Redoubt Road – Mill Road Corridor Study
for Auckland Transport

Volume 1
Final Scheme Assessment Report

June 2013
Quality Information

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Reviewed by: Ian Fones, Greg Booth

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<table>
<thead>
<tr>
<th>Revision</th>
<th>Revision Date</th>
<th>Details</th>
<th>Authorised</th>
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<tbody>
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<tr>
<td>2</td>
<td>28-Jun-2013</td>
<td>FINAL Report for client review</td>
<td>Colin MacArthur Project Director</td>
</tr>
</tbody>
</table>
Table of Contents

Executive Summary i
1.0 Introduction
  1.1 Study Approach 1
  1.2 RFT Requirements 2

2.0 Background Report and Initial Investigations
  2.1 Previous Studies
    2.1.1 Hollyford Drive to Ronwood Avenue Study, 2011 3
    2.1.2 Ormiston Road to Redoubt Road, 2010 3
    2.1.3 Manukau City Council Mill Road Corridor Study, 2011 4
    2.1.4 Papakura District Council Mill Road Corridor Study, 2010 4
    2.1.5 Summary of Previous Studies 4
  2.2 Problem Description 5
  2.3 Project Objectives
    2.3.1 Strategic Project and Core Objectives 6
    2.3.2 Developed project Sub-objectives 6

3.0 Site Description
  3.1 Description of Study Area 9
  3.2 Local Area Description 9
  3.3 Special Features 11
  3.4 Land Use and Growth Scenarios 12
  3.5 Significant Associated Transport Plans and Projects
    3.5.1 Regional Land Transport Programme 16
    3.5.2 Road Hierarchy 17
    3.5.3 Auckland Regional Passenger Transport Network Plan 18
    3.5.4 Regional Cycle Network Plan 18
    3.5.5 Integrated Transport Plan 19

4.0 Collected Data
  4.1 Topographic Survey
    4.1.1 General Topography 20
    4.1.2 Survey to date 20
    4.1.3 Anticipated Requirements for the Preliminary Design 20
  4.2 Traffic Information
    4.2.1 Traffic Flows 21
    4.2.2 Proportion of HCVs 21
    4.2.3 Cycle Traffic 21
    4.2.4 Public Transport 21
  4.3 Crash Statistics 22
  4.4 Geotechnical Testing
    4.4.1 Preliminary Geotechnical Appraisal Report 24
  4.5 Aquatic and Terrestrial Ecology 24
  4.6 Historical 25
  4.7 Acoustics 25
  4.8 Vibration 26
  4.9 Utility Services
    4.9.1 Existing Services Identification and Investigations 26
    4.9.2 Meetings and Discussions 26

5.0 Stakeholder Relationship Management and Consultation
  5.1 Consultation 29
  5.2 Identified Maori Interest 30

6.0 Option Identification and Screening
  6.1 The Do Minimum Option 32
  6.2 Option Identification – Constraints and Opportunities
    6.2.1 Whole Corridor 33
    6.2.2 Urban Section – Redoubt Road from SH1 to Murphy’s Road 34
    6.2.3 Future Urban Section – Murphy’s Road 35
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.2.4</td>
<td>Rural Section – Redoubt Road and Mill Road south of Murphy’s Road</td>
<td>35</td>
</tr>
<tr>
<td>6.3</td>
<td>Redoubt Road Alignment Options</td>
<td>36</td>
</tr>
<tr>
<td>6.4</td>
<td>Redoubt Road-Mill Road Alignment Options</td>
<td>36</td>
</tr>
<tr>
<td>6.5</td>
<td>Murphy’s Road Alignment Options</td>
<td>38</td>
</tr>
<tr>
<td>6.6</td>
<td>Summary of the Option Screening</td>
<td>40</td>
</tr>
<tr>
<td>7.0</td>
<td>Option Testing</td>
<td>41</td>
</tr>
<tr>
<td>7.1</td>
<td>Transport Modelling</td>
<td>41</td>
</tr>
<tr>
<td>7.1.1</td>
<td>Network Modelling</td>
<td>41</td>
</tr>
<tr>
<td>7.1.2</td>
<td>Intersection design</td>
<td>42</td>
</tr>
<tr>
<td>7.1.3</td>
<td>Bus Priority</td>
<td>44</td>
</tr>
<tr>
<td>7.2</td>
<td>Geotechnical</td>
<td>44</td>
</tr>
<tr>
<td>7.2.1</td>
<td>Factual Report</td>
<td>44</td>
</tr>
<tr>
<td>7.2.2</td>
<td>Interprettive Report</td>
<td>45</td>
</tr>
<tr>
<td>7.3</td>
<td>Stormwater</td>
<td>46</td>
</tr>
<tr>
<td>7.3.1</td>
<td>Catchment and Receiving System Identification-</td>
<td>46</td>
</tr>
<tr>
<td>7.3.2</td>
<td>Existing Infrastructure Assessment</td>
<td>46</td>
</tr>
<tr>
<td>7.3.3</td>
<td>Unserviced Areas</td>
<td>46</td>
</tr>
<tr>
<td>7.3.4</td>
<td>Stormwater Management Options</td>
<td>47</td>
</tr>
<tr>
<td>7.4</td>
<td>Social and Environmental</td>
<td>48</td>
</tr>
<tr>
<td>7.4.1</td>
<td>Social and Environmental Screen and Social and Environmental Assessment</td>
<td>48</td>
</tr>
<tr>
<td>7.4.2</td>
<td>Noise</td>
<td>48</td>
</tr>
<tr>
<td>7.4.3</td>
<td>Vibration</td>
<td>48</td>
</tr>
<tr>
<td>7.4.4</td>
<td>Air Quality</td>
<td>48</td>
</tr>
<tr>
<td>7.4.5</td>
<td>Water Resources</td>
<td>48</td>
</tr>
<tr>
<td>7.4.6</td>
<td>Erosion and Sediment</td>
<td>49</td>
</tr>
<tr>
<td>7.4.7</td>
<td>Social Effects, Land Use &amp; Transport Integration</td>
<td>49</td>
</tr>
<tr>
<td>7.4.8</td>
<td>Effects on Culture and Heritage</td>
<td>50</td>
</tr>
<tr>
<td>7.4.9</td>
<td>Effects on Ecological Resources</td>
<td>51</td>
</tr>
<tr>
<td>7.4.10</td>
<td>Contaminated Land</td>
<td>51</td>
</tr>
<tr>
<td>7.4.11</td>
<td>Resource Efficiency &amp; Climate Change Adaption and Mitigation</td>
<td>52</td>
</tr>
<tr>
<td>7.5</td>
<td>Visual Quality and Urban Design</td>
<td>52</td>
</tr>
<tr>
<td>7.5.1</td>
<td>Arboriculture</td>
<td>52</td>
</tr>
<tr>
<td>7.5.2</td>
<td>Landscape</td>
<td>53</td>
</tr>
<tr>
<td>7.5.3</td>
<td>Urban Design</td>
<td>53</td>
</tr>
<tr>
<td>7.5.4</td>
<td>Opportunities and Constraints</td>
<td>53</td>
</tr>
<tr>
<td>7.6</td>
<td>Utility Services</td>
<td>54</td>
</tr>
<tr>
<td>7.6.1</td>
<td>The Do minimum option – Entire route</td>
<td>54</td>
</tr>
<tr>
<td>7.6.2</td>
<td>Redoubt Road Alignment Options</td>
<td>54</td>
</tr>
<tr>
<td>7.6.3</td>
<td>Redoubt Road – Mill Road Alignment Options</td>
<td>54</td>
</tr>
<tr>
<td>7.6.4</td>
<td>Murphys Road Alignment Options</td>
<td>55</td>
</tr>
<tr>
<td>7.7</td>
<td>Bridges and Structures</td>
<td>55</td>
</tr>
<tr>
<td>7.8</td>
<td>Multi Criteria Analysis</td>
<td>61</td>
</tr>
<tr>
<td>7.8.1</td>
<td>Development of Specific Objectives</td>
<td>61</td>
</tr>
<tr>
<td>7.8.2</td>
<td>Indicators and MCA Criteria</td>
<td>62</td>
</tr>
<tr>
<td>7.8.3</td>
<td>Multi Criteria Analysis Results</td>
<td>62</td>
</tr>
<tr>
<td>7.8.4</td>
<td>Summary of Multi Criteria Assessment</td>
<td>65</td>
</tr>
<tr>
<td>8.0</td>
<td>Preferred Option Refinement</td>
<td>67</td>
</tr>
<tr>
<td>8.1</td>
<td>Refinement of Option</td>
<td>67</td>
</tr>
<tr>
<td>8.1.1</td>
<td>Policy and Strategy</td>
<td>67</td>
</tr>
<tr>
<td>8.1.2</td>
<td>Land Use and Accessibility</td>
<td>68</td>
</tr>
<tr>
<td>8.1.3</td>
<td>Urban Design and Landscaping</td>
<td>68</td>
</tr>
<tr>
<td>8.1.4</td>
<td>Geotechnical</td>
<td>68</td>
</tr>
<tr>
<td>8.1.5</td>
<td>Stormwater</td>
<td>69</td>
</tr>
<tr>
<td>8.1.6</td>
<td>Utilities</td>
<td>69</td>
</tr>
<tr>
<td>8.1.7</td>
<td>Lighting</td>
<td>70</td>
</tr>
<tr>
<td>8.1.8</td>
<td>Transport Modelling</td>
<td>71</td>
</tr>
<tr>
<td>8.1.9</td>
<td>Cost Efficiency</td>
<td>71</td>
</tr>
<tr>
<td>9.0</td>
<td>Option Assessment</td>
<td>72</td>
</tr>
</tbody>
</table>
9.1 Strategic Objectives
9.1.1 NZ Transport Strategy
9.1.2 Government Policy Statement
9.1.3 Land Transport Management Act
9.1.4 Safer Journeys
9.1.5 Summary
9.2 Risk
9.3 Cost Estimates
9.4 Economic Evaluation
9.4.1 Procedure
9.4.2 Do Minimum
9.4.3 Analysis of Benefits
9.4.4 Summary of Potential Project Benefits
9.4.5 Benefit Cost Analysis
9.5 Statutory Requirements
9.5.1 Auckland Council Regional Plan (Sediment Control)
9.5.2 Auckland Council Regional Plan (Air, Land and Water)
9.5.3 The National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (NES)
9.5.4 Auckland Council Parks
9.5.5 Other approvals required to support the application
9.5.6 Summary
9.6 Assessment Profile
9.6.1 Strategic Fit
9.6.2 Effectiveness
9.6.3 Efficiency
9.6.4 Initial Assessment Profile
10.0 Recommended Option
10.1 Option Objectives
10.2 Design Philosophy Statement
10.3 Preliminary Design Drawings
10.4 Notice of Requirement (NOR) and Constructability Staging
10.4.1 Notice of Requirement Staging
10.4.2 Construction Staging
10.5 Future Proofing of the Corridor
10.5.1 Traffic forecasts
10.5.2 Public Transport
11.0 Matters for Discussion
11.1 Integration with the wider corridor and One Network
11.2 Public Transport and Cycling Integration
11.3 Connectivity
11.4 Security of National or Strategic Infrastructure
11.5 Land Use and Development Thresholds
11.6 Designation Lapse Periods
11.7 Potential changes to Auckland Plan
11.8 On-going Public and Affected Property Owner Consultation
11.9 Continuing Iwi Engagement and Stakeholder Feedback
11.10 Funding Application
12.0 Recommendations
Executive Summary
Executive Summary

Introduction

Auckland Transport (AT) awarded the contract for the Redoubt Road- Mill Road Corridor Study to AECOM in February 2012. The study involves the upgrading of an 8.9 km arterial route between Redoubt Road in Manukau and Mill Road in Alfriston. Currently, the corridor has a poor crash record and provides a poor quality arterial connection east of State Highway 1 (SH1). Population growth and future development in the area of Flat Bush, Papakura and Takanini areas will place increased pressure on this route which necessitates the need to upgrade the corridor. This investigation follows on from a number of other studies that have been undertaken by Auckland City Council, Manukau City Council and Papakura District Council. This study utilises data and conclusions (where appropriate) from these previous investigations.

The Scheme Assessment investigation has been carried out using a staged approach. Initially all data, studies, and investigations were collated in order to identify all potential options. These options were screened by eliminating the unsuitable options prior to the technical analysis and assessment, leading to a preferred option. This preferred option was further refined based on technical assessment and public feedback. The design philosophy and likely construction staging was then developed.

Following the investigation and preliminary design phase a Notice of Requirement (NoR) is to be lodged to protect the land required for the future construction of the Redoubt Road-Mill Road Corridor.

Statement Defining the Project Objectives

The AT strategic and core objectives for the project along with those identified along with the RFT requirements are consolidated into the following project objectives that will be used:

<table>
<thead>
<tr>
<th>Category</th>
<th>Objective</th>
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<tbody>
<tr>
<td>Capacity</td>
<td>Confirm the preferred route for a 30 year planning horizon with sufficient capacity along the route to accommodate planned growth effectively and which addresses current and future predicted congestion issues, as well as providing capacity for local freight traffic.</td>
</tr>
<tr>
<td>Safety</td>
<td>Design for an appropriate level of safety to address the high crash rate, including for future traffic and multimodal users.</td>
</tr>
<tr>
<td>Resilience</td>
<td>Ensure that the corridor is a suitable secondary North/South corridor parallel to State Highway 1 to improve network security/resilience and where the risk of closure is minimised.</td>
</tr>
<tr>
<td>Connectivity</td>
<td>Provide an upgraded corridor which addresses access and mobility for walking and cycling in a safe environment, and connectivity to open spaces and community facilities.</td>
</tr>
<tr>
<td>Multi Modal</td>
<td>Ensure that the upgraded corridor makes provision for all transportation modes including road vehicles, walking and cycling and passenger transport, including provision to accommodate future changes in Public Transport use and demands.</td>
</tr>
<tr>
<td>Environmentally Sustainable</td>
<td>Manages the impact of the transport network on the local community, mitigates negative environmental impacts, and is sensitive to the cultural heritage of the area.</td>
</tr>
<tr>
<td>Constructable</td>
<td>Design a corridor which is economically justified and is able to be delivered in a staged manner.</td>
</tr>
<tr>
<td>Strategic Policy</td>
<td>The project objectives contribute to the following policy visions and objectives:</td>
</tr>
<tr>
<td></td>
<td>- New Zealand Transport Strategy (NZTS) vision</td>
</tr>
<tr>
<td></td>
<td>- Land Transport Management Act (LTMA) 2003 objectives</td>
</tr>
<tr>
<td></td>
<td>- Auckland Regional Land Transport Strategy (RLTS) 2010-30 objectives</td>
</tr>
<tr>
<td></td>
<td>- Auckland Plan transport priorities</td>
</tr>
</tbody>
</table>
Option Identification, Testing and Refinement

Initial investigations and conclusions, together with collected data and stakeholder consultation were used to identify all potential options for assessment. Initial contact with a number of property owners commenced in May 2012 when letters seeking consent to access property for geotechnical survey were issued, in parallel with a project flyer announcing the investigation phase and next stages of the project. Consultation with directly affected landowners and the wider community took place in October and November 2012 with six information days hosted by AT. In total 510 people attended the information days held in both Everglade School and Alfriston Hall. Consultation has also been undertaken with iwi commencing on 24 May 2012 with a presentation by AT.

Identified options were screened to ensure that the project objectives could be reasonably achieved and that the outcomes could be reached. Technical analysis of the options determined the engineering, social, environmental, urban design and landscaping aspects to the options. The analysis also determined the benefits and dis-benefits for the screened alignment options which were used as inputs to a multi criteria assessment of the alignment options.

The purpose of Multi Criteria Analysis (MCA) was to evaluate options against each other and remove any options which scored significantly worse than the others or had a ‘fatal flaw’ identified. In addition, the assessment identified options which scored better than others to assist with the decision making of the preferred option. The MCA identified that a combination of the Northern B and Eastern C alignment options delivers the most positive impacts across the range of criteria. The combination of these two options was considered to be the preferred alignment along the corridor, as shown below.

Option Assessment

An assessment of strategic objectives against the preferred alignment found that:

- The preferred option contributes to all five objectives of the New Zealand Transport Strategy
- The preferred option identifies a solution in support of the Government Policy Statement on Land Transport Funding (GPS) objectives by providing a safer route, with improved travel times, less congestion, supports planned land use, and links residential settlement with work centres.
- The preferred option contributes to the Land Transport Management Act (LTMA) objectives of Integration, Sustainability, Safety, Responsiveness, Economic development, Access and mobility, and Public health.
A risk assessment was carried out and the potential extreme risks include:
- Strategic objectives change through revised business case assessment
- Scope creep during the development/delivery of project
- Consents for project not obtained/challenged

A Full Risk analysis is to be undertaken during the Preliminary Design phase.

A Scheme Estimate (SE) was developed for the preferred alignments in accordance with the NZTA Cost Estimating Manual SM041, and project benefits determined in accordance with the NZTA Economic Evaluation Manual. The resulting evaluation is summarised as follows:

<table>
<thead>
<tr>
<th>Cost or Benefit Element</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Base Estimate</td>
<td>$245M</td>
</tr>
<tr>
<td>Expected Estimate</td>
<td>$297M</td>
</tr>
<tr>
<td>95th Percentile Estimate</td>
<td>$374M</td>
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<tr>
<td>Total Benefits</td>
<td>$418M</td>
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<td>Benefit Cost Ratio</td>
<td>2.2</td>
</tr>
<tr>
<td>First Year Rate of Return</td>
<td>4%</td>
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</table>

Initial Assessment Profile (Strategic Fit, Effectiveness and Efficiency) HHM

### Statutory Requirements

A NOR are required to be prepared and lodged with the Auckland Council. Resource consents will also likely be required from Auckland Council for earthworks, operational stormwater discharge, and the establishment of structures in, on, under or over the bed of a permanent stream. The following table summarises the consents potentially necessary, applicable rules, and the options likely to require consents.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Potential Applicable Rule</th>
<th>Activity Status</th>
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<tbody>
<tr>
<td>100m or More of Roading Within the Sediment Control Protection Area and Earthworks Greater than 2500m² on Slopes Greater than 15 Degrees.</td>
<td>Auckland Regional Plan: Sediment Control – Rule 5.4.3.1</td>
<td>Restricted Discretionary Activity</td>
</tr>
<tr>
<td>Establishment of Additional Impervious Area Greater than 10,000m²</td>
<td>Auckland Regional Plan: Air, Land and Water – Rule 5.5.4</td>
<td>Discretionary Activity</td>
</tr>
<tr>
<td>Discharge of Dust to Air from Earthworks Associated with the Construction of the Road</td>
<td>Auckland Regional Plan: Air, Land and Water – Rule 4.5.49</td>
<td>Permitted Activity (subject to complying with specific criteria)</td>
</tr>
<tr>
<td>Placement within the Bed or Extension of Existing Structures over the Bed of a Permanent River or Stream</td>
<td>Auckland Regional Plan: Air, Land and Water – Rule 7.5.3</td>
<td>Permitted Activity (subject to complying with specific criteria)</td>
</tr>
<tr>
<td>Use, Erection or Placement of New Structures In, On, Under or Over the Bed of a Permanent River or Stream and any Associated Bed Disturbance or Deposition</td>
<td>Auckland Regional Plan: Air, Land and Water – Rule 7.5.5</td>
<td>Permitted Activity (subject to complying with specific criteria)</td>
</tr>
<tr>
<td>Use, Erection or Placement of New Structures In, On, Under or Over the Bed of a Permanent River or Stream and any Associated Bed Disturbance or Deposition That Does Not Meet the Permitted Activity Requirements</td>
<td>Auckland Regional Plan: Air, Land and Water – Rule 7.5.9</td>
<td>Restricted Discretionary Activity (If unable to comply with specific permitted activity criteria)</td>
</tr>
</tbody>
</table>

Further technical studies are will be required to support the Notice of Requirement and Resource Consent applications.
Preliminary Design Philosophy Statement

The proposed corridor study included sections of the road which differed in form based on the adjacent land use, ranging from full urban, with a public transport requirement, to semi-rural regional arterial to rural collector. The following table is a summary of the functional requirements set out in the RFT. The complete Design Philosophy Statement is included in Appendix P.

<table>
<thead>
<tr>
<th>Sections</th>
<th>Route Description</th>
<th>Location</th>
<th>Functional Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section 1a</td>
<td>Redoubt Road – from SH1 motorway to urban fringe and Hollyford / Everglade Drive – Either side of Redoubt Road</td>
<td>Section 1a - CH0 to CH620 (Redoubt Road)</td>
<td>- Regional Urban Arterial (50km/h to 60km/h)</td>
</tr>
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<td></td>
<td>Section 1b – CH0 to CH600 (Everglade / Hollyford Road)</td>
<td>- Includes Hollyford and Everglade Drive</td>
</tr>
<tr>
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<td>- 32.4m wide corridor and 25.4m to 29m wide over lengths with existing property constraints</td>
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<td>- Bus lane along Redoubt Road</td>
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<tr>
<td>Section 2</td>
<td>Redoubt Road west of Murphys Road to SH1</td>
<td>Section 2a – CH620 to CH1290 (Redoubt Road)</td>
<td>- Regional Urban Arterial (50km/h to 60km/h) flowing into larger lifestyle block sections (urban fringe)</td>
</tr>
<tr>
<td>(2a, 2b</td>
<td></td>
<td>Section 2b – CH1290 to CH1690 (Redoubt Road)</td>
<td>- 32.4m wide corridor</td>
</tr>
<tr>
<td>and 2c)</td>
<td></td>
<td>Section 2c – CH1690 to CH2560 (Redoubt Road)</td>
<td></td>
</tr>
<tr>
<td>Section 3</td>
<td>Murphys Road north of Redoubt Road to south of Flat Bush School Road</td>
<td>Section 3a – CH0 to CH820 (Murphys Road)</td>
<td>- District Arterial (60km/h)</td>
</tr>
<tr>
<td>(3a, 3b</td>
<td></td>
<td>Section 3b – CH820 to CH1680 (Murphys Road)</td>
<td>- 30.8 to 35.8m wide corridor</td>
</tr>
<tr>
<td>and 3c)</td>
<td></td>
<td>Section 3c – CH1680 to CH1900 (Murphys Road)</td>
<td>- Adequate capacity for projected growth</td>
</tr>
<tr>
<td>Section 4</td>
<td>Redoubt Road and Mill Road east of Murphys Road through to south of Alfriston Road</td>
<td>Section 4a – CH2560 to CH2920 (Redoubt Road)</td>
<td>- Regional Rural Arterial (60km/h to 80km/h)</td>
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<tr>
<td>(4a, 4b,</td>
<td></td>
<td>Section 4b – CH2920 to CH3400 (Redoubt Road)</td>
<td>- 32.4m wide corridor</td>
</tr>
<tr>
<td>4c, 4d and</td>
<td></td>
<td>Section 4c – CH3400 to CH5300 (Mill Road)</td>
<td>- Widening at intersections and approaches</td>
</tr>
<tr>
<td>4e)</td>
<td></td>
<td>Section 4d – CH5300 to CH5750 (Mill Road)</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Section 4e – CH5750 to CH6500 (Mill Road)</td>
<td></td>
</tr>
<tr>
<td>Section 5</td>
<td>Tie-in to existing Mill Road south of Alfriston Road</td>
<td>Section 5 – CH6500 to CH7000 (Mill Road)</td>
<td>- 32.4m wide corridor</td>
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<td></td>
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<td>- Open drains instead of kerb and channel</td>
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Conclusions and Recommendations

The Redoubt Road-Mill Road corridor has been developed using a robust and comprehensive approach, the results of which have been publicly consulted to ensure stakeholder issues are understood and incorporated into the preferred option wherever practicable.

The proposed alignment (Northern C and Eastern B) meets the project objectives of AT as the requiring authority. Alternative alignments have been tested through a robust MCA process to determine the best practical solution that has an overall positive effect in terms of environmental, cultural and social impacts while meeting client requirements for funding. The outcome of these assessments would support a Notice of Requirement for the Redoubt Road-Mill Road Corridor.

The recommended option for the Redoubt Road-Mill Road corridor meets the project objectives and local, regional and national strategy and policy and can be viewed as a fundable project in line with NZTA requirements with a BCR of 2.2.

It is recommended that AT endorses and adopts the Scheme Assessment Report findings and approve proceeding to Notice of Requirement and Preliminary Design.
1.0 Introduction
1.0 Introduction

On the 29th February 2012, Auckland Transport (AT) commissioned AECOM New Zealand Ltd (AECOM) to undertake a Scheme Assessment investigation along the Redoubt Road-Mill Road corridor in the south east of Auckland. The scope of the investigation is shown in Figure 1 below. In particular the Scheme Assessment would investigate safety and capacity issues along the corridor to enable it to respond to increased future demand as a result of growth pressures.

The Redoubt Road-Mill Road corridor provides an arterial road connection east of State Highway 1 (SH1) between Manukau, Papakura and Drury. The route is coming under increasing pressure due to growth and traffic loading from commuter traffic and is expected to become more acute over time as the Flat Bush and Takanini growth areas develop.

Figure 1: Location Plan

1.1 Study Approach

The Scheme Assessment investigation has been carried out using a staged approach as portrayed in Figure 2. This staged process began by collating all available data, studies, and investigations in order to identify all potential options. These options were screened by eliminating the unsuitable options prior to the technical analysis and assessment, leading to a preferred option. This preferred option was further refined based on technical assessment and public feedback. The design philosophy and likely construction staging was then developed.
1.2 RFT Requirements

The project has multiple requirements as defined in the project scope in the RFT. These include:

- Provide an essential infrastructure upgrade to accommodate major population and industrial growth in South Auckland as predicted in the Auckland Plan and recently released Unitary Plan.

- Provide an alternative North/South corridor route parallel to State Highway 1 to improve network security/resilience.

- Provide an upgraded corridor route which addresses current and future predicted congestion issues.

- Provided an upgraded corridor route which addresses safety issues for current and future traffic and multimodal users.

- Provide an upgraded corridor which invests in Public Transport infrastructure and has provision to accommodate future changes in Public Transport use and demands.

- Provide an upgraded corridor which provides adequate provision for walking and cycling and connectivity to open spaces.

- Provide an economic efficient solution that minimises and mitigates any adverse environmental, cultural and social impacts which may result from the corridor upgrade.

In addition to these specific objectives, the study is also required to be consistent with higher strategic objectives and requirements, including the:

- New Zealand Transport Strategy (NZTS)
- Government Policy Statement on Land Transport
- LTMA
- Land Transport New Zealand Allocation Process prioritisation criteria
- Safer Journeys Strategy 2010-2020
- Auckland Regional Land Transport Strategy 2010-2040 (RLTS)
- Resource Management Act (RMA)
- Auckland Council’s Regional and District Plans.
2.0
Background Report & Initial Investigations
2.0 Background Report and Initial Investigations

The first stage of the project required the collation of existing and collection of new information. The preparation of a background report initiated this stage, as shown in Figure 3 below. This was followed by establishing the strategic context for the corridor, with the site description and collected data. In addition, Section 5.0 discusses the stakeholder consultation which was carried out to gather further information.

Figure 3: Background Report and Initial Investigations Stage

2.1 Previous Studies

A Background Report (see Appendix A) was prepared in March 2012 which identified and reviewed four previous studies that relate to the Redoubt Road to Mill Road corridor in South Auckland. These earlier studies have identified scheme options to address the increasing pressures on the existing and adjacent routes, particularly due to the planned economic growth in Flat Bush, Takanini and Papakura.

2.1.1 Hollyford Drive to Ronwood Avenue Study, 2011

This study covered the western end of the Redoubt Road-Mill Road corridor. Amongst the problems highlighted, some of the most significant were poor facilities for cyclists and pedestrians, excessive delays for buses and general congestion, becoming increasingly worse due to planned residential and economic growth.

Along Redoubt Road the scheme proposed the following:
- Widening and land acquisition to the south of the existing alignment with the northern kerbline generally on the same alignment
- Additional eastbound lane
- Cycle lanes on both sides
- Pedestrian crossing improvements

2.1.2 Ormiston Road to Redoubt Road, 2010

This study was a Quality Transit Network (QTN) Scheme Assessment relating to a 3.2km route of which Hollyford Drive forms the most southerly section. Two options were evaluated, though the Hollyford Drive section (0.5km) is only referred to as a single solution and comprises:
- Hollyford Drive widening from two lanes to four lanes
- Adding Bus priority to the existing signalled intersection with Redoubt Road
- Signalising the Hollyford Drive/Aspiring Avenue intersection and adding bus priority
The intersection of Hollyford Drive and Redoubt Road was also assessed and proposed the following:
- The southbound approach increases from 3 to 4 lanes to permit a bus-only right turn lane.
- Land take off Everglade Drive to permit safe through movements in the northbound direction due to the effect of the widened southbound approach.
- A ‘virtual’ bus lane on Aspiring Avenue with a left lane longer than the longest forecast through traffic queue (60m).

This option requires land take which was estimated to cost $1.6M. An alternative with narrower 1.5m footpaths was considered that brought costs down to $650k. The former Manukau CC was committed to the wider footpath so the original scheme was retained.

2.1.3 Manukau City Council Mill Road Corridor Study, 2011

This study evaluated the majority of the corridor of interest from west of the Murphy’s Road intersection to Ranfurly Road. The study considered ten separate options for the Redoubt Road / Mill Road corridor and four options for Murphy’s Road, which were shortlisted to three and two respectively and refined at a scheme workshop.

The proposed arterial route option for the corridor was the Option D alternative which had the following characteristics:
- Deviation from the existing alignment allowing off-line construction with minimum interference to existing traffic
- Enables Redoubt Road and Mill Road to be retained as local service roads, although results in more green field impacts
- Connections between the existing and new roads by traffic signal intersections
- A narrower cross section is possible through a reduced need to include property access
- Possibly restricting cyclists to using local service roads
- Allows a flush median to be possible due to the lack of direct property access.

The preferred Murphy’s Road option was Option K and had the following characteristics:
- It deviates from the current alignment to follow a spur to the west up to a new intersection with Redoubt Road located 50m west of the existing intersection
- Enables the new arterial to be built with minimum interference to existing traffic
- The new intersection is proposed to be at-grade to link Redoubt Road and Murphy’s Road and provides pedestrian connectivity.

2.1.4 Papakura District Council Mill Road Corridor Study, 2010

This study was a Scheme Assessment Report concerning the feasibility of improving Mill Road between the Ranfurly Road intersection southwards for 1.3km including the junction with Alfriston Road. Two main options were considered combined with two sub-options at the Alfriston/Mill Road intersection.

Option 2 with a dual roundabout at Alfriston Road was proposed, with the following characteristics:
- A favourable impact on the school and individual dwellings
- Manages traffic during congestion
- A dedicated drop-off/pick up area for the school and adjacent public amenities within the unused section of Mill Road.

2.1.5 Summary of Previous Studies

Based on the previous studies on the Redoubt Road-Mill Road corridor, the following conclusions can be drawn:
- On Redoubt Road widening on the south side is preferred, adding an additional eastbound lane, new cycle lanes on both sides and pedestrian crossing improvements.
- The Hollyford Drive / Redoubt Road intersection has additional lanes, with 4 lanes on the southbound approach to permit a double right turn and a bus-only right turn lane, 3 lanes on the eastbound and westbound approaches to allow dedicated right turn lanes and double through lanes, and 3 lanes on the Everglade Drive approach. Additional land take is needed off Everglade Drive to permit safe through movements in the northbound direction, due to the effect of the widened southbound approach.
- A separate ‘green field’ route from west of Murphy’s Road to Ranfurly Road is recommended.
- The Murphy’s Road intersection should be an at-grade intersection.
- A dual roundabout is required at Alfriston Road.

2.2 Problem Description

The Redoubt Road-Mill Road corridor is coming under increasing pressure due to growth and traffic loading from commuter traffic and is expected to become more acute over time as the local growth areas develop. The problems experienced on the corridor can be summarised as follows:

<table>
<thead>
<tr>
<th>Problem</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corridor capacity</td>
<td>The land use growth in Flat Bush, Takanini and Papakura combined with decreasing levels of service on alternative north-south routes such as SH1 and the Great South Road has led to significant traffic growth on this corridor, which has not been matched by improvements in route quality and capacity. The limited corridor capacity results in peak hour congestion, especially at the Redoubt Road / Hollyford Road intersection as well as at the connecting side roads. Analysis carried out as part of the Southern Sector Strategic Transport Study indicates that in the medium to long term, demand will exceed capacity of the current route with significantly slower travel speeds and higher levels of congestion.</td>
</tr>
<tr>
<td>Lack of pedestrian and cycling facilities</td>
<td>The route has created significant community concern in recent years, due to its safety record. Auckland Transport considers that the standard of the route at present does not align with its arterial function. There are limited cycling opportunities along the current urban section between the SH1 ramps and Murphy’s Road due to the narrow carriageway and lack of off-road cycle paths. South of Murphy’s Road to Alfriston there are no walking or formal cycle facilities, and the road alignment and high speeds makes for an unsafe journey for non-vehicle modes. Murphy’s Road is a critical link to Flat Bush and there are currently no walking or cycle facilities. Opportunities to cross the corridor do not exist as there are no formal pedestrian crossing facilities.</td>
</tr>
<tr>
<td>Access to public transport</td>
<td>Bus stops on Redoubt Road are not recessed and force traffic to wait in a queue or to overtake, with only one travel lane in each direction. This leads to long queues and congestion during busy peak hours, and creates a safety hazard if impatient drivers choose to overtake on the narrow carriageway. The current provision of public transport facilities is not in keeping with the strategic hierarchy of the route, nor is it in keeping with the importance of the public transport link between Manukau and the eastern residential areas. The public transport pressures are forecast to increase with higher levels of demand and patronage as the residential areas develop to their planned limits.</td>
</tr>
<tr>
<td>Road alignment, cross section and traffic facilities</td>
<td>The physical nature of the route is substandard for its existing and intended arterial road function with substandard horizontal and vertical curvature in places. There is currently poor provision of multimodal facilities within the corridor. The road cross section is too narrow for the forecast traffic flows, cycle facilities, public transport facilities, and pedestrian facilities. The route is not “future-proofed” against the planned growth in any of these transport modes.</td>
</tr>
<tr>
<td>Poor safety record</td>
<td>Crash analysis of corridor indicates a significant safety issue, with five fatal crashes over the most recent 5 year period, all of which occurred on the rural section of the corridor. Three of these reported crashes were ‘lost control’ type crashes. Nearly two thirds of all crashes occur in the vicinity of intersections, with a particularly high density of crashes between the SH1 ramps and Hollyford Drive.</td>
</tr>
<tr>
<td>Poor journey time reliability and congestion</td>
<td>Concerns have existed for some time regarding a lack of resilience in the transport network in the southern part of the Auckland Region. While SH1 will continue to be the preferred north-south route, the Mill Road Corridor can provide a secondary route to SH1 south of the SH20 Western Ring Route in times of high demand or emergencies.</td>
</tr>
</tbody>
</table>
2.3 Project Objectives

2.3.1 Strategic Project and Core Objectives

These strategic and core objectives are the key Auckland Transport project Objectives.

Strategic Objectives – Auckland Plan

S1. Create better connections and accessibility within Auckland.
   a) Manage Auckland’s transport as a single system.
   b) Integrate transport planning and investment with land use development.
   c) Prioritise and optimise investment across transport modes.

Core Project Objectives

C1. Improve transport access in the area of Manukau/Flatbush/Takanini/Papakura/Drury to support the growth identified within the Takanini Structure Plan area and wider southern growth area identified in the Auckland Plan.
   a) Future proof road infrastructure to meet expected growth and demand.

C2. Improve the efficiency, resilience and safety of the transport network between Manukau and Papakura.
   a) Provide an alternate north/south corridor that improves network resilience by providing an alternative route to State Highway 1.
   b) Provide an upgraded road corridor that addresses current and future network constraints identified on the transport network and improve journey time, frequency and reliability for road users.
   c) Provide an upgraded road corridor that improves safety for all road users.

C3. Provide a sustainable transport solution that contributes positively to a liveable city.
   a) Provide an upgraded road corridor which supports public transport, infrastructure and services.
   b) Provide and upgraded road corridor which provides for walking and cycling connectivity to open spaces and community services.
   c) Provide an upgraded road corridor which supports access to local community facilities.

2.3.2 Developed project Sub-objectives

The study process identified in Figure 2 was initiated in order to develop responses to the identified problems on the corridor. The project team investigated a wide range of information, followed by analysis so that the appropriate recommendations could be made for the corridor.

Figure 4 below provides details of the Issues, Problems and Objectives developed through this process as workshopped and agreed with AT and is expressed as a logic map tying together the linked Issues, Problems and Objectives. Combined with the options, these will be used to later test the project concepts through the Multi Criteria Assessment as defined later in this report.

It is noted that the project fundamentals of urban design and network performance are given assumptions, and therefore do not feature within the Issues and Problems identification process.
Figure 4: Issues, Problems and Objectives

**Issues**
- A. Safety
  - Substandard alignment geometrically
  - High number of crashes
  - Cyclist and equestrian safety-mode conflict
  - Driveway access

- B. Route Security
  - Disruption during construction
  - Network resilience

- C. Future Growth
  - Peripheral growth increasing traffic, need higher capacity
  - Over capacity for form of road
  - Growth in direct access and wider network use

- D. Social
  - Side access issues/future requirements
  - Schools and public areas (churches, parks etc.)
  - Local accessibility
  - Severance

**Problems**
- Substandard alignment geometrically
- High number of crashes
- Cyclist and equestrian safety-mode conflict
- Driveway access
- Disruption during construction
- Network resilience
- Peripheral growth increasing traffic, need higher capacity
- Over capacity for form of road
- Growth in direct access and wider network use
- Side access issues/future requirements
- Schools and public areas (churches, parks etc.)
- Local accessibility
- Severance

**Objectives**
- A corridor which is...
  - Is safe for all modes
  - Where risk of closure is minimised
  - Develops ‘One Network’ with State Highway
  - Is able to accommodate future demand effectively
  - Manages negative impact of transport network on local community
  - Mitigates negative impacts on the environment
  - Is sensitive to the cultural heritage of the area
  - Is constructible and funding is available
The Auckland Transport strategic and core objectives along with those identified in Figure 4 along with the RFT requirements are consolidated into the following core project objectives that will be used:

<table>
<thead>
<tr>
<th>Objective</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>Confirm the preferred route for a 30 year planning horizon with sufficient capacity along the route to accommodate planned growth effectively and which addresses current and future predicted congestion issues, as well as providing capacity for local freight traffic.</td>
</tr>
<tr>
<td>Safety</td>
<td>Design for an appropriate level of safety to address the high crash rate, including for future traffic and multimodal users.</td>
</tr>
<tr>
<td>Resilience</td>
<td>Ensure that the corridor is a suitable secondary North/South corridor parallel to State Highway 1 to improve network security/resilience and where the risk of closure is minimised.</td>
</tr>
<tr>
<td>Connectivity</td>
<td>Provide an upgraded corridor which addresses access and mobility for walking and cycling in a safe environment, and connectivity to open spaces and community facilities.</td>
</tr>
<tr>
<td>Multi Modal</td>
<td>Ensure that the upgraded corridor makes provision for all transportation modes including road vehicles, walking and cycling and passenger transport, including provision to accommodate future changes in Public Transport use and demands.</td>
</tr>
<tr>
<td>Environmentally Sustainable</td>
<td>Manages the impact of the transport network on the local community, mitigates negative environmental impacts, and is sensitive to the cultural heritage of the area.</td>
</tr>
<tr>
<td>Constructable</td>
<td>Design a corridor which is economically justified and is able to be delivered in a staged manner.</td>
</tr>
</tbody>
</table>

Strategic Policy

The project objectives contribute to the following policy visions and objectives:
- New Zealand Transport Strategy (NZTS) vision
- Land Transport Management Act (LTMA) 2003 objectives
- Auckland Regional Land Transport Strategy (RLTS) 2010-30 objectives
- Auckland Plan transport priorities
3.0 Site Description
3.0 Site Description

The description of the site sets the context within which the corridor presently operates. Also discussed are the future growth scenarios, which are useful in understanding the future context for which the corridor needs to be planned.

3.1 Description of Study Area

The Redoubt-Mill Road corridor provides an alternate north-south route to SH1 between Manukau, Papakura and Drury and covers a total of 8.9km. The corridor study area commences at the SH1 on and off ramps on Redoubt Road and runs east then south along Redoubt Road to the Mill Road intersection. From here, the corridor continues south along Mill Road, concluding just south of Alfriston Road near Pope Road. Two side roads are also included within the study, Murphys Road between Redoubt Road and Flat Bush School Road (1.8km) and Hollyford Drive north of Redoubt Road (0.2km).

With high growth anticipated in the Flat Bush and Takinini areas, the Redoubt-Mill Road corridor will become an increasingly important strategic link in south Auckland.

A map displaying the greater area within which the corridor operates is shown in Figure 5. The map indicates land use and zoning that will impact on the corridor, as well as some of the key features in the vicinity.

3.2 Local Area Description

The Redoubt Road-Mill Road corridor fulfils a variety of functions. It has District Arterial status in the Auckland Council District Plan (Manukau Section) and it is defined as a Regional Arterial in the Auckland Plan. The route is also part of the Auckland Transport’s Auckland Regional Cycle Network and notated on Map 13.3 of the Auckland Plan as a section of the regional cycle network. See Section 0 for further information.

Currently the corridor serves as predominantly a rural arterial providing access and mobility to the wider east Manukau area. At the western end of the route its function changes, becoming an urban arterial catering for a wide variety of land uses and a number of different modes including public transport, walking and cycling. The Redoubt Road – Mill Road corridor is included in Map 13.2 of the Auckland Plan (Auckland’s Priority Transport Projects (2012 – 2042)) as a priority network improvement.

Figure 5 below shows the land use profile in the area. The western end of Redoubt Road is zoned Main Residential in the Auckland Council District Plan (Manukau Section). As a result, land uses are predominantly medium density residential development. The exceptions are motels located at 21 Redoubt Road and 104 Redoubt Road and a Church of Jesus Christ of Latter Day Saints located at 19 Redoubt Road. The land use pattern then transitions to the east into lower density countryside living development. Totara Park, a significant public open space of approximately 216ha, adjoins the southern side of Redoubt Road. The park has approximately 1.3km of road frontage. A telecommunications mast (designation 116) is located on the southern side of Redoubt Road at the northern edge of the park approximately 200m west of the Redoubt Road / Murphy’s Road intersection. The Totara Park Equestrian centre is also located within the park at 251 Redoubt Road.

The Murphy’s Road section of the alignment is about to undergo significant change. This section of the corridor sits within the Flat Bush Structure Plan area. Development in Flat Bush is anticipated to be equivalent to that of a small to moderately sized city. Based on population growth forecasts, it is expected that development of the area will be substantially complete by 2025 and will have reached a population of approximately 40,000. The majority of Murphy’s Road is currently zoned Future Urban in the Auckland Plan (Manukau Section) in recognition of its future transition from rural to an urban environment. The Flat Bush Structure Plan shows land adjacent Murphy’s Road as being rezoned to residential. The Flat Bush Structure Plan is commented on in more detail in Section 3.3 below. The top (southern end) of Murphy’s Road is zoned Countryside Living and contains typical semi rural lifestyle development.

Alfriston School is situated on the corner of Mill Road and Alfriston Road at the southern end of the study area. Other schools close to the study area include Tyndale Park Christian School, Everglade school and Chapel Downs School.
3.3 Special Features

The following special features have been identified within and around the road corridor:

- The South Western Motorway-State Highway 20 (designation 284) extends up Redoubt Road to approximately adjacent St Johns Redoubt.
- Totara Park, a significant public open space of approximately 216ha, adjoins the southern side of Redoubt Road. The park has bridle trails, mountain bike trails and an equestrian centre located at 251 Redoubt Road.
- An overhead power line with high tension cables crosses Redoubt Road in the vicinity of No 181 with a pylon approximately 10m from the road edge
- A telecommunications mast (designation 116) is located on the southern side of Redoubt Road at the northern edge of the park approximately 200m west of the Redoubt Road / Murphys Road intersection.
- A high pressure gas pipeline (Designation 290) joins Murphy’s Road at the southern extent of Murphy’s Bush. This pipeline follows Murphy’s Road beyond Flat Bush School Road.
- Watercare’s Hunua 4 pipeline (designation 307) crosses beneath Murphy’s Road at the intersection of Hodges Road and Thomas Road. This designation falls in the path of proposed NOR 2.
- Watercare has a pump station (designation 147) at the intersection of Thomas and Murphy’s Road.

A sensitive ridge notation applies to countryside living and rural zoned land either side of Redoubt and Mill Roads. The notation commences adjacent the eastern side of Hilltop Road and ends approximately 500m north of the intersection of Mill Road and Ranfurly Road. The notation seeks to protect the rural character and landscape quality of the area and to ensure that activities are carried out in a sensitive manner.

Watercare have a water reservoir facility (designation 150 in the Auckland District Plan (Manukau Section) on a large land holding commencing approximately 400m south of the intersection of Redoubt and Mill Road.

The road corridor passes in close proximity to four areas of indigenous forest and scrub (Murphy’s Bush and three forest areas to the east of the current Mill Road alignment), Murphy’s Bush through which the proposed road corridor passes, is one of the largest remnants of indigenous forest remaining in the north of the Manukau Ecological District.

The road corridor is drained by headwater streams within two main catchments being the Totara Creek (which drains into Puhinui Creek) and Papakura Creek. A headwater stream which forms part of the Otara Creek catchment is located at the northern extent of Murphy’s Bush. Nine indigenous freshwater species and one freshwater crustacean (koura) are known to occupy the catchments.

The headwater stream which forms part of the Otara Creek catchment, is notated as part of the Stormwater Management Area on Planning Map 40 of the Auckland Council District Plan (Manukau Section).

Three areas of archaeological sensitivity have been identified along the corridor:

- There is the potential for buried archaeological remains associated with early European occupation and activity at the intersection of SH1 and Redoubt Road in the proximity of St Johns Redoubt (R11/534).
- Three sites are located at the intersection of Mill Road and Alfriston Road (R11/2063, R11/2069 and R11/2074). These recorded sites consist of the previous site of the first Alfriston Presbyterian Church, a post office and store and “the meeting house” at 350 Alfriston Road.
- There are three recorded sites in proximity to the intersection of Murphy’s Road and Flat Bush School Road. Murphy’s Homestead (CHI 12439) is located at 141 Flatbush School Road. Flatbush School (CHI2776) is located at 160 Murphy’s Road. Baverstock cottage (R11/2745) is located next to the Flatbush School hall.
3.4 Land Use and Growth Scenarios

In terms of current population, Manukau, through which a predominant portion of the alignment passes, has been the fastest growing area in New Zealand. Between the 2001 and 2006\(^1\) Census Manukau showed the biggest growth in usually resident population numbers from 283,197 in 2001 to reach 328,968 in 2006. The former boundaries of the Papakura District (at the southern end of the alignment) has a population of 45,183 (2006 Census) which is growth of 11.1\% when compared to the previous 2001 Census.

In terms of future growth, the Auckland Plan is the long-term strategy to guide Auckland’s future growth over the next 30 years. The plan was adopted by Auckland Council’s governing body on 29 March 2012. Based on growth estimates the plan expects Auckland's population to grow by 1 million people over the next thirty years. The Auckland Plan expects that most growth will be accommodated in a quality compact urban form via intensification in pre-existing urban areas that prevents excessive expansion into the rural hinterland. Most growth will be focused on centres and urban corridors. The future form will comprise a network of centres (and their walkable catchments) connected by transport corridors which will accommodate a sizable proportion of the housing and employment growth. Figure 6 shows the extent of operative and planned urban development land in Manukau, Papakura and Takanini.

Manukau City Centre, Botany Centre and Papakura all of which are in proximity to the corridor, are defined as Metropolitan Centres in the Auckland Plan. Metropolitan Centres are expected to be major social, economic and high density residential hubs supported by high frequency public transport. Notwithstanding high quality public transport networks, these centres are expected to become high traffic generators over the next 30 years.

The road corridor also falls within the Auckland Plan Southern Initiative (refer Figure 6 below). This is one of two big initiatives in the Plan, the other being the transformation of the City Centre. The purpose of the southern initiative is to plan and deliver a long term programme of coordinated investment and actions to bring about social, economic and physical change. As a result of a desire to grow business and jobs within the initiative area it is likely that travel demand will increase within the corridor.

\(^1\) Latest available census data as a result of Canterbury earthquakes
The Murphy’s Road portion of the corridor sits within the Flat Bush Structure Plan area (refer Figure 7 below).
Figure 7: Flatbush Structure Plan (Source: Auckland District Plan (Manukau Section))

Murphy's Road
The Auckland Plan assigns town centre status to Flat Bush (re-named Ormiston in the Auckland Plan). It is considered market attractive being a centre where there is strong market potential for growth, and which requires limited public sector support. Flat Bush is New Zealand’s largest and most comprehensively planned new town. Its land area is approximately 1,700 hectares. It has approximately 20 hectares set aside for a town centre. The Structure Plan area includes five neighbourhood centres and five schools. Development in Flat Bush is anticipated to be equivalent to that of a small to moderately sized city. Based on population growth forecasts, it is expected that development of the area will be substantially complete by 2025 and will have reached a population of approximately 40,000. Stage one of the Flat Bush development commenced in 2001 and approximately 70% of stage one is committed to development. Stage 2, which is being implemented via proposed Plan Change 20 to the Manukau section of the Auckland Plan, consists of 342 hectares of land currently shown as future urban on Auckland Council District Plan (Manukau section) Planning Maps. The development of Flat Bush addresses intensification policies in the Auckland Regional Policy Statement and agreements (the Southern Sector Agreement) reached under the Auckland Regional Growth Strategy. The development strategy for Flat Bush provides a framework of zonings and plan provisions which is consistent with the outcomes sought in these regional plans.

A neighbourhood centre is proposed at the intersection of Flat Bush School Road and Murphy’s Road. Development of this centre requires preparation of a Comprehensive Development Plan.

The area to the east of the Mill Road corridor has been identified as a rural area in the Auckland Plan that will have Countryside Living characteristics. As a consequence, this area will provide lifestyle type development with good amenity and hobby-scale farming and productive sites. Country Living areas are the interface between the urban and rural environment and will absorb demand for rural subdivision, protecting more sensitive areas.

Private Plan Change 38 seeks to re-zone 5.1 hectares of land at 49, 57 and 71 Mill Road from Rural 3 to Main Residential. The Plan Change allows for a maximum of 45 new residential sites immediately adjacent to “The Gardens” residential development. The Plan Change area will not have direct vehicle access to Mill Road.

Having regard to the Alfriston Road end of the corridor, which falls within the former Papakura District, the Auckland Plan, Auckland Regional Growth Strategy and Southern Sector Agreements allocate considerable growth to the area in the form of new settlements in Takanini (implemented via the Takanini Structure Plan) and Hingaia, as well as intensification around Papakura Town Centre and its associated urban area. The area is expected to accommodate a population in the vicinity of 94,000 by 2050, representing an increase of 135%. This growth comprises an additional 17,000 in the existing urban area, 2,000 in rural areas and 30,000 in the new settlements of Takanini (20,000) and Hingaia (10,000).

Takanini Structure Plan areas 6A/6B which are bounded by the Papakura Stream to the north, Porchester Road to the east, existing residential properties along Manuroa Road to the south and Takanini School Road to the west recently became operative (via Plan Change 15 to the Auckland Council District Plan: Papakura Section). The Plan Change re-zoned around 51 hectares of rural land to a combination of industrial (41.41 hectares), residential (5.04 hectares) and reserve (4.7 hectares)

To the south west of the road corridor the Drury South Structure Plan proposes the industrial zoning of 201 hectares supported by 22 hectares of commercial services development. The Structure Plan and industrial rezoning has been put forward by the Stevenson Group Limited through a private Plan Change request (Plan Changes 12 and 38) to the Papakura and Franklin sections of the Auckland Council District Plan. The site is bounded by State Highway 1 in the west, the Drury Quarry and the Hunua foothills in the east and the rural areas of Fitzgerald Road in the north and Arimu Road in the south. The development enabled by the Plan Changes is anticipated to attract in the vicinity of 6,880 employees. The Plan Changes create the opportunity to connect with the Mill Road corridor (south of the study area) via a new north-south arterial through the site.

Further growth is also anticipated in Clevedon Village, which is approximately 12km to the east of the Mill Road / Alfriston Road intersection. The Clevedon Village structure plan which is being implemented via Plan Change 32 to the Auckland District Plan (Manukau Section) anticipates an additional 600 dwellings establishing in the Clevedon village.
3.5 Significant Associated Transport Plans and Projects

3.5.1 Regional Land Transport Programme

The Regional Land Transport Programme (RLTP) outlines Auckland Transport’s projects over a three year period. The current RLTP is for the period 2012-2015. The RLTP also identifies projects for the next 4-10 years, although these projects have zero funding in the three year period of the RLTP. Projects adjacent to Mill Road, Redoubt Road and Murphys Road are identified within the RLTP are shown in Table 2.

For the AT Profile the first letter represents the project’s Strategic Fit, the second the Effectiveness and the third the Efficiency. Each category is rated High (H), Medium (M) or Low (L). The locations of the projects are shown in Figure 8.

Table 2: RLTP Projects in the vicinity of the corridor

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Year</th>
<th>AT Profile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chapel Road realignment and new bridge</td>
<td>2014/15</td>
<td>MHH</td>
</tr>
<tr>
<td>Ormiston Road widening (Ti Rakau Drive – Chapel Road)</td>
<td>2014/15</td>
<td>MHH</td>
</tr>
<tr>
<td>Murphy’s Road Bridge Improvements (Manukau)</td>
<td>2013/14</td>
<td>MHH</td>
</tr>
<tr>
<td>Flat Bush School Road – Stage 4</td>
<td>2013/14</td>
<td>MHH</td>
</tr>
<tr>
<td>Murphy’s Road Upgrade – Murphy’s Bush Roundabout</td>
<td>2013/14</td>
<td>HMH</td>
</tr>
<tr>
<td>Botany to Manukau RTN</td>
<td>2014/15</td>
<td>HHL</td>
</tr>
<tr>
<td>Flat Bush to Manukau City Centre (Bus Priority Improvement)</td>
<td>2013/14</td>
<td>MHL</td>
</tr>
<tr>
<td>Thomas Road culvert replacement</td>
<td>2015/16</td>
<td>MMM</td>
</tr>
<tr>
<td>Manukau City Rail Link (Manukau Transport interchange)</td>
<td>2012/13</td>
<td>HHM</td>
</tr>
<tr>
<td>Great South Road (Manukau Central to Drury)</td>
<td>2015/16</td>
<td>MHL</td>
</tr>
<tr>
<td>Alfriston Stratford intersection upgrade</td>
<td>2015/16</td>
<td>HMH</td>
</tr>
<tr>
<td>SH 1 Hill Road to Takanini Southbound 3L</td>
<td>2013/14</td>
<td>HMM</td>
</tr>
<tr>
<td>SH 1 Takanini to Papakura 6L</td>
<td>2013/14</td>
<td>HMM</td>
</tr>
<tr>
<td>Papakura Bus and Rail interchange</td>
<td>2014/15</td>
<td>HHL</td>
</tr>
<tr>
<td>Papakura Station upgrade</td>
<td>2012/13</td>
<td>HHM</td>
</tr>
</tbody>
</table>
Under the operative Manukau District Plan, the Redoubt Road – Mill Road corridor is classified as a District Arterial Route. As a consequence, the corridor falls under the Primary Road Zone with the overriding objective of providing safe and efficient through movements. The District Plan does not outline any standards as to cross section characteristics, speed limits or special requirements.

Regional Arterial Road Plan

The Regional Arterial Road Plan (RARP) was developed by the Auckland Regional Transport Authority (ARTA) to define the role and function of arterial roads, provide a framework for their management, prioritise projects and develop a funding rationale. The plan became operative in 2009.

The Redoubt Road-Mill Road corridor is identified as a Proposed Regional Arterial Road under the RARP, with the exception of Murphy’s Road. The corridor is identified as having a key role in providing access between Flat Bush and the Manukau CBD, especially for passenger transport.

The following functional classifications for regional arterial roads are documented within the RARP:
- High general traffic volume,
- High passenger transport frequency,
- High cycle demand,
- High freight volume.

The Redoubt Road – Mill Road corridor is not considered to fall under any of these classifications. Additionally the RARP does not consider that the corridor has an important place function.

**Regional Land Transport Strategy**

The Regional Land Transport Strategy (RLTS) outlines principles for the management of Regional Arterial Roads:

- On regional arterial roads, the movement of people and goods on the road should generally have priority over the access function of the road
- On both strategic and regional arterial corridors, provision should be made for pedestrians and cyclists to move safely and conveniently
- Both strategic and regional arterial roads should facilitate the movement of heavy motor vehicles
- Both strategic and regional arterial roads should be designed to accommodate public transport and to provide priority for public transport vehicles where warranted by demand and traffic conditions
- The design and operation of regional arterial roads should support the amenity of communities they pass through
- Where regional arterial roads pass through high-density centres and corridors, the balance of travel and land use demands should be carefully considered to ensure that the road network supports the growth strategy in an integrated manner
- Consistent, coherent and high-quality signage (both directional and street) should be implemented on strategic and regional arterial roads.

**3.5.3 Auckland Regional Passenger Transport Network Plan**

The current Auckland Regional Passenger Transport Network Plan (ARPTNP) provides the strategy for developing Auckland’s passenger transport network for the 10 year period 2006-2016. Specifically the plan outlines two key network types: the Rapid Transit Network (RTN) and Quality Transit Network (QTN), providing different levels of service.

The RTN will consist of a modern and electrified rail network and an expanded busway system operating at high frequency with high quality services along transport spines. The QTN will provide for cross town movements and will cater for movements not included in the RTN. The QTN will utilise strategic bus corridors and bus priority measures to provide this level of service.

However this categorisation is in the process of changing. The soon to be released Integrated Transport Plan redefines the QTN as the Frequent Service Network. The new service network structure is built around a core network of frequent services, including the existing rapid transit services and supplemented with a number of high-frequency bus routes connecting major centres.

The Frequent Service Network will deliver at least a 15-minute service operating all day and will be complemented by a network of connector routes that operate all day at half-hourly frequencies. In addition, a supporting network of local services, peak-only services, and targeted services will cater for specific market needs.

The Redoubt Road-Mill Road corridor is identified both as part of the QTN and also on the 2016 Frequent Service Network, with a route that follows the Chapel Road / Aspiring Road / Hollyford Road / Mill Road corridor between Botany Town Centre and Manukau City.

**3.5.4 Regional Cycle Network Plan**

The Redoubt Road – Mill Road corridor is included on the existing Regional Cycle Network and will form part of the consolidated Auckland Cycle Network (ACN). The entire extent of the corridor, including Murphys Road, is classified as a proposed part of the Regional Cycle Network. Chapel Road which connects to the northern part of the corridor and Ranfurly Road to the south are also identified as proposed routes.

Currently under development, the ACN will consolidate the existing Regional Cycle Network and other legacy Cycle Networks into a coherent plan for Auckland. The ACN will form part of the ‘one network’ of transport options in Auckland, with the aim that it will be completed by 2031. The Redoubt Road-Mill Road corridor will form part of the consolidated ACN.
Design standards and cycle typologies are still under development as part of the ACN review. The likely network hierarchies to be recommended under the CAN include Cycle Highways, Cycle Connectors, and Cycle Feeder.

For the extents of the Redoubt Road – Mill Road corridor study the following hierarchies are likely to be applicable:

- **Cycle Highway:** This is most likely to follow the PT route along Redoubt Road between SH1 and Hollyford Drive, extending across the SH1 bridge westwards and up Hollyford Drive northwards to Aspiring Ave. The Cycle Highway is intended to provide the best possible facilities possible to cyclists.

- **Cycle Connector:** This is most likely to follow Redoubt Road eastwards from the Hollyford intersection, continuing along the length of Murphy’s Road and Mill Road down to Ranfurly Road. The Cycle Connector also includes Ranfurly Road west of Mill Road. Cycle Connectors will not be as highly specified as Cycle Highways, but are intended to provide good cycle facilities, including marked on-road cycle lanes.

- **Cycle Feeder:** There are not likely to be any Cycle Feeder routes within the study area.

### 3.5.5 Integrated Transport Plan

The Auckland ITP is currently under development and once issued will supersede many of the existing ‘Regional’ documents including the ARPTNP and RCN.
4.0 Collected Data
4.0 Collected Data

In addition to the existing data this study collected further data within the corridor. This included topographical survey and geotechnical testing, ecological studies, an historical assessment, and investigating the impact of traffic noise along the corridor.

4.1 Topographic Survey

A topographical survey utilises the original Opus survey merged with existing LiDAR information in all areas which were not covered by the Opus project. Areas not covered have had a full topographical survey undertaken which will then be used in the Preliminary design phase.

This survey generally covered the roading corridor and essential private land. It is planned to have the preliminary design completed using this survey to ensure enough detail is available to accurately identify property effects and the need for land for the works. The detail obtained from the preliminary design will also provide sufficient detail to accurately identify the areas requiring alteration to designation.

4.1.1 General Topography

The general topography varies from relatively flat urban terrain to rolling rural countryside.

Properties from CH0 to CH1300 Redoubt Road and CH0 to CH600 Everglade Drive/Hollyford Drive are all urban residential, with the topography changing from flat to steep with some existing steep driveways affected.

The alignment from CH1300 to CH3500 Redoubt Road is bordered by larger residential sections or countryside living and reserves (Totara Park). The road runs along a ridge with the residential grades generally falling away from the outer berms or road corridor.

CH3500 to CH5200 Redoubt Road/Mill Road runs through generally open farm land due to the steep terrain and crosses the existing Mill Road and two stream gullies.

From CH5200 to the end at CH6900 the surrounding terrain is generally very flat with deep open roadside drains while land use is predominantly open paddocks with isolated residences.

Murphy’s Road CH0 to CH1900 (the intersection with Redoubt Road) starts at the bottom of the hill, surrounded by flat farm land. The terrain quickly changes as the alignment tracks up the hill to the intersection with Redoubt Road on the ridge with a vertical grade of 9%.

4.1.2 Survey to date

The Draft Scheme Assessment drawings (shown in Volume Three) have been generated from a 3D design model designed in MX using AutoCAD for the output files.

A GIS based LiDAR survey (Light Detection And Ranging) combined with data from a previously undertaken topographical survey was used to develop the digital 3D terrain model. The LiDAR survey has been produced to an accuracy of 1m.

Ortho-rectified aerial photography has been used to provide backgrounds and visual tie-in locations.

4.1.3 Anticipated Requirements for the Preliminary Design

A Preliminary Ground Survey in accordance with NZTA’s Minimum Standard Z/16 standard (section 6, table 1) is recommended for the preliminary design. Bridge tie-in points and intersections will require specific attention.

The required accuracy of the control survey is:
- X and Y Co-ordinates: ±20mm in plan in any direction and
- Z Co-ordinate: ±10mm in level.

The survey has to be produced in Geodetic Datum 2000. Where GPS is used, the survey shall make use of the orthometric height origin. Table 3 details the required topographical survey accuracies.
### Table 3: Topographic Survey Accuracy

<table>
<thead>
<tr>
<th>Feature</th>
<th>Northing/Easting</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carriageways and solid surfaces, culvert inverts and drainage system water levels</td>
<td>±50mm</td>
<td>±50mm</td>
</tr>
<tr>
<td>Spot heights on grassed areas</td>
<td>±150mm</td>
<td>±200mm</td>
</tr>
<tr>
<td>All other features</td>
<td>±100mm</td>
<td>±80mm</td>
</tr>
</tbody>
</table>

### 4.2 Traffic Information

#### 4.2.1 Traffic Flows

The Southern Strategic Saturn traffic model (S3M) has been calibrated according to traffic data in the southern area surrounding the corridor. Traffic flows along Mill Road, Redoubt Road and Murphy’s Road have been extracted from the S3M for 2011 are shown in Table 4. The traffic flows represent midblock AADT in total vehicles per day.

#### Table 4: Traffic Flows

<table>
<thead>
<tr>
<th>Location</th>
<th>2011 AADT (vpd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Redoubt Road East of SH1</td>
<td>22,000</td>
</tr>
<tr>
<td>Redoubt Road East of Hollyford Dr</td>
<td>10,000</td>
</tr>
<tr>
<td>Mill Rd South of Redoubt Rd</td>
<td>13,500</td>
</tr>
<tr>
<td>Mill Rd North of Alfriston Rd</td>
<td>9,000</td>
</tr>
<tr>
<td>Mill Rd South of Alfriston Rd</td>
<td>11,000</td>
</tr>
<tr>
<td>Murphy’s Rd North of Redoubt Rd</td>
<td>10,500</td>
</tr>
</tbody>
</table>

#### 4.2.2 Proportion of HCVs

The existing proportion of HCVs along the Redoubt Road-Mill Road corridor has not been determined. For modelling purposes an estimate of 5% has been assumed.

#### 4.2.3 Cycle Traffic

The Auckland Regional Cycle Monitoring Plan has been in operation since 2007 and collects cycle counts annually at certain locations throughout Auckland. This enables a consistent methodology to be applied to cycle counts and allows accurate comparison over time. There are no monitoring points within or adjacent to the Redoubt Road-Mill Road corridor.

#### 4.2.4 Public Transport

There are no existing public transport routes that utilise the Mill Road section of the corridor. Five routes are however present on Redoubt Road between Hollyford Drive and State Highway 1.

#### Table 5: Frequencies and Operational Hours of Current Bus Services

<table>
<thead>
<tr>
<th>Service</th>
<th>Hours of Operation</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>457 / 457X</td>
<td>Otahuhu, Downtown via Otara</td>
<td>6:25am – 10pm, 3:05pm – 6:30pm</td>
</tr>
<tr>
<td>466</td>
<td>Manukau City Centre to Manurewa via Everglade Terrace and the Gardens</td>
<td>6:25am – 7:20pm</td>
</tr>
<tr>
<td>497 / 497X</td>
<td>Otahuhu, Downtown via Otara</td>
<td>5:30am – 11:10pm</td>
</tr>
<tr>
<td>566</td>
<td>Wattle Downs to East Tamaki via Wiri, Manukau City and Chapel Road</td>
<td>6:25am – 7:20pm</td>
</tr>
<tr>
<td>580</td>
<td>Manukau City Centre to Howick via Stancombe Road and Botany Town Centre</td>
<td>6:10am – 7:10pm</td>
</tr>
</tbody>
</table>
In addition to these routes the 568 route runs adjacent to the Mill-Redoubt Road corridor along Alfriston Road at 30 min frequencies between 6:15am and 5:45pm.

Currently there are four bus stops within the corridor. These are located either side of the Diorella Drive intersection.

4.3 Crash Statistics

Using the CAS online database, crash data for the Mill-Redoubt Road corridor for the period 2007-2011 has been analysed. Overall, there were 301 crashes in the defined period, with 90 of these causing injuries. Crash data extracted from CAS is appended in Appendix B.

The different characteristics along the corridor have resulted in a varied distribution of crash types and factors. The majority (69%) of crashes along the route were located along the urban area.

There were 5 fatal crashes during this period. All occurred in the rural section of the corridor and are diagrammatically shown in Figure 9. Three of these being loss of control type crashes, one cutting corner type crash and the final one due to failure to give way.

There were 10 serious injury crashes on the corridor with 75 resulting in minor injuries. Figure 10 shows the crashes clustered by location. From this it is clear that the majority of the crashes (65%) occurred near intersections along the corridor. However, there are significant ‘hot-spots’ at curves in the road where crashes are common. In total 29% of all crashes are as a result of loss of control on bends in the road, with all of these crashes occurring in the rural or urban-rural interface of the corridor. A further 6% of crashes were as a result of losing control on straight sections of the road, again in the rural section of the corridor.

30% of all crashes were rear end / obstruction type crashes, most of which were located within the urban section of the corridor. Crossing / turning crashes accounted for 26% of crashes with many of these occurring in the urban section of the corridor, and a significant number at the Murphy’s Road intersection.

The major factors influencing crashes are poor observation (33%), failure to give way / stop (24%) and poor handling (21%). A further 15% of crashes were as a result of road factors.

Time of day does not appear to be a significant factor in causing crashes, with 65% of crashes occurring in light or overcast conditions. 33% of crashes occurred in wet or icy conditions, however, weather was only considered to be a factor in 4% of crashes. This indicates that weather is not a large influence on crashes within the corridor.
There has been a consistent trend in the annual numbers of crashes which range between 55 and 60 crashes a year. The only outlier is 2008 in which there were 72 crashes.

Figure 10: Mill-Redoubt Road Crash Locations 2007-2011
4.4 Geotechnical Testing

4.4.1 Preliminary Geotechnical Appraisal Report

Three preliminary geotechnical appraisal reports (PGAR) have been prepared for options or parts of options within the study area as follows:

- Opus Consultants Limited, Mill Road to Redoubt Road Corridor Study, PGAR dated July 2008
- GHD Limited, Hollyford to Ronwood Corridor Study, PGAR dated October 2010
- AECOM New Zealand Limited, Redoubt to Mill Road Corridor, PGAR dated July 2012.

The Opus PGAR includes nine main options with three additional Murphy’s Road options between the Redoubt Road / Hollyford Drive junction and Mill Road / Ranfurly Road junction. The PGAR includes a summary of a qualitative geotechnical risk assessment and concludes that Opus options C, D, E and J appear to be the preferred options for the main alignment. All options for Murphy’s Road are suitable from a geotechnical perspective.

The GHD PGAR only considers widening of the southern side of Redoubt Road from SH1 to the Redoubt Road / Hollyford Drive junction.

The AECOM PGAR includes a review of the previous PGARs above. The main geotechnical risks for the project identified in the PGARs are summarised as follows:

- Deep and shallow slope instability associated with the Southern Landslide Zone
- Foundation stability of sidling / embankment fills
- Stability of cut slopes, particularly where bedding plane shear features are exposed
- Control of groundwater, including seeps and springs from gullies and cut slopes
- Construction adjacent to and over existing infrastructure.

Based on the above, the PGARs generally conclude that where possible areas of instability should be avoided and that care is required when designing and constructing the cut and fill sections of the alignment to ensure stability. Where areas of instability require to be traversed, it is expected that significant engineering measures will be required to ensure the stability of deep cuts and high fills. This is likely to include drainage of slopes and underdrainage beneath fills and the use of retaining structures and soil reinforcement techniques.

All PGARs recommend geotechnical investigations, although the scope is not defined in the Opus PGAR. A full copy of each report is included in Appendix C.

4.5 Aquatic and Terrestrial Ecology

An Ecological Assessment Report was conducted by Wildlands Consultants Ltd and is included in Appendix D, the main findings of the report are summarised below.

The corridor lies within both the Manukau and Hunua Ecological Districts. Murphy’s Bush through which the proposed road corridor passes, is located within the Manukau Ecological District. It is one of the largest remnants of indigenous forest remaining in the north of the Manukau Ecological District. This forest, which regenerated following logging and forest clearance in the 1880s is regarded as the best remaining example of dense Kahikatea forest in Auckland.

The Mill Road corridor passes in close proximity to three forest areas in the Hunua Ecological District all to the east of the current road alignment. The Hunua Ecological District is known as valuable habitat for indigenous wildlife, supporting at least 52 bird species, four lizard species, one species of frog, 22 freshwater species, two freshwater crustacean species and over 100 species of land snail. Long tailed bats are also present in this ecological district and may utilise forest habitats within the corridor.

The corridor crosses headwater streams within two main catchments being the Totara Creek (which drains into Puhinui Creek) and Papakura Creek. Nine indigenous freshwater species and one freshwater crustacean (koura) are known to occupy the catchments. The small headwater streams which the alignment crosses are most likely to be the habitat for longfin eel, shortfin eel, Cran’s bully, banded kokopu, koura and koura. Of these, longfin eel and koura have a threat ranking of “At Risk Declining” and Koura has a threat ranking of “At Risk-Gradual Decline.”
4.6 Historical

Clough and Associates have prepared an archaeological assessment of the corridor. The assessment notes that the likelihood of previously undetected Maori archaeological sites being discovered along the corridor is low. A full copy of the archaeological assessment is included in Appendix E.

There is the potential for buried archaeological remains associated with early European occupation and activity at the intersection of SH1 and Redoubt Road in the proximity of St Johns Redoubt (R11/534).

Three recorded sites are located at the intersection of Mill Road and Alfriston Road (R11/2063, R11/2069 and R11/2074). These recorded sites consist of the previous site of the first Alfriston Presbyterian Church, a post office and store and “the meeting house” at 350 Alfriston Road.

There are three recorded sites in proximity to the intersection of Murphy’s Road and Flat Bush School Road. Murphy’s Homestead (CHI 12439) is located at 141 Flatbush School Road. Flatbush School (CHI2776) is located at 160 Murphy’s Road. Baverstock cottage (R11/2745) is located next to the Flatbush School hall.

The report also indicates that there are potential heritage items within the vicinity of Redoubt Road and its intersection with Mill Road. These potential items consist of old hedges, ditches and banks and post and wire fences. The report notes that no visual evidence of these features was identified during previous survey work in this vicinity.

There is a possibility of unknown Maori artefacts / taonga being unearthed during construction.

The report also notes the large stone gates and walls at the entrance to Totara Park. Although unlikely to be heritage items the report recommends retaining them if possible.

4.7 Acoustics

A survey of existing noise levels has been carried out adjacent to the current alignment of Redoubt Road and Mill Road in order to establish the baseline conditions and to validate the noise modelling predictions. A copy of the full Traffic Noise Assessment Report is included in Appendix F.

An environmental noise logger was installed in accordance with the procedures prescribed in NZS 6801:2008, Acoustics - Measurement of Sound as required by NZS 6806 at three locations, 14 Redoubt Road building façade, 51 Murphy’s Road boundary and 111 Mill Road boundary. The survey period was 48 hours. A summary of the measured noise levels is presented in Table 6.

<table>
<thead>
<tr>
<th>Location No.</th>
<th>Property Address</th>
<th>Measurement Period</th>
<th>$L_{Aeq, 24hr}$, dB(A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>14 Redoubt Road</td>
<td>03/04/13 – 04/04/13</td>
<td>67</td>
</tr>
<tr>
<td></td>
<td></td>
<td>04/04/13 – 05/04/13</td>
<td>67</td>
</tr>
<tr>
<td>2</td>
<td>51 Murphys Road</td>
<td>03/04/13 – 04/04/13</td>
<td>62</td>
</tr>
<tr>
<td></td>
<td></td>
<td>04/04/13 – 05/04/13</td>
<td>60</td>
</tr>
<tr>
<td>3</td>
<td>111 Mill Road</td>
<td>03/04/13 – 04/04/13</td>
<td>71</td>
</tr>
<tr>
<td></td>
<td></td>
<td>04/04/13 – 05/04/13</td>
<td>71</td>
</tr>
</tbody>
</table>

A computer model has been generated in SoundPLAN to enable comparison between the noise impact of the existing road alignment and the noise impact of the proposed road alignment. The model was generated using topographic contours, building footprint details, existing & proposed road alignments, road surface details and traffic flow data. The accuracy of the model was determined by comparing the predicted noise levels for the existing road alignment with the noise levels measured during the survey. Averaged $L_{Aeq, 24hr}$ noise levels measured during the survey were shown to fall within ±2dB of those predicted by the model and as such the modelled noise levels are considered acceptable under the requirements of NZ6806:2010 Acoustics – Road traffic noise – New and altered roads.
The predicted noise levels at 33 properties in the Project area satisfy the test for an Altered Road under the first condition of NZS 6806 i.e. 64 dB LAeq(24h) and increase of do-nothing to do-minimum of 3dB. The predicted noise levels at a further 107 properties in the Project area satisfy the test for an Altered Road under the second condition of NZS 6806 i.e. 68 dB LAeq(24h) and increase of do-nothing to do-minimum of 1dB. On this basis, the proposed Project is confirmed to be classified as an Altered Road under NZS 6806 and it is therefore necessary to consider noise mitigation options.

4.8 Vibration

There is potential for some vibration to be experienced by residents during the construction of all options. In addition on completion of works there is potential for on-going vibration to occur associated with vehicle movements. A vibration assessment will be undertaken during the detailed design phase and submitted with the Notice of Requirement application. The assessment will include recommendations for dealing with adverse vibration effects.

4.9 Utility Services

4.9.1 Existing Services Identification and Investigations

Collection of services data included obtaining Auckland Council GIS data covering their and Watercare stormwater, water and wastewater services along with all utility service providers’ plans and records. These were then compiled into a set of existing services drawings, Volume 3, Drawings 60250009-CV-0551 – 0583.

AECOM has in addition carried out site visits to investigate and visually verify where possible services and compare them to the utility providers data. While there may be differences at this stage of the project AECOM has relied on the utility service providers to provide valid information. This has helped to better understand those services and any likely effects on each alignment option.

Utility Services Investigation Trenches have been dug at critical positions to better quantify the impact on the options. This information is included in this report.

4.9.2 Meetings and Discussions

As part of the consultation process AECOM undertook the following

- Provided utility service owners with a set of drawings showing all existing services and a link to AT’s project website which provided them with further information
- Provided a scope of service which included a request for a rough order of cost (ROC) estimate + / - 100% and indicative design, contingency percentages and likely cost increases from 2015 to 2022, and where possible to identify any betterment they may wish to include
- Held at least one meeting with each affected utility services provider to present and discuss the project, its key divers, timeframe, preferred option, agree the level of information required, and betterment.

As the current AT programmed construction period is several years away all utility services concept agreements, costing and future service requirements / betterment are based on their current requirements and 2012 prices. These could change due to various factors which are controlled by the utility services provider requirements and thus need to be risk managed by all parties.

Meetings and communications were held with Watercare, Transpower, Vector (power, communications and gas), TelstraClear (Vodafone) and Chorus with the main points summarised below.

Watercare

A meeting was held to discuss the following major items, concerns and requirements.

- Watercare Services Limited (WSL) mains cross Redoubt Road, Mill Road and Murphy’s Roads.
- WSL Wiri trunk main and meter and a 550mm dia steel main at the intersection of Redoubt Road / Hollyford Drive Intersection are critical supply links attached to the new Hunia 4 main which is due to be fully operational in approximately the next 5 years.
- WSL is to supply as-built information and AECOM to arrange checks on the cover to this main at critical positions.
WSL at Thomas Road have four bulk mains crossing Murphys Road and are currently installing the New Hunia No. 4 main.

Two major WSL mains run either side for the entire length of Murphys Road north of Thomas Road. The existing East Tamaki No 3 main is planned to be replaced with a 1700mm dia main on the other side of Murphys Road.

Thomas Road Pump Station is to be retained to connect the new pipework. Access is required to be maintained.

Mill Road, Manurewa and Waikato mains along with No 58 main and fibre telemetry cables cross and run the length of the alignment connecting to the Redoubt Rd Reservoir. AECOM’s alignment levels need to be checked against the as-built plans and adjusted where possible to allow adequate carriageway cover to these services.

WSL minor assets along carriageways may need modifications or relocation depending on their position relative to the new carriageway.

WSL requested that the following should be considered during the design process for protection of all bulk and rider mains:

- Consideration given to box culvert type structures to protect the main pipes.

- Keep the length of the culverts as short as possible to allow easy safer access.

- Consider concrete encasement to protect major mains as secondary choice only.

AECOM has undertaken a Scheme estimate (SE) to identify effected WSL watermains and wastewater assets. Stormwater assets are covered in a separate section of this report.

**Vector – Power**

Two meetings were held to discuss the following major items, concerns and requirements.

- Redoubt Road urban section is a narrow corridor with many services

- Vector’s electricity network along Redoubt and Mill Roads is generally a distribution network

- Streetlighting is designed in accordance with Auckland Transport’s current revised standards. All street lights to be connected to 24 / 7 Vector’s LV network. Each fitting/small cluster of lights will require its own control arrangement

- Vector are comfortable working with Auckland Transport’s civil contractor and a shared trench arrangement

- Where required new poles will be installed at the property boundary to maintain the supply to customers.

- The existing services will be unaltered in any section of the existing legal road that remains as an access road to the residents.

Vector has provided their scheme estimate (SE) to identify effected assets. The civil cost component (30 – 40%) is included in this estimate. No allowance is made for traffic management, rock or rock breaking, installation of streetlight columns, environmental requirements, easements and work inside private property. A high level estimate is $3500.00 to $4000.00 for each individual connection has been added to the estimate.

**Vector – Communications**

Two meetings were held to discuss the following major items, concerns and requirements.

- Vector Communications has no infrastructure in the proposed corridor, with no plans for future or reinforcement currently.

**Vector – Gas Transmission and Network**

Two meetings were held to discuss the following major items, concerns and requirements.

- Vector was unable to quantify at this stage the likely impact on the two high pressure gas (HPG) Transmission lines in Murphy’s Road until more detailed design is provided including cross sections.

- Any activities within 3m of the gas transmission pipeline require permitting and supervision. Safety training would be required for the Contractor carrying out the construction works.
- An allowance of $700,000 - $1,000,000 has been included in the estimate for the relocation at HPG Transmission lines.

- Vector has an existing gas distribution network along Redoubt and Mill Roads. Based on recent projects similar to the Redoubt and Mill Road project, Vector has provided a gas distribution’s scheme estimate (SE) base estimate to identify effected assets. No allowance is made for traffic management, rock or rock breaking and for environmental requirements and easements.

Chorus

Two meetings were held to discuss the following major items, concerns and requirements.

- Chorus are happy to work with Telstra Clear and other utility service providers in using a common trench for services

- Chorus has provided a scheme estimate with an accuracy of -10% to + 50% to identify effected assets.

TelstraClear (Vodafone)

Two meetings were held to discuss the following major items, concerns and requirements.

- Chorus was happy to work with Telstra Clear and other utility service providers in using a common trench for relocated or new services

A concept design was supplied and is included in detail in Appendix L.

- TelstraClear has provided a scheme base estimate with an accuracy of -20% to + 30%, based on 2012 unit rates to identify effected assets including all civil works (trenching, supply and lay, reinstatement).

Transpower

A meeting was held to discuss the following major items, concerns and requirements.

- Transpower are close to issuing a DRAFT power line crossing policy covering new clearance requirements

- Recommend that AECOM survey the tower base positions so as to locate them accurately

- AECOM outlined that clearances to all power lines have been achieved for the scheme design.

- Redoubt Road tower AO195 proposed relocation to corner of no 177 likely to require consenting easement / access agreement

- Fencing around towers not preferred and there is a need to check the proximity of street lighting and any other overhead lines

- At the time of writing this report no response has been received from Transpower. However verbal discussion at the meeting covering likely costs to relocate a tower was outlined by AECOM as being in the order of $500,000 to $750,000. Based on this figure AECOM has made the following allowances for the relocation of two towers

  - These figures are provided as a very rough indication of the likely works and are subject to confirmation from Transpower of their concept agreement.
5.0 Stakeholder Relationship Management and Consultation
5.0 Stakeholder Relationship Management and Consultation

Engaging and building relationships with important stakeholders, including consulting with all potentially affected parties is an important component of the project. The ability to which these activities are carried out is directly related to the ultimate success of the project.

5.1 Consultation

Significant communication and consultation has been undertaken to inform the Scheme Assessment Report for the Redoubt Road-Mill Road Corridor Study. Consultation has aligned with the consultation plan which was developed using the principles and core values of the International Association of Public Participation (IAP2) as well as the requirements of the Land Transport Act 2003, Local Government Act 2002 and best practice under the Resource Management Act 1991. A Consultation report has been prepared and is attached as Appendix G.

The objective of the pre-notice of requirement lodgement consultation was to inform affected parties and communities, reduce misinformation, gather knowledge from the community, take their views into account, and respond to concerns.

Initial contact with a number of property owners commenced in May 2012 when letters seeking consent to access property for geotechnical survey were issued. The letter coincided with the public distribution of a project flyer announcing the investigation phase and next stages of the project.

Consultation with directly affected landowners and the wider community took place in October and November 2012 with six information days hosted by Auckland Transport. In total 510 people attended the information days held in both Everglade School and Alfriston Hall. Auckland Transport Property staff, project team and AECOM consultants attended to provide information on the proposed corridor improvements.

Of the 33 written submissions and informal discussions captured, the majority of feedback pertained to the location of the proposed route, the number and extent of residential property impacts and the impacts on the amenity, ecology and character of the area.

As a result of landowner information days a number of sites on the corridor underwent further geotechnical investigation. Further assessment centred primarily on water catchments, including natural springs near Mill Road, wells and springs at the Murphy’s Road intersection and existing stormwater run-off issues at Kinnard Lane.

Previous Opus ‘Option D’ was also reintroduced following community feedback in support of this option over the proposed route, particularly in the area of Murphy’s Road.

As a result of further investigations and subsequent amendments to the proposed design presented publicly in 2012, the extent of property impact changed for a small number of landowners. All affected landowners communicated with in 2012 were informed of these changes and invited to two ‘Clarification Sessions’ hosted by Auckland Transport at the Manukau Civic Centre in May 2013.

Consultation has also been undertaken with iwi, recognising that Auckland Transport is committed to the principles of the Treaty of Waitangi and meeting the relevant statutory obligations under the Land Transport Management Act (2003), and the Resource Management Act (1991). Iwi consultation commenced on 24 May 2012 with a presentation by Auckland Transport to representatives from the following iwi:

- Ngati Te Ata
- Ngai Tai ki Tamaki
- Ngati Tamaoho
- Te Akitali Waiohua
- Ngati Paoa

The meeting sought to introduce the project, acknowledge history and legacy of the project, and to identify mana whenua with kaitiakitanga ties to the project area.
A follow up presentation to iwi was made on 30 August 2012. The meeting sought to confirm with mana whenua and to seek Maori understanding, co-operation and future assistance as the project progresses through the designation process.

Prior to commencing geotechnical investigations, iwi were invited to host a dawn blessing on a culturally significant ridge line within the project area.

In addition to project wide community consultation for the project, a tailored consultation program specific for the purpose of a Social Impact Assessment has been undertaken. The SIA has involved the compilation of selected information to provide an understanding of the project’s social setting, potential stakeholders, stakeholder issues and the range of probable social impacts to be addressed. Discussions with community members, landholders, government agencies and council representatives were an effective means to identify and understand different perspectives, concerns and aspirations of communities. The SIA will be included as an appendix to the Notice of Requirement (NoR).

5.2 Identified Maori Interest

To further identify significant sites and values within the project area requiring protection and careful management, a Maori Values Assessment (MVA) was proposed for mana whenua to prepare for inclusion in the Scheme Assessment Report.

The MVA presented by Te Akitai Waiohua references the significance of Puhinui Creek and the iwi’s interest in ‘restoring and maintaining the health of this waterway.’ Te Akitai Waiohua request the history of the area is acknowledged through accurate signage of landmarks and that remnant of native forest should be avoided.

The assessment makes the following key recommendations:

- That the history of Te Akitai with the project area be acknowledged where possible. This could be acknowledged by signage of landmarks, correct naming as well as references in published materials.
- Provision should be made to minimise the impact on the pre-existing landscape. Younger plants can be moved, the older forest with whakapapa or longstanding historical ties should be avoided.
- Where replanting occurs, native trees are preferred.
- The appropriate usage of Kaitiakitanga protocols and establishment of unknown site discovery protocols.
- The on-going participation, consultation and involvement of Te Akitai Waiohua must be ensured in phases of the project.
- All stormwater systems should aim to maintain the highest possible treatment standards in relation to (clean) water quality and flow.
- The on-going restoration of Puhinui Creek must also be considered in this project.
- A firm commitment should be made to keep fresh water and stormwater separate.
- Maori cultural values and concepts should be recognised in the design aspects of the project where applicable.

The MVA prepared by Ngati Te Ata Waiohua affirms support to the Redoubt Road – Mill Road corridor project provided the issues and concerns raised in the MVA report are addressed and provided for. The report makes the following recommendations:

- The need for relevant mana whenua groupings to have high quality formal relationships with all key stakeholders including Auckland Transport and Auckland Council.
- Reviving names. In conjunction with iwi an inventory of names associated with a given site can be developed allowing iwi to choose the most appropriate names from which to develop design, interpretation and artistic responses.
- Further consultation with Ngati Te Ata Waiohua should be undertaken where opportunities arise to name new or existing features within the corridor.
- The project should embrace opportunities for creating or enhancing visual and physical connections to landmarks.
- Opportunities should be taken to reintroduce natural landscape elements back into the urban streetscape e.g. specific native trees, springs, promoting bird, insect and aquatic life to create meaningful urban ecosystems which connect with former habitats, food gathering areas and living sites.

- Planting along the length of the corridor can enhance and restore the environmental values of the area.

- The natural world could also be referenced through the use of artistic motifs on retaining walls and other contrasted elements in the vicinity of the roadway.

- Ensuring emphasis is placed on maintaining and enhancing the environmental quality of water, soil and air and where possible remediating sites to enhance mauri.

- Careful stormwater management is particularly important given potential impacts on the Puhinui Stream. Reference the Puhinui Stream Restoration Concept Plan prepared by the former Manukau City Council in 2002 in the design and implementation of the project.

- Developing strategies to creatively re-inscribe iwi narratives into architecture, landscape, urban design and public art to enhance a sense of place.

- Exploring environmental, cultural and commercial opportunities in partnership with iwi entities.

- Remove references to heritage constraints or balance with heritage opportunities and heritage responsibilities.

The MVA prepared by Ngai Tai Ki Tamaki states that Ngai Tai wish to discuss and have input into:

- Mitigation and design elements of the project.

- Involvement and input into the mitigation of the flora and fauna which may be adversely affected from the project which include:
  - Mitigation of loss of indigenous vegetation
  - Mitigation of loss of lizard populations
  - Mitigation of potential loss of long tailed bat habitat
  - Mitigation of reduced connectivity of habitats

In order to ensure the potential to damage archaeological features associated with pre-european occupation is mitigated, Ngai Tai Ki Tamaki also wish to monitor the enabling works that will be carried out with the associated earthworks where it is felt appropriate.

Ngai Tai Ki Tamaki would also like to ensure that adverse effects on the quality of water within the catchment are minimised.

Ngai Tai Ki Tamaki would also like to see appropriate Maori cultural design features incorporated into the design of the corridor landscape.
6.0 Option Identification and Screening
6.0 Option Identification and Screening

The method of development of the options and criteria is linked to the key issues and problems within the study area. The background report provided a review of previous work carried out and incorporated the conclusions and recommendations from those reports. Together with initial investigations, conclusions, collected data, and stakeholder consultation, this informed the review of those aspects to ensure the current project objectives serve the purpose of ensuring the outcomes required are reached, through strong linkages with the problems. This was supplemented by further investigations carried out over the course of this study, which included:

- Policy and Strategy
- Land use and sensitive areas
- Preliminary engineering assessments (geotechnical, stormwater, topographical)
- Utility Services (existing underground and overhead)
- Strategic transport modelling
- Client supplied information (supplied through workshops, one-on-one meetings, and issue specific meetings)

The Option Identification and Screening is the second stage of the project, as shown in Figure 11 below.

Figure 11: Option Identification and Screening Stage

6.1 The Do Minimum Option

The Do Minimum option represents the scenario where no improvements are made to the corridor over and above usual or routine maintenance. These maintenance activities typically include:

- Repairs to infrastructure that has been damaged through normal use, for example repairing of potholes, crack sealing
- Repairs to footpaths, kerbs and other small scale repairs
- Stormwater maintenance, including fixing broken catchpit grates and cracked pipes, as well as other planned maintenance activities
- Surface reseals to repair loss of skid resistance, loss of aggregate within the seal, or planned maintenance
- Cyclical roadmarking required to refresh the painted lines and symbols to keep them up to standard
- Road sign maintenance and replacement

The failure to upgrade the corridor is likely to result in current problems becoming more serious over time as planned growth puts increasing demands on the infrastructure.
Capacity
Corridor capacity will be exceeded as the land use growth in the sub region places more traffic on the infrastructure. Peak hour congestion is forecast to grow and in the medium to long term demand will exceed capacity of the current route with significantly slower travel speeds and higher levels of congestion.

Pedestrian and Cycling
The current lack of pedestrian and cycling facilities along various sections of the route due to the narrow carriageway and lack of off-road cycle paths, combined with the substandard road alignment and high speeds will increasingly become a safety and connectivity problem for non-vehicle modes.

Public Transport
The public transport pressures are forecast to increase with higher levels of demand and patronage as the residential areas develop to their planned limits. Unless upgraded, the access to public transport will continue to cause traffic to wait behind stopped buses, leading to significant congestion and potential safety concerns.

Geometric Standards
The horizontal and vertical alignment especially along the rural sections will continue to be substandard for the intended arterial function of the corridor, with a narrow carriageway that does not include sufficient space for the forecast traffic flows, cycle facilities, public transport facilities, and pedestrian facilities.

Road Safety
The current poor safety record will continue to worsen as exposure through increased traffic flows is likely to lead to higher numbers of crashes. The rural section is problematic already (5 fatal crashes in last 5 years) and will worsen over time with more traffic. Increased flows through intersections will also lead to higher numbers of crashes if these intersections are not upgraded.

Journey Time Reliability
The increase in traffic flows will lead to higher levels of congestion and increasingly worse reliability in the time taken to travel along the corridor.

The Do Minimum is not recommended as a viable option as the impacts are considered to be severe, leading to poor levels of service.

6.2 Option Identification – Constraints and Opportunities
The review of background reports, collection of data, engagement with stakeholders, and consideration of the project specific issues, problems and objectives has been used to identify the options that were to be assessed. Each of these inputs has led to a set of constraints and opportunities which inform the total number of options available. In general and as a result from the inputs listed above there are opportunities and constraints that either apply to the corridor as a whole, or apply to specific sections of the corridor. These factors are discussed below.

6.2.1 Whole Corridor
Consultation
Consultation with iwi and the public generally reflected support for the project, with some concerns relating to the location of the proposed route, the number and extent of residential property impacted, and the impacts on the amenity, ecology and character of the area. Specifically, Te Akitai Waiohua references the significance of Puhinui Creek and the iwi’s interest in ‘restoring and maintaining the health of this waterway.’

Geotechnical
From a geotechnical perspective, initial indications were that where possible areas of instability should be avoided and that care is required when designing and constructing the cut and fill sections of the alignment to ensure stability. In areas of instability it is expected that significant engineering measures will be required to ensure the stability of deep cuts and high fills, including drainage of slopes, underdrainage Beneath fills, and the use of retaining structures and soil reinforcement techniques.
Stormwater and Ecology

The road corridor is drained by headwater streams within two main catchments being the Totara Creek (which drains into Puhinui Creek) and Papakura Creek.

A headwater stream which forms part of the Otara Creek catchment is located at the northern extent of Murphy’s Bush, and is noted as part of the Stormwater Management Area on Planning Map 40 of the Auckland Council District Plan (Manukau Section).

Nine indigenous freshwater species and one freshwater crustacean (koura) are known to occupy these catchments, including species that have a threat ranking of “At Risk Declining” and “At Risk-Gradual Decline.”

6.2.2 Urban Section – Redoubt Road from SH1 to Murphy’s Road

Background Studies

The background studies indicated that widening and land acquisition to the south of the existing Redoubt Road alignment is preferred with the northern kerbline generally on the same alignment. An additional eastbound lane with cycle lanes on both sides and pedestrian crossing improvements are required.

On Hollyford Drive widening is required, with Bus priority at the existing Redoubt Road signalled intersection, a bus-only right turn lane, and land take off Everglade Drive to align the intersection with Hollyford Drive.

Between Hollyford Drive and Murphy’s Road the preferred “Option D” deviated from the existing Redoubt Road alignment allowing Redoubt Road to be retained as a local service road, although results in more green field impacts. Traffic signal intersections are preferred.

Special Features

The north side of Redoubt Road between SH1 and Hollyford Drive has a significant number of mature trees. Ideally these would be retained as part of the landscape quality of the corridor and to visually offset the wide road width required to carry the increased traffic flows.

Totara Park is a significant public open space at 251 Redoubt Road, consisting of bridle trails, mountain bike trails and an equestrian centre.

There is the potential for buried archaeological remains associated with early European occupation and activity at the intersection of SH1 and Redoubt Road in the proximity of St Johns Redoubt.

The large stone gates and walls at the entrance to Totara Park are not likely to be heritage items although the archaeological report recommends retaining them if possible.

Urban Development

There is medium density residential development on both sides of Redoubt Road between the SH1 and Totara Park. Minimising the impact on these properties whilst still achieving the project objectives limits the alignment options available. Closer to Totara Park the housing density reduces in the countryside living zone.

There are motels at 21 and 104 Redoubt Road, and a church at 19 Redoubt Road.

A sensitive ridge notation applies to countryside living and rural zoned land either side of Redoubt and Mill Roads from the eastern side of Hilltop Road to approximately 500m north of the Mill Road/Ranfurly Road intersection. The notation seeks to protect the rural character and landscape quality of the area and to ensure that activities are carried out in a sensitive manner.

Utility Services

A Chorus UFB tower on light pole and cabinet exist in berm Ch 740m outside no 89 Redoubt Road will require relocation to the new berm.

Watercare’s Wiri Bulk Supply main has valves / spindles and chambers at the Redoubt Road/Hollyford Drive intersection. Relocating or altering this service has significant cost and operational impacts.

A Transpower tower / pylon at no 181 Redoubt Road will be on the route of the new carriageway approximately 10m from the road edge.
6.2.3 Future Urban Section – Murphy’s Road

Background Studies

The preferred Murphy’s Road option was “Option K” which deviated from the current alignment to follow a spur to the west up to a new intersection with Redoubt Road located 50m west of the existing intersection. This alignment included an at-grade intersection with Redoubt Road to improve pedestrian connectivity.

Special Features

Murphy’s Bush is located within the Manukau Ecological District and is one of the largest remnants of indigenous forest remaining in the north of the district. It is regarded as the best remaining example of dense Kahikatea forest in Auckland.

There are three recorded archaeologically sensitivity sites in proximity to the intersection of Murphy’s Road and Flat Bush School Road. These are Murphy’s Homestead at 141 Flatbush School Road, Flatbush School at 160 Murphy’s Road, and Baverstock cottage next to the Flatbush School hall.

Urban Development

Murphy’s Road is within the Flat Bush Structure Plan area which sets out the rezoning of the land adjacent Murphy’s Road to residential.

Murphy’s Road is currently very sparsely developed apart from the first 400m closest to Redoubt Road where there are low density dwellings, and a few dwellings along the length of the road and offset far enough back from the road that the new road alignments will have little to no effect.

Utility Services

There are Watercare bulk mains (4) and valves at the Thomas Road intersection are affected.

Watercare also has a 700mm dia East Tamaki No 3 watermain on the eastern side of Murphys Road is being planned to be replaced with a 1700mm dia on the western side of Murphys Road.

A Nova Energy gas main will be required to be replaced clear of the new carriageway.

6.2.4 Rural Section – Redoubt Road and Mill Road south of Murphy’s Road

Background Studies

South of Murphy’s Road the preferred “Option D” deviated from the existing Redoubt Road and Mill Road alignments allowing both to be retained as local service roads, although results in more green field impacts. A narrower cross section with or without a flush median is possible through a reduced need to include property access and there is an opportunity to include cyclists on local service roads.

South of the Ranfurly Road intersection, including the junction with Alfriston Road, the proposal included a dual roundabout at Alfriston Road which has a favourable impact on the school and individual dwellings.

Special Features

Totara Park is a significant public open space at 251 Redoubt Road, consisting of bridle trails, mountain bike trails and an equestrian centre.

Three sites of archaeological sensitivity are located at the intersection of Mill Road and Alfriston Road. These recorded sites consist of the previous site of the first Alfriston Presbyterian Church, a post office and store and “the meeting house” at 350 Alfriston Road.

There are potential heritage items within the vicinity of the Redoubt Road/Mill Road intersection, consisting of old hedges, ditches and banks and post and wire fences. There is no current visual evidence of these features however.

The Mill Road corridor passes in close proximity to three forest areas in the Hunua Ecological District, all to the east of the current road alignment. The district is valuable habitat for indigenous wildlife, including bird, lizard, frog, freshwater fish, freshwater crustacean, land snail, and long tailed bats.
Urban Development

A sensitive ridge notation applies to countryside living and rural zoned land either side of Redoubt and Mill Roads from the eastern side of Hilltop Road to approximately 500m north of the Mill Road/Ranfurly Road intersection. The notation seeks to protect the rural character and landscape quality of the area and to ensure that activities are carried out in a sensitive manner.

There is currently low density development along Redoubt Road, leading to a few rural dwellings along the length of Mill Road.

Utility Services

Watercare have a water reservoir facility (designation 150 in the Auckland District Plan (Manukau Section) on a large land holding commencing approximately 400m south of the intersection of Redoubt and Mill Road.

There are significant Watercare bulk water mains (4) including the Waikato and Manurewa trunk mains running to and from this reservoir.

6.3 Redoubt Road Alignment Options

The westernmost portion of the corridor between SH1 and Murphy’s Road through the current urban area has only a single alignment option that was considered. This option was identified through the previous / background studies and is characterised by an alignment that follows the existing road with all widening on the south side of Redoubt Road.

Figure 12: Redoubt Road Alignment Options

6.4 Redoubt Road-Mill Road Alignment Options

All alignments are the same at the extremities of this section of the corridor (i.e. near Murphy’s Road in the north and near Alfriston Road and Ranfurly Road in the south).

For the Redoubt Road-Mill Road alignment between Murphy’s Road and Ranfurly Road three options were identified based a preliminary site walkover of the alignment and confirmed by the background data regarding existing ground conditions. The three identified alignments included one previously preferred alignment and two new alignments south of Murphys’ Road adjacent to the Redoubt Road Reservoir Site due to historic and recent ground instability. The section options are displayed in Figure 13and are described as follows:

Eastern 1 -- As per previous investigation, this alignment met all the criteria proposed as a Regional Rural Arterial and followed a largely green field route east of the existing alignment.

Eastern 2 -- A new green field route closer to the existing alignment and with a high standard of alignment geometry. It is relocated away from the Redoubt Road Reservoir Site due to historic and recent ground instability.

Eastern 3 -- A new green field route similar to Eastern 2 with a lower standard of alignment.
Following is a brief discussion of the positive and negative aspects of each of the alignment options.

### Table 7: Redoubt Road-Mill Road Option Screening

<table>
<thead>
<tr>
<th>Alignment Option</th>
<th>For</th>
<th>Against</th>
</tr>
</thead>
</table>
| **Eastern 1** (Pink) | - The preferred option from the background reports  
- Highest geometric standards | - Discounted due to its proximity to the Redoubt Road Reservoir Site and the historic instability at this location  
- Advice from Watercare that the reservoir site will be expanding westwards in the future and any alignment needs to kept away from it |
| **Eastern 2** (Blue) | - Alignment is closer to the ridgeline (but not as close as Eastern 3) resulting in less earthworks  
- Recent instability near the intersection between Mill Road and Polo Prince Drive results in advantages to moving the alignment further north | - Bridging of an additional gully |
| **Eastern 3** (Yellow) | - Alignment closest to the ridgeline, (which is preferred) resulting in least earthworks  
- Recent instability near the intersection between Mill Road and Polo Prince Drive results in advantages to moving the alignment further north  
- Most cost effective alignment. | - Lowest geometric alignment but still within standards |
All three options were found to have sufficient merit to warrant further assessment and were taken forward to the next stage of the investigation.

6.5 Murphy’s Road Alignment Options

AECOM met with Auckland Transport to specifically discuss the Murphy’s Road alignment and presented the identified options Northern 1 to Northern 4 during a design meeting on 12 July 2012. In addition to these four options Northern 5 was identified at the meeting and added to the alignment options. The options are displayed in Figure 14 and are described as follows:

**Northern 1** – As per the previous Option D alternative (Preferred option in the previously undertaken investigation)

**Northern 2** – Primarily following the existing alignment but with an increased horizontal design speed of 60km/h

**Northern 3** – Alignment following the existing centreline (50km/h) but with an increased vertical design speed and reduced grade

**Northern 4** – Geometrically superior alignment following the existing road corridor and cutting through the ridge to a new intersection with Redoubt Road.

**Northern 5** – Priority change at the Murphy’s/Redoubt Road intersection to cater for specific traffic movements.

*Figure 14: Murphy’s Road Alignment Options*
Following is a brief discussion of the positive and negative aspects of each of the alignment options.

<table>
<thead>
<tr>
<th>Alignment Option</th>
<th>For</th>
<th>Against</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Northern 1 (Orange)</strong></td>
<td>Preferred option from the background reports, Impact on properties (14 affected properties) less than Northern 4 and 5, A greater proportion of the upper alignment could be constructed off line.</td>
<td>Greatest deviation from existing alignment, Angled alignment causes visual disconnect for properties for the wider Flat Bush area, Angled alignment is out of context with the Flat Bush future grid road layout, More earthworks required than all other options.</td>
</tr>
<tr>
<td><strong>Northern 2 (Yellow)</strong></td>
<td>Follows the existing alignment to reduce the effect on properties</td>
<td>Geometrically inferior to the options Northern 1, 4 and 5 and with substandard horizontal curves not meeting the preferred design speed, A less than preferred horizontal design speed to allow the alignment to loosely follow the existing alignment, Large investment for a lower than desirable design speed (60km/h)</td>
</tr>
<tr>
<td><strong>Northern 3 (Pink)</strong></td>
<td>Follows the existing alignment to reduce the effect on properties</td>
<td>Geometrically inferior to all other options and with substandard horizontal curves not meeting the required design speed, A less than desirable vertical design speed to allow the alignment to loosely follow the existing alignment, Large investment for a lower than desirable design speed (50km/h)</td>
</tr>
<tr>
<td><strong>Northern 4 (Red)</strong></td>
<td>Geometrically superior to the other options with preferred design speed able to be achieved, Visually superior to the other options (including existing/do minimum) enhancing long range views, Proposed alignment follows the existing road from the bottom of the hill, Less earthworks than Northern 1</td>
<td>More properties affected than Northern 1 (19 affected properties).</td>
</tr>
<tr>
<td><strong>Northern 5 (Green)</strong></td>
<td>Visually superior to the other options (including existing/do minimum) enhancing long range views, Proposed alignment follows the existing road from the bottom of the hill, Less earthworks than Northern 1</td>
<td>Geometrically inferior to the options Northern 1 and 4, Most properties affected (24 affected properties).</td>
</tr>
</tbody>
</table>

This screening of the alignment options confirmed that Northern 2 and Northern 3 would not be taken forward for any further assessment. Alignment options Northern 1, Northern 4 and Northern 5 were found to have sufficient merit to warrant further assessment and were taken forward to the next stage of the investigation.
6.6 Summary of the Option Screening

As a result of the alignment options screening some options were eliminated. The Alignment Options for further investigation and consideration were renamed for clarity and are shown in Table 9 and in Figure 15.

Table 9: Alignment Option Naming

<table>
<thead>
<tr>
<th>Eastern alignment option naming</th>
<th>Northern alignment option naming</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern A previously named Eastern 1</td>
<td>Northern A previously named Northern 1</td>
</tr>
<tr>
<td>Eastern B previously named Eastern 2</td>
<td>Northern B previously named Northern 4</td>
</tr>
<tr>
<td>Eastern C previously named Eastern 3</td>
<td>Northern C previously named Northern 5</td>
</tr>
</tbody>
</table>

Figure 15: Alignment Options for Investigation and Analysis (Refer to drawing 60250009-CV-0013)
7.0 Option Testing
7.0 Option Testing

The Option Testing stage of the study is shown in the study process in Figure 16 below. This stage required technical analysis of the options to determine the engineering, social, environmental, urban design and landscaping inputs. This analysis determined the benefits and dis-benefits for the screened alignment options which were used as inputs to a multi criteria assessment of the alignment options.

Figure 16: Option Development and MCA Stage

7.1 Transport Modelling

7.1.1 Network Modelling

The approach involved modelling a sub network for the AM and PM peaks for the base year and horizon years in with the Southern Strategic SATURN model (S3M). The S3M considered the Do Min and Option modelling in the Redoubt Road-Mill Road Traffic Modelling project, consisting of:
- Drury South Business Park by 2026 in the Do Min and the Option
- No SH1 widening
- Mill Road Widening by 2026 in the Option only.

The S3M forecasts for the corridor in 2026 and 2041 are shown in Table 5 and represent midblock AADT in total vehicles per day.

<table>
<thead>
<tr>
<th>Location</th>
<th>Current AADT</th>
<th>Future AADT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2011</td>
<td>2026</td>
</tr>
<tr>
<td>Redoubt Road East of SH1</td>
<td>22,000</td>
<td>34,000</td>
</tr>
<tr>
<td>Redoubt Road East of Hollyford Dr</td>
<td>10,000</td>
<td>22,000</td>
</tr>
<tr>
<td>Mill Rd South of Redoubt Rd</td>
<td>13,500</td>
<td>24,500</td>
</tr>
<tr>
<td>Mill Rd North of Alfriston Rd</td>
<td>9,000</td>
<td>17,000</td>
</tr>
<tr>
<td>Mill Rd South of Alfriston Rd</td>
<td>11,000</td>
<td>19,500</td>
</tr>
<tr>
<td>Murphy’s Rd North of Redoubt Rd</td>
<td>10,500</td>
<td>22,500</td>
</tr>
</tbody>
</table>

The modelling of the Do Min and the Option and showed that peak hour travel times in the dominant flow directions are improved by upgrading the corridor, and that significantly more traffic is attracted to the route due to the additional capacity that has been provided. This has significant network affects, and supports the One Network philosophy in the Auckland region.
7.1.2 Intersection design

The traffic demands along the route and through the intersections provided by the S3M were then used as inputs for SiDRA intersection modelling for the AM and PM peaks in 2041 to determine the ultimate intersection layouts at each of the key intersections along the corridor.

Intersections were designed to operate at a target degree of saturation of 1.0 during the busiest peak periods in 2041. This target represents an intersection that is designed to be busy but yet still within acceptable limits in terms of operational performance, and without excessive capacity or implementation costs.

Table 11 below shows sketch layouts of each of the key intersections on the corridor. The sketches diagrammatically display the lane configuration and intersection control at each site, accompanied by supporting commentary on the traffic facilities and performance of each.

<table>
<thead>
<tr>
<th>Redoubt Road / Diorella Drive Intersection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic signals will replace the current give way.</td>
</tr>
<tr>
<td>The capacity of the intersection will be increased with additional lanes to cater for the future traffic flows.</td>
</tr>
<tr>
<td>Average 2041 AM performance – LOS A, degree of saturation 0.8. Average 2041 PM performance – LOS A, degree of saturation 0.6.</td>
</tr>
<tr>
<td>There is a new westbound bus lane for buses and cyclists to minimise public transport delays (not shown).</td>
</tr>
<tr>
<td>Diorella Drive is widened to allow separate left and right turns.</td>
</tr>
<tr>
<td>On road cycle facilities (not shown) include cycle lanes on all approaches with stop boxes. The westbound cyclists will share the bus lane.</td>
</tr>
<tr>
<td>Pedestrian crossing facilities on all intersection legs (not shown).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Redoubt Road / Hollyford Drive Intersection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upgraded traffic signals to increase intersection capacity with additional lanes to cater for the future traffic flows.</td>
</tr>
<tr>
<td>The existing free left turn lane from Redoubt Road into Hollyford Drive will be reinstated to allow for the busy left turn.</td>
</tr>
<tr>
<td>Average 2041 AM performance – LOS D, degree of saturation 0.9. Average 2041 PM performance – LOS D, degree of saturation 0.9.</td>
</tr>
<tr>
<td>On Hollyford Drive there is a separate right turn bus lane (shown diagrammatically skewed to represent a separate lane) which turns into a westbound bus lane heading to the Motorway.</td>
</tr>
<tr>
<td>On road cycle facilities include cycle lanes (not shown) on all approaches and stop boxes at the stop line.</td>
</tr>
<tr>
<td>Pedestrian crossing facilities on all intersection legs.</td>
</tr>
</tbody>
</table>
Redoubt Road / Murphy’s Road Intersection

Traffic signals are proposed for the intersection to cater for the future traffic flows.

Additional lanes will be provided on all approaches, with give way controlled left turns to maximise the efficiency of the intersection.

Average 2041 AM performance – LOS B, degree of saturation 0.6. Average 2041 PM performance – LOS C, degree of saturation 1.0.

On road cycle facilities include cycle lanes (not shown) on all approaches and stop boxes at the stop line.

Pedestrian crossing facilities (not shown) on all intersection legs.

Mill Road / Ranfurly Road Intersection

Two lane roundabout with two lanes northbound and two lanes southbound on Mill Road to cater for the future traffic flows.

Ranfurly Road is one lane in both directions and is widened on the western approach to allow for the higher flows.

Average 2041 AM performance – LOS A, degree of saturation 0.9. Average 2041 PM performance – LOS A, degree of saturation 0.6.

On road cycle facilities (not shown) through the roundabout.

Low pedestrian demand anticipated.

Mill Road / Alfriston Road Intersection

Two lane roundabout with two lanes northbound and two lanes southbound on Mill Road to cater for the future traffic flows.

Mill Road is realigned westwards away from the school.

Alfriston Road is one lane in both directions although is widened on both approaches to allow for the future turning flows.

Average 2041 AM performance – LOS A, degree of saturation 0.7. Average 2041 PM performance – LOS B, degree of saturation 0.7.

The new road ties into the existing Mill Road/Alfriston Road roundabout.

On road cycle facilities (not shown).

Pedestrian activity near the school will be accommodated on existing footpaths near the school.
Redoubt Road / Hilltop Road Intersection

Seagull Island (not shown) on Redoubt Road to accommodate right turns into and out of Hilltop Road.

Redoubt Road is the priority route with two lanes in each direction. Hilltop Road is give-way controlled with separate left and right turn lanes.

Average 2041 AM performance – N/A for through movement, LOS C for side road, degree of saturation 0.5. Average 2041 PM performance N/A for through movement, LOS D for side road, degree of saturation 0.7.

On road cycle lanes (not shown) on Redoubt Road.

The intersection plans are provided in Volume 3: Drawings.

7.1.3 Bus Priority

Section 3.5.3 discusses the Frequent Service Network intended for the route between Botany Downs and Manukau, which travels through the Hollyford Drive / Redoubt Road and Diorella Drive / Redoubt Road intersections. Both of these intersections therefore become critical in terms of level of service provided to public transport passengers. The SIDRA analysis carried out on both of these intersections calculated the peak hour queues experienced at the intersections, and the S3M analysis determined the peak hour travel speeds experienced by through traffic.

The design for the Hollyford Drive / Redoubt Road intersection includes a 230m long bus only lane running southbound to the junction. This bus only lane has been determined by evaluating southbound queues backing up from Redoubt Road. This dedicated bus only lane permits buses to travel in the general traffic lanes until queues develop, and then jump into the dedicated lane to approach the limit line where a separate Bus Phase is triggered. The Bus Phase provides minimal delays to buses, which are then able to right turn into a dedicated westbound bus only lane which runs between Hollyford Drive and the motorway junction.

Through the Diorella Drive intersection in the direction of the motorway, travel speeds in 2026 are forecast to be in the order of 35 km/h (AM peak period) with 95 percentile queues of about 250m. In 2041 through speeds drop to 25 km/h with 95 percentile queues lengthening to 490m. In order to improve the travel times in the peak periods the westbound dedicated bus only lane on Redoubt Road will bypass these very long queues and minimise westbound travel times.

The recommended layout at the Hollyford / Redoubt and Diorella / Redoubt intersections and along Redoubt Road will significantly improve bus travel speeds.

It is intended that bus stops remain in their current locations, with future additional stops considered on a case by case basis. In addition, buses are expected to stop in the live lanes supported with appropriate line marking. Recessed bus bays are not favoured due to the delays imposed on the service due to the difficulty in merging into the live travel lanes.

7.2 Geotechnical

Following the PGAR referenced in Section 4.4 the Factual and the Interpretive reporting was commenced upon the alignments identified and screened in Section 6.0. These are documented below.

7.2.1 Factual Report

Two geotechnical factual reports have been prepared for options or parts of options within the study area as follows:

- Opus Consultants Limited, Mill Road Realignment – Alfriston to Hollyford Drive, Manukau, Geotechnical Factual Report, April 2011.
- AECOM, Redoubt to Mill Road Corridor, Geotechnical Factual Report, February 2013.
The Opus geotechnical investigation was carried out for route options D and D Alternative and comprised 19 boreholes, 7 Cone Penetrometer Tests (CPT’s), 2 dynamic probes, 2 test pits, 26 hand augerholes and 6 pavement pits.

The AECOM geotechnical investigation was carried out for route options Eastern C and Northern B and comprised 9 boreholes and 12 hand augerholes with adjacent DCPs.

The geology beneath much of the proposed alignment is indicated to generally comprise alternating sandstone and mudstone of Waitemata Group and their soil equivalents, within the unstable terrain known as the Southern Landslide Zone. The southern end of the proposed alignment traverses the Manukau lowlands and is generally underlain by recent alluvium and alluvial soils of the Puketoka Formation.

The findings of the Opus investigations confirm the published geology with Waitemata Group residual soils and rock being encountered. Slope instability was evident, including “Slump Blocks” which were identified and investigated. In addition, colluvium or slip debris and localised fill of variable thickness was found to overlie the natural soils in some boreholes, and alluvium was encountered in numerous hand augers.

The geotechnical factual reports are included in Appendix C.

### 7.2.2 Interpretive Report

Based on the findings of the site investigations and the proposed alignment geometries, areas which will require retaining / slope stabilisation, fill foundation improvements and cut slope design have been identified in the geotechnical interpretive report. Recommendations for design of those areas are summarised as follows:

- The preliminary design of cuts and fills is based on batter slopes no steeper than 1(v) in 2(h) for heights less than 3 m and 1(v) in 3(h) for greater heights.

- In the case where significant fill heights (10 m) are indicated, it is anticipated that MSE walls / slopes are likely to be suitable. For lower cut / fill heights the use of timber pole, gravity wall, concrete pile or concrete crib walls may be considered. Soil nailing may also be used to stabilise cut slopes formed within the upper colluvial and completely weathered Waitemata materials.

- The design of any retaining structures will require to accommodate the presence or re-location of underground services.

- The design of significant cuts and fills includes the use of drainage blankets and / or horizontal bored drains, particularly within the vicinity of the Watercare reservoirs where historic instability has occurred.

- It is generally expected that most excavated materials will be suitable for re-use as fill, but as the materials are wet of optimum soil improvement measures may be required to reduce moisture contents if drying cannot be achieved in the earthworks area.

- Preliminary pavement design is based on a CBR value of 4, although at the southern end of the route a design value of 3 and an allowance for ground improvement is recommended.

- A site seismic hazard assessment indicates structures having an importance level of 4 should be designed using PGAs of 0.31 and 0.04 for ULS and SLS1, respectively.

- Allowance is made for piling all bridge abutments.

- Where the proposed alignment crosses existing pipelines and other critical infrastructure, measures will be required to be taken to mitigate the effects from the cut and fill operations.

- It is anticipated that some additional geotechnical investigations will be required once bridge crossing locations have been finalised and areas of deep cuts and fills confirmed. In particular, areas of historic and current instability are anticipated to require further investigation to determine the extent of stabilisation works required.

- From our assessment it appears that the Eastern A option will require more significant remedial measures to manage the geotechnical risks associated with land instability than the alternative Eastern B and C options.

- The Northern A, B and C options for Murphy’s Road appear to pose similar levels of geotechnical risk.

- The geotechnical interpretive report is included in Appendix C.
7.3 Stormwater

The proposed works will increase the impervious area along the road corridor. The potential effects of this on stormwater runoff include:

- Increased volume of runoff
- Increased peak runoff rates
- Increased flow velocities
- Reduced water quality

7.3.1 Catchment and Receiving System Identification

Affected stormwater catchment areas and potential receiving systems were identified. The corridor is located within three main catchment areas, discharging into three main watercourses:

- Otara Creek (including Flatbush) to the north
- Puhinui Stream to the west
- Papakura Stream to the south

The majority of the corridor is located along a ridgeline, with a number of stormwater discharges being at the head of systems.

7.3.2 Existing Infrastructure Assessment

Review of the GIS services information for the road corridor identified existing stormwater infrastructure is generally limited to the western section of the corridor at the following locations:

The western section of Redoubt Road up to Hollyford Drive, and Hollyford Drive

- These sections of existing road currently drain via catchpits to existing piped systems. The westernmost 120m of Redoubt Road is reticulated west to the Puhinui Stream. Stormwater from Redoubt Road between 120m to 600m, and along Hollyford Drive, is reticulated north to the Otara Creek.

Redoubt Road from Hollyford Drive to Totara Park, and Everglade Drive

- These sections of existing road currently drain via catchpits to existing piped systems that are reticulated south and west to the De Havilland Drive Drainage Reserve. The stormwater pond in the drainage reserve discharges via reticulation to the Puhinui Stream.
- The road corridor is at the head of the stormwater systems in these locations. The existing systems consist of small diameter (e.g. 225mm) pipes. Considering the areas currently draining to the existing reticulated systems it is highly unlikely that there will be any spare capacity in these systems. The existing stormwater pipes run through properties and under buildings in a number of locations so there is limited ability to upsize the existing systems.

7.3.3 Unserviced Areas

The sections of road corridor without existing stormwater infrastructure currently drain via sheet flow / overland flow, following the existing topography to the nearest watercourse. The unserviced sections of the corridor can be split into the following sections:

Redoubt Road adjacent to Totara Park, and Mill Road up to Polo Prince Drive

- The section of Redoubt Road adjacent to Totara Park currently drains south to a number of small gullies located in Totara Park. These gullies drain south and combine to form a tributary of the Puhinui Stream.
- The westernmost section of Mill Road, up to Polo Prince Drive, drains into the Puhinui Stream near its headwaters. The stream drains west to combine with flows from Totara Park and then continues west.

Mill Road from Polo Prince Drive to Alfriston

- This section of Mill Road drains into a number of shallow gullies that drain south and join the Papakura Stream.
Murphys Road and Murphys Bush Road

- These sections of road drain to shallow gullies that drain north-west, through Flatbush, and join the Otara Creek system.

### 7.3.4 Stormwater Management Options

#### Areas of Existing Stormwater Infrastructure

The areas of road corridor with existing stormwater infrastructure (i.e. the section west of Totara Park) have buildings located on each side of the existing road and numerous services located within the road reserve. As such there are constraints on space available for stormwater management systems.

Road widening works in this section will retain the existing vertical alignments and incorporate kerb and channel stormwater collection for the carriageway.

The above constraints, including the limited capacity of the existing stormwater network in these areas, limits the options available for stormwater management. Soakage to ground has been excluded due to the unsuitable nature of the soils.

The recommended approach is to use the existing connections into the reticulated system. Due to limitations on existing pipe capacity, stormwater flows from the widened road corridor are to be restricted to estimated existing flows. This would require an underground storage system for each connection capable of controlling flow rates.

No treatment is currently provided to stormwater runoff for this section of road but collection and treatment of stormwater runoff from the existing Murphy’s Road section of the corridor is proposed as part of the works. This is considered suitable mitigation for the section of untreated road west of Totara Park.

#### Unserved Areas

Sections of the road corridor that do not currently have stormwater infrastructure will need stormwater management systems and suitable discharge locations.

A number of low-points are proposed along the road corridor. The majority of the road is to incorporate kerb and channel stormwater collection for the carriageway.

Accounting for the restrictions presented by the proposed low-points and the use of kerb and channel, the options available for stormwater management are limited. Soakage to ground has been excluded due to the unsuitable nature of the soils.

The recommended approach is to reticulate the stormwater along the road corridor to locations suitable for the construction of wetland areas.

Wetland areas designed in accordance with ARCs TP10 Design Guideline Manual for Stormwater Treatment Devices (2003) will provide sufficient water quality treatment and flow attenuation. Provision of extended detention (capture of the first 34.5mm of rainfall and slow release over 24 hours), combined with suitable energy dissipation and erosion protection measures at outfalls to watercourses, will help mitigate potential erosion downstream of the wetlands. Erosion control is especially important in the headwater gullies of the Puhinui Stream. The flow attenuation element of the wetlands enables any discharges to watercourses to be limited to existing discharge peak rates, thus alleviating potential issues of overloading existing watercourses in the area.

A review of the proposed road low-points, surrounding topography, existing land use and potential receiving systems identified the most suitable locations for stormwater management wetlands along the road corridor.

Indicative wetlands sizes, in accordance with TP10, were estimated using ARC TP108 Guidelines for Stormwater Modelling in the Auckland Region.

The section of road east of Alfriston Road is proposed to utilise swale drains. As such, the swale drains can be designed to provide the required level of water quality treatment and stormwater attenuation prior to discharge to existing roadside drains at the extent of the works.

Stormwater schematic plans are provided in the Preliminary Design Drawings.
7.4 Social and Environmental

The Social and Environmental Screen and Social and Environmental Assessments, addressed below and contained in Appendix I, provide an initial assessment of potential effects on the environment of each alternative alignment.

7.4.1 Social and Environmental Screen and Social and Environmental Assessment

NZTA’s Social and Environmental Management form PSF/13 has been filled out for each alternative alignment (Eastern A, B, C and Northern A, B and C) and are included in Appendix I. The following sub-sections provide an overall summary of the key findings from the Social and Environmental Screen and the Social and Environmental Assessments undertaken.

7.4.2 Noise

Temporary construction noise effects will be experienced by residents of nearby dwellings and other land uses in the vicinity of the road widening and re-alignment options.

On-going operational noise effects will be experienced where traffic lanes move closer to dwellings and other land uses as a result of road widening and the revised rural alignment.

Having regard to on-going operational noise effects, a preliminary computer noise modelling exercise of the preferred alignment option has been undertaken by AECOM using assessment years of 2026 and 2041, 10 years after completion of the project. The modelling includes the scenario without the project (do nothing), the scenario with the project (do minimum), and various noise mitigation options.

The results of the noise assessment and the impact of the new road alignments are reported against the criteria for altered roads under NZS 6806:2010.

Noise mitigation options have been considered in accordance with NZS 6806:2010 which represents best practice. Following NZS 6806:2010 should result in road traffic noise within reasonable levels.

The report provides an indication of the road traffic noise mitigation measures likely to be required. The best practicable option for noise mitigation will be determined in accordance with NZS 6806 by the project team during preparation of the Notice of Requirement application with input from stakeholders.

The report considers that for all alignment options noise can be attenuated through a combination of methods including low noise surfacing (taking into consideration the design and maintenance requirement) and building modification mitigation.

7.4.3 Vibration

Vibration can have an effect on human comfort and cause building damage. There is potential for some vibration to occur during the construction of all alternative alignment options associated with the use of machinery. Additionally on completion of the works there is potential for vibration to occur associated with vehicle movements.

The opinion of an acoustics specialist should be sought on the matter of construction vibration. An operational vibration assessment considering vibration from vehicle movements which will recommend measures to avoid, remedy or mitigate the effects of vibration will be included in the Notice of Requirement application. Consideration to construction vibration should also be given during the preparation of the Construction Management Plan prepared by the contractor.

7.4.4 Air Quality

Construction works could result in disturbance of particulate matter impacting on local air quality during construction. An Erosion and Sediment Control Plan is likely to be required to be submitted with the resource consent application for earthworks and it will include mitigation measures for dust control, which is likely to be the spray application of water.

7.4.5 Water Resources

Alternative Eastern alignments A, B and C cross headwater streams within two main catchments being the Totara Creek (which drains into Puhihi Creek) and Papakura Creek corridor. Eastern A crosses two headwater streams whilst Eastern B and C cross three headwater streams. It is noted that bridge construction will fall within the Auckland Sediment Control Plan Sediment Control Protection Area.
An ecological assessment of the alternative alignment options was prepared by Wildland Consultants Limited (attached as Appendix D). It advises that nine indigenous freshwater species and one freshwater crustacean (koura) are known to occupy the catchments. Alignments Eastern A, B and C cross three head water streams which are typical habitat for longfin eel, shortfin eel, cran's bully, banded kokopu, koaro and koura. Longfin eel and koaro have a threat ranking of “At Risk Declining” and Koura has a threat ranking of “At Risk-Gradual Decline.” The decline of these species is often linked to the degradation or loss of stream habitats through excess nutrient input, stream loss, migration barriers and forest loss.

Of the Eastern A, B and C alternative alignments, the report considers that Eastern A has the lowest ecological adverse effects on aquatic species.

Alignment options Northern A, B and C will cross a headwater stream which forms part of the Otara Creek catchment. The stream is located at the northern end of Murphy’s Bush. This small stream is most likely to be the habitat for long fin eel, short fin eel, cran’s bully and banded kokopu. Of these, long fin eel has a threat ranking of “at risk declining”. The report considers that alignment options Northern A, B and C will only have minor potential effects on aquatic species.

7.4.6 Erosion and Sediment

As the works associated with alternative alignments Eastern A, B and C contain works within the Sediment Control Protection Area and will involve in excess of 100m of roading; restricted discretionary activity resource consent will be required under Rule 5.4.3.1 in Activity Table C of the Auckland Council Sediment Control Plan.

During construction works, earthworks and disturbance of soil and vegetation could result in erosion and the transfer of sediment into the surrounding environment, particularly during storm events. Under all alignment options, due to the earthworks required and proximity to sensitive receiving environments an Erosion and Sediment Control Plan will be required to be provided with the resource consent applications to address and identify methodologies for the avoidance and mitigation of adverse effects associated with stormwater and runoff during construction works. The Erosion and Sediment Control Plan should form part of the Contractors Construction Management Plan.

The alignment options are also in an area of known instability being in the western extent of the southern landslide zone. This zone has undergone historic deep-seated slope movement. Deep and shallow slope instability is a geotech risk particularly in relation to cut/batter design and the foundation stability of sidling fills and embankment fills.

Consideration should be given to on-going stability of the road during the detailed design phase.

7.4.7 Social Effects, Land Use & Transport Integration

At a strategic level all alignment options will improve land use/transport integration. The physical nature of the current route is substandard for its existing and intended arterial function. Significant growth in Flat Bush as well as in Takanini, Papakura and Drury means that the current route is incapable of handling current and proposed land use demands. The route also provides a secondary route to Clevedon where a Council initiated Plan Change proposes further development. Additionally, the alignment options will also provide an alternative to State Highway 1 in periods of high demand or emergencies.

There are currently limited cycling opportunities along the current urban section of the alignment in between State Highway 1 and Murphy’s Road. There is no current walking or formal cycle facilities on Murphy’s Road and between Murphy’s Road and Alfriston. Cycling infrastructure will be improved via the addition of cycle lanes along the entire extent of the corridor. Public footpaths will be included in all urban sections.

The current provision of public transport facilities is not in keeping with the strategic hierarchy of the route nor is it in keeping with the importance of transport linkages between Manukau and eastern residential areas. Public transportation pressure is forecast to increase with high levels of demand and patronage as urban development areas are developed to their planned limits. The preferred alignment design provides future bus priority measures for urban Section 1a. Section 1b will be designed to have a dedicated bus lane. All alignment options will “future proof” rural sections to enable the extension of public transportation initiatives over time.

Due to road widening and revised alignments, options Eastern A, B, C and Northern A, B and C will potentially affect the following number of land parcels:
Table 12: Impact of alignment options on land parcels

<table>
<thead>
<tr>
<th>Alignment Option</th>
<th>Number of Land Parcels Affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern A</td>
<td>318</td>
</tr>
<tr>
<td>Eastern B</td>
<td>313</td>
</tr>
<tr>
<td>Eastern C</td>
<td>313</td>
</tr>
<tr>
<td>Northern A</td>
<td>14</td>
</tr>
<tr>
<td>Northern B</td>
<td>19</td>
</tr>
<tr>
<td>Northern C</td>
<td>24</td>
</tr>
</tbody>
</table>

Although Northern A affects the least number of land parcels of the Murphy’s Road alignment options, it significantly affects future land development opportunities in the southern most section of the Flatbush Structure Plan area. This is because it diagonally cuts across the land making a rectilinear grid road pattern difficult to achieve which is the preferred pattern because it provides flexible block sizes which suit different housing typologies.

The stress involved for affected landowners (in terms of potential property loss and land negotiations) may give rise to significant adverse health effects. In addition there is the potential for adverse effects on community cohesion as a result of a significant number of residents of the local community potentially having to vacate their homes. There is a risk that these persons may leave the community indefinitely.

To assist the scheme assessment process and understand actual and potential social effects, a community consultation programme was prepared and implemented by Auckland Transport and AECOM staff. This is discussed in Section 5.1 and in detail in Appendix G.

As a result of landowner information days a number of sites on the corridor require further geotechnical investigation. Further assessment centres primarily on water catchments, including natural springs near Mill Road, wells and springs at the Murphy’s Road intersection, and existing stormwater run-off issues at Kinnard Lane.

Iwi consultation with representatives from the Ngati Te Ata, Ngai Tai ki Tamaki, Ngati Tamaoho, Te Akitai Waiohua, and Ngati Paoa are on-going. The MVA presented by Te Akitai Waiohua references the significance of Puhinui Creek and the iwi’s interest in ‘restoring and maintaining the health of this waterway.’ Te Akitai Waiohua request the history of the area is acknowledged through accurate signage of landmarks and that remnants of native forest should be avoided.

Consultation also identified that alignment options may cause connectivity issues with Totara Park (at the intersection of Redoubt Road and Murphy’s Road) particularly for horse riders. The alignment options will also result in the loss of sections of a Totara Park bridle trail and a mountain bike trail. These concerns are able to be mitigated and will need to be addressed as part of detailed design once the preferred alignment is selected.

The arboricultural assessment identified that pine forest planting blocks on Watercare owned land will be affected through removal of trees and works within the root zone. This is identified as a potential risk as the pine forest is likely to have been planted as an investment and large sums of money may be associated with the plantations.

The alignment options will also impact on existing services such as Vector and Transpower power lines, Watercare infrastructure, telecommunications equipment and gas mains. This is addressed in detail in section 7.6.

### 7.4.8 Effects on Culture and Heritage

Clough and Associates has prepared an archaeological assessment of the alternative alignment options. The assessment was essentially a desktop study (including general background information and study of LINZ maps and plans) with limited field work. The desk top study concluded that although the likelihood of previously undetected Maori archaeological sites being discovered along the alignment options is low there is a possibility of unknown Maori artefacts / taonga being unearthed during construction.

Having regard to alternative alignment options Eastern A, B and C there is the potential for buried archaeological remains associated with early European occupation and activity at the intersection of SH1 and Redoubt Road in the proximity of St Johns Redoubt (R11/534).
Three recorded sites are also located at the intersection of Mill Road and Alfriston Road (R11/2063, R11/2069 and R11/2074). These recorded sites consist of the previous site of the first Alfriston Presbyterian Church, a post office and store and “the meeting house” at 350 Alfriston Road. There are three recorded sites in proximity to the intersection of Murphy’s Road and Flat Bush School Road. Murphy’s Homestead (CHI 12439) is located at 141 Flatbush School Road. Flatbush School (CHI2776) is located at 160 Murphy’s Road. Baverstock cottage (R11/2745) is located next to the Flatbush School hall.

The report also indicates that there are potential heritage items within the vicinity of Redoubt Road and its intersection with Mill Road. These potential items consist of old hedges, ditches and banks and post and wire fences. The report notes that no visual evidence of these features was identified during previous survey work in this vicinity.

The report considers that the potential archaeological effects of the various alternative alignments are not considered significant for any of the options based on current knowledge. The report recommends that a more detailed assessment involving field survey work will be required to confirm this once an alignment has been selected.

The report also notes the large stone gates and walls at the entrance to Totara Park. Although unlikely to be heritage items the report recommends retaining them if possible.

### 7.4.9 Effects on Ecological Resources

The road corridor passes in close proximity to four areas of indigenous forest and scrub (Murphy’s Bush and three forest areas to the east of the current Mill Road alignment). Murphy’s Bush, through which the proposed road corridor passes, is one of the largest remnants of indigenous forest remaining in the north of the Manukau Ecological District. This forest, which regenerated following logging and forest clearance in the 1880s, is regarded as the best remaining example of dense Kahikatea forest in Auckland.

An ecological assessment of each alternative alignment option was prepared by Wildlands (see Appendix D). In terms of Eastern A, B and C, the assessment considers that alignment Eastern B has the highest adverse ecological effects. The report notes that the potential ecological effects of Eastern B includes loss of forest, loss of streams and potential adverse effects on downstream receiving environments. Effects also include habitat loss for indigenous fauna such as lizards, bats, birds and invertebrates, and reduced connectivity of terrestrial habitats. The extent of forest loss is considered significantly greater in the assessment when compared to the other proposed alignments. This is because the forest affected is older and more mature, with more tree cavities, epiphytes, and a diversity of canopy species. The report states that this indicates that the potential adverse ecological effects for terrestrial habitats will be major. The report considers that Eastern A has the lowest adverse ecological effects.

Alternative alignments Northern A, B and C have potential to affect the roadside margins of Murphy’s Bush. This area of forest is regionally significant and the assessment recommends effects on the forest should be avoided or minimised.

The alignment options also cross a headwater stream (as does the pre-existing alignment) which forms part of the Otara Creek catchment located at the northern extent of Murphy’s Bush. The small stream is most likely to be the habitat for longfin eel, shortfin eel, cran’s bully and banded kokopu. Of these, longfin eel has a threat ranking of “At Risk Declining”. The report considers that the Northern A, B and C alignments will have only minor potential effects on aquatic species.

In terms of the Redoubt Road/Murphy’s Road intersection end (southern end) of the Murphy’s Road corridor, the assessment considers that the Northern A route has the least ecological impact of the three alignment options since it avoids passing through a relatively large area of mature exotic trees. The assessment notes that this area of vegetation will have ecological values in terms of habitat for birds and indigenous lizards and provide a stepping stone to and from surrounding bush remnants.

### 7.4.10 Contaminated Land

A preliminary review of potential contamination was undertaken by AECOM for the alternative alignment options. The review included a visual inspection of the immediate and surrounding areas of the alignments and a desktop review of historical aerial photos and relevant historical documentation to identify potentially contaminating practices, which may have occurred on or nearby the alignment options. Searches included a review of a summary of permits and consents (excluding council visits to view files), reported incidents, a search request of available previous environmental reports and contaminated sites files of the Auckland Council (former Auckland
Regional Council and former Manukau City Council). A search of the Auckland Council’s database of consented bores within a 50 m radius of the alternative alignments and a review of other relevant geological and hydrogeological resources was also conducted to assess the general sensitivity of the environment.

The review states that no contamination was visually identified as being present along the alignments during the site inspection or from a review of historic aerial photos. Based on the current information, it is likely however that Hazardous Activities and Industry List (HAIL) activities related to uncontrolled waste disposal have occurred along the alignments. Waste dumping activities have been reported by the former Manukau City Council in the area and could possibly impact parts of the alignment during construction; however effects relating to these environmental impacts can be controlled.

Uncontrolled waste dumping containing ACM is unlikely to be encountered along the section of road bounded by residential land use. Illegal dumping is more likely to have occurred (if at all) along the rural sections of road.

Testing may be required to be undertaken to determine if the land required for the preferred alignment option contains contaminated land.

**7.4.11 Resource Efficiency & Climate Change Adaption and Mitigation**

The proposed improvements under all alignment options will allow for more efficient traffic movements and less congestion which should increase the efficient operation of vehicles and reduce the vehicle emissions per vehicle.

The roading re-alignment will also improve roading, cyclist and pedestrian connections. Cycle lanes will be provided for the entire extent of the corridor. Footpaths will be included in all urban sections of the alignment. Under all alternative alignment scenarios, earthworks cutting will be required to form appropriate gradients. This material may be required to be transported off site for disposal. Wherever possible, cut should be reused as fill on site.

If material is not able to be reused disposal options in proximity of the site should be considered to reduce transportation distance and associated inefficiencies in energy use and consequential greenhouse gas emissions.

**7.5 Visual Quality and Urban Design**

**7.5.1 Arboriculture**

An Arboricultural assessment of the alternative roading alignment options was undertaken by Arborlab in late August 2012 and updated in December 2012 to assess the effects of new alignment option Northern A (refer Appendix D).

That part of the alignment from Redoubt Road to the Murphy’s Road intersection contains a number of trees within the current road reserve which could be altered and removed as a result of road widening. The trees along part of this section of the corridor between No 2 Redoubt Road and Hollyford Drive and along Everglade Drive and Hollyford Drive are medium sized Ash trees which are considered by the arborist to confer valued visual amenity to the locality. A number of other trees outside the current road reserve will also need to be removed along with some that could be relocated especially within Totara Park. The arborist considers that these trees are not as arboriculturally valuable as the Ash Trees. Nevertheless some trees provide a screening role and increase potential loss of privacy issues.

The Murphy’s Road section of the corridor will pass alongside Murphy’s Bush and works will most likely involve works within the root zone and removal of edge trees. The report considers that it is preferable that any loss of the forest edge is avoided. The report also notes the large Spruce tree and Himalayan Cedar outside the old Flatbush School and notes them as being large valued specimens. In terms of the southern section of the Murphy’s Road alignment, the preferred alignment option from an arboricultural perspective is Northern A as this alignment option is largely devoid of mature trees.

From the intersection of Redoubt Road and Murphy’s Road the report notes that the landscape becomes predominantly rural. The tree planting in this area is described in the report as shelterbelt planting of large, vigorous robust species consistent with agricultural land use. The report notes that there are isolated stands of high quality remnant and regenerating bush areas particularly in the northern area of Mill Road on its eastern side. Having regard to this section of the corridor, the arborist considers that in terms of effects on trees the Eastern B alignment requires the most alteration of the valued bush remnants. The alignment disturbs the south-eastern second and third copse, which are forested areas dominated by mature taraire and puriri. The report considers that Eastern A is preferred from an arboricultural perspective due to the limited alteration of valued native forest.
7.5.2 Landscape

A landscape assessment was prepared by AECOM, refer Appendix J. In terms of potential landscape effects the landscape assessment considers that for Murphy’s Road, Northern B is the most favourable route although it will still require sensitive design and mitigation measures including scrutiny of existing tree treatments and new planting strategies. Of the three alternative Mill Road alignments, the report considers that Eastern B and C are the most favourable options however care is needed to ensure space is available between the new road selected and the existing Mill Road so they are not read together to increase their impact on the landscape.

7.5.3 Urban Design

An Urban design assessment was prepared by AECOM, refer Appendix J. The urban design assessment considered the alternative alignment options against the Seven C’s of the New Zealand Urban Design Protocol. The report also gave consideration as to whether the opportunities for social and environmental improvement brought by each option outweighs any negative impact the option brings. The report concludes that within the Murphy’s Road section of the corridor, Northern B is the preferred alignment. Although it will bring major medium term adverse effects, these will be balanced by overall major (positive) long term improvements including social and environmental improvements.

Having regard to the three alternative Mill Road alignments, the report considers that Eastern B and Eastern C are most favourable which, whilst having high effects (with potential permanent, serious and widespread adverse effects), these would be countered by the opportunities for social and environmental improvement.

7.5.4 Opportunities and Constraints

The report prepared by AECOM entitled Urban Design and Landscape Study (attached as Appendix J) examines the opportunities and constraints for the corridor. The report breaks the corridor into Character Areas consisting of:

- Motorway to Totara Park;
- Totara Park;
- Murphy’s Road;
- Totara Park to north of Ranfurly Road; and
- North of Ranfurly Road to Alfriston School

- The report identifies opportunities and constraints for each section of the corridor and sets out a number of principals for landscape and urban design within the corridor depending on whether the section of the alignment is urban or rural.

For urban sections the report recommends:

- Accepting the use of retaining structures but ensure they are faced in scoria;
- Carefully considering the alignment to minimise impacts on buildings that front the street;
- Provide planting sympathetic to ‘commuting birds’ and other fauna between larger clusters such as Totara Park and Murphy’s Bush;
- Carefully consider implications for safety created by cuttings, orphaned roading sections and planting through CPTED analysis and recommendations.
- For rural sections the report recommends:
- Recognise the rural character of the area;
- Narrow perceived width of road corridor with areas of bush planting;
- Soften engineering with additional planting;
- Utilise swales to retain rural character;
- Design bridges to reflect local context;
- Consider appropriate lighting for bridge structures for night time use to reduce pollution for neighbours yet create a feature for drivers;
- Consider CPTED analysis and recommendations.

Auckland Council has requested that any retaining walls in rural areas be faced with suitable materials, which are to be determined during the detailed design.

### 7.6 Utility Services

The Utilities Options Assessment summary below is covered in more detail in the Utility Services Report in Appendix K. and volume 3: Drawings, sheets 60250009-CV-0551 to 0583. The report provides an initial assessment of the potential effects utilities have on each alternative alignment.

#### 7.6.1 The Do minimum option – Entire route

The Do Minimum option for the entire existing route represents the scenario where no improvements are made to the corridor over and above usual or routine maintenance. This maintenance of utility services activities typically could include repairs to services when they are damaged or fail and cyclic maintenance.

#### 7.6.2 Redoubt Road Alignment Options

The section between SH1 and Murphy’s Road through the current urban area has only a single alignment option that was considered. The previous reports all have similar alignments and hence similar effects on the Utility Services along this section of the route.

Eastern C is based on the previous options however it takes in to account the additional investigations and Utility Services Provider’s consultation that has been undertaken. This includes identifying major services that could be affected and are summarised below.

**SH 1 to Totara Park**

Typically utilises most of the existing berms on both side of the carriageway up to Totara Park and in most cases will need to be relocated to the new berm areas in common service trenches. The following major services affected for all options have been identified:

- Watercare’s bulk Wiri main and the valves at the Hollyford intersection, Vector overhead & underground power, and TelstraClear (Vodafone) cables and chambers.

**Totara Park Entrance to Murphys Road**

Typically utilises a small amount of the existing berms on both side of the carriageway and in most cases will need to be relocated to the new berm areas in common service trenches. The following major services affected for all options have been identified:

- A Transpower tower / pylon at no 181 Redoubt Road will be on the route of the new carriageway and requires relocation, Vector overhead & underground power, TelstraClear (Vodafone) cables and chambers, and Radio control mast wires and building.

**Redoubt Road – Mill Road Alignment Options**

All alignments have similar effects on the Utility Services as outlined below at the extremities of this section of the corridor (i.e. Murphy’s Road to existing Mill Road and north of Ranfurly Road to the end south of Alfriston Road). For the northern section of Murphys Road to Bridge 1 (exist. Mill Road) the previous reports all have similar alignments and hence similar effects on the Utility Services along this section of the route.

The following major services affected for all options have been identified:

- Vector Overhead Power affected in Kinnard Lane, Mill Rd bridge crossing and sections of the existing Mill Road need to be relocated underground.
- Chorus and TelstraClear (Vodafone) affected ducts and cabling to be re-laid in new berm including new chambers.
- For the central section of Bridge 1 (exist. Mill Road) to Mill Road there are three sub alignments with Eastern C found to have less sufficient utility services issues. The following major services affected for all options have been identified
- Bridge 1 crossing at Redoubt Road / Mill Road intersection. The Vector overhead power to be underground along with the Chorus and TelstraClear (Vodafone) cable.
- Watercare have requested that they prefer an alignment as far as possible away from their reservoirs to allow for future expansion. Eastern A alignment is the closest to these reservoirs.
- Watercare bulk water mains (4) cross the proposed alignment at CH4400. Allowance in the design is required to provide sufficient cover along with box culverts to enable full maintenance access.
- For the southern section Mill Road to south of Alfriston Road there option alignments are affected to a similar extent. The following major services affected for all options have been identified
- The Watercare 1200mm dia Waikato watermain on Mill Road was piloted and found to have 1300mm cover in the berm and indications there is sufficient cover
- Vector Overhead Power in selected areas and TelstraClear (Vodafone) areas of cable including stream crossing are affected and needs to be either relocated or relocated underground.

7.6.4 Murphys Road Alignment Options

AECOM met with Auckland Transport to specifically discuss the Murphy’s Road alignment and presented the identified options Northern A (Opus preferred alignment) to Northern B during a design meeting on 12 July 2012. At this meeting another option Northern B was identified and added to the alignment options.

Further screening of the other alignment options with Auckland Transport resulted in the other options not being taken forward for further assessment.

Northern A and Northern B have been divided in to two subsections to compare the two alignments with the following major services being identified.

Redoubt Road to Thomas Road
- All option alignments have similar minimal effects on services in the top section (Ch 1600m – 1850m)
- Northern B option alignment in the middle section (Ch 1290m – 1600m) requires undergrounding of the existing Vector overhead power and replacement of the existing TelstraClear cable.

Thomas Road to Flat Bush School Road
All option alignments have similar effects on services as follows:
- Watercare bulk mains (4) and valves at the Thomas Road intersection are affected. Box culverts (4) will be required to be constructed to enable full maintenance access
- Watercare 700mm dia East Tamaki No 3 watermain on the eastern side of Murphys Road is being planned to be replaced with a 1700mm dia on the western side of Murphys Road
- Nova Energy gas main will be required to be replaced
- Both options Northern A and B have similar effects on existing services for the first section (Ch 0m – 900m) and the middle section (Ch 1000m – 1290m) as follows:-
- Vector Overhead Power in selected areas needs to be relocated underground.
- A section of the Vector high pressure gas is under the proposed carriageway and will require relocation
- TelstraClear (Vodafone) areas of cable to be replaced and any chamber lids and surrounds to roadway strength.
- Option Northern A for the middle section (Ch 900m – 1290m) has a significant effect on the Transpower tower / pylon which is required to be relocated as the alignment passes through it. Option Northern B is clear of the Transpower tower / pylon.

7.7 Bridges and Structures

The proposed new alignment of the Redoubt Road - Mill Road corridor upgrade will require new bridge structures at three locations, all of which are located within the Eastern section of the corridor upgrade. The different alignment options have varying degrees of impact on the corridor, and have different requirements for bridges and structures depending on the topography traversed, geotechnical conditions encountered, and access and connectivity demands. These impacts are reflected in the number and type of structures required, the complexity of those structures, and ultimately the cost associated in the provision of those structures.
The proposed corridor alignments cross existing roads, driveways to different properties, vegetated areas and gullies, including two gullies which require bridges and retaining walls. For these alignments, batters of 1:3 are achievable in most fill situations, although in some cases MSE walls with and without fascia panels may be required. In areas of cut geotechnical soil conditions and drainage will determine the types of earth retaining structures required. The geotechnical conditions of the soil along the route have a number of issues including the possibility of land slips. Based on the preliminary geotechnical evidence the potential for liquefaction over much of the route is very low, although south of Ranfurly Road there is a higher potential of liquefaction. This is to be confirmed as further investigations are completed.

It should be noted that the procurement method for the detailed design and construction is still to be confirmed by the client. The bridge design statement is a key project deliverable and forms part of the development of the Scheme Assessment and Notice of Requirement.

In particular this outline design must define design expectations and include sufficient information to:

- Prove the design is viable.
- Support consenting requirements.
- Identify land requirements.
- Refine estimates.
- Clearly convey the design intent to suppliers.
- Identify design constraints which are fixed and cannot change.

It is important that in order to accommodate future procurement options for the Design and Construction phases, sufficient design flexibility is retained to encourage designer and contractor innovation. Therefore, while this report recommends a preferred structural solution, it does not prevent alternative solutions being proposed by others, subject to specific Principal’s Requirements being met where necessary. As such the information provided in this report is intended to support any future work.

Based on the proposed alignments, there is a requirement to overbridge the existing Mill Road and also two bridged gully crossings and the various considerations for scheme design are as follows:

- Materials
- Traffic Volume
- Pedestrians and Cyclists
- Utilities and Services
- Lighting
- Hydrology
- Drainage
- Side Protection
- Collision Effect
- Foundation Conditions
  - Site Seismic Hazard and Potential for Ground Instability
- Environmental Considerations and Constraints
  - Construction Limitations
- Inspection and Maintenance
- Design Life and Exposure Classification
- Climate Effects
The development of the structural arrangements of the bridges is based on New Zealand design codes and standards including the Transit New Zealand (now New Zealand Transport Agency - NZTA) Bridge Manual. The various considerations for scheme design are summarised below.

Table 13: General bridge requirements for Eastern and Northern alignment

<table>
<thead>
<tr>
<th>Bridge No and Location</th>
<th>Structural Aspects of Bridges</th>
<th>Constructability</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Eastern Alignment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bridge 1 – Mill Rd Overbridge</td>
<td>52m, Minimum 47 Degrees skew – with modifications to the existing Mill Road alignment to accommodate the central bridge pier</td>
<td>Uncomplicated</td>
</tr>
<tr>
<td>Bridge 2 – Puhinui Creek Gully Bridge</td>
<td>170m overall length, comprising 6 No. 28m spans with substructure located behind MSE walls.</td>
<td>Complicated. Needs careful construction planning and management with suitable equipment</td>
</tr>
<tr>
<td>Bridge 3 – South Mill Rd Bridge</td>
<td>28m single span</td>
<td>Simplest of all three bridges in the route</td>
</tr>
<tr>
<td><strong>Northern Alignment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No bridges required</td>
<td>N / A</td>
<td>N / A</td>
</tr>
</tbody>
</table>

A qualitative assessment of the pros and cons of the alternative alignments from a structural perspective is discussed for each of the Eastern and Northern alignment options in the table below.
### Table 14: Eastern and Northern alignment structural comparison

<table>
<thead>
<tr>
<th>Alignment Option</th>
<th>Alignment / Topography</th>
<th>Bridges</th>
<th>Retaining Wall</th>
<th>Cost Implications</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Eastern A</strong></td>
<td>Preferred solution from previous study by OPUS. Mostly common to Eastern B and C. Alignment moves the road out into undulating ground adjacent to Watercare Redoubt Rd reservoir site.</td>
<td>Three bridges 50m, 90m and 30m along the route. Three bridges 60m, 170m and 30m in length.</td>
<td>Simple Multispan and single span bridges. Ground conditions and geotechnical issues associated with slope stability will complicate construction, especially at the 90m span structure adjacent to the Watercare site. Structures are of a standard design and well known construction type. Ground conditions and geotechnical issues associated with slope stability will complicate construction, especially at the 90m span structure adjacent to the Watercare site. Structures are of a standard design and well known construction type.</td>
<td>Bridge structures similar to Option C although a larger span is required for Eastern C. Ground conditions at the 90m span bridge are difficult and additional ground stabilisation to protect the Watercare site will increase construction costs.</td>
<td>Eastern A was the preferred option from the previous OPUS study. The extensive development at the Watercare reservoir site and the ground stability issues at the 90m bridge location discount the option.</td>
</tr>
<tr>
<td><strong>Eastern B</strong></td>
<td>The proposed route runs closely to the existing Mill Road and is very similar to Eastern C. Both options follow undulating ground, and retain a close proximity to the existing Mill Road.</td>
<td>Three bridges 50m, 90m and 30m along the route. Three bridges 60m, 170m and 30m in length.</td>
<td>Typically batter for cuttings and embankments. Retaining structures required at driveway and property boundaries. MSE walls are recommended to avoid heavy expensive abutment structures at bridges. No special retaining walls identified.</td>
<td>Eastern B and Eastern C will have similar costs. Lower construction risk than Eastern A and easier access from the existing road.</td>
<td>More complex bridging requirements than Eastern A. Similar wall requirements to Eastern A. Bridging and structural cost in a similar range as Eastern C. Eastern B was however discounted as the preferred option on road alignment grounds.</td>
</tr>
<tr>
<td>Alignment Option</td>
<td>Alignment / Topography</td>
<td>Bridges</td>
<td>Retaining Wall</td>
<td>Cost Implications</td>
<td>Comments</td>
</tr>
<tr>
<td>------------------</td>
<td>------------------------</td>
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<td>---------</td>
</tr>
<tr>
<td>Eastern C</td>
<td>The proposed route runs close to the existing Mill Road. The proposed road geometry is considered best of the three Eastern route options selected.</td>
<td>Three bridges: Bridge 1: Highly skewed 2-span bridge 56 m long. Bridge 2: Multi-span bridge approx. 170 m long. Bridge 3: Single span bridge approx. 30m long.</td>
<td>Bridge 1: Single span but skewed. Bridge 2: Complicated and needs careful construction planning and management with suitable equipment. Bridge 3: Simplest construction of all three bridges on the route.</td>
<td>Structures are of a standard design and well known construction type. Ground conditions and geotechnical issues associated with slope stability will complicate construction but lower overall risk than Eastern A. Eastern B and Eastern C will have similar costs. Lower construction risk than Eastern A and easier access from the existing road.</td>
<td>The proposed road geometry is the best out of three options selected. More complex bridging requirements than Eastern A. Similar wall requirements to Eastern A. Highest cost for bridging and structural elements. Preferred option.</td>
</tr>
<tr>
<td>Northern A</td>
<td>Preferred option from previous OPUS report. Large embankment crossing stream ways and on steep hillside.</td>
<td>No bridges required.</td>
<td>N/A</td>
<td>Road will be required to span across major Watercare supply pipes. Possible requirement for service culvert. Battered embankments required. Possible requirement for localised retaining wall structures at access points and around watercourse crossings.</td>
<td>Basic earthwork construction but on major hillside. Northern A provides off-line construction which minimises traffic disruption on existing road. Northern A reduces available land for development in later Flatbush stages.</td>
</tr>
<tr>
<td>Alignment Option</td>
<td>Alignment / Topography</td>
<td>Bridges Requirements</td>
<td>Constructability</td>
<td>Retaining Wall Requirements</td>
<td>Constructability</td>
</tr>
<tr>
<td>-------------------</td>
<td>------------------------</td>
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</tr>
<tr>
<td>Northern B</td>
<td>Preferred Option utilising existing route with a significant cutting at the top of Murphys Road. No bridges required.</td>
<td>N/A</td>
<td>Road will be required to span across major Watercare supply pipes. Possible requirement for service culvert which will be shorter than that required in Northern A. Battered embankments required. Possible requirement for localised retaining wall structures at access points and around watercourse. Significant cutting at the top of Murphys Road.</td>
<td>Basic earth work construction and requiring less fill than Northern A.</td>
<td>Releases land for Flatbush development. Will require extensive traffic management and diversions for construction.</td>
</tr>
<tr>
<td>Northern C</td>
<td>High impact on properties. No bridges required.</td>
<td>N/A</td>
<td>Battered embankments, cuts and retaining structures required.</td>
<td>Simple construction but disruptive.</td>
<td>Discounted as property impact adds cost to Northern A.</td>
</tr>
</tbody>
</table>
Appendix L recommends that a supertee beam bridge is the most suitable bridge type for all bridges proposed for Mill Road-Redoubt Road corridor. It is proposed that this bridge type be developed further in the ongoing phases of this project. The supertee system provides greater benefits than alternative systems considered. Typically the concrete options provide less construction and procurement risks and also assist in maintaining suitable clearance at Bridge 1. For the shorter span bridges at Bridge 1 and Bridge 3 there is potential to consider some of the other options reviewed, however for consistency the supertee becomes the prominent option. A summary of bridge types is given in Table 15.

Table 15: Summary of Bridges

<table>
<thead>
<tr>
<th>Bridge No.</th>
<th>Approximate Location</th>
<th>Bridge Reference</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ch. 3479 - 3538</td>
<td>Bridge 1: Mill Road Overbridge</td>
<td>Two 26m span at 48 degrees with substructure located behind MSE walls.</td>
</tr>
<tr>
<td>2</td>
<td>Ch. 3882 – 4052</td>
<td>Bridge 2: Puhinui Creek Gully Bridge</td>
<td>Six 28m spans integrated with substructure located behind MSE walls.</td>
</tr>
<tr>
<td>3</td>
<td>Ch. 4850 – 4883</td>
<td>Bridge 3: South Mill Road Bridge</td>
<td>Single 28m span integrated with substructure located behind MSE walls.</td>
</tr>
</tbody>
</table>

7.8 Multi Criteria Analysis

7.8.1 Development of Specific Objectives

A multi criteria analysis was undertaken by AECOM to provide a qualitative assessment of the options. The purpose of this assessment was to evaluate each option and remove any options which scored significantly worse than the others or had a ‘fatal flaw’ identified. In addition, the assessment should identify options which scored better than others to assist with the decision making of the preferred option.

The method of development of the options and criteria is linked to the key issues and problems within the study area. The background report provided a review of previous work carried out and the problems and issues that had been identified previously. This informed this review of those aspects to ensure the current project objectives serve the purpose of ensuring the outcomes required are reached, through strong linkages with the problems.

Section 2.3 provides details of the Issues, Problems and Objectives developed through this process. Combined with the options, these elements will be used to test the project concepts through the MCA.

The project team identified the issues relating to the project and this allowed identification of specific problems. Based on these problems, specific objectives that will address these problems were developed. These specific objectives defined in this process align with the RFT project objectives, and contribute to the following policy visions and objectives:

- New Zealand Transport Strategy (NZTS) vision: ‘People and freight in NZ have access to an affordable, integrated, safe, responsive and sustainable transport system.’
- Land Transport Management Act (LTMA) 2003 objectives, which are also reflected in the Auckland Regional Land Transport Strategy (RLTA) 2010-30 objectives:
  - Assisting economic development;
  - Assisting safety and personal security;
  - Improving access and mobility;
  - Protecting and promoting public health; and
  - Ensuring environmental sustainability.
- Auckland Plan Transport priorities:
  - Manage Auckland’s transport as a single system;
  - Integrate transport planning and investment with land use development;
  - Prioritise and optimise investment across transport modes; and
  - Implement new transport funding mechanisms.
7.8.2 Indicators and MCA Criteria

The corridor was split into three sections by land use to assist in the assessment of the options – Urban, Future Urban, and Rural. These three sections incorporated the sections defined in the RFT.

The determination of the specific objectives provided a platform against which to develop the Indicators, which then formed the MCA criteria. The MCA scoring of the alignment options therefore provided a consistent methodology of comparing the various options.

Table 16: Indicators Linked to the Objectives

<table>
<thead>
<tr>
<th>Issues</th>
<th>Objectives</th>
<th>Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Safety</td>
<td>A corridor which is safe for all modes.</td>
</tr>
<tr>
<td>B</td>
<td>Route Security</td>
<td>A corridor where risk of closure is minimised and which develops ‘One Network’ with State Highway.</td>
</tr>
<tr>
<td>C</td>
<td>Future growth</td>
<td>A corridor which is able to accommodate future demand efficiently.</td>
</tr>
<tr>
<td>D</td>
<td>Social</td>
<td>A corridor which manages negative impact of transport network on the local community.</td>
</tr>
<tr>
<td>E</td>
<td>Environmental impacts</td>
<td>A corridor which minimises or mitigates against negative impacts on the environment.</td>
</tr>
<tr>
<td>F</td>
<td>Cultural impacts</td>
<td>A corridor which is sensitive to the cultural heritage of the area.</td>
</tr>
<tr>
<td>G</td>
<td>Constructability</td>
<td>A corridor which is constructible and funding is available.</td>
</tr>
</tbody>
</table>

7.8.3 Multi Criteria Analysis Results

For each of the Urban, Future Urban, and Rural corridor sections three alignment options were analysed against the MCA Indicators. The alignment options analysed in each of the corridor sections is described in Table 17, with the alignments shown previously in Figure 15.

Table 17: Alignment Options Analysed in Each Corridor Section

<table>
<thead>
<tr>
<th>Corridor Section</th>
<th>Alignment Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>Three alignments are listed in this section of the corridor as Eastern A, Eastern B, and Eastern C. All three alignments are common on this section of the corridor, and hence a single option between the Motorway and Murphy’s Road is analysed. The Murphy’s Road intersection assessment is included in Future Urban section.</td>
</tr>
<tr>
<td>Future Urban</td>
<td>Three alignments are listed in this section of the corridor as Northern A, Northern B, and Northern C. The alignment options are the same for the northernmost section of Murphy’s Road and follow the existing road alignment. The southern section approaches Redoubt Road on 3 alternative horizontal and vertical alignments with different Murphy’s Road / Redoubt Road intersection arrangements.</td>
</tr>
<tr>
<td>Rural</td>
<td>Three alignments are listed in this section of the corridor as Eastern A, Eastern B, and Eastern C. Alignments of the road in the northernmost and southernmost sections are the same with alternative horizontal and vertical alignments in the central section.</td>
</tr>
</tbody>
</table>
Project workstream leaders each analysed and scored the three corridor sections according to the Indicators. Table 18 shows a summary of the analysis with the key benefits and disbenefits tabled. Refer to Appendix M for the full Multi Criteria Analysis tables which describe all recognised benefits and disbenefits. The MCA carried out on each section determined the preferred alignment for those sections, and hence the preferred alignment of the corridor.

The MCA is separated into three corridor sections:
- Urban (sections 1a, 1b and 2 from the RFT)
- Future Urban (3a and 3b)
- Rural (4a, 4b and 4c).
Table 18: Option Analysis

<table>
<thead>
<tr>
<th>Category</th>
<th>Ranking Score</th>
<th>URBAN (sections 1a, 1b and 2)</th>
<th>FUTURE URBAN (sections 3a and 3b)</th>
<th>RURAL (sections 4a, 4b and 4c)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Eastern</td>
<td>Northern</td>
<td>Eastern</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10.0</td>
<td>10.0</td>
<td>10.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
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<tr>
<td></td>
<td></td>
<td>10.0</td>
<td>10.0</td>
<td>10.0</td>
</tr>
<tr>
<td>Criteria / Indicators</td>
<td></td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>Safety</td>
<td></td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Conflict between modes at intersections</td>
<td></td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Access and connectivity</td>
<td></td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Route Security</td>
<td></td>
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<td>Good</td>
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</tr>
<tr>
<td>Network assessment of model</td>
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<tr>
<td>Engineering assessment of geotechnical risks</td>
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<tr>
<td>Future growth</td>
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</tr>
<tr>
<td>Developing Level of Service</td>
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<td>Good</td>
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<td>Good</td>
</tr>
<tr>
<td>Social</td>
<td></td>
<td>Poor</td>
<td>Poor</td>
<td>Poor</td>
</tr>
<tr>
<td>Impact on residential access</td>
<td></td>
<td>Good</td>
<td>Good</td>
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</tr>
<tr>
<td>Severance assessment</td>
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<tr>
<td>Impact on community facilities</td>
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<td>Environmental</td>
<td></td>
<td>Neutral</td>
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<td>Stormwater management</td>
<td></td>
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<td>Ecological</td>
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<td>Poor</td>
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<tr>
<td>Noise and vibration</td>
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<td>Poor</td>
<td>Poor</td>
<td>Poor</td>
</tr>
<tr>
<td>Landscape visual</td>
<td></td>
<td>Good</td>
<td>Good</td>
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<td>Urban design</td>
<td></td>
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<td>Good</td>
<td>Good</td>
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<tr>
<td>Cultural</td>
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<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
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<tr>
<td>Archaeology and heritage</td>
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<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
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<tr>
<td>Cultural sites</td>
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<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
</tr>
<tr>
<td>Constructability</td>
<td></td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Benefit Cost Ratio</td>
<td></td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Bridges and Structures</td>
<td></td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
</tr>
<tr>
<td>Deliverability</td>
<td></td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Utilities and Services</td>
<td></td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
</tr>
<tr>
<td>Funding</td>
<td></td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
</tbody>
</table>

The scoring for each Indicator was based on the following grading system:

- **Best** = 2: The best performing indicator when comparing the options to the Do Minimum and to each other
- **Good** = 1: An indicator which performs better than the Do Nothing scenario
- **Neutral** = 0: An indicator which performs neither better nor worse than the Do Nothing scenario, or on balance has some equally good and bad aspects
- **Poor** = -1: An indicator which performs worse than the Do Nothing scenario.
- **Fatal Flaw** = -2: An indicator which performs so poorly that the option is eliminated and not considered any further
7.8.4 Summary of Multi Criteria Assessment

The MCA identified that a combination of Northern B and Eastern C delivers the most positive impacts across the range of criteria and is considered to be the preferred alignment along the corridor, as shown in Figure 17.

Figure 17: Preferred Alignment

Positive impacts delivered by this preferred alignment:

- Latest design standards provide improved horizontal and vertical alignment, including updated traffic facilities, road marking, signage, berm / footpath facilities.
- New traffic signals at Diorella and Murphy’s cater for existing and future traffic flows while minimising travel times on Redoubt Road.
- Existing traffic signals at Hollyford are to be upgraded to cater for future traffic flows including separate bus lane.
- Large diameter roundabouts at Ranfurly and Alfriston with multiple lanes provide good gap acceptance.
- The road alignment and intersection layouts cater best for the balance of flows and travel desire lines.
- The high number of right turns into and out of adjacent properties, especially along the Urban Section, is catered for with a 3.5m flush median, allowing a safe refuge for turning traffic.
- Potential exists within the median area to incorporate future pedestrian crossing facilities as desire lines alter over time.
- Increased future corridor capacity with less congestion, improved travel times and greater route security for lane configuration changes, all providing a positive effect on the One Network, especially by balancing flows on alternative parallel routes such as Te Irirangi Drive, Chapel Road and SH1.
- Future development to the south of the corridor is accommodated through increased capacity on the south of the corridor.
- The design will accommodate the future urban, future urban and rural character, as well as the natural and topographical landscape features.
- Planting on new embankments provide opportunities for an entrance experience to Murphy’s Bush and ecological treatment, with accentuated views down the incline to Murphy’s Bush.

- Realignement of the route away from Alfriston School in the south presents opportunities to provide future school drop off and pick up areas and additional parking for social and community facilities adjacent old Mill Road.

- The new Redoubt / Mill Road intersection improves access, and opportunities to consolidate driveways.

- The alignment is designed to help minimise the identified risks, especially the geotechnical instabilities in the vicinity of the Watercare reservoir.

- The Watercare pump station building at Murphys Road / Thomas Road is retained.

- Dedicated on-road cycle lanes along the entire route with additional off-road shared pedestrian / cycle paths.

- Realignment of sections of Redoubt Road and Mill Road allows the residual Redoubt Road and Mill Road to be used as a future cycle route segregated from the new and busier road alignment and provides improved cycle safety by separating competing modes.

- Bus only lanes at Diorella and Hollyford signalised intersections.

- Pedestrian connectivity and access is improved through the provision of designated and safe pedestrian crossing opportunities at Diorella / Redoubt, Hollyford / Redoubt, and Murphys / Redoubt traffic signals.

- New footpaths both sides of Redoubt Road (SH 1 to Murphys Road) and Murphys Road.

- Improved pedestrian and cycle access and connectivity to Totara Park for recreational use.

- Wetlands stormwater ponds provide collection and treatment of runoff from existing road surface in addition to collection and treatment of runoff from new road surface.

- Some driveways are consolidated to improve access to properties, for example at Kinnard lane.

- Areas of kerb and channel collect and convey stormwater runoff to wetlands stormwater ponds or storage attenuation units.

- Main watercourses will be bridged.

- On-line alignment along Redoubt Road could allow construction to be staged initially on the south side to create additional carriageway space prior to upgrading on the north side.

- The Murphy’s intersection, Totara Park to Mill Road connection section could be constructed off-line and is easily staged.

Negative impacts delivered by this preferred alignment:

- The raised alignment of the southern portion of Murphys Road has an effect on the ability of the road to interface with the adjacent development. Driveways on Murphy’s Road will not be accessible from the road. Urban design and landscape design mitigation is required to optimise land development potential.

- Road widening means road edge is closer to some properties on south side of Redoubt Road between Motorway and Hollyford.

- Some property acquisition requires purchase of entirely properties.

- Road widening of existing urban corridor increases stormwater runoff.

- Existing stormwater system in Redoubt Road (SH 1 to Totara Park) has no capacity for additional flows so stormwater needs to be managed within road corridor by attenuation systems.

- The gullies within Totara Park are a constraint on the alignment and are preserved although treatment at the gulley heads may be required additional requirements.

- The main areas of geotechnical concern are identified are where the alignment traverses the slopes below Redoubt Road and the Watercare reservoir facility.
8.0 Option Refinement
8.0 Preferred Option Refinement

This section describes the refinement of the preferred alignment (Northern B and Eastern C) identified by the MCA process. This stage of the project is shown in Figure 18 below, and is followed by the assessment of the option in Section 9.0.

Figure 18: Preferred Option Refinement and Assessment

8.1 Refinement of Option

The preferred alignment was overlaid over the 3D terrain model to accurately assess the implications of the layout on all the elements identified below:

- Policy and Strategy
- Land use and accessibility
- Connectivity
- Geotechnical conditions and ground instability
- Stormwater
- Existing Terrain and Topographical Constraints
- Utilities (existing underground and overhead)
- Strategic transport modelling
- Cost efficiency.

The preferred alignment was assessed against each of these criteria to determine where, if at all, the alignment needed to be refined.

8.1.1 Policy and Strategy

The preferred alignment meets the project objectives described in the RFT and is in line with the policies and strategies of the Auckland Council and Auckland Transport. The preferred alignment meets the 30 year planning requirements by allowing for an appropriate cross section based on traffic flow forecasts.

The design will increase the route’s safety by providing appropriate design speed sight distances, alignments appropriate for the operating speeds, smoother vertical grades and increased curve radii.

Where appropriate, the preferred alignment deals with the requirements for public transport, walking and cycling.

No change is required to the preferred alignment in order to meet policy and strategy requirements.
8.1.2 Land Use and Accessibility

As a result of the topographical terrain and the first section of Redoubt Road is located along the top of a ridge line, the alignment was refined to ensure private land remains accessible. Where possible, land accesses were combined, for example at Kinnard Lane, while the existing Redoubt and Mill Roads were retained to limit access from off the new alignment.

Improved access to the Pony Club at the southern entrance to Totara Park is provided with turning lanes designed to accommodate vehicles with horse floats.

8.1.3 Urban Design and Landscaping

An Urban Design and Landscape Study identify and recommend urban design strategies and landscaping concept design for the preferred alignment, refer Appendix J.

The strategies and design take in to consideration the character areas that exist along the corridor, including Murphy’s Road. The design provides a degree of continuity along the corridor but still recognises the unique character of each section. A concept design has been developed for each sub-areas taking account of this and to ensure that an appropriate design is achieved.

An important feature establishes additional street tree planting within the urban section of Redoubt Road, Hollyford Drive and Everglade Drive of the route in order to visually narrow and reduce the dominance of the road and to improve the amenity for residents and users, in particular pedestrians and cyclists. Careful attention has been paid to the design of cut, batter and retained areas to allow the maximum number of lots to be retained alongside the road, including the potential to realign lot boundaries to ensure that land is capable of redevelopment.

The boundary with Totara Park has been kept as open as possible to maintain views into the park and towards the Manukau Harbour / Manukau Heads. However, additional planting could be incorporated at the head of the existing gullies and around the stormwater treatment ponds to both add to the experience of the users of the route and to increase the ecological significance of the Park. Existing cycle tracks within the park will be amended to ensure their future continuity and linkage to the project.

Within the Murphys Road section the design makes allowance for future dwellings to front the road for part of its length. Where this is not possible, a landscaped area is established alongside the road that will be overlooked by dwellings on the Flat Bush Stage 3 (future urban) land. The width of the road reserve has been kept as narrow as possible as it traverses Murphy’s Bush to allow maximum ecological linkages across the road between the eastern and western sections of Bush.

The realignment of the corridor at Alfriston School is seen as an opportunity to improve the physical environment within that area, to allow existing activities including a pupil drop off and pick up parking area, the weekend market and use of the Alfriston hall to take place more safely.

Where sections of the original road are to remain but no longer used as part of the arterial route, new uses have been found. This could include becoming part of a future recreational cycle route to allow less experienced or less confident cyclists the opportunity travel along the route.

8.1.4 Geotechnical

As discussed in the Option Screening, Eastern B and C were developed as a result of instability near the Watercare Reservoir site. The preferred alignment (Eastern C) is closer to the ridgeline and will involve the least earthworks. In addition, the headwaters of the streams will over time encroach on the road edge in areas of historical instability, for example directly opposite the Murphy’s Road intersection – headwalls or other suitable earth retention systems will be used to stabilize embankments.

It is recommended that some additional geotechnical investigations be undertaken during the detailed design phase once bridge crossing locations have been finalised and areas of deep cuts and fills confirmed. In particular, areas of historic and current instability are anticipated to require further investigation to determine the extent of stabilisation works required.
8.1.5 Stormwater

As a result of the need to control and treat runoff prior to discharge into open water courses, all the sections apart from the southernmost section (CH6500 to end) include kerb and channel systems for stormwater management. The kerb and channel systems will connect to stormwater reticulation that will drain the runoff either to attenuation tanks (CH0 to 1300) or treatment ponds (CH1300 to 6500) at appropriate locations.

Attenuation tanks (CH0 to 1300) will control the rate of stormwater discharge to the existing reticulated system to no greater than existing peak flow rates.

Treatment ponds (CH1300 to 6500) will enable treated stormwater to be discharged to the receiving watercourses at controlled rates. The locations of these permanent treatment ponds have been determined to best support the drainage requirements while fitting in with the topography in the immediate vicinity.

8.1.6 Utilities

The proposed option will impact on existing Services Authorities assets. This includes details of existing services, initial consultation with the various Service Authorities and the development of existing services drawings. Where noted by the Services Authorities any future service or betterment provisions are not included in their estimate.

In developing the preliminary design we will undertake further consultations with the Service Authorities and better understanding their priorities and their assets. The Service Authorities that we have consulted and that have affected assets:
- Vector – Power, communication and Gas
- Chorus – Telecommunications
- Telstra Clear (Vodafone) – Telecommunications
- Transpower
- Watercare – Watermains, wastewater mains and stormwater mains
- Nova Energy – Gas

Details of the various Utility Authorities plant in the project area were collected along with undertaking utility services trenches at locations of critical services to determine cover, position and asset type. This was then used to prepare an updated set of existing services drawings. The service drawings were overlaid over the preferred option alignment and an assessment undertaken to identify where clashes occurred. Major services that conflicted with proposed features such as kerb lines, property access and structures were look at to best identify likely clearances and further design requirements. The relative risk to Service Authorities services, the continuity of supply to customers, traffic management, costs, safety and construction methodology will also be taken into account during preliminary design.

Various existing services will need to be relocated and / or protected as part of the project and need to be identified in detail during the detailed design phase of the project.

The general philosophy in dealing with utility services is that services will be protected where possible if agreed with the utility provider, in preference to relocation to reduce the disruption to the Service Authority and their customers.

Future Utility Service Requirements Betterment / Upgrades

Consultation undertaken with the Service Authorities has indicated to date the following Utility service provider betterment or upgrades.

Chorus: Redoubt Road two large and small manholes and Murphy’s Road, two new ducts

The following betterment works are included in the cost estimates:
- Eastern C (Redoubt Rd at SH1 to start Mill Rd)
- Construction of two off large manholes and four off small manholes
- Eastern C (Mill Rd intersection with Redoubt Rd to Alfriston)
- No betterment works
- Northern B (Murphy’s Rd)
- Installation of two off ducts the entire length of the new Murphy’s Rd (Northern B portion).

Any betterment or improvement and associated costs included in agreements need to be reviewed and, where required, the respective Service Authority’s concept designs need to take into account improvement and identify it for inclusion in the preliminary design.

**Utility Services Trenches**

On-site utility trenches were undertaken at critical locations to validate the existing services information, determine cover, position and asset type. These were then added to the existing services drawings and assisted with costing of Watercare owned services.

It is recommended that further detailed utility trenches and piloting needs to be undertaken early on during the detailed design phase to confirm more accurately the extent of services affected. This will then assist the Utility services providers with their design requirements.

**Common Service Trenches**

All services that require relocation works need to be relocated in accordance with the following approach.

- Urban areas: common service trench in the back berm (in front of the boundary) and where possible under the footpath (excluding areas for stormwater attenuation units) on either side of the carriageway
- Other areas: the back berm and under the footpath on either side of the carriageway

The use of common service trenches is dependent on many factors such as carriageway position and level which are typically able to be more clearly identified once the alignment is finalised during the detailed design stage. The service configuration and clearances within a common service trench need to be identified and determined for each stage during the detailed design phase. This includes liaison and acceptance by all affected service authorities to ensure that all minimum clearances and design requirements are able to be met.

**Constructability**

It is recommended that an advanced enabling services physical works contract be undertaken prior to the main contract for each stage and include the relocation / removal of existing services as required, making allowance for excavation / disposal of soil / rock and backfilling.

8.1.7 **Lighting**

Upgrading, replacing and / or relocating existing lighting within the corridor shall comply with Auckland Councils street lighting policy and is based on the lighting technical parameters of Category V1 (AS/NZS 1158.1.1.2005 Table 2.2) estimate for >20,000 VPD. It does not include dimmable lamps.

The likely column spacing’s being between 45-50m in a staggered arrangement on either side of the carriageway and when approaching major intersections with widening they oppose each other. Outreach arms shall be mitred, and have 5 degree tilt angle from the horizontal for luminaires on the carriageway and 5-10 degrees for local roads and bridges. Tilts up to 10 degrees may be used in exceptional cases. A typical mounting height of 12m with a 2m outreach arm or 3m in special circumstances is being used.

All columns are typically octagonal lighting columns either ground planted in areas under 70km / hr or standard flange base and shear bases for speeds over 71km / hr or special bridge connections & need to be confirmed at the design stage.

This luminaires are based on using either the Auckland Transport approved AEC KAOS 2 or Schreder Ambar 3 with flat glass protectors. The lamp shall be from the Auckland Transport approved list being the GE TT 250 W Metal Halide Lamp.

Cable systems shall be in accordance with AS/NZS 3000. The cable shall be 16mm, PVC insulated, neutral screened, with soft drawn copper conductors, having a sheath radial thickness of no less than 3.2mm screened with the screen connected as the earth.

Vector Networks will supply and install their own cables from the network to the connection point in the base of the street light column. No more than 4 columns shall be supplied by each phase on each cable.

Cable is to be connected directly to the Vector network providing continuous supply (24/7) into the street light column and undertaken during the design stage. In some sections of road it may be more cost effective to connect more than one light to a single feed from the LV network connection. Selections and voltage drop
calculations shall take into account relevant start up currents of luminaries as well as the lowest striking voltage for the number of luminaries per circuit.

Outdoor distribution cabinets will be provided, including lighting control and facilities for remote metering.

The detailed design consideration should be given to investigate the potential of using the LED lanterns on the approved list to determine if they can meet the required standards. Undertake a whole of life cost assessment against the recommended lighting in this report to see if any cost savings occur.

8.1.8 Transport Modelling

Traffic modelling affected the alignment selections of a number of side roads and accessways. Kinnard Lane and the link to the existing alignment of Redoubt Road / Mill Road at CH3300 initially formed a cross roads priority intersection. Traffic flows out of Kinnard Lane resulted in substantial delays from the existing Kinnard Lane alignment trying to access the new alignment. As a result the Redoubt Road / Mill Road and Redoubt Road / Kinnard Lane intersections have been staggered to ensure delays at the intersections are minimal.

8.1.9 Cost Efficiency

The preferred alignment curves north at CH4750 to avoid a gully and is therefore more cost effective.

In addition, intersection layouts have been modified so that the capacity provided is adequate but not excessive.
9.0
Option Assessment
9.0 Option Assessment

The identification of the preferred alignment and subsequent refinement provided a preferred option against which an assessment of objectives and costs, an economic evaluation, and a test of statutory requirements could be carried out. This was followed by completing an Assessment Profile in accordance with NZTA guidelines.

9.1 Strategic Objectives

To ensure that the project is in alignment with strategic objectives, various assessments were carried out to determine the project options contribution to those objectives. These objectives are those included in the NZ Transport Strategy (NZTS), the Government Policy Statement on Transport Funding (GPS), the Safer Journeys road safety strategy, and the Land Transport Management Act (LTMA).

9.1.1 NZ Transport Strategy

This current version of the NZTS takes a long term view by setting the direction for transport to 2040 for all parts of the transport sector. This acknowledges that many transport investments have long-term implications.

The NZTS has a vision for transport in 2040:

“People and freight in New Zealand have access to an affordable, integrated, safe, responsive and sustainable transport system.”

Table 19 lists the five transport objectives identified in the NZTS and discusses the project’s contribution to these objectives.

<table>
<thead>
<tr>
<th>Objective</th>
<th>Impacts of Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ensuring environmental sustainability</td>
<td>- The preferred option improves travel times and reduces pollution produced by</td>
</tr>
<tr>
<td></td>
<td>congestion over the course of the project life</td>
</tr>
<tr>
<td></td>
<td>- Environmentally sensitive stormwater design collects and treats stormwater from</td>
</tr>
<tr>
<td></td>
<td>sealed road surfaces prior to discharge into natural systems.</td>
</tr>
<tr>
<td>Assisting economic development</td>
<td>- Essential transport link to planned development areas of Flat Bush</td>
</tr>
<tr>
<td></td>
<td>- Provides improved transport linkage to Manukau city.</td>
</tr>
<tr>
<td>Assisting safety and personal security</td>
<td>- Upgraded engineering standards improves road safety through reduction of fatal and</td>
</tr>
<tr>
<td></td>
<td>serious crashes</td>
</tr>
<tr>
<td></td>
<td>- Improved urban design and public space (road corridor) lighting in urban and future</td>
</tr>
<tr>
<td></td>
<td>urban areas increases opportunities for passive surveillance and personal security</td>
</tr>
<tr>
<td>Improving access and mobility</td>
<td>- Improved multimodal transport linkages between residential areas and commercial /</td>
</tr>
<tr>
<td></td>
<td>retail centre of Manukau city.</td>
</tr>
<tr>
<td>Protecting and promoting public health</td>
<td>- New cycle lanes and pedestrian paths along the strategic corridor permit safe and</td>
</tr>
<tr>
<td></td>
<td>convenient cycle and walking routes which encourage active modes of travel.</td>
</tr>
</tbody>
</table>

9.1.2 Government Policy Statement

Within the land transport sector, a Government Policy Statement on Land Transport Funding (GPS) is produced every three years that sets out the levels of funding allocated to different areas of the transport system. The GPS contains short-term targets within the longer term strategy, and are given affect to by the three-yearly National Land Transport Programmes.

The GPS objectives are:

“An effective, efficient, safe, secure, accessible and resilient transport system that supports the growth of our country’s economy in order to deliver greater prosperity, security and opportunities for all New Zealanders.”

The preferred option identifies a solution in support of the GPS objectives by providing a safer route, with improved travel times, less congestion, supports planned land use, and links residential settlement with work centres.
9.1.3 Land Transport Management Act

A summary of the contribution to the Land Transport Management Act (LTMA) is provided in Table 20. The preferred option identifies a solution in support of the LTMA objectives.

Table 20: Contribution to the LTMA

<table>
<thead>
<tr>
<th>Objective</th>
<th>Impacts of Preferred Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integration</td>
<td>- The project provides walking and cycling facilities and improved public transport linkages to Manukau city.</td>
</tr>
<tr>
<td>Sustainability</td>
<td>- Promotes mode shift from car to pedestrian / cycle / passenger transport through providing facilities and improves mode choice between major land use destinations.</td>
</tr>
<tr>
<td></td>
<td>- Reducing private car travel and reducing journey times will lead to a reduction in fuel use and emissions, and shorter travel times.</td>
</tr>
<tr>
<td>Safety</td>
<td>- Improved pedestrian facilities (footpaths) and cycle facilities will all improve the personal safety and security.</td>
</tr>
<tr>
<td></td>
<td>- Providing an upgraded road alignment will reduce the potential for loss of control crashes.</td>
</tr>
<tr>
<td>Responsiveness</td>
<td>- The Redoubt Road-Mill Road corridor has been previously consulted with affected residents, and there has been an expectation that the project will be implemented in the near future to relieve current congestion problems.</td>
</tr>
<tr>
<td>Economic development</td>
<td>- Supports economic development by reducing congestion. Travel time savings are achieved due to capacity improvements.</td>
</tr>
<tr>
<td>Access and mobility</td>
<td>- Improves access to the transport network by providing travel choice and alternative routes for pedestrians and cyclists.</td>
</tr>
<tr>
<td></td>
<td>- Provides reasonable accessibility to Manukau city transport facilities and connections.</td>
</tr>
<tr>
<td>Public health</td>
<td>- Reduces vehicle emissions through mode shift and reduced travel times. Provides for active travel modes which have positive impacts on public health.</td>
</tr>
</tbody>
</table>

9.1.4 Safer Journeys

Safer Journeys is the government’s strategy to guide improvements in road safety over the period 2010 to 2020. The strategy’s vision is “A safe road system increasingly free of death and serious injury”. The Safe System recognises that people make mistakes and are vulnerable in a crash. The approach aims for a more forgiving road system that takes human fallibility and vulnerability into account, and looks at four cornerstones:

- safer roads and roadsides,
- safer speeds,
- safer vehicles and
- safer road use.

In the context of the Redoubt Road-Mill Road Corridor project, all system designers must share the responsibility for road safety outcomes, including designers include planners, engineers, parents, policy makers, enforcement officers, educators, utility providers, insurers, vehicle manufacturers and importers, the media, fleet managers and many more.
Table 21: Contribution to Safer Journeys

<table>
<thead>
<tr>
<th>Safety Cornerstone</th>
<th>Expected Outcomes of Preferred Option</th>
</tr>
</thead>
</table>
| Safer roads and roadsides| - Improved horizontal and vertical alignment eliminating sharp bends, crests or sags, reducing the highest risk crash types such as head-on and run-off road.  
- Median separation for opposing traffic flows where possible and practical to reduce the likelihood of head-on crashes, with the use of a solid median along the rural section and a flush median in the urban sections.  
- Improved intersection controls and priorities to reduce exposure to conflict and better manage side road flows competing for road space. This reduces the risk of intersection and pedestrian crash types.  
- Street lighting will be included in all urban areas, intersections, and allowance has been made for lighting of the entire route.  
- Road design will accommodate improved surfaces, roadside hazards removed, and barriers installed where necessary.  
- Cycle lanes and facilities at intersections reduce the risk to cyclists. |
| Safer speeds              | - The upgraded design incorporates a lower posted 80 km / hr speed limit along the rural section of the corridor.  
- Urban speed limits are consistent throughout the project area and in accordance with an urban arterial route.  
- Improved vertical and horizontal alignment allows a more legible / self-explaining corridor with an expected outcome of reliable and consistent travel speeds. |
| Safer vehicles            | - The project is not able to influence the outcome of this cornerstone                                                                                                                                                                |
| Safer road use            | - Active modes (walking and cycling) will have improved facilities for travelling along the corridor or for crossing the corridor. Improved safety is provided through the provision of dedicated infrastructure, including pedestrian crossing phases at traffic signals, new footpaths, new cycle lanes (on-road) and cycle paths (off-road).  
- Improved road alignment permits better visibility of road signage, pedestrians, cyclists, and other corridor features, allowing the driver to remain alert and unimpaired, resulting in safe driving choices and decisions.  
- Improved design standards allow for better identification of potential risks to the road users, who will be able to drive or ride to the conditions. |

9.1.5 Summary

The preferred option identifies a solution in support of the NZ Transport Strategy objectives, the GPS objectives, the LTMA objectives, and the Safer Journeys road safety strategy.

9.2 Risk

The full risk option adjusted register including rating definitions is provided in Appendix R. This risk register was prepared in accordance with the NZTA’s Risk Management Process Manual AC/MAN/1.

A Risk Workshop was undertaken for the preferred option to revisit all risks developed during the course of the project. Each identified risk was given a post mitigation score to determine the Scheme Assessment risk profile for the project and a mitigation approach developed for each. All listed risks should be actively managed during the next project phase (detailed design) to ensure they do not cause disruption to the project.

Potential Extreme Risks for the project include:
- Strategic objectives change through revised business case assessment
- Scope creep during the development/delivery of project
- Consents for project not obtained/challenged
A Full Risk analysis is to be undertaken during the Preliminary Design phase.

### 9.3 Cost Estimates

A Scheme Estimate has been developed for the preferred alignments in accordance with the NZTA Cost Estimating Manual SM041 and the results summarised in Table 22 below. The cost estimates and a full breakdown of estimates is included in Appendix N and is to be adjusted for risk during the Preliminary Design phase.

<table>
<thead>
<tr>
<th></th>
<th>Base Estimate</th>
<th>Expected Estimate</th>
<th>95th Percentile Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$244,793,589</td>
<td>$297,087,100</td>
<td>$373,913,000</td>
</tr>
</tbody>
</table>

### 9.4 Economic Evaluation

#### 9.4.1 Procedure

The economic evaluation assessed the viability of a single option against the Do Minimum scenario. The evaluation was underpinned by a number of key assumptions, the most important of which are:

- Evaluation period – 30 years assumed from the first year when major expenditure occurs; the evaluation period for public transport is 15 years;
- Real prices expressed in a constant price for all costs and benefits – discounted to the base date of 1 July 2012;
- Real discount rate – 8% as per current New Zealand Treasury guidance;
- Year Zero – 2012; and
- For the economic evaluation the corridor was considered as a rural strategic road for the Do Minimum scenario, which will become an urban arterial for the option.

The inputs to the economic evaluation (travel time and vehicle operating costs) were derived from the S3M SATURN transport modelling. The simulations were run for the Do Minimum and the option for the years 2011, 2026 and 2041 for AM, IP and PM. The simulation results were shown as total vehicle hours travelled per hour and total vehicle kilometres travelled per hour for the network comprising the Mill Road/Redoubt Road corridor and parallel routes.

In addition to these benefit sources the benefits of congestion reduction, accident reduction, provision of bus lanes and cycle lanes and agglomeration were explored.

The evaluation was carried out using the procedures developed by the NZ Transport Agency and presented in the Economic Evaluation Manual. The project time frame was based on the assumption that the land purchases would start in the financial year 2015 followed by construction start in 2017. The time stream of economic resource cost savings was estimated in constant price terms to exclude inflation, bringing together the cost savings for the road users. These savings were then compared with the corresponding stream of capital investment costs.

The resulting stream of net benefits and costs offered by the alternative option over the Do Minimum case formed the basis for the appraisal. The construction would be carried out in several stages, with the last stage expected to be completed in 2024. Therefore year one of the analysis is 2015, the first year of benefits is 2018 and the last year of the analysis is 2044.

#### 9.4.2 Do Minimum

The Do Minimum scenario for the purposes of economic evaluation is based on no upgrades being carried out on the corridor. It is considered that operational and maintenance costs on the Do Min and the Option are cost neutral and therefore excluded from the evaluation.
9.4.3 Analysis of Benefits

Project Staging

The implementation of the project is to be staged over multiple years and is discussed further in Section 10.4. The assigning of costs and benefits have been carried out according to this staging plan.

The sequence of staging of the upgrading components of the project over a ten year period has a substantial impact on the economic efficiency of the project. Typically, the costs and benefits occurring earlier are discounted at a high rate (e.g. at 80%), while the ones occurring later will be discounted at say 50%. Since the model results were too rigid to reflect the staging process, an appropriate methodology was developed to address this issue.

The total of travel time and VOC option benefits was derived from the model for 2026. This total was split between the project stages on the basis of the stage length. This assumption was made to simplify the calculations, although the evaluator appreciates that the benefits of a shorter stage might in some cases be higher than another, longer stage.

A similar methodology was adopted for passenger transport, cycling and accident benefits, although the total amount of benefits for the year 2026 did not come from the SATURN model but from another type of analysis.

Data Input

The travel time and vehicle operating cost data were obtained from a third party that was responsible for modelling the impact of the full length of the Mill Road/Redoubt Road corridor development. The full proposal comprises the corridor between SH1 at the Manukau Interchange to the SH1 Drury Interchange. However for the purpose of this work AECOM were provided with the results of the simulations of the window of the overall model, focused on the impact of the upgrading of the corridor between the Manukau Interchange and the Alfriston Road intersection.

The data obtained from the model were the total vehicle hours travelled per hour and total vehicle kilometres travelled per hour for the network comprising the Mill Road/Redoubt Road corridor and parallel routes. These data were produced for the Do Minimum and the option for the years 2011, 2026 and 2041 for AM peak, interpeak and PM peak. Travel time costs included the cost of congestion.

The accident record was retrieved from the CAS database for the five year period 2007 – 2011. The number of buses on the affected route was retrieved from the MAXX timetables. The number of existing and new cyclists on the route was established using the Economic Evaluation Manual simplified procedure SP11.

Travel Time Savings

Travel time savings were estimated by comparing the travel time costs of the option with those for the Do Minimum scenario. The output of the S3M SATURN model was limited to the weekdays. However traffic counts in Redoubt Road recorded between July and October 2011 show that weekend traffic flows are also high. Typically, the observed weekday PM peak flows were around 1,300vph for four hours daily, while Saturday peak flows were around 1,200vph for five hours, and Sunday flows were around 1,100vph also for five hours.

It was plausible therefore to include the weekend travel time savings in the analysis. In order to avoid an overestimation of these benefits a conservative approach was adopted – only 2 hours per weekend day were allowed, the benefits were restricted to 60% of the weekday hour benefits, and 120 weekend and holiday days per year were considered.

The costs were discounted over the analysis period 2015 – 2044 to obtain the Net Present Value. The resulting benefit of travel time savings was $271M accounting for 65% of all benefits.

Reduction of Congestion

The reduction of congestion was estimated by comparing the volume capacity ratios on the link by link basis between Do Minimum and the option. The S3M SATURN model produced these ratios as well as the volumes on the links. The Economic Evaluation Manual procedure A4.4 allows calculating the congestion costs for the roads and intersections where the volume capacity ratios exceed 70%.

The net present value of congestion reduction benefit amounted to $2M.
Improved Trip Time Reliability

Section A4.5 of the *Economic Evaluation Manual* outlines an assessment of the benefits of improved trip time reliability. Trip time reliability is measured by the unpredictable variations in journey times, such as bottlenecks on road sections. Reduced variability arises from a reduction of congestion on road links. For the purpose of this evaluation the benefits were estimated at 5% of the travel time savings. Such a value is consistent with the benefits for similar type of projects.

The net present value of benefits of improved trip time reliability was $14M. This accounted for 3% of all benefits.

Vehicle Operating Costs Reduction

The savings in the operating costs were derived from the output of the model by comparing the VOC of the option with that of Do Minimum. It has to be noted that the operating costs of the Do Minimum situation were assessed using the rural strategic road unit costs, while for the option the urban arterial unit cost were used.

The cost of CO$_2$ emissions was estimated at 4% of VOC as recommended in the LTNZ *Economic Evaluation Manual*, Vol.1, Section A9.6.

The net present value of vehicle operating cost savings including the emission reduction amounted to $28,000,000, accounting for 7% of all benefits.

Accident Reduction

Accident costs and benefits were calculated using Accident-by-Accident analysis for the Do Minimum and the option. *Economic Evaluation Manual* values were used to calculate the percentage reduction of the accidents. In cases where no *Manual* guidance was available common sense reduction rates were applied.

Table 23 shows the applied average reduction rates. The net present value of accident savings was $17M accounting for 4% of all benefits.

<table>
<thead>
<tr>
<th>Crash Type</th>
<th>Code</th>
<th>Reduction Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head on</td>
<td>AB, B</td>
<td>90%</td>
</tr>
<tr>
<td>Hit object</td>
<td>E</td>
<td>33%</td>
</tr>
<tr>
<td>Lost control off road</td>
<td>AD, CB, CC, CO, D</td>
<td>40%</td>
</tr>
<tr>
<td>Overtaking</td>
<td>AA, AC, AE-AO, GE</td>
<td>33%</td>
</tr>
<tr>
<td>Rear end, crossing</td>
<td>FB, FC, GD</td>
<td>90%</td>
</tr>
<tr>
<td>Rear end, queuing</td>
<td>FD, FE, FF, FO</td>
<td>30%</td>
</tr>
<tr>
<td>Rear end, slow vehicle</td>
<td>FA, GA-GC, GO</td>
<td>45%</td>
</tr>
<tr>
<td>Crossing direct</td>
<td>H</td>
<td>70%</td>
</tr>
<tr>
<td>Crossing turning</td>
<td>J, K, L, M</td>
<td>90%</td>
</tr>
</tbody>
</table>

Benefits of Passenger Transport

Section 7 of *Economic Evaluation Manual* Vol.2 and special procedure SP10 define four types of benefits generated by improved bus transport facilities, such as the proposed bus lane in Hollyford Drive and Redoubt Road. These benefits are the reduction of road traffic due to modal shift from cars to buses, benefits for bus passengers, improved service reliability and the benefits for infrastructure and vehicles.

Benefits of road traffic reduction

Road traffic reduction is based on the growth in the numbers of bus passenger attracted by the improved efficiency of bus service. Current and future passenger growth rates adopted for this project have been based on the rates observed on similar projects in Auckland. Conservative growth rates of 3% for the Do Minimum and 5% for the option were used.
Applying the methodology of the SP10 the value of the first year of road traffic reduction benefits for the option was found to be $86,000.

**Passenger transport user benefits**

The analysis using the SP10 revealed that the passenger transport user benefits of the option amounted to $39,000 in the first year.

**Passenger transport reliability benefits**

Applying the SP10 procedure the value of the first year of the improved service reliability benefits for the option was found to be $970,000.

**Passenger transport infrastructure and vehicle benefits**

The infrastructure and vehicle benefits result from the general service improvements, such as comfortable seating, clean bus interior and exterior, clearly visible digital clock on board, bus ventilation, glass cubicle shelters, CCTV, etc.

It might be expected that the future bus service on the route will incorporate many of such improvements. The improvements most likely to be implemented on buses are smooth rideability, clean exterior and interior, ventilation and interior displays of real time and approaching bus stops. Similarly, the upgraded infrastructure might include modern bus stop shelters, CCTV and lighting improving passenger security, and real time information system.

These improvements are expected to bring the first year benefits of $41,000.

The total benefits of passenger transport benefits were discounted at an 8% discount rate over a period of 15 years. The resulting net present value of these benefits was $10M.

**Cycling Benefits**

The *Economic Evaluation Manual* provides procedures to assess the benefits of the improved cycling facilities. The proposed cycling facilities in the Redoubt Road-Mill Road corridor include over 6km on-road cycle lanes on either side of the road and nearly 3km long off-road cycle paths through parks and in the sections of Mill Road that will no longer be used by main vehicle traffic.

Generally cycling provides health and environmental benefits, improves access, mobility, community liveability and increase transport mode choices, contributing to the New Zealand Transport Strategy objectives. Economic value of these benefits has been captured in procedures described in the special procedure SP11 (Walking and Cycling Projects).

Estimates of the cycling benefits quantified in accordance with SP11 and discounted at an 8% discount rate over a period of 30 years show the net present value of $7M.

**Agglomeration Benefits**

Agglomeration economies describe the productivity advantages that arise from the close spatial concentration of economic activity. There is a strong link between transport provision and the benefits that arise from the spatial concentration of economic activity.

The contribution of the improved Redoubt Road-Mill Road corridor to the upgrading of the Auckland transport system qualifies for the agglomeration benefits to be taken into consideration. *Economic Evaluation Manual*, Vol.1, Section A10 provides the methodology for estimation of these benefits.

The corridor provides an access route to Auckland CBD and Manukau City Centre. Both are major employment and commercial centres, which justify an adoption of the agglomeration benefits for the project. The value of these benefits was assumed at 20% of the total benefits, which is conservative as similar projects in the Auckland region use values in excess of 25% to 30%.
9.4.4 Summary of Potential Project Benefits

The benefits discussed above have been summarised in Table 24 below.

Table 24: Summary of project benefits (NPV)

<table>
<thead>
<tr>
<th>Benefit Source</th>
<th>Do Minimum Cost</th>
<th>Option Cost</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travel Time</td>
<td>13,187</td>
<td>12,917</td>
<td>271.0</td>
</tr>
<tr>
<td>Congestion</td>
<td>11.0</td>
<td>9.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Reliability</td>
<td>660.0</td>
<td>644.0</td>
<td>14.0</td>
</tr>
<tr>
<td>VOC</td>
<td>190.0</td>
<td>163.0</td>
<td>27.0</td>
</tr>
<tr>
<td>CO₂</td>
<td>7.0</td>
<td>6.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Accidents</td>
<td>82.0</td>
<td>65.0</td>
<td>17.0</td>
</tr>
<tr>
<td>Public Transport</td>
<td>10.0</td>
<td>0</td>
<td>10.0</td>
</tr>
<tr>
<td>Cycling</td>
<td>7.0</td>
<td>0</td>
<td>7.0</td>
</tr>
<tr>
<td>Agglomeration</td>
<td>-</td>
<td>-</td>
<td>69.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>418</strong></td>
</tr>
</tbody>
</table>

9.4.5 Benefit Cost Analysis

Benefit Cost Analysis and the First Year Rate of Return

Benefit Cost Ratio (BCR) is the ratio of the value of discounted benefits to the value of discounted costs. The BCR of the option assessed on the basis of the assumptions discussed earlier is 2.2.

The First Year Rate of Return is 4%.

Incremental Benefit Cost Analysis

Since only one set of outputs for the option was produced by the S3M, there is no difference between the alignment options. There is no need therefore to conduct the incremental analysis.

Sensitivity Analysis

In order to assess the robustness of the results of the economic evaluation, a series of sensitivity tests were undertaken. These included the following:

- Increased/decreased capital costs – these were tested for the cost decrease of 20% and the upper bound cost assumed as NPV of the 95th percentile estimate;
- Increased/decreased by ±20% travel time benefits;
- Increased/decreased by ±20% vehicle operating benefits; and
- Accident reduction benefits reduced by 20% and increased by 20%.
- Agglomeration benefits decreased to 0% of the total benefits and increased to 30%.

The BCR proved to be robust.

- The largest positive effect would be achieved by a reduction of capital costs by 20% or an increase of agglomeration benefits to 30% of the total benefits. In either case the BCR would increase to 2.7.
- An increase in travel time benefits would increase the BCR to 2.5. Conversely, an increase in capital costs would reduce the BCR to 1.8 – this, as well as the removal of the agglomeration benefits, is the most detrimental effect.
- A decrease of the travel time benefit by 20% would reduce the BCR to 1.9.
- Changes in the amount of vehicle operating benefits as well as accident costs have very small influence on the BCR.
9.5 Statutory Requirements

Pre-application meetings with the Auckland Council to confirm the required consents that are necessary, and any specific matters that should be addressed in the applications, should be undertaken during the design stage.

Sections 9.5.1 to 9.5.5 of this SAR set out the consents and approvals that may potentially be necessary and are able to be identified at this stage.

As the design progresses and more information becomes available, further consents may be identified as necessary and / or consents identified as necessary may no longer be needed. As such the consent requirements should be re-checked during the detailed design stage.

Auckland Transport is a Requiring Authority, and as a Network Utility operator (under Section 47 of the Local Government (Auckland Council) Act 2009), is able to designate land for particular works, such as roads. In order to facilitate the works, a Notice of Requirement under Section 168A of the Resource Management Act 1991 (the “RMA”) will be required to Designate the land necessary for the works. If the written agreement from affected owners cannot be secured or the works will have adverse effects on the environment that are deemed more than minor the Notice of Requirement application will need to be either limited notified or fully notified. This will need to be discussed with Auckland Council.

Subject to the progress of the design of the project, it is possible that a separate Outline Plan of Works under Section 176A of the RMA, addressing the height, shape and bulk of the works, will not need to be lodged with the Auckland Council prior to construction, as details of the proposed works may be able to be addressed in the Notice of Requirement.

Where all aspects of the proposed works are not known at the time of the preparation of the Notice of Requirement to secure the land a separate Outline Plan of Works will be required to be lodged with the Council on completion of the detailed design in addition to the Notice of Requirement.

The Notice of Requirement should address any relevant provisions of:
- A national policy statement, a New Zealand coastal policy statement, a regional policy statement or proposed regional policy statement, a plan or proposed plan;
- Whether adequate consideration has been given to alternative sites, routes or methods of undertaking the work;
- Whether the work and designation are reasonably necessary for achieving the objectives of the requiring authority for which the designation is sought; and
- Any other matter the territorial authority considers reasonably necessary in order to make a decision on the requirement.

Should an Outline Plan be required to be submitted separately from the NOR it should contain the following information:
- The height, shape, and bulk of the public work, project, or work;
- The location on the site of the public work, project, or work;
- The likely finished contour of the site;
- The vehicular access, circulation, and the provision for parking;
- The landscaping proposed; and
- Any other matters to avoid, remedy, or mitigate any adverse effects on the environment.

9.5.1 Auckland Council Regional Plan (Sediment Control)

The Auckland Council Regional Plan (Sediment Control) (the “SC Plan”) was declared operative in November 2001. The SC Plan addresses the issue of sediment discharge, and defines the mechanisms chosen for avoiding, mitigating or remediying any adverse effect on the environment due to sediment discharge from bare earth surfaces.

It contains provisions that provide for the control of the use of land for the purpose of the maintenance and enhancement of the quality of water in water bodies and coastal water and the control of discharges of contaminants into or onto water.
The SC Plan addresses the issue of sediment discharge, and sets in place thresholds (via rules) for discharges from bare earth surfaces.

Due to the presence of streams along the corridor the option would most likely include works within the Sediment Control Protection Area which is defined in the SC Plan as being 50 metres landward of the edge of a watercourse, or wetland of 1000m² or more.

The likely activity status and consents necessary under the SC Plan for the alternative alignment options are addressed in the following table:

Table 25: Resource Consent’s Likely to be Required under the Auckland Council Regional Plan (Sediment Control)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Likely Applicable Rule and Activity Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>100m or more of Roading / Tracking / Trenching within the Sediment Control Protection Area and Earthworks Exceeding 2,500m² on Slopes Exceeding 15 Degrees</td>
<td>Rule 5.4.3.1 – Restricted Discretionary Activity</td>
</tr>
<tr>
<td></td>
<td>The proposed road alignment will exceed 100m within the Sediment Control Protection Area. In addition earthworks along the alignments will likely exceed 2500m² where the land has a slope greater than or equal to 15 degrees. Resource consent will therefore be required under Rule 5.4.3.1 in Activity Table C for a Restricted Discretionary Activity. Discretion is restricted to the matters listed under 5.4.3.2 of the SC Plan which include criteria such as proposed mitigation measures. The Application may be notified under 5.4.3.3 of the SC Plan unless the Council is satisfied that the adverse effect on the environment of the activity for which consent is sought would be minor and written approval has been obtained from every person who, in the opinion of the Council, may be adversely affected by the granting of the resource consent.</td>
</tr>
</tbody>
</table>

9.5.2 Auckland Council Regional Plan (Air, Land and Water)

The Auckland Council Regional Plan (Air, Land and Water) (the “ALW Plan”) was declared operative in part in October 2010 and provides for the management of air, land and water resources in the region. The ALW Plan provides for the use and development of these resources while also containing objectives, policies and rules that seek to ensure that adverse effects of development are avoided, remedied or mitigated.

The likely activity status and consents necessary under all options are addressed in the following table:

Table 26: Resource Consent’s Likely to be Required under the Auckland Council Regional Plan (Air, Land and Water)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Likely Applicable Rule and Activity Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diversion and Discharge of Stormwater From Less than 1000m² of Development and it Complies With all of Conditions (b), (g), (h) and (i);</td>
<td>Impervious Area Less Than 1000m² - Rule 5.51 – Permitted Activity</td>
</tr>
<tr>
<td></td>
<td>The additional impervious surface area under all alignment options will exceed 1000m², and therefore permitted activity status does not apply.</td>
</tr>
<tr>
<td>Diversion and Discharge of Stormwater from Areas Greater than 10,000m²</td>
<td>Impervious Area Greater Than 10,000m² - Rule 5.5.4 – Discretionary Activity</td>
</tr>
<tr>
<td></td>
<td>The road alignment options will most likely involve additional impervious areas greater than 10,000m², and therefore fall to be assessed as Discretionary Activities.</td>
</tr>
<tr>
<td>Discharge of Contaminants to Air from Earthworks or from the Construction, Maintenance or Repair of Roads</td>
<td>Discharge of Dust to Air from Earthworks Associated with the Construction of a Road – Rule 4.5.49 – Permitted Activity</td>
</tr>
<tr>
<td></td>
<td>Earthworks and construction activities will need to comply with conditions (a) to (c) in order to remain a permitted activity.</td>
</tr>
<tr>
<td></td>
<td>“The discharge of contaminants into air from earthworks or from the construction, maintenance or repair of roads (road works) is a Permitted Activity, subject to conditions (a) to (c) of Rule 4.5.1”.</td>
</tr>
<tr>
<td></td>
<td>Conditions (a) to (c) of Rule 4.5.1 are as follows:</td>
</tr>
<tr>
<td></td>
<td>“(a) That beyond the boundary of the premises where the activity is being undertaken there shall be no noxious, dangerous, offensive or objectionable odour, dust, particulate, smoke or ash; and</td>
</tr>
</tbody>
</table>
Activity | Likely Applicable Rule and Activity Status
--- | ---
(b) | That there shall be no noxious, dangerous, offensive or objectionable visible emissions; and
(c) | That beyond the boundary of the premises where the activity is being undertaken there shall be no discharge into air of hazardous air pollutants that does, or is likely to, cause adverse effects on human health, ecosystems or property."

**Use, Erection or Placement of New Structures In, On, Under or Over the Bed of Rivers or Streams**

**Permitted Activity**

Redoubt Road-Mill Road will involve the establishment of new bridges over streams. Murphy’s Road will also require the extension of a pre-existing culvert to the north of Murphy’s Bush.

Should the structures in, on, under or over streams be able to comply with the relevant specified specific structure conditions, the general new structure conditions and the general performance conditions as follows, the structure should be assessed as a Permitted Activity:

"(a) the Specific Structure Conditions listed in Rule 7.5.5.1 below:
(b) the General New Structure Conditions listed in Rule 7.5.5.2 below; and
(c) the General Performance Conditions listed in Rule 7.5.6. List of Structures:

(i) a culvert or pipe subject to Specific Structure Conditions (b), (d), (e), (h), (i), (j) and (n);

(iii) a bridge subject to Specific Structure Conditions (a), (c), (d), (e), (f), (g), (j) and (r);

(xi) a stormwater or wastewater outfall subject to Specific Structure Conditions (a),
(c), (e), (f) and (g);

The specific structure conditions applicable to a culvert under Rule 7.5.5.1 are:

The 110 year ARI flood shall be accommodated by the structure and / or by an overland flow path;

(d) The structure shall not cause flood levels in events up to and including the 100 year ARI flood to rise within 0.5 m of the habitable floor levels of dwellings or increase flooding of a State Highway, unless the relevant District Plan establishes an alternative freeboard requirement in which case the District Plan freeboard requirement shall prevail.

(e) Other than provided for by clauses (s) and (t), the structure shall not be located in a Natural Lake, Natural Stream or Wetland Management Area as described in sections 3.3, 3.4 and 3.2 of Chapter 3: Management Areas;

(h) For any culverting or piping of a river or stream in Urban Areas the nominal internal culvert diameter shall not exceed 900 mm, the actual internal diameter shall not exceed 920 mm and the cross-sectional area of any box culvert shall not exceed 0.67m² and multiple culverts shall not be erected or placed across the bed;

(i) Other than restricted by clause (f) any culverting or piping of a river or stream outside Urban Areas, the nominal internal culvert diameter shall not exceed 1200 mm, the actual internal diameter shall not exceed 1225 mm and the cross sectional area of any box culvert shall not exceed 1.18m² and multiple culverts shall not be erected or placed across the bed;

(j) If erosion or scour protection works are required to prevent erosion or scour upstream or downstream of the structure, they shall not exceed 5 metres in length each side of the structure (such works protruding into the bed shall not require a separate consent as they shall be authorised under this rule). All works shall comply with Rule 7.5.6(a) in relation to fish passage. Erosion and scour protection works required under this clause shall not be included in any assessment of structure length under Rule 7.5.5.2(a);"
### Activity | Likely Applicable Rule and Activity Status
--- | ---
(n) Structures such as pipes or cables that are to be located completely under the bed of the lake or river shall be installed using trenchless means;  
The specific structure conditions applicable to a bridge under Rule 7.5.5.1 are:  
*The structure shall not cause a more than minor impediment to the passage of flood flows up to and including the 100 year ARI flood;  
(c) The structure shall not cause more than a temporary impediment to the passage of flood debris and it shall be maintained free of flood debris;  
(d) The structure shall not cause flood levels in events up to and including the 100 year ARI flood to rise within 0.5 m of the habitable floor levels of dwellings or increase flooding of a State Highway, unless the relevant District Plan establishes an alternative freeboard requirement in which case the District Plan freeboard requirement shall prevail.  
(e) Other than provided for by clauses (s) and (t), the structure shall not be located in a Natural Lake, Natural Stream or Wetland Management Area as described in sections 3.3, 3.4 and 3.2 of Chapter 3: Management Areas;  
(f) Structures in navigable watercourses shall not prevent navigation of vessels;  
(g) The structure shall not prevent public access along the lake, river or stream;  
(j) If erosion or scour protection works are required to prevent erosion or scour upstream or downstream of the structure, they shall not exceed 5 metres in length each side of the structure (such works protruding into the bed shall not require a separate consent as they shall be authorised under this rule). All works shall comply with Rule 7.5.6(a) in relation to fish passage. Erosion and scour protection works required under this clause shall not be included in any assessment of structure length under Rule 7.5.5.2(a);  
(r) No piles either permanent or temporary shall be located in, on or under the bed.  
The specific Structure conditions applicable to a stormwater outfall under Rule 7.5.5.1 are:  
*The structure shall not cause a more than minor impediment to the passage of flood flows up to and including the 100 year ARI flood;  
(c) The structure shall not cause more than a temporary impediment to the passage of flood debris and it shall be maintained free of flood debris;  
(e) Other than provided for by clauses (s) and (t), the structure shall not be located in a Natural Lake, Natural Stream or Wetland Management Area as described in sections 3.3, 3.4 and 3.2 of Chapter 3: Management Areas;  
(f) Structures in navigable watercourses shall not prevent navigation of vessels;  
(g) The structure shall not prevent public access along the lake, river or stream;  
The General New Structure Conditions applicable to any new structure listed in Rule 7.5.5.2 are:  
*The length of any new structure shall not exceed 30 metres in total when measured parallel to the direction of water flow, and no new structure shall be erected or placed in individual lengths of 30 metres or less where this would progressively encase or otherwise modify the bed of a Permanent river or stream;  
Other than provided for by Rule 6.5.52, the activity shall not involve the use, erection or placement of any dam that increases the height or storage capacity of the dam;  
(c) The activity shall not result in an increase to existing flood levels on land or structures other than that owned or controlled by the person undertaking the activity;  
(d) The activity shall not cause more than minor bed erosion, scouring or undercutting immediately upstream or downstream;
<table>
<thead>
<tr>
<th>Activity</th>
<th>Likely Applicable Rule and Activity Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>(e)</td>
<td>The activity shall not compromise the structural integrity of the structure;</td>
</tr>
<tr>
<td>(f)</td>
<td>Any discharge of sediment directly associated with the activity shall be minimised by the use of best practice erosion and sediment control measures.</td>
</tr>
<tr>
<td>(g)</td>
<td>The General Performance Conditions in Rule 7.5.6.</td>
</tr>
</tbody>
</table>

The General Performance Conditions applicable to any new structure listed in Rule 7.5.6. are:

- The passage of fish both up and down stream shall be maintained, where it already occurs on existing structures and provision shall be made for fish passage on new structures. Where structures are removed or demolished the bed shall be restored to a profile that enables the passage of fish where this is relevant and practicable;
- Condition (a) does not prevent temporary restrictions on fish passage to enable work to be carried out in accordance with the other conditions of Rules 7.5.2 to 7.5.6. However temporary restrictions shall not be in place for a length of time that causes significant adverse effects on the ability of fish to migrate up and down the stream during the period September to February;
- Provision if necessary and where practicable shall be made for the temporary diversion of the Permanent river or stream flow around the extent of the works while the activity is undertaken. Where temporary diversions are constructed they shall be able to cater for typical flows for the river or stream at the time of the year that the work is carried out and the adverse effects of the flow exceeding the diversion shall be minimised;
- Following completion of the activity maintenance and construction material or maintenance or construction ancillary structures shall be removed from the bed as far as practicable;
- There shall be no use of explosives in the bed of the lake or Permanent river or stream when undertaking the activity;
- The activity shall not involve the placement of any waste material, including but not limited to vehicle bodies, tyres, demolition rubble or clean fill;
- Any bed disturbance or deposition associated with the activity shall comply with the following conditions:
  - (i) The length of bed disturbance upstream or downstream of the structure shall not exceed 10 metres each side. This disturbance length excludes the structure itself;
  - (ii) Any bare earth surfaces on that part of the bed that is above the water level or wetted cross section of the lake or Permanent river or stream shall be stabilised against erosion as soon as practicable after completion of the activity;
  - (iii) The mixing of construction materials (such as concrete), or the refuelling or maintenance of equipment associated with the activity shall use best practice methods to avoid the discharge of contaminants into the lake, river or stream;
  - (iv) The activity shall not remove, damage or destroy any other existing structure and where any vegetation used for flood protection or erosion control purposes is removed, damaged or destroyed, it shall be replaced;
  - (v) Machinery shall not sit directly on the wetted cross section of the bed at the time of the work;
  - (vi) Conditions (g) i and iv do not apply to the necessary trimming or removal of vegetation around structures owned by operators of regionally significant infrastructure to ensure public health and safety and the operational integrity of the structures or network; Debris or other material cleared or removed from upstream or downstream of a structure shall not be re deposited elsewhere in the bed of the lake or Permanent river or stream, or on any adjacent land in a manner or at a location, where it will enter any waterbody;
- The activity shall not disturb any wāhi tapu or other archaeological site including those identified in any regional or district plan, in the Archaeological Association’s Site Recording...
## Activity

### Likely Applicable Rule and Activity Status

<table>
<thead>
<tr>
<th>Activity</th>
<th>Rule 7.5.9 – Restricted Discretionary Activities</th>
</tr>
</thead>
</table>
| Use, Erection or Placement of New Structures In, On, Under or Over the Bed of a Permanent River or Stream and any Associated Bed Disturbance or Deposition That Does Not Meet The Permitted Activity Requirements. | Should any new structure in, on, under or over streams NOT be able to comply with the Permitted Activity Rule, the structure should be assessed as a Restricted Discretionary Activity under Rule 7.5.9 subject to the following standards and terms:

The structure is not located in a Natural Stream or Wetland Management Area; and

Inside Urban Areas any culvert, pipe or channel or other linear structure is greater than 30 metres in length when measured parallel to the direction of water flow and has a diameter greater than that provided by Rule 7.5.5.1 (h); or

Outside Urban Areas other than in Water Supply Management Areas any culvert, pipe, channel or other linear structure outside Urban Areas is less than or equal to 30 metres in length when measured parallel to the direction of water flow, but has a diameter greater than that provided by Rule 7.5.5.1 (i);

Rule 7.5.10 sets out that:

“The ARC will restrict the exercise of its discretion under Rule 7.5.9 to the following matters:

(a) The actual and potential adverse effects (including any cumulative effects) arising from any matters in the conditions of Rules 7.5.2 to 7.5.6 that the activity is unable to comply with, together with the following additional matters:

(b) The method of diversion and discharge (inlet works, overland flow path, outlet works and erosion control works) and the effects arising from the method chosen;

(c) The cumulative effects of culverts, pipes, channels and tunnels and other linear structures on the natural character of any Permanent river or stream, including effects on riparian vegetation having regard to the Urban River and Stream Management Framework where relevant;

(d) The degree to which the activity meets the outcomes of any structure plan, Integrated Catchment Management Plan, flood management plan or approved stormwater or wastewater network resource consent which has assessed whether the Permanent river or stream should be used, developed or protected;

(e) Inside Urban Areas whether the pre-structure flow rate of the Permanent river or stream is sufficient to sustain natural aquatic habitat values;

(f) Effects on archaeological sites, wāhi tapu and the matters listed in Policy 2.3.4.4;

(g) The duration of the consent;

(h) The monitoring of the consent;

(i) The timing and nature of reviews of consent conditions; and

(j) The requirement for and conditions of a bond or financial Contribution”.

Non Notification

“Applications for restricted discretionary activities shall be considered without public notification or the need to serve notice of the application on affected persons in accordance with Sections 95A(3) and 95B(2) of the RMA, unless in the opinion of the ARC there are special circumstances justifying public notification in accordance with Section 95A(4) of the RMA”.

---

In the event that an archaeological site or wāhi tapu is discovered while undertaking the activity, the activity shall cease immediately and the ARC shall be notified as soon as possible. The activity shall not re-commence without the approval of the ARC.”
9.5.3  **The National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (NES)**

The National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health is an environmental standard (under the Resource Management Act 1991) which came into force on 1 January 2012. This standard means that if your land is, or has been, used for a hazardous activity and you want to change the use of the land, or disturb the soil you will need to comply with this standard.

Preliminary contamination analysis work undertaken by AECOM has identified that it is likely that Hazardous Activities and Industry List (HAIL) activities related to uncontrolled waste disposal have occurred along the alignment. In particular, uncontrolled waste dumping activities has been reported by the former Manaukau City Council in the vicinity of the alignment options.

Construction activities will trigger the need for discretionary activity consent under the NES.

9.5.4  **Auckland Council Parks**

The road widening and realignment of the Redoubt Road section of the corridor has an impact on Totara Park which is owned by Auckland Council. Totara Park is not gazetted under the Reserves Act as reserve. Instead, it is held in fee simple ownership and is zoned Open Space 1, 2 and 3 in the Auckland District Plan (Manukau Section). The Totara Park Management Plan has an expectation that gazetting the park will occur at some point in the future in order to aid management of the park by the Council. Given that the Park is not currently gazetted, there is not the need to revoke that land required for the widening and re-alignment under section 24 (1)(b) of the Reserves Act. Instead, the appropriate legal mechanism to acquire the necessary land is under the Public Works Act which is the same legal mechanism that will apply to other land purchases within the preferred corridor.

9.5.5  **Other approvals required to support the application**

Should any potential archaeological sites be found during the works an archaeological assessment may be necessary to determine their status. Should they be confirmed as archaeological sites an application for Archaeological Authority will need to be sought from the New Zealand Historic Places Trust for approval to affect the site in any way.

Section 177 of the Resource Management Act applies to pre-existing designations. This section of the Resource Management Act requires the written consent of the earlier designation holder before the new designation holder (ultimately being Auckland Transport) can do anything in accordance with their designation over the pre-existing designated land.

The following pre-existing designations are within the corridor:

- The South Western Motorway-State Highway 20 (designation 284) extends up Redoubt Road to approximately adjacent St Johns Redoubt.
- Watercare’s Hunua 4 pipeline (designation 307) crosses beneath Murphys Road at the intersection of Hodges Road and Thomas Road. This designation falls in the path of proposed NOR 2.
- Watercare has a pump station (designation 147) at the intersection of Thomas and Murphys Road.
- Watercare have a water reservoir facility (designation 150 in the Auckland District Plan (Manukau Section) on a large land holding commencing approximately 400m south of the intersection of Redoubt and Mill Road.
- A telecommunications mast (designation 116) is located on the southern side of Redoubt Road at the northern edge of the park approximately 200m west of the Redoubt Road / Murphys Road intersection.
- A gas pipeline (Designation 290) joins Murphy’s Road at the southern extent of Murphy’s Bush. This pipeline follows Murphy’s Road beyond Flat Bush School Road.

In this regard, NZTA, Watercare, Vector and Telecom (as the relevant requiring authorities) are key stakeholders in discussions around the alternative alignment options.

9.5.6  **Summary**

A Notice of Requirement is required to be prepared and lodged with the Auckland Council. It is likely that notification in some form will be required particularly if the written agreement of all affected landowners is not obtained, and/or the works have adverse effects on the environment that are more than minor.
Resource consents will likely be required from Auckland Council for earthworks, operational stormwater discharge, and the establishment of structures in, on, under or over the bed of a permanent stream. Table 27 summarises the consents potentially necessary, applicable rules, and the options likely to require consents.

Table 27: Summary of Resource Consents Likely to be Required

<table>
<thead>
<tr>
<th>Activity</th>
<th>Potential Applicable Rule</th>
<th>Activity Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>100m or More of Roading Within the Sediment Control Protection Area and Earthworks Greater than 2500m² on Slopes Greater than 15 Degrees.</td>
<td>Auckland Regional Plan: Sediment Control – Rule 5.3.1</td>
<td>Restricted Discretionary Activity</td>
</tr>
<tr>
<td>Establishment of Additional Impervious Area Greater than 10,000m²</td>
<td>Auckland Regional Plan: Air, Land and Water – Rule 5.5.4</td>
<td>Discretionary Activity</td>
</tr>
<tr>
<td>Discharge of Dust to Air from Earthworks Associated with the Construction of the Road</td>
<td>Auckland Regional Plan: Air, Land and Water – Rule 4.5.49</td>
<td>Permitted Activity (subject to complying with specific criteria)</td>
</tr>
<tr>
<td>Placement within the Bed or Extension of Existing Structures over the Bed of a Permanent River or Stream</td>
<td>Auckland Regional Plan: Air, Land and Water – Rule 7.5.3</td>
<td>Permitted Activity (subject to complying with specific criteria)</td>
</tr>
<tr>
<td>Use, Erection or Placement of New Structures In, On, Under or Over the Bed of a Permanent River or Stream and any Associated Bed Disturbance or Deposition</td>
<td>Auckland Regional Plan: Air, Land and Water – Rule 7.5.5</td>
<td>Permitted Activity (subject to complying with specific criteria)</td>
</tr>
<tr>
<td>Use, Erection or Placement of New Structures In, On, Under or Over the Bed of a Permanent River or Stream and any Associated Bed Disturbance or Deposition That Does Not Meet the Permitted Activity Requirements</td>
<td>Auckland Regional Plan: Air, Land and Water – Rule 7.5.9</td>
<td>Restricted Discretionary Activity (If unable to comply with specific permitted activity criteria)</td>
</tr>
</tbody>
</table>

Likely technical studies required to support the Notice of Requirement and Resource Consent applications include, but may not be limited to:

- Stormwater Report;
- Erosion and Sediment Control Plan;
- Urban Design assessment;
- Landscape assessment;
- Construction and Operational Acoustics Assessment;
- Construction and Operational Vibration Assessment;
- Ecology Assessment;
- Tree Impact Assessment;
- Geotechnical Assessment;
- Social Impact Assessment;
- Archaeological Assessment;

9.6 Assessment Profile

An assessment profile for the scheme was carried out in accordance with the NZTA Planning and Investment Knowledge Database and the Auckland Transport 2012/15 Draft Regional Land Transport Programme prioritisation process. This includes creating an assessment profile with High (H), Medium (M) and Low (L) ratings for Strategic Fit, Effectiveness and Economic Efficiency.
### Strategic Fit

The strategic fit assessment considers how an identified problem, issue or opportunity aligns with the NZTA’s strategic investment direction, which derives from the Government Policy Statement on Land Transport Funding. Strategic fit ensures that the activities the NZTA invests in demonstrate the potential contribution to outcomes that are significant from a national perspective.

Strategic fit focuses on the problem, issue or opportunity being addressed and is considered without regard to the possible solution.

The Strategic Fit assessment carried out for this project determined a **HIGH** strategic fit against NZTA assessment factors and AT Focus Areas and covered in Table 28 below.

#### Table 28: Strategic Fit Assessment

<table>
<thead>
<tr>
<th>NZTA Assessment Factor / AT Focus Area</th>
<th>Commentary</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>NZTA</td>
<td>The project aims to significantly reduce the actual crash risk (where the actual fatal and/or serious crash rate is greater than 3 fatal and/or serious crashes over a 5 year period) in line with the Safer Journeys on a high risk rural road.</td>
<td>High</td>
</tr>
<tr>
<td>AT Priority 1: Support the integration between land use and transport</td>
<td>The upgraded corridor aims to provide improved access between the residential areas of Botany Downs and Papakura and the employment centre of Manukau city through improved public transport, walking and cycling, and general traffic infrastructure. This will lead to a reduction in the need for car travel by enabling a greater proportion of trips to be made by public transport, walking and cycling. The planned intensification and development of existing and future urban residential areas justifies the need for this infrastructure. This project is an investigation that will enable route protection for a major road extension which supports land use development as proposed in the Auckland Plan, hence contributing to a specific activity in the Auckland Transport programme which contributes to Priority 1. The public transport infrastructure improvements along Hollyford Drive and Redoubt Road also contribute directly to a specific activity in the Auckland Transport programme which contributes to Priority 1.</td>
<td>High</td>
</tr>
<tr>
<td>AT Priority 2: Improve the connectivity and integration of the region’s transport networks</td>
<td>This project aims to improve journey time reliability and ease severe peak hour congestion on Redoubt Road. This is a defined type of activity in the Auckland Transport programme which contributes to Priority 2. This public transport infrastructure project on the QTN routes will improve efficiency and effectiveness of the network and its connectivity, which is also a defined activity which contributes to Priority 2.</td>
<td>High</td>
</tr>
</tbody>
</table>
| AT Priority 3: Make best use of the existing transport system | The project will provide improved access to Manukau City for pedestrians and cyclists, thus contributing to increasing the choice of active modes for shorter trips and getting more out of the existing system. The project provides transport choices in a developing area where existing transport choices are limited. Additional vehicle capacity provided on the corridor aims to optimise the operation of the network by improving travel times and reducing congestion over a wider area than only the Redoubt Road-Mill Road corridor. The project includes:  
- Management of road space to prioritise the movements of people, goods and services;  
- Cycle improvements;  
- Footpath improvements;  
- Providing more transport choices to communities;  
- Minimising community severance between the development area and Manukau city. | High       |
These are defined activities in the Auckland Transport programme and therefore contribute to Priority 3.

AT Priority 4: Improve transport safety and reduce the adverse impacts from transport on the surrounding environment

There is potential for significant improvements in safety given the five fatalities on the corridor. Three fatalities were due to loss of control on Mill Road in the rural area with poor horizontal and vertical alignment.

In response to the challenge of providing a transport system that is safe to use, the project will:
- Aim to reduce the number of loss of control type crashes through a new speed limit regime and improved road alignment
- Provide vulnerable users with safer facilities such as improved footpaths, safer crossing facilities, and new cycle lanes and shared paths.

High

9.6.2 Effectiveness

The Effectiveness assessment factor considers the contribution that the proposed solution makes to achieving the potential identified in the Strategic Fit assessment, and to the purpose and objectives of the Land Transport Management Act 2003. Higher ratings are provided for those proposals that provide long-term, integrated and enduring solutions.

An activity or a combination of activities may be given a rating for Effectiveness by checking the performance of the project against a range of criteria. The Effectiveness assessment is carried out in Table 29. Transport related activities which mitigate or reduce vulnerabilities of essential transport networks can also enable Approved Organisations to justify an improved Effectiveness rating if local and regional network plans are supported by the NZTA.

The Effectiveness assessment carried out for this project determined a HIGH assessment against NZTA assessment criteria.

Table 29: Effectiveness Assessment

<table>
<thead>
<tr>
<th>NZTA Assessment Criteria</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirements for Low Criteria</td>
<td></td>
</tr>
<tr>
<td>Potential impact or outcome identified in the Strategic Fit assessment</td>
<td>Achieved</td>
</tr>
<tr>
<td>An agreed level of service</td>
<td>Achieved</td>
</tr>
<tr>
<td>Alignment with the purpose and objectives of the LTMA</td>
<td>Achieved</td>
</tr>
<tr>
<td>Consideration of:</td>
<td>Achieved</td>
</tr>
<tr>
<td>Relevant problems, issues and opportunities</td>
<td></td>
</tr>
<tr>
<td>Appropriate alternatives</td>
<td></td>
</tr>
<tr>
<td>Opportunities for collaboration</td>
<td></td>
</tr>
<tr>
<td>Adverse effects or impacts</td>
<td></td>
</tr>
<tr>
<td>Is an affordable solution with a funding plan</td>
<td></td>
</tr>
<tr>
<td>Avoids duplication of activities</td>
<td></td>
</tr>
<tr>
<td>Solution is appropriate to the potential impact or outcome</td>
<td></td>
</tr>
<tr>
<td>Includes a monitoring and review framework in plans and strategies.</td>
<td></td>
</tr>
<tr>
<td>Requirements for Medium Criteria</td>
<td></td>
</tr>
<tr>
<td>Will contribute to an NZTA supported strategy, endorsed package, programme or plan</td>
<td>Achieved</td>
</tr>
</tbody>
</table>
## NZTA Assessment Criteria

<table>
<thead>
<tr>
<th>NZTA Assessment Criteria</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is significantly effective in achieving the potential impact or outcome identified in the Strategic Fit assessment</td>
<td>Achieved</td>
</tr>
<tr>
<td>Provides a long term solution with enduring benefits</td>
<td>Achieved</td>
</tr>
<tr>
<td>Provides a solution that responds to land use strategies and implementation plans</td>
<td>Achieved</td>
</tr>
<tr>
<td>Provides a solution that makes a contribution to GPS</td>
<td>Achieved</td>
</tr>
</tbody>
</table>

## Requirements for High Criteria

<table>
<thead>
<tr>
<th>Requirements for High Criteria</th>
<th>Achieved</th>
<th>Included in previous NLTP and has been flagged as a high priority for AT in future plans</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is a key component of an NZTA-supported strategy, endorsed package, programme or plan</td>
<td>Supports the One Network with positive benefits on parallel corridors</td>
<td></td>
</tr>
<tr>
<td>Is part of a whole-of-network approach</td>
<td>Multimodal solution along the corridor linking with the transport interchanges and linkages in Manukau city</td>
<td></td>
</tr>
<tr>
<td>Improves integration within and between transport modes</td>
<td>Solution is integral to supporting planned land use development, especially Flat Bush residential expansion</td>
<td></td>
</tr>
<tr>
<td>Provides a strategic approach that successfully integrates land transport, land use, other infrastructure and activities</td>
<td>Supports the One Network with positive benefits for SH1 travel times and congestion</td>
<td></td>
</tr>
<tr>
<td>Supports networks from a national perspective</td>
<td>A solution that provides a safer route, with improved travel times, less congestion, supports planned land use, and links residential settlement with work centres</td>
<td></td>
</tr>
<tr>
<td>Provides a strategic approach that makes a significant contribution to multiple GPS impacts</td>
<td>Solution is designed to support planned strategic cycle and public transport networks, improving safety through Safer Journeys principles, and improved travel times for general traffic</td>
<td></td>
</tr>
<tr>
<td>Is optimised against multiple transport outcomes and objectives</td>
<td>The project has been thoroughly consulted and developed with input from multiple stakeholders and affected parties, through a programmed consultation strategy including public open days.</td>
<td></td>
</tr>
<tr>
<td>Adopts a collaborative approach to the development of studies, strategies and plans.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Effectiveness assessment

**HIGH**

### 9.6.3 Efficiency

The economic efficiency assessment considers how well the proposed solution maximises the value of the project by measuring the Benefit Cost Ratio (BCR), which is the primary tool to rate the economic efficiency of the project.

The calculated BCR for the project is 2.2 and is discussed in Section 9.4. The resulting Efficiency of the project is **MEDIUM** as the BCR falls within the range of 2.0 to 4.0.

### 9.6.4 Initial Assessment Profile

The Initial Assessment Profile for the project is expressed as the Strategic Fit, Effectiveness and Efficiency as a single statement.

For the preferred option as identified in this study the Initial Assessment Profile is **HHM**.
10.0
Recommended Option
10.0 Recommended Option

The option refinement and assessment process confirmed the recommended option to be Northern B and Eastern C as identified in section 7.8.

This section of the report is the final stage in the process, as shown below, and summarises the Preliminary Design Philosophy Statement, discusses the staging and constructability of the preferred option, and confirms the future proofing of the corridor.

10.1 Option Objectives

The project has strategic and core objectives as detailed in Section 2.3 and against which the performance of the option needs to be tested. This assessment is detailed in Table 30 below with commentary on the degree to which of these objectives are achieved.

**Table 30: Assessment against Strategic and Core Objectives**

<table>
<thead>
<tr>
<th>Strategic and Core Objectives</th>
<th>Objective Type</th>
<th>Description</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>Capacity</td>
<td>Confirm the preferred route for a 30 year planning horizon with sufficient capacity along the route to accommodate planned growth effectively and which addresses current and future predicted congestion issues, as well as providing capacity for local freight traffic.</td>
<td>Refer to the following: Section 10.2, Section 10.3, Section 10.4</td>
</tr>
<tr>
<td>C2</td>
<td>Safety</td>
<td>Design for an appropriate level of safety to address the high crash rate, including for future traffic and multimodal users.</td>
<td>Refer to the following: Section 9.15, Section 10.2</td>
</tr>
<tr>
<td>C2</td>
<td>Resilience</td>
<td>Ensure that the corridor is a suitable secondary North/South corridor parallel to State Highway 1 to improve network security/resilience and where the risk of closure is minimised.</td>
<td>Refer to the following: Section 10.2, Section 10.5</td>
</tr>
<tr>
<td>S1</td>
<td>Connectivity</td>
<td>Provide an upgraded corridor which addresses access and mobility for walking and cycling in a safe environment, and connectivity to open spaces and community facilities.</td>
<td>Refer to the following: Section 10.2, Section 10.3, Section 10.4</td>
</tr>
<tr>
<td>C3</td>
<td>Multi Modal</td>
<td>Ensure that the upgraded corridor makes provision for all transportation modes including road vehicles, walking and cycling and passenger transport, including provision to accommodate future changes in Public Transport use and demands.</td>
<td>Refer to the following: Section 10.2, Section 10.3, Section 10.4</td>
</tr>
</tbody>
</table>
### Strategic and Core Objectives

<table>
<thead>
<tr>
<th>Objective Type</th>
<th>Description</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>C3</td>
<td>Environmentally Sustainable&lt;br&gt;Manages the impact of the transport network on the local community, mitigates negative environmental impacts, and is sensitive to the cultural heritage of the area.</td>
<td>Refer to the following:&lt;br&gt;Section 9.6</td>
</tr>
<tr>
<td>Other</td>
<td>Constructable&lt;br&gt;Design a corridor which is economically justified and is able to be delivered in a staged manner.</td>
<td>Refer to the following:&lt;br&gt;Section 9.2,&lt;br&gt;Section 9.3,&lt;br&gt;Section 9.4,&lt;br&gt;Section 10.4</td>
</tr>
<tr>
<td>S1</td>
<td>Strategic Policy&lt;br&gt;The project objectives contribute to the following policy visions and objectives:&lt;br&gt;- New Zealand Transport Strategy (NZTS) vision&lt;br&gt;- Land Transport Management Act (LTMA) 2003 objectives&lt;br&gt;- Auckland Regional Land Transport Strategy (RLTS) 2010-30 objectives&lt;br&gt;- Auckland Plan transport priorities.</td>
<td>Refer to the following:&lt;br&gt;Section 9.1,&lt;br&gt;Section 9.5</td>
</tr>
</tbody>
</table>

### 10.2 Design Philosophy Statement

The proposed corridor study included sections of the road which differed in form based on the adjacent land use, ranging from full urban, with a public transport requirement, to semi-rural regional arterial to rural collector. Table 31 is a summary of the functional requirements set out in the RFT. The complete Design Philosophy Statement is included in Appendix P.

#### Table 31: Summary of functional requirements

<table>
<thead>
<tr>
<th>Sections</th>
<th>Route Description</th>
<th>Location</th>
<th>Functional Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section 1a and b</td>
<td>Redoubt Road – from SH1 motorway to urban fringe and Hollyford / Everglade Drive – Either side of Redoubt Road</td>
<td>Section 1a - CH0 to CH620 (Redoubt Road)&lt;br&gt;Section 1b – CH0 to CH600 (Everglade / Hollyford Road)</td>
<td>- Regional Urban Arterial (50km/h to 60km/h)&lt;br&gt;- Includes Hollyford and Everglade Drive&lt;br&gt;- 32.4m wide corridor and 25.4m to 29m wide over lengths with existing property constraints&lt;br&gt;- Bus lane along Redoubt Road</td>
</tr>
<tr>
<td>Section 2 (2a, 2b and 2c)</td>
<td>Redoubt Road west of Murphys Road to SH1</td>
<td>Section 2a – CH620 to CH1290&lt;br&gt;Section 2b – CH1290 to CH1690&lt;br&gt;Section 2c – CH1690 to CH2560 (Redoubt Road)</td>
<td>- Regional Urban Arterial (50km/h to 60km/h) flowing into larger lifestyle block sections (urban fringe)&lt;br&gt;- 32.4m wide corridor</td>
</tr>
<tr>
<td>Section 3 (3a, 3b and 3c)</td>
<td>Murphys Road north of Redoubt Road to south of Flat Bush School Road</td>
<td>Section 3a – CH0 to CH820&lt;br&gt;Section 3b – CH820 to CH1680&lt;br&gt;Section 3c – CH1680 to CH1900 (Murphys Road)</td>
<td>- District Arterial (60km/h)&lt;br&gt;- 30.8 to 35.8m wide corridor&lt;br&gt;- Adequate capacity for projected growth</td>
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<tr>
<td>Section 4 (4a, 4b, 4c, 4d and 4e)</td>
<td>Redoubt Road and Mill Road east of Murphys Road through to south of Alfriston Road</td>
<td>Section 4a – CH2560 to CH2920 (Redoubt Road)&lt;br&gt;Section 4b – CH2920 to CH3400 (Redoubt Road)&lt;br&gt;Section 4c – CH3400 to CH5300 (Mill Road)</td>
<td>- Regional Rural Arterial (60km/h to 80km/h)&lt;br&gt;- 32.4m wide corridor&lt;br&gt;- Widening at intersections and approaches</td>
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</table>
10.3 Preliminary Design Drawings

The preliminary design drawings are contained in Volume 3: Scheme Drawings.

10.4 Notice of Requirement (NOR) and Constructability Staging

The Preferred Option can be constructed in stages to maximise the Economic Efficiencies of the project. In conjunction with the constructible stages, the project also requires to be designated in sensible sections to allow for staged construction. The advantage of these Notice of Requirement (NOR) sections is that different designation lapse periods can be applied to the corridor, and there are practical constructability, topographical and major infrastructure relocation advantages. Figure 19 displays the section split showing both the NOR split and the construction staging.

Figure 19: Staging of preferred Option (Refer to drawing 60250009-CV-0012)
10.4.1 Notice of Requirement Staging

Three NOR sections are shown.

NOR 1  This is the Urban Section running from SH1 through to Hilltop Road, where NOR 1 tapers down from the upgraded corridor to the existing 2 lane road near CH1700 to ensure that the Transpower Pylon relocation is not required in this stage of the project. The increasing use of Hilltop Road needs to be accounted for however, as well as any safety considerations at this location.

NOR 2  This section covers Murphys Road and most of the roadway adjacent Totara Park. The tie in to NOR 1 is at CH1700 and to NOR 3 at CH2950 where both the new road and existing road are at similar grades.

NOR 3  This section covers the rural section from Totara Park to the tie in just south of Alfriston Road. The tie in to NOR 2 is at CH2950 to the southernmost point on the project, and encompasses the greenfield route of the Rural Section.

10.4.2 Construction Staging

The project can be divided into 6 separable construction stages with initial staging, constructability and Traffic Management ideas outlined below.

Construction Stage 1: Redoubt Road / Hollyford Drive  The intersection between Redoubt Road and Hollyford Drive is heavily trafficked and roads users experience significant delays during peak times. The proposed widening of Redoubt Road and Hollyford/Everglade Drive will ensure delays are minimised. As a first priority stage, this separable portion can be constructed in isolation on the southern side without affecting the existing traffic flows. Once completed traffic can be moved to the south and the northern side constructed.

Construction Stage 2: Redoubt Road  This stage is dependent on the completion of Stage 1 and involves widening the remaining urban and some of the rural sections, opposite the Totara Park and includes a realigned Hilltop Road. Stage 2, southern side could be constructed during Stage 1 followed by the northern side connecting into the existing Redoubt Road at the eastern end. It is not essential to have Stage 3 completed.

Construction Stage 3: Murphys Road  This stage includes the widening of an existing section connecting to Flat Bush School intersection constructing the eastern side, then moving the traffic across and finishing the western side. The green fields section (cutting) between the existing Murphys Road and Redoubt Road can be undertaken independently. The section connects between the other sections and involves a large amount of fill not necessarily obtained from other stages of the project and will therefore have to be imported. This section would require major traffic management planning to provide both a north / south flow possibly utilising a link along Flat Bush School Road and or Ormiston Road / Chapel Road / Matthews Road / Hilltop Road with temporary traffic signals at Hilltop / Redoubt Road intersection. This construction of this section is dependent on having Construction Stage 2 especially the upgrade to Hilltop Road intersection completed.

Construction Stage 4: Redoubt Road / Mill Road  This stage is essentially green fields the most costly and involves large cuts and fills. There are 3 bridges within the section, a Mill Road overbridge and two gully crossings. The southern tie in can be constructed to tie back into the existing Mill Road near Ranfurly Road.

Construction Stage 5 and 6: Mill Road  Stage 5 and 6 consists of two roundabouts, at the Mill / Ranfurly Road intersection and at the Mill / Alfriston Road intersection and sections linking them. The two roundabouts have been separated as they can be constructed in phases. Stage 5 can be constructed to tie into Stage 4 at its northern end, while Stage 6 requires the completion of Stage 5 to function as a roundabout.

The staged implementation of the corridor will take place over multiple years, with each stage as identified in the staging plan above implemented could be undertaken as separate projects. Each of these staged sections will require preparation of a practical linked programme covering each phase being the detailed design, land purchase and project procurement. This includes looking at ways to meet the Auckland Transport program and budget by
overlap various phases. A staging programme that aligns with their current program is displayed in Table 32 below.

### Table 32: Staging Programme of Preferred Option

<table>
<thead>
<tr>
<th>Stage</th>
<th>Length</th>
<th>Detail design, land purchase, procurement</th>
<th>Construction</th>
</tr>
</thead>
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<tr>
<td></td>
<td></td>
<td>Start Date</td>
<td>Duration</td>
</tr>
<tr>
<td>Stage 1</td>
<td>SH1 to Hollyford midblock plus Hollyford intersection</td>
<td>1,333m</td>
<td>2015 / 16</td>
</tr>
<tr>
<td>Stage 2</td>
<td>Hollyford to Murphy’s midblock</td>
<td>1,553m</td>
<td>2016 / 17</td>
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<td>Stage 3</td>
<td>Murphy’s intersection plus Murphy’s</td>
<td>2,690m</td>
<td>2017 / 18</td>
</tr>
<tr>
<td>Stage 4</td>
<td>Murphy’s to Ranfurly midblock</td>
<td>2,930m</td>
<td>2018 / 19</td>
</tr>
<tr>
<td>Stage 5</td>
<td>Ranfurly intersection</td>
<td>1,070m</td>
<td>2020 / 21</td>
</tr>
<tr>
<td>Stage 6</td>
<td>Alfriston intersection plus N and S links</td>
<td>1,917m</td>
<td>2022 / 23</td>
</tr>
</tbody>
</table>

### 10.5 Future Proofing of the Corridor

The preferred option demonstrates provision for the planned growth in land use in the Southern Sector by allowing for and managing the expected impacts of that development.

#### 10.5.1 Traffic forecasts

Traffic modelling carried out on the corridor confirms that the capacity recommended for the corridor caters for the forecast growth over the next 30 years without over-supplying capacity. This is reflected in forecast travel times and levels of service that is better than the do minimum scenario. Midblock travel lanes are generally two lanes in each direction, with additional lanes provided at the busiest intersections located at Murphy’s Road and Hollyford Drive. This additional road capacity provides immediate relief to a currently congested corridor, whilst also allowing for the planned development growth in the Southern Sector.

In addition to performance of traffic on the corridor, the additional capacity provides relief to the wider network by balancing travel over parallel routes such as Chapel Road, Te Irirangi Drive, and especially SH1. Traffic flows on the wider One Network are able to operate under improved levels of service, providing positive transportation impacts to travel time, congestion relief, and trip reliability.

#### 10.5.2 Public Transport

The Frequent Service Network between Botany Downs and Manukau will deliver at least a 15-minute service operating all day and will be complemented by a network of connector routes that operate all day at half-hourly frequencies. In addition, a supporting network of local services, peak-only services, and targeted services will cater for specific market needs.

The Hollyford Drive / Redoubt Road and Diorella Drive / Redoubt Road intersections have both been designed to provide bus priority measures that will support the 15-minute bus headway, including a westbound bus-only lane between Hollyford Drive and the motorway interchange. The bus lane develops immediately north of the Hollyford Drive/Redoubt Road intersection, providing a Bus only right turn lane at the signalised intersection with a dedicated Bus only phase in the signal timing. All existing bus stop locations are to remain.

The capacity of these bus priority measures is far in excess of the demand created by the Frequent Service Network and is suitable also for connector services to use.
The remainder of the corridor does not form part of the planned public transport network. The small number of controlled intersections on the corridor will therefore allow any future services to run on the corridor with minimal delays on the through movements, and especially during off peak periods will not be subject to any significant delays.

The public transport provisions are therefore in accordance with strategic public transport planning for future services in excess of those considered in the 10 year horizon of the current Auckland Regional Passenger Transport Network Plan and proposed Integrated Transport Plan.

10.5.2.1 Cycling

The cycle facilities proposed for the corridor are in accordance with the existing Regional Cycle Network and will form part of the consolidated Auckland Cycle Network. The Auckland Cycle Network will form part of the ‘One Network’ of transport options in Auckland, adding to the range of travel choices along the corridor.

On-road cycle lanes are provided throughout, and are supplemented with off-road paths where the environment is more suitable, for example connection to the adjacent Totara Park and along the old Redoubt / Mill Road’s. A bus lane has been included west bound along Redoubt Road west of the Hollyford Drive / Everglade Drive intersection and will be a shared lane with cycles.

The road corridor has sufficient width for the proposed facilities. All intersections are to have appropriate cycle markings in accordance with the design guidelines and standards.

10.5.2.2 Walking

Footpaths will be provided on both sides of Redoubt Road between SH1 and Murphy’s Road. Murphy’s Road will have footpaths on both sides. The section of corridor between Murphy’s Road and south of Alfriston Road will have no footpaths due to the very low pedestrian demand. There are however opportunities to improve pedestrian facilities off road by using the low trafficked old Mill Road for recreational walking and cycling.

Traffic signal intersections at Diorella Drive, Hollyford Drive and Murphy’s Road will all have pedestrian facilities incorporated into the signals, providing safe and certain crossing opportunities.
11.0 Matters for Discussion
11.0 Matters for Discussion

11.1 Integration with the wider corridor and One Network

This investigation identified the importance of this section to the Redoubt Road-Mill Road corridor including the connectivity with the southern sector. It is a corridor which facilitates planned growth by accommodating and managing the impacts of that growth. It has also identified that any increased capacity provided by the upgraded of the corridor in turn attracts traffic as other adjacent corridors experience increasingly congested conditions.

At the edges of this corridor however, the capacity constraint within the adjoining networks and need to be considered during the detailed design phase of this project including:

- The SH1 overbridge width and lane configuration is not fully consistent with the lane configuration recommended for Redoubt Road, especially in the westbound direction.
- The current Hollyford Drive width and lane arrangement at the northern extremity of the study area have less capacity than is proposed in this SAR. Looking at extending this to at least connecting with Aspiring Avenue
- At the southernmost portion of the investigation area and the planned infrastructure upgrades need to be extended in to the southern section of this planned corridor in order to integrate fully with the planned growth in the Takanini and Drury areas.

11.2 Public Transport and Cycling Integration

The Redoubt Road – Mill Road corridor has been designed to be modified as required to accommodate when required a higher quality infrastructure and services required under the Frequent Service Network (public transport) and Cycle Highway. The integration with the adjoining network needs to be considered, and high quality infrastructure provisions and services could be extended to the existing route. Particular pinch points adjacent to this corridor include:

- SH1 overbridge – The bridge width and lane configuration does not fully accommodate the proposed bus lane and cycle lanes on Redoubt Road.
- The Aspiring / Hollyford intersection – The current layout of this intersection needs to be upgraded to accommodate the priority for buses and cycles, including high quality infrastructure.

11.3 Connectivity

Pedestrian and cycling facilities are improved with the preferred option. Consultation with AT and with Cycle Action Auckland has identified the opportunity to improve the walking and cycling connectivity along the corridor. These improvements need to be considered during the detailed design phase of the project including the following:

- A shared off-road pathway between Totara Park and the Hollyford Drive intersection to assist vulnerable users
- High quality cycle facilities (for example Copenhagen cycle lanes) on Redoubt Road (up to the Totora Park entrance and Hollyford Drive in support of the new Auckland Cycle Network standards
- A cycle lane in the westbound direction bypassing the Diorella Drive intersection to reduce cycle delays.
- Initial indications undertaken at the conclusion of the scheme design are that these improvements are able to be accommodated within the corridor and within the road width, although require some reallocation of space within the corridor is required.

11.4 Security of National or Strategic Infrastructure

There are significant water, gas and electrical bulk supplies that intersect this corridor. Ongoing engagement and liaison with these infrastructure stakeholders is crucial, especially in understanding the future requirements of those networks and any impacts that those upgrades or expansion may have on the corridor – both in terms of land use / settlement and also for the roadway. Corridor upgrades and infrastructure upgrades need to be
planned and implemented in an integrated manner in order to minimise any negative impacts one may have on the other.

11.5 Land Use and Development Thresholds
Much of the future land use and development in the catchment of the corridor is master planned. This staged development will have an increasing impact on the transport and supporting infrastructure network as development comes on line. These effects and impacts needs to be measured, and thresholds (or triggers) need to be confirmed in order that the land use and infrastructure are managed and implemented in a coordinated manner.

11.6 Designation Lapse Periods
The lapse periods on the designation of the corridor (or sections of the corridor) need to be appropriate such that AT is able to give effect to those designations in a planned and budgeted manner. These lapse periods will therefore give certainty of project progression to the community. In practice this means that the project will be delivered in a staged programme of works which comply with the consenting conditions and time frames (lapse periods).

11.7 Potential changes to Auckland Plan
The Auckland Plan is a relatively new document, and it is not possible at this time to determine the likelihood of review or changes to the Plan. It is feasible however that the Plan will evolve and change over time, and in this case those changes should be monitored and evaluated to determine the implications for the corridor.
This applies also to other high level planning documents.

11.8 On-going Public and Affected Property Owner Consultation
During the project lifecycle more detailed information will continue to come to hand. This information will be used to continuously improve the design, possibly resulting in changed impacts for users of the corridor of adjacent land owners. It is recommended that these impacts and changes be accounted for and that ongoing consulted be undertaken with the public in particular the affected property owners.

11.9 Continuing Iwi Engagement and Stakeholder Feedback
Relationships established during the course of the project lifecycle need to be maintained and managed. Relevant new or important information needs to be shared with Iwi and project stakeholders to ensure continued engagement with the project and their feedback sought.
This is seen as a crucial aspect of the ongoing life of the project to ensure delivery of the project outcomes and project objectives.

11.10 Funding Application
Funding Allocation Process forms have not been included as part of this scheme assessment. On receipt and following the review of this Scheme Assessment Report, it is recommended that AT provide direction to AECOM on the completion of the necessary funding applications.
12.0 Recommendations
12.0 Recommendations

The Redoubt Road-Mill Road Corridor meets the project strategic and core objectives, local, regional and national strategy and policy and can be viewed as a fundable project in line with NZTA requirements with a BCR of 2.2 and at an expected cost of $297M.

The Redoubt Road-Mill Road preferred option (Northern C and Eastern B) has been developed using a robust and comprehensive approach, including being publicly consulted on to ensure stakeholder issues are understood and incorporated into the preferred option wherever practicable.

Alternative alignments and connections within the study area have been considered, tested through a robust MCA process to determine the best practical solution that has an overall positive effect in terms of environmental, cultural and social impacts while meeting client requirements for funding. The outcome of these assessments would support a Notice of Requirement for the Redoubt Road-Mill Road Corridor.

On the basis of above, it is recommended that AT endorse and adopt the Scheme Assessment Report findings and approve proceeding to completion of the Notice of Requirement based on all the information presented in this report.
Addendum 1

to

the Scheme Assessment Report
Redoubt Road - Mill Road Corridor Project

Rural Section 4B - Multi-Criteria Assessment
Redoubt Road - Mill Road Corridor Project

Rural Section 4B - Multi-Criteria Assessment

Client: Auckland Transport

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29-Sep-2014

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Quality Information

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Ref

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Reviewed by  Craig Hind

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</tbody>
</table>
# Table of Contents

**Mill Road Corridor – Rural Section 4B Alternative Alignment Review**

1.0 Introduction
   1.1 Purpose 2
   1.2 Background 2

2.0 Alignments and Assessment
   2.1 Development of Alignments 3
   2.2 Multi-Criteria Assessment 3
      2.2.1 Methodology 3
      2.2.2 Scoring Workshop 3
      2.2.3 Sensitivity Analysis 3
      2.2.4 Comments and Justification 4

3.0 Conclusion
   3.1.1 Summary 5
   3.1.2 Recommendation 5

Appendix A
   Alignment Review Report A

Appendix B
   Multi-Criteria Assessment B
Redoubt Road - Mill Road Corridor – Rural Section 4B Alternative Alignment Review

Executive Summary

AECOM NZ Ltd (AECOM) has completed a high level review of the current recommended option for the Rural Section 4B of the Redoubt Road - Mill Road Corridor in comparison to alternative alignments which avoid a stand of native bush at 146 Mill Road.

The recommended option was issued by AECOM as part of the Scheme Assessment Report for the Redoubt Road - Mill Road Corridor Upgrade in 2013. In response to questions raised on the ecological value of the native bush at 146 Mill Road, a total of three alternative alignments were investigated.

These alignments were initially investigated for feasibility purposes using geometric design, geotechnical and utility services criteria. The “northern alignment” was considered to be unfeasible in response to particularly challenging geotechnical conditions and construction within Watercare owned land.

Two feasible options (known as Option 1 and Option 2) were investigated using more detailed technical analysis. A report was issued that outlined the feasibility and technical detail behind these alignments (Redoubt Road - Mill Road Alternative Alignment Review: AECOM, July 2014 – included in Appendix A).

The technical review concluded:
- Options 1 and 2 are both feasible alternatives to the existing recommended option.
- Option 1 has a feasibility cost estimate of $90M; Option 2 has a feasibility cost estimate of $86M (in comparison to the recommended option of $47M).
- Option 1 impacts upon 10 rural/residential properties (along the existing Mill Road alignment); Option 2 impacts upon 15 rural/residential properties (along the Mill Road and Polo Prince Drive alignments). This compares to the recommended option impacting upon 2 rural/residential properties).

A multi-criteria assessment (MCA) was then undertaken by the project team and relevant specialists to compare the alternative alignments to the current recommended option. The criterion used to score the options was the same as for the original scheme assessment of options. For assessment purposes the existing recommended option was ‘zeroed’ and the options scored a positive, neutral or negative impact in comparison.

Option 1 scored negative 4 in comparison to the recommended option.
Option 2 scored negative 7 in comparison to the recommended option.

The MCA score sheet and comments / justifications are included in Appendix B.

A sensitivity test was undertaken on the MCA results. The differentiating criteria include:
- Ecological impact: Options 1 and 2 have a positive impact, avoiding the native bush.
- Social impact: Options 1 and 2 have a negative impact due to residential access and severance issues.
- Constructability: Options 1 and 2 generally have a negative impact in terms of service utilities, deliverability and funding related criteria.

Sensitivity testing concluded that weighting in favour of environmental criteria of 50% or more would result in Option 1 scoring above the recommended option (i.e. environmental criteria weighted at over 50%; other six criteria totalling less than 50%).

Due to the unexceptional nature of the existing ecological conditions it is unlikely that the environmental criteria would warrant a weighting of 50% against all other criteria. Also as social and constructability criteria warrant significant consideration as differentiators between options.

It is therefore considered that, on the balance of technical evidence and qualitative assessment, the existing recommended option remains the preferred option for the Mill Road Corridor Upgrade.
1.0 Introduction

1.1 Purpose

Auckland Transport has requested AECOM NZ Ltd (AECOM) to complete a high level review of the currently recommended alignment for Rural Section 4B of the Redoubt Road - Mill Road Corridor in comparison to alternative alignments which avoid a stand of native bush at 146 Mill Road. This report summarises the multi-criteria assessment process undertaken to assess and compare the alternative alignments.

1.2 Background

AECOM issued a Scheme Assessment Report for the Redoubt Road - Mill Road Corridor Upgrade in 2013. The recommended option includes a section that deviates from the existing Mill Road alignment and passes through an area of native bush at 146 Mill Rd. This is shown as the “Recommended Option” in Figure 1.

In response to questions raised on the ecological value of the native bush at 146 Mill Road, a total of three alternative alignments were investigated. The alternative alignments were identified through discussions within the Auckland Transport project team, reviewed on site and subsequently investigated for feasibility.

The alternative alignments were investigated for feasibility purposes using geometric design, geotechnical and utility services criteria. The “northern alignment” was considered to be unfeasible in response to particularly challenging geotechnical conditions and construction within Watercare owned land.

The two feasible alignments (known as Option 1 and Option 2) were investigated using more detailed technical analysis. The alignments are shown in Figure 1. The general route diverts at the Puhinui Creek Gully Bridge and utilises the existing Mill Road alignment to tie into the Ranfurly Road Roundabout. The alternative alignments generally avoid the native bush.

Figure 1 Alignment Location
2.0 Alignments and Assessment

2.1 Development of Alignments

The alternative alignments were developed and broadly assessed for technical feasibility purposes. The feasibility review report is attached in Appendix A (Redoubt Road - Mill Road Alternative Alignment Review: AECOM, July 2014).

The review concluded:
- Option 1 and 2 are both feasible alternatives to the existing recommended option.
- Option 1 has a feasibility cost estimate of $90M; Option 2 has a feasibility cost estimate of $86M. This compares to the recommended option of $47M.
- Option 1 impacts upon 10 rural/residential properties (along the existing Mill Road alignment); Option 2 impacts upon 15 rural/residential properties (along the Mill Road and Polo Prince Drive alignments). This compares to the recommended option impacting upon 2 rural/residential properties).

2.2 Multi-Criteria Assessment

2.2.1 Methodology

A multi-criteria assessment (MCA) was undertaken by the project team to compare the alternative alignments to the current preferred option. The criterion used to score the options is the same as for the original scheme assessment of options. For the sake of assessment the existing recommended option was ‘zeroed’ and the options scored a positive, neutral or negative impact in comparison.

2.2.2 Scoring Workshop

A workshop was undertaken on 28 May 2014. Attendees included the Auckland Transport and AECOM project team members, including specialists in the different project areas.

The criterion were discussed and scored in comparison to the recommended option. Subsequent reviews were undertaken by the project specialists and the final agreed scoring was completed in September 2014.

Option 1 scored negative 4 in comparison to the recommended option.

Option 2 scored negative 7 in comparison to the recommended option.

The MCA score sheet and comments / justifications are included in Appendix B.

2.2.3 Sensitivity Analysis

Sensitivity testing was undertaken on the results. The differentiating criteria include:
- Social criteria, in particular:
  - Impact on residential properties and access
  - Severance of community / residential property
- Environmental criteria, in particular
  - ecological impact
  - landscape and visual impact
- Constructability criteria, in particular
  - Cost benefit analysis
  - Bridges and structures
  - Deliverability, comprising earthworks and staging
  - Utility Services, comprising the Watercare pipeline
  - Project funding
Analysis concluded that weighting towards social and / or constructability criteria would only magnify the scoring in favour of the recommended option.

However weighting towards environmental criteria could change the ranking of results in favour of Option 1. More specifically, if environmental criteria were to be given approximately 50% or more of the total weighting across the seven criteria groupings, then Option 1 would score over zero (i.e. greater than the recommended option).

While this is a subjective argument it is considered unlikely that existing environmental criteria would warrant a weighting of 50% against all other criteria. This was due to no significant environmental considerations being encountered. In particular, it was suggested by the project ecological specialist that existing environmental conditions warranting such a high weighting may include protected species of flora or fauna or significant species that could not easily be relocated. These conditions are not evident within the native bush.

It is also considered inequitable to value environmental criteria at 50% when other criteria such as social and constructability criteria are seen as having a significant impact in terms of the scale and nature of change.

2.2.4 Comments and Justification

Safety

The general response verifying the neutral scoring of the options was that the design specifications would exclude any negative or positive impacts compared to the existing recommended option.

Route Security

The neutral scoring is verified for both the network assessment and geotechnical risk sub-criteria through the design specification having neither a positive or negative effect in relation to the recommended option.

Future Growth

The neutral scoring is verified through the lack of any differentiation between the alignments and recommended option in terms of the ability to cater for future land use growth. All testing alignments have the same transport outcomes.

Social

The ‘poor’ scoring assigned to the alternative alignments is verified generally by the scale and magnitude of impacts on private property. Both alternatives require additional land take, alter access and have severance impacts on existing established communities.

Environmental

The key differentiating criteria is the sub-criteria of ecological impact, for which the alternative alignments do not impact upon the native bush at 146 Mill Road. Option 1 scores ‘best’ and Option 2 ‘good’ as it has less relative impact on watercourses. The other differentiating sub-criteria is visual and landscape, for which Option 2 scores ‘poor’ as a result of the visual impact of the additional bridge height and the greater visibility of the road from surrounding viewpoints.

Cultural

There is no known archaeological or cultural site that would differentiate scoring between alternatives.

Constructability

On the balance of all constructability sub-criteria both alternative alignments are negative in relation to the recommended option. From a benefit cost and funding perspective the options are more costly and deliver similar benefits to the recommended option, and therefore are less likely to be fundable.

The differentiating sub-criteria are bridges and structures. Option 1 has a positive impact compared to the recommended option as it avoids the need for structures over the native bush. Option 2 involves a large bridging structure up to 8m in height and therefore has a negative impact. For deliverability, Option 2 also scores ‘worse’ due to the significant earthworks required, potentially pushing construction into two earthworks seasons.

1 Clarification: Option 1 would score more than the recommended option if the environmental criteria were weighted over 50% and the other six criteria totalled less than 50%.
3.0 Conclusion

3.1.1 Summary

A qualitative assessment was undertaken on the alternative alignments and the following findings were identified:

- Option 1 and Option 2 have a negative impact compared to the existing recommended option.
- Sensitivity concluded that weighting in favour of environmental criteria of 50% or more would result in Option 1 scoring above the recommended option (i.e. environmental criteria weighted at over 50%; other six criteria totalling less than 50%). However, it was concluded that due to no significant environmental considerations being encountered this additional weighting was not warranted.

3.1.2 Recommendation

Based on the evidence presented in this report and the MCA of qualitative impacts the current recommended option is preferred over the alternative alignments.
Appendix A

Alignment Review Report
Redoubt Road - Mill Road Corridor Project

Rural Section 4B - Alignment Review Report
Quality Information

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Reviewed by: Greg Booth

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Table of Contents

1.0 Introduction 1
  1.1 Purpose of Report 1
  1.2 Background 1

2.0 Alternative Alignments 2
  2.1 Option Development 2
    2.1.1 The Problem 2
    2.1.2 The Options 2
  2.2 Option 1 Technical Assessment 3
    2.2.1 Horizontal and Vertical Alignment 3
    2.2.2 Cut and Fill 3
    2.2.3 Intersections 3
    2.2.4 Geotechnical 3
    2.2.5 Cost Estimate 3
  2.3 Option 2 Technical Assessment 4
    2.3.1 Horizontal and Vertical Alignment 4
    2.3.2 Cut and Fill 4
    2.3.3 Intersections 4
    2.3.4 Geotechnical 4
    2.3.5 Cost Estimate 4
  2.4 Constructability of Options and Cost Summary 5

3.0 Conclusion 6
  3.1 Summary 6
  3.2 Recommendations 6

Appendix A
  Drawings A

Appendix B
  Cost Estimate B
1.0 Introduction

1.1 Purpose of Report

Auckland Transport requested that AECOM NZ Ltd (AECOM) carry out a review of possible alternative alignments on Mill Road in order to avoid the area of bush at 146 Mill Road. This document provides a summary of the technical review and includes an initial qualitative assessment of the alignment options in comparison to the existing recommended option identified in the current Scheme Assessment Report, and shown in previous consultation and communication media.

1.2 Background

AECOM issued the Scheme Assessment Report (SAR) for the Mill Road Corridor Upgrade in July 2013. The recommended option in the SAR deviates from the existing Mill Road and runs below the Watercare Redoubt Road reservoir site and through the land at 146 Mill Road until again joining the existing Mill Road approximately 130 metres south of 146 Mill Road. This preferred alignment provides a safe compliant design and also minimises the impact on the area of native bush at 146 Mill Road by bridging the majority of the impacted bush.

Two alternative alignment options that avoid the area of bush at 146 Mill Rd entirely were identified in collaboration with the Auckland Transport project team and a further review on site. These two alignments are notated as Option 1 and Option 2, and in plan both follow a similar alignment to the existing Mill Road. However these two alignments follow differing vertical profiles which have different impacts on the surrounding area but avoid the area of bush under review at 146 Mill Rd.

The recommended option and alternative options (Option 1 and Option 2) are shown in Figure 1below.

Figure 1 Alignment Location
2.0 Alternative Alignments

2.1 Option Development

2.1.1 The Problem

AECOM were asked by Auckland Transport to look at alternative alignment options that address the existing problems associated with the sub-standard vertical and horizontal road alignment along Mill Road, which have led to recent fatalities, and also to avoid the area of native bush at 146 Mill Road.

In addition to the highway design standards and environmental parameters there are also major water supply pipe lines which run along and across Mill Road to facilitate Auckland’s water supply via the Redoubt Road Reservoir site. These have a significant impact on any option at this particular location.

2.1.2 The Options

AECOM have identified two alternative options where both follow the existing Mill Road alignment but have different vertical alignments. The design parameters used to assess the suitability of these options are consistent with the rest of the Mill Road Corridor Design.

- **Option 1**: (Refer Appendix A - Sketch 60250009-SK-028)
  - Follows the existing Mill Road alignment in accordance with the AUSTROADS design guide using a design speed of 90km/h
  - Avoids the area of native bush at 146 Mill Road
  - Provides a compliant intersection to access Polo Prince Drive
  - Requires relocation of the existing Manurewa #1 Watercare pipeline that crosses Mill Road due to the vertical level change (shown at design chainage 4300 on Sketch 60250009-SK-028)
  - Impacts on approximately 10 properties on the eastern side of Mill Rd

- **Option 2**: (Refer Appendix A - Sketch 60250009-SK-029)
  - Follows the existing Mill Road alignment in accordance with the AUSTROADS design guide using a design speed of 90km/h
  - Avoids the area of native bush at 146 Mill Road
  - Avoids the relocation of the existing Watercare asset at design chainage 4300
  - Provides a compliant intersection to Polo Prince Drive but with a major repositioning of the Polo Prince access requiring additional land purchase
  - Requires substantial earthworks to achieve the vertical and horizontal design profiles required for a compliant design
  - The earth works will impart additional loading to the WaterCare pipeline between the design chainage 4680 and 4920. WaterCare have indicated that this main would need to be re-located
  - The impact due to earthworks on 15 properties on the eastern side of Mill Road
2.2 Option 1 Technical Assessment

2.2.1 Horizontal and Vertical Alignment

Option 1 complies with the project design standard (AUSTROADS) for the 90km/h designated design speed which is also identified in the project requirements. This standard ensures that adequate provision is made for the safe movement of vehicles along the road corridor and that the existing problems associated with the sub-standard vertical and horizontal road alignment along Mill Road are addressed.

To obtain the required alignment the existing crest curve on the hill prior to 146 Mill Road requires flattening out as it is substandard. To achieve this, the road therefore needs to be lowered by at least 10m to achieve a more compliant profile (minimum K value of 55). This in turn requires the Manurewa #1 WaterCare pipeline to be lowered.

AECOM was informed at a meeting with WaterCare on 9th May 2014 that the relocation of this main could have a lead in time of up to 10 years and an estimated cost of around $10 million. Although this could be done, WaterCare had stated that they were not in favour of this relocation.

In addition to the Manurewa Line #1 bulk supply water main that crosses Mill Road, WaterCare’s Waikato bulk supply water main is located on the left side of Mill Road from design chainage 4300 running southwards. The Option 1 road alignment is situated over this main for approximately 500m and requires the addition of earthworks fill over the pipe and over the fibre optic cable that runs adjacent to the pipeline. WaterCare’s preference is to relocate this section of pipe rather than imposing additional load onto the pipe and fibre optic cable. This relocation work would also have a lead time around 10 years and an estimated cost of approximately $20 million.

WaterCare would require easements for any relocated pipelines. Although feasible to relocate the Waikato water main and obtain the necessary easements, WaterCare is not supportive of this option.

2.2.2 Cut and Fill

Due to earthworks for this option (5m high fills, 10m high cuts) partial or full acquisition of approximately 10 adjacent properties would be required. Option 1 would require the movement of approximately 150,000m$^3$ of material.

2.2.3 Intersections

At this stage it is envisaged that the existing Polo Prince Drive / Mill Road intersection can be retained with minimal additional work. On Sketch 60250009-SK-028 this is shown as a minor junction improvement and re-grading over approximately 20m.

2.2.4 Geotechnical

Limited geotechnical investigation/assessment has been carried out on this alternative alignment option therefore further investigation would be required to mitigate the slope stability risk with regard to the fill and cut embankments. The existing geotechnical information for this location has identified potential land stability risk.

2.2.5 Cost Estimate

The rough order cost estimate for alignment Option 1 is $90M. The Recommended Option estimate from the Scheme Assessment Report is $47M. These costs are shown in Table 1 below.

There are a number of significant items that contribute to the $43M ($90M - $47M) increase in cost compared to the SAR Recommended Option at $47M:

- Ground improvement measures required due to unstable terrain ($0.9M)
- Cross drainage culvert lengths increase due to higher fill embankments ($0.5M)
- Costs associated with WaterCare water main relocations ($30M)
- Approximately 5 properties would require full acquisition, with an additional 5 requiring partial acquisition. (Property costs have been provided by AT’s property team).
2.3 Option 2 Technical Assessment

2.3.1 Horizontal and Vertical Alignment

Option 2 has a similar horizontal alignment to Option 1 and is compliant with AUSTROADS for a 90km/h design speed.

In Option 2 the issues with substandard crest curves have been addressed by lifting the road. In order to achieve this, the Puhinui Creek Bridge needs to be raised by an additional 8m compared to the Recommended Option. This in turn results in further earthworks embankments or retaining walls, or by lengthening the Puhinui Creek bridge.

The resulting crest curve over WaterCare’s Manurewa Line #1 water main is at the absolute minimum to achieve a design speed of 90km/h. The departure grade, once over the main is -8% at a length of 730m in comparison to a maximum length of 300m for any grade over 6% as recommended in (Austroads). Improvement may be possible if this option is developed further. This vertical alignment design allows the road to cross over the Manurewa #1 water main at existing ground level therefore only requiring protection to the pipe at an estimated cost of $50k.

Similar to Option 1, the Waikato bulk supply is affected by the proposed Option 2 alignment but differs in that it would be situated within the earthworks embankment and not directly under the road as in Option 1. WaterCare would prefer to relocate this main rather than subject it to additional earthworks fill loading. This has similar timing and associated costs to Option 1. There are however other options to address this;

- Retain the earthworks embankment to avoid the water main.
- Realign the road to avoid the water main at the cost of additional earthworks. This could be developed further if this option is acceptable.

2.3.2 Cut and Fill

This option requires fill embankments in the order of 20m high that directly impact 11 adjacent properties, therefore requiring full or partial acquisition. Option 2 would require the movement of approximately 700,000m$^3$ of material.

The areas of fill are shown on the long section Sketch 60250009-RD-1001 to 1003 and cross sections Sketch 60250009-RD-1011 to 1034 included in Appendix A.

2.3.3 Intersections

For this option it is not possible to provide a compliant Polo Prince Drive / Mill Road intersection design at its current location. A new intersection is therefore proposed at design chainage 4930. The new alignment of Polo Prince Drive, and the new position of the intersection with Mill Road impacts on a further 4 properties. Refer to Sketch 60250009-SK-029, 60250009-RD-1004, and 60250009-RD-1035 to 1037 included in Appendix A for plan, long section and cross sections.

An alternative option to provide access to Polo Prince Drive would be to connect Polo Prince Drive to Aunceston Rise (off Ranfurly Road). This alternative option has not been assessed, but it is envisaged that some improvements to these roads would be necessary. A traffic assessment would be required to ascertain the additional road user costs for the affected properties on Polo Prince Drive. This option could be developed further if required.

2.3.4 Geotechnical

Limited geotechnical investigation/assessment has been carried out on these alternative alignment options therefore further investigation would be required to mitigate the slope stability risk with regard to the fill and cut embankments. The existing geotechnical information for this location has identified potential land stability risk.

2.3.5 Cost Estimate

The rough order cost estimate for Option 2 alignment is $86.4M. The Recommended Option estimate from the Scheme Assessment Report is $47M. These costs are shown in Table 1 below.

There are a number of significant items that contribute to this additional cost:
- Earthworks ($16M)
- Ground improvement measures required due to unstable terrain ($0.9M)
- Cross drainage culvert lengths due to higher fill embankments ($0.9M)
- Lifting the Puhinui Stream Bridge by an additional 8m ($2.4M)
- Accommodating the Waikato Watermain ($1.0-10.0M estimate range, used lower estimate based on embankment options above)
- Approximately 9 properties would require full acquisition, with an additional 6 requiring partial acquisition. This accounts for an additional five properties required over and above Option 1 due to the new alignment of the Polo Prince Drive/Mill Road intersection. (Property costs have been provided by AT’s property team)

The estimated property and construction costs are summarised in Table 1 below.

### 2.4 Constructability of Options and Cost Summary

A detailed constructability assessment of the alternative Mill Road alignment Options 1 and 2 has not been undertaken as part of this review. However both options require construction work to be undertaken along the alignment of the existing Mill Road. For both options regardless of the earthworks being the excavation and removal of material or the import of material to elevate the road levels it will require work over 2 earthwork periods. These will also accommodate any major infrastructure work that WaterCare require for their assets in this location.

The construction could be planned as either multiple stages of work with short duration closure of Mill Road to facilitate transitions between the construction sequences or could be closed entirely for the earthwork season and temporarily re-opened between seasons. Either approach will require long term traffic management and diversions which could accrue costs in excess of $5m.

A summary of estimated costs for the project options are included in Table 1.

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3.0 Conclusion

3.1 Summary
A technical review was undertaken by AECOM on the two alternative alignment options that avoid the area of native bush at 146 Mill Road, the following findings were identified:

- Both Option 1 and 2 require additional property purchase than the recommended option
- Both Option 1 and Option 2 will require additional work to address the ground stability risk incurred from the proposed works
- WaterCare confirmed that they have significant concerns regarding their infrastructure for the proposed alignments identified in Options 1 and 2. WaterCare have stated that they support the recommended option
- Both Options 1 and 2 have a significant detrimental impact to property and, accessibility during construction
- Both Option 1 and Option 2 have a higher cost and construction risk when compared to the existing Recommended Option

3.2 Recommendations
Based on the assessments presented in this report and the MCA of qualitative impacts the current preferred option is recommended over the alternative alignments (Option 1 and Option 2).
Appendix A

Drawings
All reasonably practicable steps have been taken to ensure safety in design has been considered within AECOM's scope of work in this design in accordance with IPENZ Practice note 07 'Design for safety in buildings and other structures' (July 2006). It remains the responsibility of the owner and/or operator to ensure appropriate practices are in place to protect the safety of workers and the public in the operation of the facility.
SAFETY IN DESIGN

All reasonably practicable steps have been taken to ensure safety in design has been considered within AECOM's scope of work in this design in accordance with IPENZ Practice note 07 'Design for safety in buildings and other structures' (July 2006).

It remains the responsibility of the owner and/or operator to ensure appropriate practices are in place to protect the safety of workers and the public in the operation of the facility.
Appendix B

Cost Estimate
### Alternative Alignment - Option 1

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### Preferred NOR Option

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Pavement Markings and Signs

$165,800.00

Safety Barriers

Assumption that existing

$221,000.00

$0.00

$45,109,600.00

$73,477,200.00

$260,000.00

Utility Services

$31,851,000.00

Extraordinary Construction Costs

$440,000.00

Landscaping

$14,700,000.00

Property Modifications

$618,000.00

Road is now closer to

$260,000.00

$615,000.00

$0.00

$440,000.00

$0.00

$165,800.00

Road is now closer to

$221,000.00

Assumption that existing

$15,712,000.00

Structures

$81,556,700.00

Assumption that existing

13.05 Road signs LS 1 $40,000.00 $40,000.00 1 $40,000.00 $40,000.00 1 $40,000.00 $40,000.00

18.07 Box Culverts of Watercare trunk watermains m 0 $2,200.00 $0.00 460 $2,200.00 $1,012,000.00 60 $1,800.00 $108,000.00

13.04 New marker posts (provisional) ea 40 $20.00 $800.00 40 $20.00 $800.00 40 $20.00 $800.00

17.05 Landscaping inside traffic islands LS 1 $0.00 1 $0.00 1 $0.00

15.04 Relocate existing street lighting ea 0 $2,500.00 $0.00 0 $2,500.00 $0.00 0 $2,500.00 $0.00

18.05 Gully Bridge 2 (CH 4850) sq.m 0 $2,500.00 $0.00 0 $2,500.00 $0.00 700 $2,500.00 $1,750,000.00

14.03 Trailing/Leading end guardrail terminals ea 4 $3,750.00 $15,000.00 4 $3,750.00 $15,000.00 4 $3,750.00 $15,000.00

13.03 Raised Road Pavement Markers km 2 $1,250.00 $2,500.00 2 $1,250.00 $2,500.00 2 $1,250.00 $2,500.00

12.05 Open Graded Porous Asphalt - Ogpa (35mm depth) sq.m 0 $30.00 $0.00 0 $30.00 $0.00 0 $30.00 $0.00

13.02 Pavement markings (incl. lettering and green cycling/bus lanes markings) km 2.5 $45,000.00 $112,500.00 2.5 $45,000.00 $112,500.00 2.5 $45,000.00 $112,500.00

12.02 Pavement Markings and Curb Lines - incl. Lettering km 8 $80,000.00 $640,000.00

Alternative Alignment - Option 1

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Utility Services

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Utilities

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$72,427,200.00

$45,109,600.00

$45,109,600.00

Alternative Construction Costs

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$0.00
Appendix B

Multi-Criteria Assessment
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<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Both options would be designed to the same geometric specification. Intersections are not an issue within Section 4B. Any potential conflict area would be designed to the same specification.</td>
</tr>
<tr>
<td></td>
<td>Access and connectivity</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>The design response will ensure safe access and connectivity consistent with the design specification of the corridor. Properties can safely be connected to the corridor.</td>
</tr>
<tr>
<td>Route Security</td>
<td>Network assessment of model</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>There is nothing between the options that would differentiate scoring based on providing for route security.</td>
</tr>
<tr>
<td></td>
<td>Engineering assessment of geotechnical risks</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>The option differentiation is minor and there are no known geotechnical risks associated with the options that would compromise future route security.</td>
</tr>
<tr>
<td>Future growth</td>
<td>Volume/capacity assessment</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>There is no differentiation in the ability to provide for future traffic demand.</td>
</tr>
<tr>
<td></td>
<td>Developing Level of Service</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Options have the same transport outcomes.</td>
</tr>
<tr>
<td></td>
<td>Comparable trip time model outputs</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Options have the same transport outcomes.</td>
</tr>
<tr>
<td>Social</td>
<td>Impact on residential access</td>
<td>Neutral</td>
<td>Poor</td>
<td>Poor</td>
<td>Both the temporary impact is negative and long term is negative compared to recommended option. Some access points for residents will change as a result of the project, and bring the road closer to their property.</td>
</tr>
<tr>
<td></td>
<td>Severance assessment</td>
<td>Neutral</td>
<td>Poor</td>
<td>Poor</td>
<td>Removes the ability to provide for improved community integration. Property acquisition separates houses that have stood together for decades, increasing residents feelings of isolation.</td>
</tr>
<tr>
<td></td>
<td>Impact on community facilities</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Negligible social impact in relation to existing community facilities, such as the church. There is a potential impact in terms of the options removing the option for use of residual Mill Road for recreational use (alternative cycling/walking route to preferred alignment), however this is not considered a negative impact as the facility does not currently exist.</td>
</tr>
<tr>
<td>Cultural</td>
<td>Archaeology and heritage</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Nothing currently known to be different within the option areas.</td>
</tr>
<tr>
<td></td>
<td>Cultural sites</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Nothing currently known to be different within the option areas.</td>
</tr>
<tr>
<td>Constructability</td>
<td>Benefit Cost Ratio</td>
<td>Neutral</td>
<td>Poor</td>
<td>Poor</td>
<td>Option costs are significantly higher taking property costs into account and other construction items. Benefits unlikely to cover cost increase therefore net decrease expected in BCR.</td>
</tr>
<tr>
<td></td>
<td>Bridges and Structures</td>
<td>Neutral</td>
<td>Good</td>
<td>Poor</td>
<td>Option 1 has a net positive impact compared to the current option as it involves similar retaining structures but avoids the need for a structure over the bush at 146 Mill Road. Option 2 involves raising the bridge on approach to the deviation by up to 8m, adding significant risk to the project.</td>
</tr>
<tr>
<td></td>
<td>Deliverability</td>
<td>Neutral</td>
<td>Poor</td>
<td>Poor</td>
<td>Ignoring structures and utilities, earthworks are the differentiating factor affecting deliverability in terms of risk and traffic management, programme and noise and vibration impacts on residential property. Both options require work on top of the existing road, Option 1 requires earthworks over one season and Option 2 over two seasons.</td>
</tr>
<tr>
<td></td>
<td>Utility services</td>
<td>Neutral</td>
<td>Poor</td>
<td>Poor</td>
<td>Both option alignments are located directly over the Watercare main, and add additional fill over the water main for approximately 500m. Therefore Watercare would relocate this main which would also have a lead in time of 10 years. The design and construction costs are unknown but best case would be in the order of $20 million.</td>
</tr>
<tr>
<td></td>
<td>Funding</td>
<td>Neutral</td>
<td>Poor</td>
<td>Poor</td>
<td>Higher costs are likely to expose the options to additional funding risk.</td>
</tr>
</tbody>
</table>
Murphys Road – Design considerations (Update)

A site visit was carried out with Auckland Transport representatives to discuss the selection process that was undertaken in order to arrive at the preferred alignment for Murphys Road.

1.0 Murphys Road

1.1.1 Alignment Options

As part of their investigations Opus International Consultants identified Option J as the preferred option. This option was renamed as Northern 1 and was investigated as part of AECOM’s Corridor Scheme Assessment (refer Figure 1).

During the development of the design, it became apparent that other alignment options existed that may provide benefits not previously investigated as part of the Opus study. AECOM suggested to AT that those other options be considered. That led to the development of Northern 2, Northern 3 and Northern 4.

A meeting was held at the AT Henderson offices on the 12th July 2012 to assess progress on the alternative Murphys alignment options and agree the direction for further design. An alternative alignment, Northern 5 was discussed at that meeting and included for further consideration (refer figure 1).

![Figure 1: Murphys Road - Alignment Options](image)
1.1.2 Vertical Gradients

All the alignments presented at the meeting (12th July 2012) with AT were designed with similar vertical gradients for direct comparison.

Murphys Road is described as a District Arterial in the Operative District Plan and has a posted speed limit of 80km/h.

The following design and legislative guidelines were discussed and used for consideration:

- NZS4404 (2010) - Land Development and Subdivision Infrastructure (Table 3.2): Max vertical grade for a connector exceeding 8,000vpd should not exceed 10%.
- AGRD Part 3 –Geometric Design (Table 8.3): for an Operating speed of 80km/h the maximum vertical grade should not exceed 9% if the surrounding area is considered “mountainous”.
- Urban Design Guide (Section 10.2): 8% is suggested as the maximum gradient for Urban Arterials.
- AGRD Part 6A – Appendix C (Commentary 10): The design guide suggests that a gradient greater than 10% over 50m with Horizontal curves and 12% over 50m on a straight is considered to be “extremely hazardous” for cyclists.

Considering the above design guidelines, it was agreed at the meeting not to exceed 9% as the maximum vertical grade for Murphys Road.
1.1.3 Preferred Alignment

After an examination of the alternative alignment options relative to the project objectives and in terms of environmental effects, Northern 1 and 4 became the preferred alignments for further consideration. In order to recommend a preferred alignment, the working group discussed the pros and cons of each alignment. Following is a table representing the findings of the working group in an effort to select the preferred alignment.

<table>
<thead>
<tr>
<th>Constructability &amp; Earthworks</th>
<th>Northern 1 (N1) (Previously preferred alignment)</th>
<th>Northern 4 (N4) (Preferred Alignment)</th>
</tr>
</thead>
<tbody>
<tr>
<td>This alignment can be constructed off-line to reduce effects on existing traffic, while local property access can be easily maintained.</td>
<td>Existing traffic, including local access, will have to be accommodated during the construction. This will be time-consuming and will require a robust construction methodology.</td>
<td></td>
</tr>
<tr>
<td>This alignment follows an existing ridge line or saddle.</td>
<td>A large cut volume can be used to supplement the fill required.</td>
<td></td>
</tr>
<tr>
<td>This alignment has a greater impact on private land ownership compared to N4. 7 properties are affected at a total affected area of approx. 49,436m².</td>
<td>This alignment affects a smaller area of privately owned land compared to N1. 12 properties are affected at a total affected area of 34,405 m². The remaining 14,484 m² is existing road reserve (Total = 48,889m²).</td>
<td></td>
</tr>
<tr>
<td>At a max gradient of 9%, this alignment option requires more fill compared to N4.</td>
<td>At a max gradient of 9%, this alignment option requires less fill compared to N1.</td>
<td></td>
</tr>
</tbody>
</table>

| Social Impact & Urban Design |
|-------------------------------|-------------------------------------------------|
| This alignment is less intuitive compared to N4. The “angled” alignment severs properties between its alignment and the existing Murphys Road, creating new parcels of land that would be awkward to develop. | The alignment is more intuitive compared to N1 as it is straight and follows the existing road alignment. |
| The remaining Murphys Road will have to be retained to maintain access to privately owned property. | Multiple local accesses will require re-grading and retaining to ensure the existing accesses are maintained. |
| This option will negatively affect the line of sight to the city and Flat Bush area for the properties remaining between its alignment and the existing Murphys Road. | From an Urban Design perspective, this option provides added benefits as the cut to fill provides a “gateway” to the Flat Bush development area. |

<table>
<thead>
<tr>
<th>Structure Plan &amp; Severance of Parcels</th>
</tr>
</thead>
<tbody>
<tr>
<td>This angled alignment compromises the Flat Bush Structure Plan road grid system.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transpower Assets</th>
</tr>
</thead>
<tbody>
<tr>
<td>At least 1 Transpower pylon will require relocation while the effects on the overhead cables are not clear.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Geometry</th>
</tr>
</thead>
<tbody>
<tr>
<td>The horizontal curve near the Redoubt Road intersection (radius of 350m at CH180) will have a non-compliant Approach Sight Distance (ASD in accordance with AGRD Part 3) compared to a compliant ASD for option N4.</td>
</tr>
</tbody>
</table>

Table 1: Option comparison
1.1.4 Multi Criteria Assessment

Northern 1, 4 and 5 were shortlisted for consideration in the project Multi Criteria Assessment (MCA) where they were compared against the project objectives as outlined in the RFT. The objectives and scoring are provided in Table 2: MCA Ranking where the higher the score, the better the solution.

<table>
<thead>
<tr>
<th></th>
<th>Northern 1 (A)</th>
<th>Northern 4 (B)</th>
<th>Northern 5 (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td>3</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Route Security</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Future Growth</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Social</td>
<td>1</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Environmental</td>
<td>1</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Cultural</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Constructability</td>
<td>3</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>12</td>
<td>21</td>
<td>11</td>
</tr>
</tbody>
</table>

Table 2: MCA Ranking

1.1.5 Recommended Alignment

Based on the benefits of one over the other discussed at the AT meeting highlighted in Table 1 as well as in accordance with the MCA ranking in Table 2, it was agreed to progress the design of Northern 4 as the preferred alignment.
1.2 Additional Gradient Analysis for Options Northern 1 and 4

The alignment options presented in section 1.1.1 were designed and presented with a 9% vertical gradient and fill and cut batters of 3H: 1V.

Further design development of the preferred alignment (N4) has since been undertaken to reduce the effects of the fill and impact on adjacent properties by introducing retaining walls or steeper mechanically stabilized earth (MSE) batters while remaining largely within the existing road corridor.

AT requested that AECOM undertake a design alternative for Northern 1 and 4 using a maximum gradient of 10% (instead of the agreed 9%) with compliant tangent curves at both ends, while maintaining a design speed of 80km/h, similar to the posted speed limit of 80Km/h.

AT also requested to consider lowering the Redoubt Road alignment to reduce the tie in point level for N1, thus reducing the overall fill required for Murphys Road.

Detailed below in item 1.2.1 is a comparison between the Murphys Road N1 and N4 alignments at 10% and the item 1.2.2 the comparison between the proposed and lowered Redoubt Road alignments.

1.2.1 Murphys Road – Comparison of Options at 10%

The adjustments of the gradient and vertical curves for the options (to 10%) are presented in Table 3.

The earthworks comparison for the Murphys Road options are as follows:

<table>
<thead>
<tr>
<th>Gradient 10%</th>
<th>Northern 1 (N1) (Previously preferred alignment)</th>
<th>Northern 4 (N4) (Preferred Alignment)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Fill</td>
<td>69,971m³</td>
<td>85,420m³</td>
</tr>
<tr>
<td>b) Cut</td>
<td>7,005m³</td>
<td>45,398m³</td>
</tr>
<tr>
<td>Diff (a-b)</td>
<td>+62,966m³</td>
<td>+40,022m³</td>
</tr>
</tbody>
</table>

Table 3: Northern 1 (N1) and 4 (N4) - Earthworks Comparison using gradient of 10% (excl. Redoubt Road)

- N1 – The alignment for this option more closely follows the existing ground profile (saddle/crest), resulting in less overall fill compared to Northern 4.
- N4 – Although the overall fill is greater compared to N1, the residual fill required is 22,944m³ less than for N1 due to a better balance between cut and fill (excl. lowered Redoubt Road).
- N4 – The change from 9% to 10% significantly reduces the need for retaining walls to avoid spilling into privately owned property.
- N1 and N4 – Changing to 10% is a reduction in standard for all modes, especially for cyclists and pedestrians.
- N1 and N4 - A gradient of 10% exceeds the recommended maximum stated in Austroads Part 3 (Table 8.3) for a road with a posted speed limit of 80km/h.
- N1 and N4 – Access onto Thomas Road can be accommodated in both alignments.

Following in Appendix A are the design layouts for the 10% gradients for Northern 1 and Northern 4.

1.2.2 Redoubt Road - Comparison of Options

At the request of AT, AECOM investigated lowering Redoubt Road to reduce the residual fill required at the location of the intersection between Murphys and Redoubt Road for the Murphys Road option N1 (Opus preferred alignment). As a result, the Redoubt Road alignment was lowered by approx. 3m.

For the preferred option, in combination with Murphys Road option N4, Redoubt Road cannot be lowered as Murphys Road already cuts through the crest of the peak resulting in a good cut and fill balance.

The following is a comparison in earthworks between the preferred Redoubt Road (for use with N4) and the alternatively lowered Redoubt Road alignments (for use with N1) from approx. CH2000 – CH3100:
Table 4: Redoubt Road - Earthworks Comparison of Redoubt Road in combination with N1 and N4

- **Lowered Redoubt Road (A)**
  - Effects on properties are significant, requiring larger retaining walls to maintain access to adjacent privately owned land and access to existing driveway and the redundant portions of Redoubt Road between CH2700 and CH3100.
  - Lowered Redoubt Road – Existing services will be significantly affected as the Redoubt Road alignment is lowered.
  - Residual cut can be used as fill along Murphys Road.

- **Designed Redoubt Road Alignment (B)**
  - Imported fill required to address cut to fill balance.

Following in **Appendix B** are the design layouts for Redoubt Road and the alternative, lowered Redoubt Road.

### 1.2.3 Recommendation

Based on the decisions made at the outset of the Scheme and Preliminary Design stages and on the project objectives; safety, route security, future growth, social effect, environmental, cultural and constructability, and the evidence provided in this memorandum, Northern 4 remains the preferred alignment as opposed to Northern 1.

With the focus on alternative modes, appropriate and fit for purpose design standards, it is recommended to retain Northern 4 with the maximum vertical gradient at 9% to ensure that the corridor will be sufficient to cater for a design compliant to the guideline standards and that cater for all forms on transport.

During the detailed design, a steeper gradient, potentially 10% for Murphys Road may be considered, without requiring any alterations to the designation footprint because the current 9% gradient would represent the worst case land take.
Appendix A: Design layouts for 10% gradients for Northern 1 and Northern 4
Appendix B: Layouts for Redoubt Road and alternative, lowered, Redoubt Road
Memorandum

To
Richard Black - Auckland Transport

CC
Craig Hind; Greg Booth

Subject
Mill Road - Design Considerations for the Puhinui Creek Bridge

From
Dawie Maritz

File/Ref No.
60317081

Date
11-Sept-2014

Mill Road – Design considerations for the Puhinui Creek Bridge

1.0 Alignment Options background

As part of their investigations Opus recommended Option D as the preferred alignment for Mill Road. This option was renamed Eastern A and was investigated further as part of AECOM’s Corridor Scheme Assessment (refer Figure 1).

![Figure 1: Opus Option D Alignment](image)

During the geotechnical investigation process, the area near the Watercare reservoirs was identified as an area of historic instability. In addition, Watercare advised that this alignment option would likely compromise their proposed expansion of their reservoir facility. As a result of this, alternative alignments to the previously preferred alignment were considered, leading to the development of Eastern B. Although Eastern A is geometrically superior, alignment Eastern B still meets the project objectives and achieves a design speed similar to the posted speed of 80km/h. During the design refinement and in an effort to avoid the “head” of a bush clad gully at 134 Mill Road and to minimise the effect on established vegetation, Eastern C was developed. This alignment better follows the existing ridgelines and contours, resulting in fewer earthworks.

Eastern C was selected as the preferred alignment (refer Figure 2).
2.0 Vertical Gradients

During a meeting held at the AT Henderson offices on the 12th July 2012, it was agreed that, due to its classification as a Regional Arterial, Redoubt/Mill Road should not exceed a vertical gradient of 7% based on the posted speed limit as well as the following design guidelines:

- NZS4404 (2010) - Land Development and Subdivision Infrastructure (Table 3.2): Max vertical grade for a connector exceeding 8,000vpd should not exceed 10%.
- AGRD Part 3 –Geometric Design (Table 8.3): for an Operating speed of 80km/h the maximum vertical grade should not exceed 9% if the surrounding area is considered “mountainous”.
- Urban Design Guide (Section 10.2): 8% is suggested as the maximum gradient for Urban Arterials.

3.0 Puhinui Creek Gully Bridge

The project ecologist, Dave Slaven from Boffa Miskell, has identified a section of forest at 38 Mill Road as “mature” and established within the alignment footprint. The recommendation from Mr Slaven was for the alignment (incl. the Puhinui Creek Gully Bridge) to avoid the area if practical. Survey information showing the extent of the “large tree dripline” has been supplied from CKL Surveyors as well as a proposed location (identified at meeting held with the project ecologist and AT on 11th July 2014) to reposition the bridge and alignment. Refer Figure 3.
Using the information supplied by CKL Surveyors and the project ecologist, AECOM have re-designed the alignment of Mill Road and the Puhinui Creek Bridge. The bridge and alignment can be shifted laterally by 13m without a significant effect on design guidelines in terms of vertical and horizontal alignment, retaining wall heights, fill or the structure length. The lateral shift to the east would avoid the wider "established" tree drip line represented by the green line in Figure 3 and Figure 4.

The road and bridge re-alignment will require an alteration to the proposed designation and land requirements as the footprint extends beyond the proposed designation line represented by the orange line in Figure 4.

The proposed re-alignment’s effect (incl. costs) on the existing bridge have not yet been confirmed in detail, however upon inspection it appears that the bridge length, height, span lengths or number of supports will not be severely affected and will have no significant cost implications.

Refer to Figure 4 and Figure 5 for details of the re-alignment.
Figure 5: Cross Section @ chainage 3940 (middle of bridge)

4.0 Summary

The road and bridge alignment can be adjusted to accommodate the “larger or established” tree dripline, without a significant effect on the geometric design standards.

However larger cuts on the north eastern side are required (refer to Figure 4), resulting in an extension of the proposed retaining walls to avoid additional privately owned land.

Additional land will be required as the footprint extends beyond the proposed designation, however land taken on the one side will result in giving land back on the other side.

Based on the current level of design development the bridge realignment will have no significant impact on the project estimate.

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