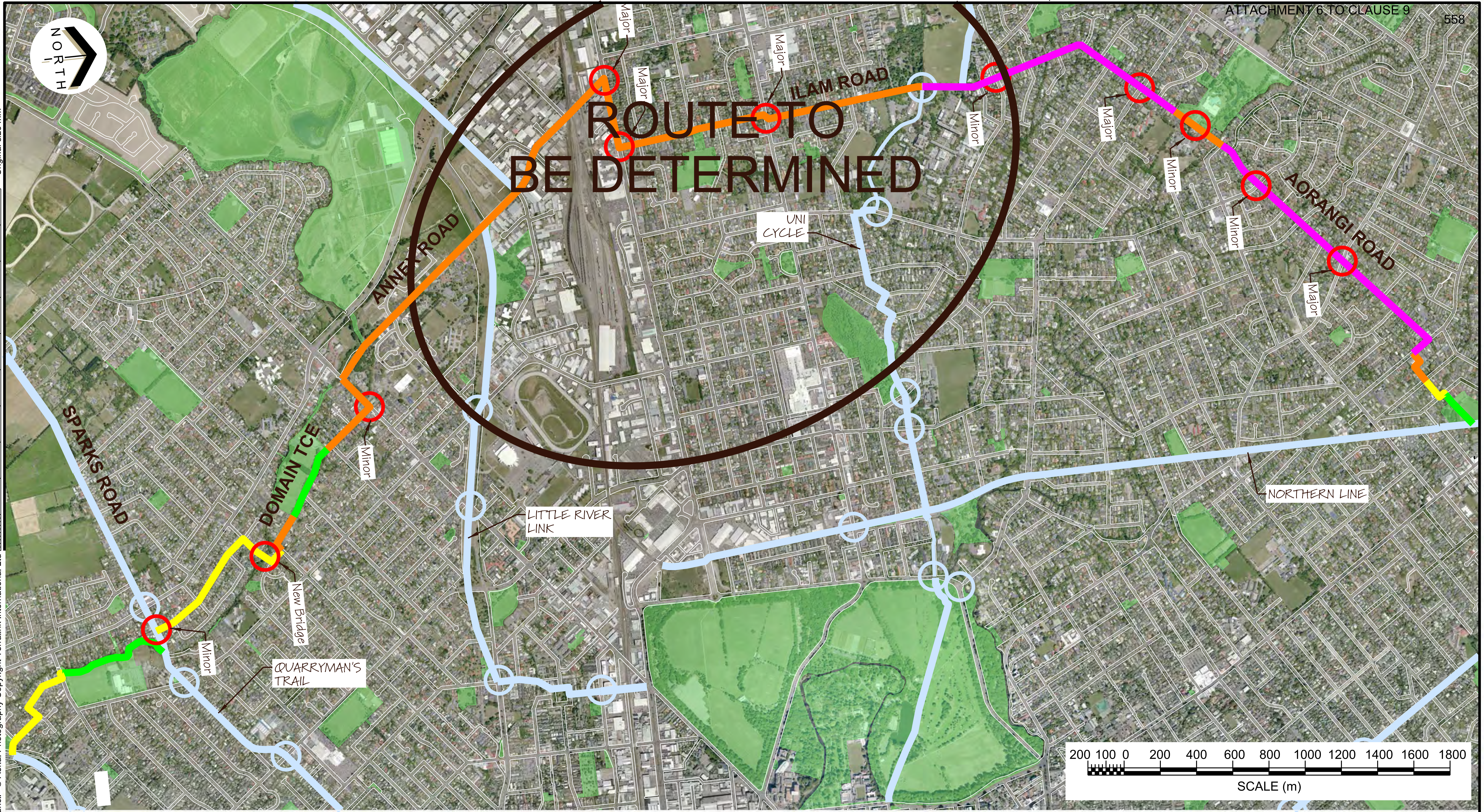
Major Cycleways - South Express

Route Alignment Overview Plan

Original Plan Size: A3

ISSUE. 1 03/02/2015

RD340601 VMI CP501963/08



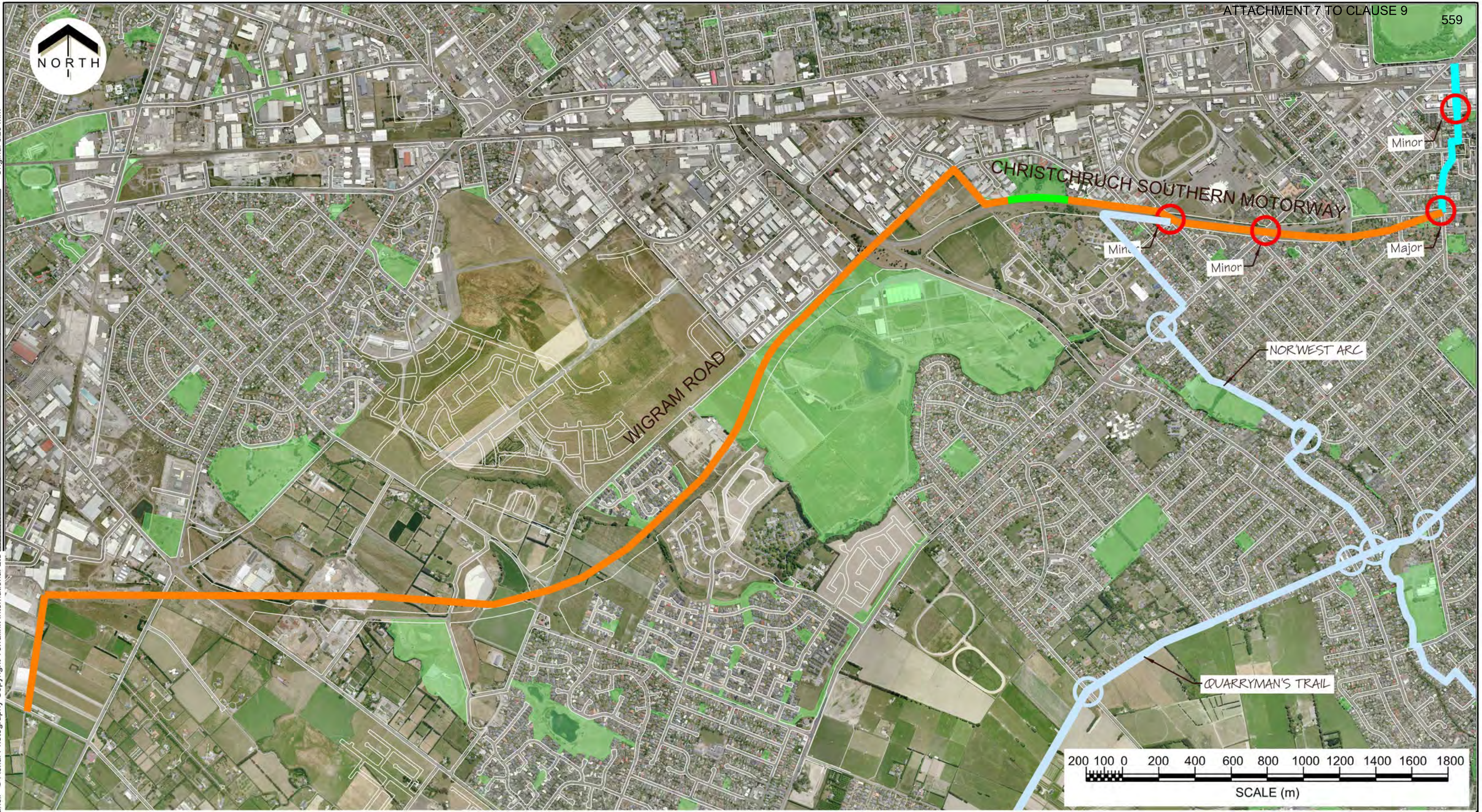
KEY

- Off Road Path (shared or separate)
- Neighbourhood Greenway (Quiet Street)
- Cycle Crossing Improvements
- Separated Cycle Path 1 Way On Street
- Shared Path - Parks - Generally 2 way
- Separated Cycle Path - 2 Way On Street
- Major Cycleway Routes

Christchurch City Council

Major Cycleways - Nor'west Arc
Route Alignment Overview Plan

Original Plan Size: A3
ISSUE. 1 03/02/2015
RD340701 VMI CP501963/14



KEY

- Off Road Path (shared or separate)
- Separated Cycle Path - two way on Street
- Cycle Crossing Improvements
- Shared Path - Parks - Generally 2 way
- Major Cycleway Routes

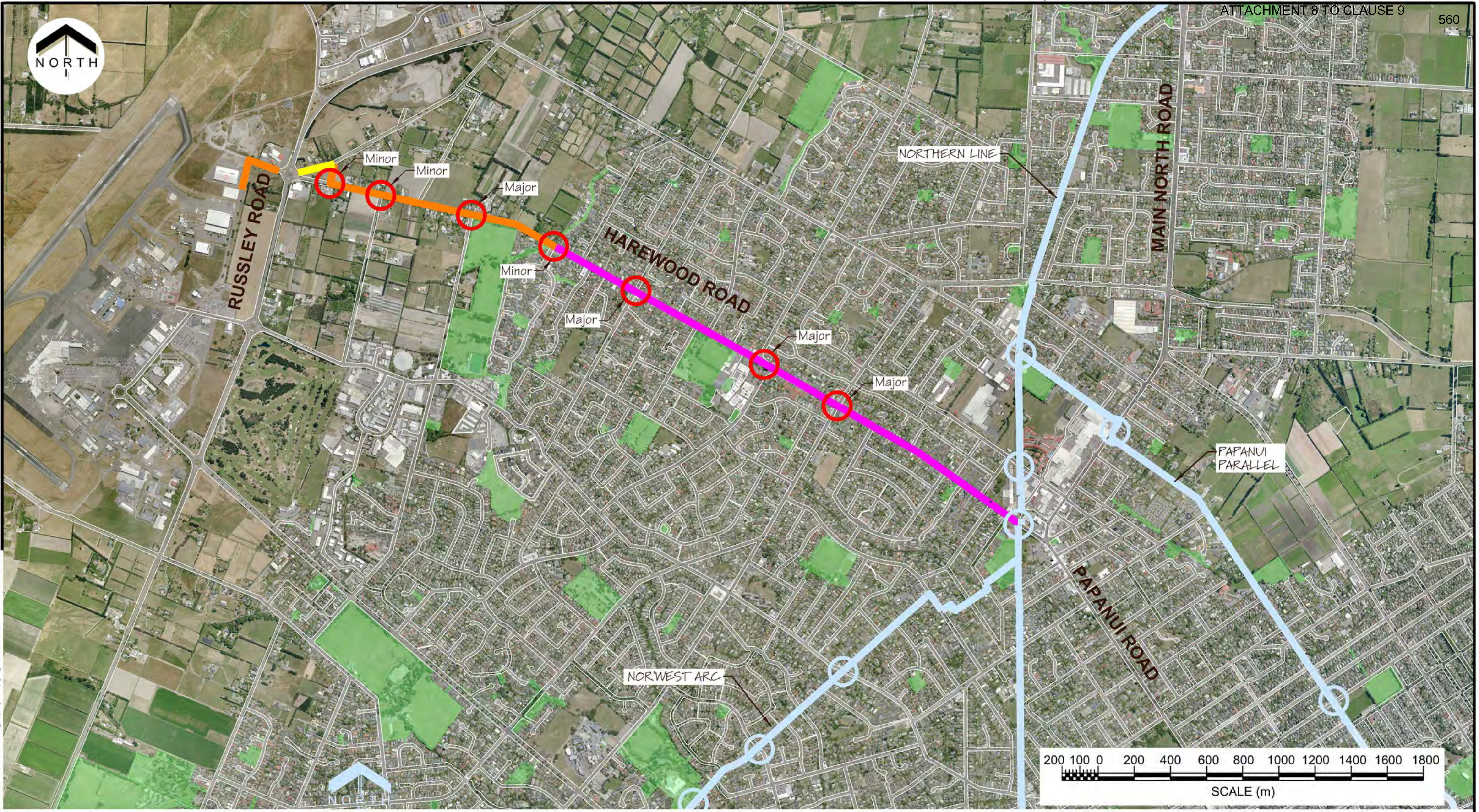
Christchurch City Council

Major Cycleways - Little River Link

Route Alignment Overview Plan

Original Plan Size: A3
ISSUE. 1 03/02/2015
RD340801 VMI CP501963/08

Original size mm
0 10 30 50 100



Original size mm

KEY

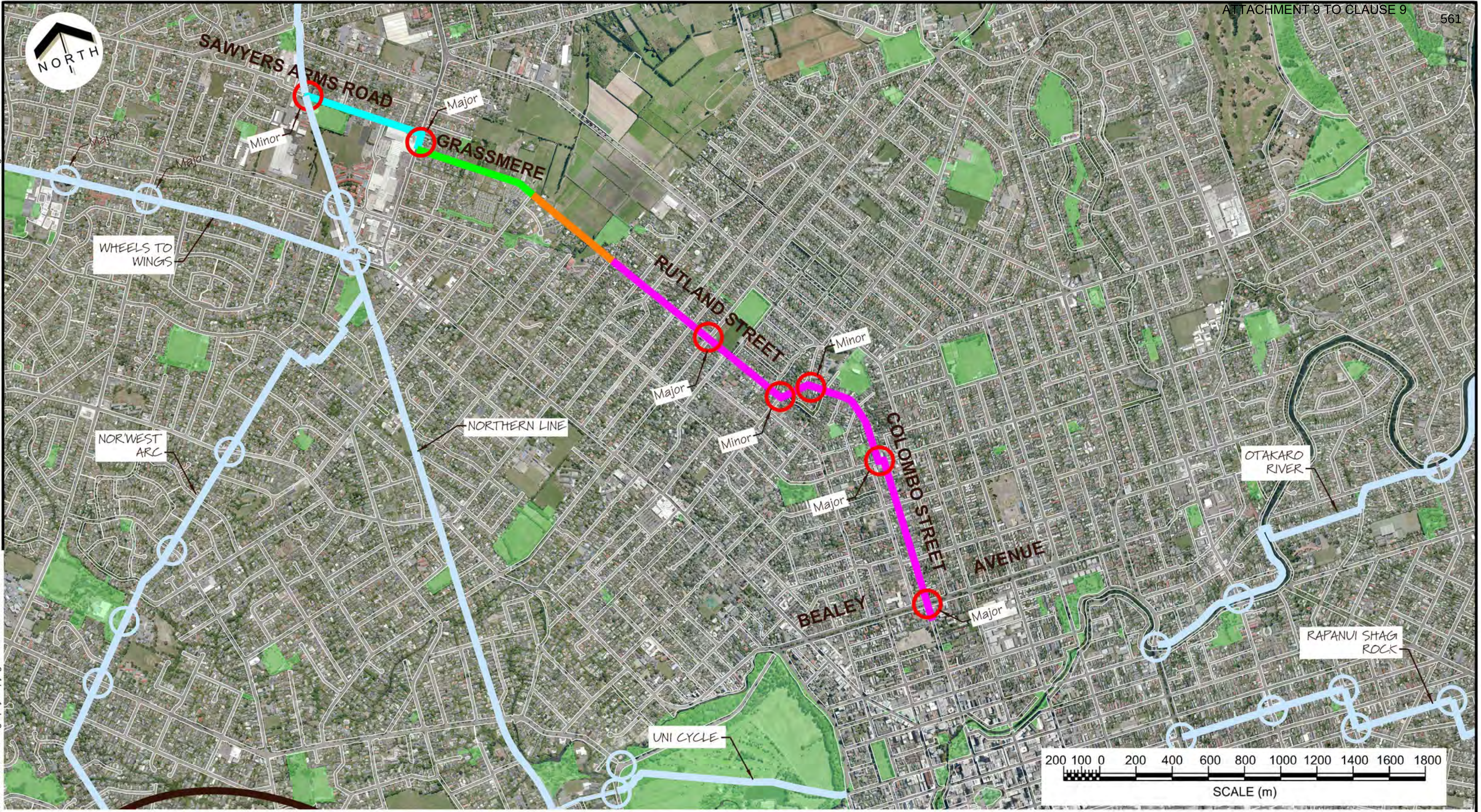
- Off Road Path (shared or separate)
- Neighbourhood Greenway
- Cycle Crossing Improvements
- Separated Cycle Path 1 Way On Street
- Major Cycleway Routes

Christchurch City Council

Major Cycleways - Wheels to Wings

Route Alignment Overview Plan

Original Plan Size: A3
ISSUE. 1 03/02/2015
RD340901 VMI CP501963/01



KEY

Off Road Path (shared or separate)	Shared Path - Parks - Generally 2 way
Separated Cycle Path 1 Way On Street	Separated Cycle Path - 2 Way On Street
Cycle Crossing Improvements	Major Cycleway Routes

Christchurch City Council

Major Cycleways - Papanui Parallel

Route Alignment Overview Plan

Original Plan Size: A3
ISSUE. 1 03/02/2015
RD341001 VMI CP501963/03

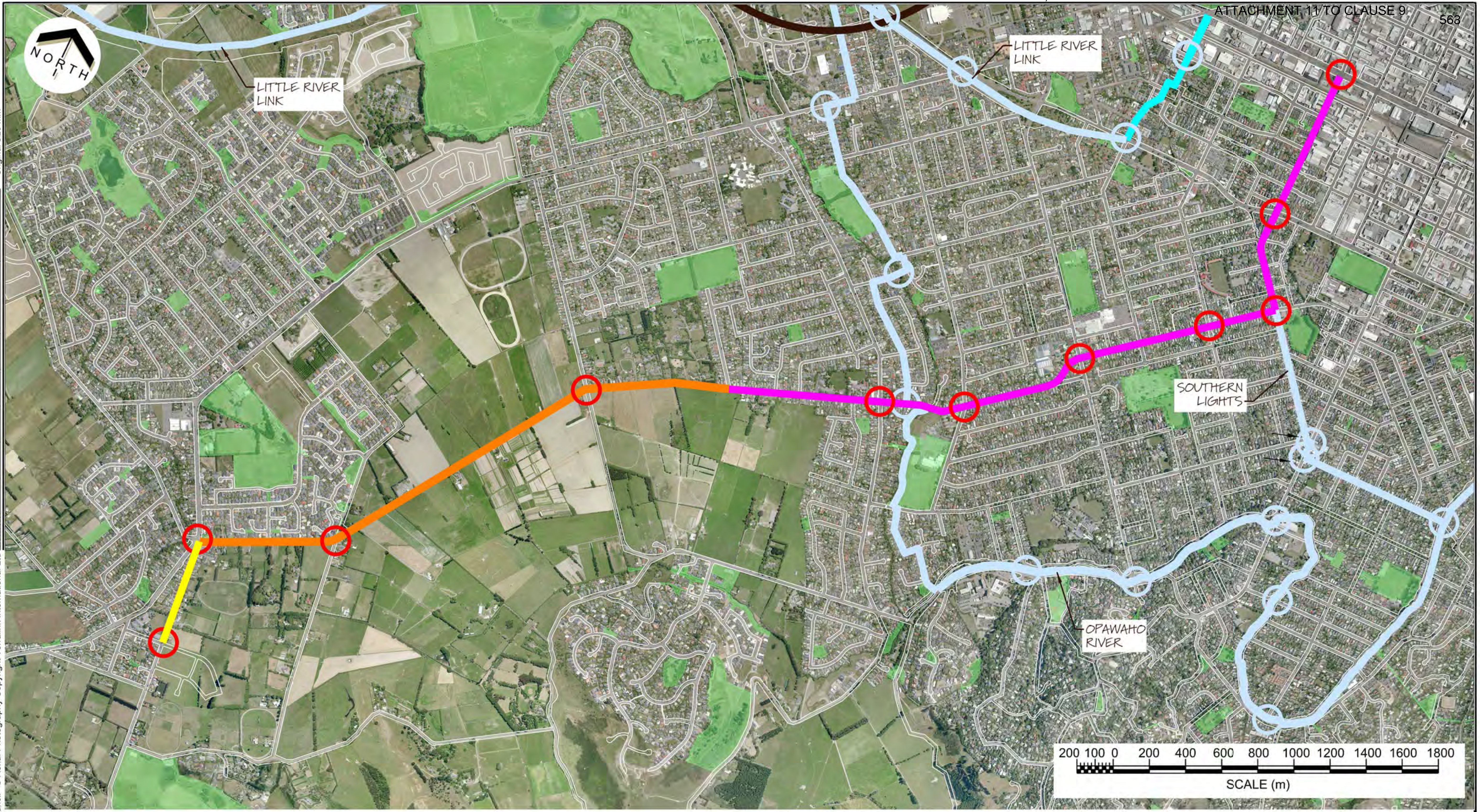
KEY

Off Road Path (shared or separate)	Shared Path - Parks - Generally 2 way
Neighbourhood Greenway (Quiet Street)	Separated Cycle Path - 2 Way On Street
Cycle Crossing Improvements	Separated Cycle Path - 1 Way On Street

Christchurch City Council

Major Cycleways - Heathcote Expressway
Route Alignment Overview Plan

Original Plan Size: A3
ISSUE. 1 03/02/2015
RD341101 VMI CP501963/05



KEY

Off Road Path (shared or separate)	Shared Path - Parks - Generally 2 way
Neighbourhood Greenway (Quiet Street)	Separated Cycle Path - 1 Way On Street
Cycle Crossing Improvements	Major Cycleway Routes

Christchurch City Council

Major Cycleways - Quarryman's Trail

Route Alignment Overview Plan

Original Plan Size: A3
ISSUE. 1 03/02/2015
RD341201 VMI CP501963/04

Original size mm

KEY

- Separated Cycle Path - 1 Way On Street
- Major Cycleway Routes
- Cycle Crossing Improvements

Christchurch City Council

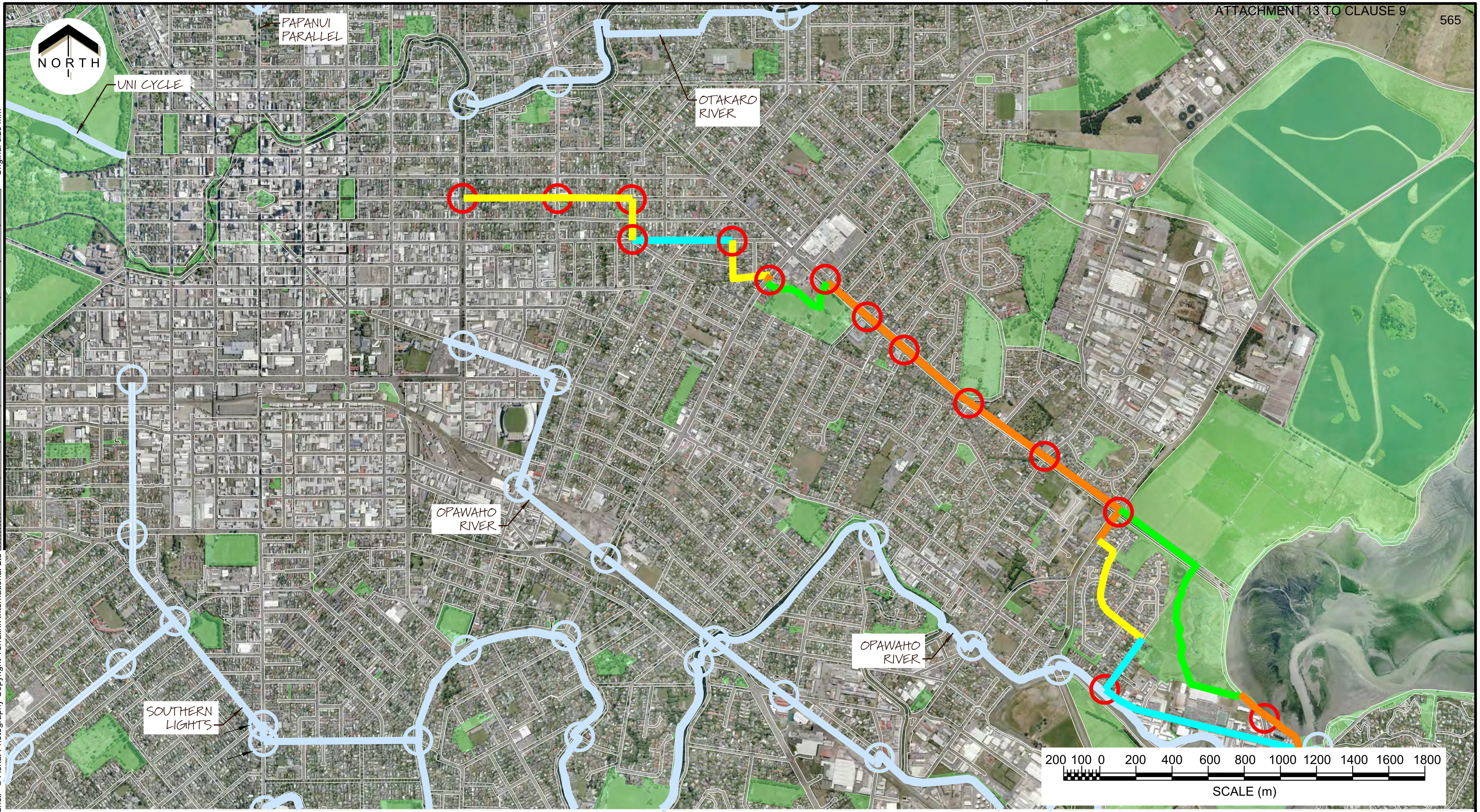
Major Cycleways - Southern Lights

Route Alignment Overview Plan

Original Plan Size: A3

ISSUE. 1 03/02/2015

RD341301 VMI CP501963/10



KEY

Off Road Path (shared or separate)	Shared Path - Parks - Generally 2 way
Neighbourhood Greenway (Quiet Street)	Separated Cycle Path - 2 Way On Street
Cycle Crossing Improvements	Major Cycleway Routes

Christchurch City Council

Major Cycleways - Rapanui Shag Rock
Route Alignment Overview Plan

Original Plan Size: A3
ISSUE. 1 03/02/2015
RD341401 VMI CP501963/13