



Transport
Roads & Maritime
Services

Windsor Bridge replacement project

Submissions report
Incorporating preferred infrastructure report

APRIL 2013



RMS 13.208
ISBN 978-1-922245-07-6

ARTIST'S IMPRESSION

(blank page)

Roads and Maritime Services

Windsor Bridge Replacement

Submissions Report
including a Preferred Infrastructure Report

April 2013 – Final



(blank page)

Executive summary

Roads and Maritime Services NSW (RMS) is seeking approval under Part 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) to replace the existing bridge over the Hawkesbury River at Windsor (known as Windsor Bridge) with a new bridge around 35 metres downstream of the existing Windsor Bridge. The existing bridge needs to be replaced as its structural integrity is deteriorating with age and it is no longer cost-effective to maintain.

RMS used a range of consultation tools and activities to ensure the community was actively involved in the project development and options selection process. Consultation for the project began in July 2009 with input sought on the ten options to rehabilitate or replace the existing bridge. Consultation continued on the preferred option to allow community issues to be considered in the design of the bridge, Thompson Square and surrounding project elements.

Exhibition of the EIS and bridge design

The EIS was formally exhibited for 34 days from 14 November 2012 to 17 December 2012. A public notice was also made under the *Roads Act 1993* for proposing to construct a bridge over navigable waters.

The exhibition was advertised in a media release, as well as local and metropolitan newspapers. The EIS was exhibited at seven display locations and was made available for review and electronic download on the RMS and Department of Planning and Infrastructure websites.

Community consultation activities were undertaken during the public exhibition period that included release of a community update, an email alert to those preregistered to receive project updates and EIS display information letterbox dropped and mailed to various stakeholders. A number of community information sessions were also held during the exhibition period. The project team was available at these sessions to discuss the project and answer any enquiries.

Submissions received during public exhibition

No submissions were made in response to the navigable waters notice required under the *Roads Act*. However, the Department of Planning and Infrastructure received a total of 101 submissions in response to the exhibition of the EIS, comprising six government agency submissions and 95 submissions from the community. Five of these submissions were received after the formal exhibition period had closed. The final submission accepted and responded to in the Submissions Report was received on 14 February 2013.

Most community submissions objected to the project due to significant impacts on the heritage of Thompson Square, Windsor and the demolition of the existing heritage listed Windsor Bridge. Other community submissions raised issues around the justification for the project and the integrity and transparency of the project development and community consultation process. Some submissions expressed a preference for a bypass option to avoid heritage and traffic-related impacts on Thompson Square, while others supported the project as a cost-effective and reasonable solution for a replacement bridge identifying benefits to local traffic, flood immunity and pedestrian safety.

Agency and council submissions identified a range of construction and operation phase issues that would need to be addressed by the project, including potential flooding impacts, urban design, and impacts on riparian vegetation and agricultural land. Notably, the Heritage Council of NSW objected to the project on the grounds of long-term irrevocable and serious negative impacts on the Thompson Square heritage conservation area and the heritage of Windsor.

Additional investigations

To respond to issues raised in submissions and during consultation for the EIS, a number of additional investigations have been undertaken and information has been provided as follows:

- Heritage investigations, including additional historic archaeological investigations that confirmed the conclusions of the earlier investigations undertaken as part of the EIS.
- More detailed flooding investigations including modelling that concluded the project would have considerably less impacts than those presented in the EIS, with no or negligible increases in flood levels immediately upstream of the replacement bridge.
- The feasibility of refurbishing the existing Windsor bridge including assessing the alternative refurbishment method proposed by ex-RMS bridge engineers and comparing their refurbishment method with that proposed by RMS.
- Potential impacts, feasibility and costs of the alternative Rickabys Line option proposed by ex-RMS bridge engineers, which would partially bypass Windsor to the west.
- A detailed examination of options for archaeological investigation of Thompson Square prior to construction commencing.

Further information on the deteriorating condition of the existing bridge is also provided. This is in response to submissions that questioned the validity of bridge condition information provided in the EIS.

Design changes

The following project changes are proposed to minimise environmental impacts and have been assessed in the preferred infrastructure report within this Submissions Report:

- Increasing the clearance of the new bridge over The Terrace from 3.6 metres to 4.6 metres to allow large coaches to directly access Windsor Wharf.
- Changing the location of bridge piers.
- Noise mitigation being identified for consideration at additional properties, including heritage properties.

The assessment of design changes demonstrates that these changes will minimise environmental impacts. While the design changes will also result in impacts, they have been assessed as comprising only a minor or negligible change compared to the impacts of the project identified in the EIS.

Contents

| | |
|---|----|
| Executive summary | i |
| 1 Introduction and background | 1 |
| 1.1 The project | 1 |
| 1.2 Statutory context..... | 1 |
| 1.3 Environmental impact statement exhibition..... | 2 |
| 1.4 Purpose of the document..... | 3 |
| 2 Response to issues..... | 5 |
| 2.1 Respondents | 5 |
| 2.2 Overview of the issues raised..... | 5 |
| 2.3 Scope of response to submissions | 6 |
| 2.4 Issue – Alternatives to the project..... | 7 |
| 2.4.1 Rickabys Line option | 7 |
| 2.4.2 Other bypass options..... | 8 |
| 2.4.3 Other alternative crossing locations..... | 9 |
| 2.4.4 Alternative bridge alignments..... | 10 |
| 2.4.5 Refurbishment of the existing Windsor Bridge | 10 |
| 2.4.6 Construction of a tunnel..... | 13 |
| 2.4.7 Upgrading intersections only..... | 13 |
| 2.4.8 Other alternatives | 14 |
| 2.5 Issue – Bridge design | 16 |
| 2.5.1 General objection to proposed bridge design..... | 16 |
| 2.5.2 Bridge type and form | 16 |
| 2.5.3 Bridge width and lane numbers | 17 |
| 2.5.4 Clearance over The Terrace..... | 19 |
| 2.6 Issue – Heritage | 20 |
| 2.6.1 Adverse impacts on heritage | 20 |
| 2.6.2 Impacts on Thompson Square..... | 21 |
| 2.6.3 Impacts on archaeological evidence..... | 23 |
| 2.6.4 Impacts on maritime heritage..... | 24 |
| 2.6.5 Impacts on heritage buildings and properties..... | 25 |
| 2.6.6 Impacts on the existing Windsor Bridge..... | 26 |
| 2.6.7 Aboriginal heritage..... | 26 |
| 2.6.8 Heritage approvals | 28 |
| 2.6.9 Director General’s requirements for heritage assessment | 30 |
| 2.7 Issue – Urban design and landscape | 32 |
| 2.7.1 Visual impacts | 32 |
| 2.7.2 Tree removal | 34 |
| 2.7.3 Landscape treatments | 35 |
| 2.7.4 Final form of Thompson Square | 37 |
| 2.7.5 Anti-social activities | 38 |
| 2.8 Issue – Traffic and access | 40 |
| 2.8.1 Through traffic and heavy vehicles | 40 |
| 2.8.2 Growth in traffic volumes | 41 |
| 2.8.3 Right turn from Bridge Street north into George Street west | 42 |
| 2.8.4 Right turn from Bridge Street into Court Street | 43 |
| 2.8.5 Performance of the Macquarie Street intersection | 44 |

| | | |
|--------|---|----|
| 2.8.6 | Performance of the Freemans Reach Road/ Wilberforce Road intersection..... | 45 |
| 2.8.7 | Safety at the George Street and Bridge Street intersection..... | 46 |
| 2.8.8 | Traffic performance of the project..... | 46 |
| 2.8.9 | Traffic speed and benefit cost ratio..... | 47 |
| 2.8.10 | Design speed of the project..... | 48 |
| 2.8.11 | Upgrade of the McGraths Hill section of Windsor Road..... | 48 |
| 2.8.12 | Construction traffic impacts..... | 49 |
| 2.8.13 | Impacts on access to properties..... | 50 |
| 2.8.14 | Coach access to Windsor Wharf..... | 51 |
| 2.8.15 | Loss of maritime navigational area due to scour protection..... | 51 |
| 2.9 | Issue – Noise and vibration..... | 52 |
| 2.9.1 | Operational noise impacts..... | 52 |
| 2.9.2 | Operational vibration impacts..... | 54 |
| 2.9.3 | Construction noise and vibration impacts..... | 55 |
| 2.10 | Issue – Socio-economic impacts..... | 57 |
| 2.10.1 | Severance of the town..... | 57 |
| 2.10.2 | Impacts on tourism..... | 57 |
| 2.10.3 | Impacts on local businesses..... | 60 |
| 2.10.4 | Impacts on the road freight industry..... | 61 |
| 2.10.5 | Impacts on agriculture..... | 62 |
| 2.11 | Issue – Flooding, hydrology and climate change..... | 63 |
| 2.11.1 | Flood immunity of project..... | 63 |
| 2.11.2 | Flood impacts of the project..... | 64 |
| 2.11.3 | Development on the floodplain..... | 65 |
| 2.11.4 | Hydrological impacts..... | 65 |
| 2.11.5 | Climate change considerations..... | 66 |
| 2.12 | Issue - Impacts on riparian vegetation..... | 67 |
| 2.12.1 | Impacts of the replacement bridge on riparian vegetation..... | 67 |
| 2.12.2 | Riparian plantings for the water quality basin..... | 67 |
| 2.13 | Issue – Community consultation process..... | 69 |
| 2.13.1 | Timing of the community consultation process..... | 69 |
| 2.13.2 | Integrity of the community consultation process..... | 70 |
| 2.13.3 | Scope of the community consultation process..... | 71 |
| 2.13.4 | Quality of responses to community correspondence..... | 73 |
| 2.13.5 | Statutory requirements for the consultation process..... | 74 |
| 2.13.6 | Quality of display material used in community displays for the project..... | 74 |
| 2.13.7 | Time allowed for submissions on the EIS..... | 75 |
| 2.13.8 | Design and Heritage Focus Group..... | 75 |
| 2.14 | Issue – Accuracy and adequacy of information..... | 77 |
| 2.14.1 | Accuracy and adequacy of information – Flooding..... | 77 |
| 2.14.2 | Accuracy and adequacy of information – Heritage..... | 78 |
| 2.14.3 | Accuracy and adequacy of information – Restoration of Thompson Square..... | 79 |
| 2.14.4 | Accuracy and adequacy of information - Noise and vibration impacts..... | 80 |
| 2.14.5 | Accuracy and adequacy of information - Traffic..... | 82 |
| 2.14.6 | Accuracy and adequacy of information – Socio-economic impacts..... | 84 |
| 2.14.7 | Accuracy and adequacy of information - Project need..... | 85 |
| 2.14.8 | Accuracy and adequacy of information - Project description..... | 86 |
| 2.14.9 | Accuracy and adequacy of information - Manipulation of data..... | 87 |

| | | |
|---------|--|-----|
| 2.14.10 | Areas of insufficient information..... | 87 |
| 2.15 | Issue - Project need..... | 89 |
| 2.15.1 | Lane widths and design standards of the existing bridge..... | 89 |
| 2.15.2 | Load limits of the existing bridge..... | 90 |
| 2.15.3 | Structural condition of the existing bridge..... | 91 |
| 2.15.4 | Maintenance history of the existing bridge..... | 94 |
| 2.15.5 | Need for demolition of the existing Windsor Bridge..... | 96 |
| 2.15.6 | Crash history..... | 97 |
| 2.16 | Issue - Project justification..... | 98 |
| 2.16.1 | Project development process..... | 98 |
| 2.16.2 | Director General's requirements for assessment of alternatives..... | 99 |
| 2.16.3 | Use of stated aims and objectives to justify the project..... | 100 |
| 2.16.4 | Cost effectiveness of selected preferred option..... | 101 |
| 2.16.5 | Weighting given to heritage impacts in the assessment of alternatives..... | 102 |
| 2.16.6 | Changes in the Benefit Cost Ratio methodology..... | 104 |
| 2.16.7 | Weighting given to cost in the assessment of alternatives..... | 105 |
| 2.16.8 | Accuracy of cost estimates provided by RMS..... | 105 |
| 2.16.9 | Project objectives and benefits..... | 106 |
| 2.16.10 | Benefits to pedestrian and cyclist safety..... | 108 |
| 2.16.11 | Benefits of removing the 1934 road cutting..... | 109 |
| 2.16.12 | Sustainability..... | 110 |
| 2.16.13 | The approval process and right to appeal the EIS..... | 111 |
| 2.16.14 | Justification of the project using local and NSW plans and policies..... | 112 |
| 3 | Additional assessment..... | 113 |
| 3.1 | Additional historic heritage archaeological investigations..... | 113 |
| 3.1.1 | Scope and purpose of additional investigations..... | 113 |
| 3.1.2 | Archaeological evidence gained from the test excavations..... | 113 |
| 3.1.3 | Potential impacts of the intersection works..... | 114 |
| 3.2 | Archaeological investigation options for Thompson Square..... | 115 |
| 3.2.1 | Assessment of archaeological options..... | 116 |
| 3.2.2 | Managing the archaeological excavation..... | 117 |
| 3.2.3 | Public interpretation..... | 120 |
| 3.3 | Revised flood modelling..... | 121 |
| 4 | Rickabys Line option..... | 122 |
| 4.1 | Overview and description of the option..... | 122 |
| 4.1.1 | Bridge structure..... | 126 |
| 4.1.2 | Bridge height and levels..... | 126 |
| 4.1.3 | Pedestrian and cycle access..... | 127 |
| 4.1.4 | Intersections..... | 127 |
| 4.1.5 | Route alignment..... | 128 |
| 4.2 | Environmental Impacts..... | 129 |
| 4.2.1 | Historic heritage..... | 129 |
| 4.2.2 | Aboriginal heritage..... | 129 |
| 4.2.3 | Visual impact and urban design..... | 130 |
| 4.2.4 | Traffic and access..... | 131 |
| 4.2.5 | Noise and vibration..... | 134 |
| 4.2.6 | Soil and water..... | 135 |
| 4.2.7 | Flora and fauna..... | 138 |
| 4.2.8 | Socio-economic impacts..... | 138 |
| 4.2.9 | Hydrology..... | 139 |

| | | |
|--------|--|-----|
| 4.2.10 | Air quality..... | 141 |
| 4.3 | Alternative bridge refurbishment methodology..... | 142 |
| 4.3.1 | Outline of alternative bridge refurbishment methodology..... | 142 |
| 4.3.2 | Comparison of alternative and RMS bridge refurbishment methodology..... | 142 |
| 4.3.3 | Technical review of alternative bridge refurbishment methodology..... | 144 |
| 4.4 | Review of cost estimates for Rickabys Line option..... | 146 |
| 4.4.1 | Costs estimates for the alternative route..... | 146 |
| 4.4.2 | Cost estimate for the alternative bridge refurbishment methodology..... | 149 |
| 4.5 | Assessment of the Rickabys Line option..... | 151 |
| 4.5.1 | Economic analysis..... | 151 |
| 4.5.2 | Assessment of Rickabys Line option against project objectives and criteria..... | 153 |
| 4.6 | Conclusion..... | 154 |
| 5 | Preferred infrastructure report..... | 155 |
| 5.1 | Increase in the clearance of the new bridge over The Terrace..... | 155 |
| 5.1.1 | Description..... | 155 |
| 5.1.2 | Historic heritage impacts..... | 160 |
| 5.1.3 | Visual, urban design and landscape impacts..... | 160 |
| 5.1.4 | Operational noise impacts..... | 163 |
| 5.1.5 | Land use and socio-economic impacts..... | 166 |
| 5.2 | Minor changes in bridge pier location and bridge type..... | 167 |
| 5.2.1 | Description..... | 167 |
| 5.2.2 | Environmental impacts..... | 167 |
| 5.3 | Additional heritage properties requiring noise mitigation..... | 170 |
| 5.3.1 | Background..... | 170 |
| 5.3.2 | Advice on architectural treatments for noise mitigation..... | 171 |
| 5.3.3 | Appropriate noise mitigation treatments..... | 171 |
| 5.3.4 | Recommendations for noise mitigation treatments..... | 174 |
| 6 | Revised environmental management measures..... | 176 |
| 7 | Conclusion..... | 178 |
| 8 | References..... | 180 |
| | Appendix A - List of submissions..... | 181 |
| | Appendix B - Additional heritage investigations..... | 185 |
| | Appendix C - Technical review of alternative bridge refurbishment methodology .. | 186 |
| | Appendix D - Landscape character and visual impact assessment addendum..... | 187 |
| | Appendix E - Operational noise and architectural treatment addendums..... | 188 |
| | Appendix F - Options for archaeological investigation of Thompson Square..... | 189 |
| | Appendix G - Technical investigations of the structural condition of Windsor Bridge..... | 190 |

1 Introduction and background

1.1 The project

Roads and Maritime Services NSW (RMS) is proposing to replace the existing bridge over the Hawkesbury River at Windsor. The proposal for bridge replacement (hereafter referred to as “the project”) includes the following key features:

- Construction of a new bridge over the Hawkesbury River at Windsor, around 35 metres downstream of the existing Windsor Bridge.
- Construction of new approach roads and intersections to connect the new bridge to existing road network.
- Modifications to local roads and access arrangements, including changes to the Macquarie Park access and connection of The Terrace.
- Construction of pedestrian and cycling facilities, including a shared pedestrian/cycle pathway for access to and across the new bridge.
- Removal and backfilling of the existing bridge approach roads.
- Demolition and removal of the existing road bridge, known as Windsor Bridge.
- Urban design and landscaping works, including within the parkland area of Thompson Square and adjacent to the northern intersection of Wilberforce Road, Freemans Reach Road and the Macquarie Park access road.
- Ancillary works such as public utility adjustments, water management measures and scour protection works, as required.

A more detailed description of the project is found in Chapter 5 of the Windsor Bridge replacement project environmental impact statement (EIS) prepared by RMS in November 2012.

1.2 Statutory context

RMS formed the opinion that the project is likely to significantly affect the environment and would require an environmental impact statement to be prepared under Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The project does not require development consent under Part 4 of the EP&A Act. Accordingly, as per clause 14 and Schedule 3 of *State Environmental Planning Policy (State and Regional Development) 2011* the project is State significant infrastructure under Part 5.1 of the EP&A Act and requires the approval of the Minister for Planning and Infrastructure.

An application report to support a State significant infrastructure application under Section 115X of the EP&A Act was prepared by RMS. This application was submitted to the Department of Planning and Infrastructure on 4 October 2011 and the Director General’s requirements for environmental impact assessment were issued on 24 November 2011. In accordance with the requirements of the EP&A Act, an EIS was prepared to assess the potential impacts of the project.

In addition, as a roads authority, RMS is authorised to construct bridges across navigable waters, under Part 6, Division 2, Section 78 of the *Roads Act 1993* (Roads Act). The Roads Act provides that such bridges are lawful obstructions of navigable waters.

Sections 79 to 81 of the Roads Act provide for RMS to carry out a public consultation process for a proposed bridge across navigable waters. The notice must indicate where and when the plans of the proposed bridge may be inspected by members of the public, and must state that any person is entitled to make submissions to RMS with respect to the proposal within 28 days from the date of the notice.

RMS must consider any submissions received before deciding whether or not to proceed. If the decision is made to construct the bridge, RMS must notify each person who has objected to the proposal.

1.3 Environmental impact statement exhibition

The EIS was formally exhibited for 34 days from 14 November 2012 to 17 December 2012. The exhibition was advertised in a media release, as well as the following newspapers:

- Sydney Morning Herald.
- The Daily Telegraph.
- Hawkesbury Courier.
- Hawkesbury Gazette.

In addition:

- A community information flyer was sent to around 330 interested stakeholders and 12,000 residents in Freemans Reach, Wilberforce, Pitt Town, Windsor, South Windsor, McGraths Hill, Windsor Downs, Berkshire Park, Bligh Park, Mulgrave and Glossodia.
- An email alert was sent to around 200 registered stakeholders accompanied by community update material.

Unstaffed information displays were also set up during the EIS exhibition period at the following locations:

- Hawkesbury City Council chambers.
- RMS Motor Registry, Richmond.
- RMS Office, Blacktown.
- RMS Head Office, North Sydney.
- Deerubbin Centre (Windsor Central Library).
- NSW Department of Planning and Infrastructure, Bridge Street, Sydney.
- Nature Conservation Council of NSW, Newtown.

Staffed displays in support of the formal public exhibition (but not part of the formal public exhibition administered by the Department of Planning and Infrastructure) were held at:

- Windsor Marketplace (8 December 2012).
- Windsor Riverview Shopping Centre (24 November 2012).

The public was able to access information from the project's enquiries email (Windsor_Bridge@rms.nsw.gov.au) and telephone line (1800 822 486). The EIS was also available for review and electronic download on the RMS and Department of Planning and Infrastructure websites.

For the purposes of the navigable waters notice, plans of the proposed bridge were also placed on public exhibition at RMS' Maritime Office at Blacktown during the same period as the EIS exhibition, from 14 November 2012 to 17 December 2012.

A notice of RMS' intention to construct a bridge across navigable waters was published in the following local newspapers:

- Hawkesbury Courier.
- Hawkesbury Gazette.

1.4 Purpose of the document

During the exhibition of the EIS, 101 submissions were made. The Director General of the Department of Planning and Infrastructure provided copies of the submissions to RMS. This Submissions Report including a preferred infrastructure report (PIR) has been prepared to assist the Department with its' assessment of the project .

No submissions were made in response to the navigable waters notice required under the Roads Act. As such the remainder of this report only appropriately addresses matters relevant to the EP&A Act.

This report identifies the issues raised during exhibition of the EIS and provides responses to those issues (**Chapter 2**). It also includes information on additional studies carried out since exhibition of the EIS (**Chapter 3**), further details of an alternative option (the Rickabys Line option) proposed by ex-RMS bridge engineers (**Chapter 4**), and a description of changes to the project since the EIS exhibition included in the PIR (**Chapter 5**). Revised environmental management measures for the project are also included (**Chapter 6**).

While a number of design changes are proposed, the additional environmental effects of these changes would be minor and would not alter the findings of the EIS. The proposed design changes and associated environmental effects are discussed in the preferred infrastructure report within **Chapter 5** of this report.

To respond to issues raised in submissions and during consultation for the EIS, a number of additional investigations have been undertaken. These investigations (which are detailed in **Chapter 3** and **Chapter 4**) include the following:

- Heritage investigations, including additional archaeological investigations.
- More detailed flooding investigations.
- Investigations into the feasibility of refurbishing the existing Windsor Bridge, including assessing the alternative refurbishment method proposed as part of the Rickabys Line option, and comparing this method with that proposed by RMS.
- Investigations into the potential impacts, feasibility and costs of the bypass component of the Rickabys Line option, which would provide an alternative route to the west of Windsor.

Only minor revisions have been made to the outcomes of the environmental assessment. Minor changes to three environmental management measures presented in the EIS are also proposed.

2 Response to issues

2.1 Respondents

The Department of Planning and Infrastructure received a total of 101 submissions in response to the exhibition of the EIS, comprising six government agency submissions and 95 submissions from the community. Five of these submissions were received after the formal exhibition period had closed. The final submission accepted and responded to in this Submissions Report was received on 14 February 2013. A list of submissions and a description of the respondents is provided in **Appendix A**.

2.2 Overview of the issues raised

Each submission has been examined individually to understand the issues raised. The issues raised in each submission have been extracted and collated, and corresponding responses to the issues have been provided. Where similar issues have been raised in different submissions, only one response has been provided. The issues raised and RMS' responses form the basis of this chapter.

The main issues raised in the community submissions were:

- Objection to the project due its impacts on the heritage of Thompson Square and Windsor.
- Objection to the project due to the demolition of the existing Windsor Bridge, which is listed on RMS' Heritage and Conservation Register in accordance with Section 170 of the *Heritage Act 1977* (RMS' Section 170 Heritage and Conservation Register) and the heritage schedule of the Hawkesbury Local Environmental Plan 2012.
- Objection to the project on the grounds that it does not provide a long-term solution for traffic issues and will allow increasing volumes of through traffic and heavy vehicles to impact the heritage precinct of Windsor.
- Objection to the project on the grounds that there is not sufficient justification for it to proceed due to a perceived lack of benefits and significant adverse impacts.
- Objection to the project and support for an alternative route to avoid impacts on Thompson Square and remove through traffic and heavy vehicles from Windsor town centre.
- Objection to the project due to perceived issues with the integrity and transparency of the project development process, including the integrity of information provided in community consultation and the EIS.
- Support for the project as a cost-effective and reasonable solution for a replacement bridge and its benefits to local traffic, flood immunity and pedestrian safety.

The main issues raised by each of the government agencies were as follows:

- **Environment Protection Authority** – stated that a detailed construction noise and vibration management plan, and a soil and water management plan, should be required by the Minister's Conditions of Approval for the project.

- **Heritage Council of NSW** – unequivocally objects to the project on the grounds of long term irrevocable and serious negative impacts on the Thompson Square heritage conservation area and the heritage of Windsor. The Heritage Council of NSW supports rehabilitation of the existing bridge and construction of a bypass. The Heritage Council also provided detailed Minister’s Conditions of Approval for the project, if it should proceed.
- **Hawkesbury City Council** – supports the project but requested further information on the urban design aspects of the new bridge and consolidation of Thompson Square open space.
- **Department of Primary Industries (DPI) Fisheries NSW** – stated that the EIS adequately addresses potential impacts but requested further consultation on scour protection when detailed design is available.
- **DPI Crown Land** – raised the issue of outstanding Aboriginal Land Claims on Crown Land acquired for the project.
- **DPI Agriculture NSW** – identified that excess land on the northern bank would still be suitable for agricultural/horticultural use and these uses should be considered rather than making the land public open space.
- **DPI NSW Office of Water** – requested that additional consideration be given to riparian vegetation rehabilitation on the northern bank.
- **Office of Environment and Heritage (OEH) (Aboriginal Cultural Heritage)** – recognised that the site may contain superior archaeological deposits and recommended salvage if disturbance cannot be avoided.
- **OEH (Flooding)** – recognised that the flooding assessment undertaken for the EIS is comprehensive, although further work and consultation is required to determine and mitigate the potential flooding impacts of the new bridge.

2.3 Scope of response to submissions

Some submissions raised issues outside the scope of the information provided in the EIS. This included:

- Media releases and speeches in NSW Parliament Hansard by various NSW Government politicians.
- Extracts from planning approval documentation from other developments or from Hawkesbury City Council minutes or other documentation.
- Purported conversations, emails and other interactions between members of the public, politicians and RMS officers.
- Current and potential complaints to the Ombudsman regarding various matters associated with the project.
- Accusations of defamation and associated potential legal action.

While these matters relate to the project, they do not directly relate to the EIS or its scope and objectives as defined in the EP&A Act. Consequently, no response has been provided in this Submissions Report to matters such as those identified above.

2.4 Issue – Alternatives to the project

Many of the submissions did not support the current proposed alignment and other features of the project and suggested that alternative options such as a bypass or alternative route (eg option 6 described in the EIS) would be more suitable. One particular alternative raised in a large number of submissions was the Rickabys Line option, which was developed by ex-RMS bridge engineers. The Rickabys Line option comprises a partial bypass to the west of Windsor and refurbishment of the existing Windsor Bridge using an alternative methodology to the one identified and costed by RMS.

Some submissions suggested that the option development and assessment process had a pre-determined outcome, and insufficient investigation and assessment of alternative options was undertaken. There was also criticism of the project objectives and how they were used to assess different options. Additionally, some submissions were concerned about the lack of detail in the EIS on other recently identified potential alternatives, such as the Rickabys Line option and the alternative Windsor Bridge refurbishment method.

The specific issues raised in submissions in relation to alternatives for the river crossing are identified in the following sections.

2.4.1 Rickabys Line option

Submission number(s)

24, 27-29, 66, 70, 90, 93 and 94.

Issue description

Many submissions supported the Rickabys Line option, which comprises a road partial bypass to the west of Windsor and refurbishing the existing bridge for light traffic. In summary, the respondents raised the following issues:

- The Rickabys Line option developed by ex-RMS bridge engineers should be the preferred option for the river crossing.
- The estimated cost of the Rickabys Line option, as estimated by the ex-RMS bridge engineers, is comparable to the current project cost.
- An alternative route to the west of Windsor, such as the Rickabys Line option, should have been considered during the options development and selection phase of the project.
- The EIS did not contain a detailed assessment or costing of the Rickabys Line option.

Response

Two ex-RMS bridge engineers have developed an alternative option to the project involving a new two lane alternative route to the west of Windsor and refurbishing and retaining the existing Windsor Bridge for light traffic. The two ex-RMS bridge engineers provided details of and preliminary cost estimates for this option in their submission, which suggested that the Rickabys Line option could be constructed for a similar cost to the project. This option was identified in a considerable number of submissions as a preferred alternative option to the project.

The EIS considered the Rickabys Line option identified by the ex-RMS bridge engineers, including three potential alternative routes for the bypass. The level of detail and assessment provided in the EIS for the Rickabys Line option was based on the level of information available at that time.

Since the completion of the EIS, further detail on the proposed Rickabys Line option has been provided by the ex-RMS bridge engineers. Based on this additional information, RMS has developed a preliminary strategic concept design to enable a more detailed impact assessment and costing to be undertaken in response to the EIS submissions. The detailed impact assessment and cost estimates for the Rickabys Line option are presented in **Chapter 4**.

The level of impact assessment undertaken for the Rickabys Line option (as presented in **Chapter 4**) is sufficient to allow a comparison of this option with the RMS project presented in the EIS. While detailed assessment has been undertaken on a number of environmental aspects, a qualitative assessment has been undertaken on others. Examples of situations where a qualitative approach has been adopted include where the level of design detail available is not sufficient to enable an accurate quantitative assessment and where the impacts are likely to be minor and do not require a more detailed or quantitative assessment.

2.4.2 Other bypass options

Submission number(s)

2, 6, 7, 9, 11, 16, 17, 24, 27-29, 32, 37, 38, 41, 42, 44, 45, 47, 49, 52, 54, 56, 58, 62, 63, 66, 68-69, 71, 73-75, 77, 80, 84-86, 91, 92, 95 and the Heritage Council of NSW.

Issue description

Many submissions contended that a road bypass of Windsor should be constructed rather than the project. In summary, the respondents contended that a bypass would:

- Avoid heritage impacts on Thompson Square.
- Provide a better solution for existing and future traffic.
- Remove through traffic and heavy vehicles from Windsor.
- Improve the amenity of Thompson Square and the surrounding businesses and residences.
- Improve pedestrian and vehicle safety around Thompson Square.

Response

A number of options were examined during the options assessment process, including a number of options identified by the community. The options assessment process took into account transport needs, heritage impacts, environmental impacts, engineering constraints and costs. Consultation for the project began in July 2009 with input sought on the ten options, including options to retain the existing bridge, provide a bypass of Windsor or replace the existing bridge at Windsor. While a bypass option was shown to provide a number of benefits, there are a number of additional considerations such as:

- The noise, visual and traffic impacts associated with any bypass are likely to affect areas that are not currently impacted by these issues, including residential and rural residential areas.

- Depending on where the bypass joins the existing road network, all traffic issues may not be resolved or new traffic issues may arise.
- There are other impacts associated with the various bypass options, such as increased flooding, and impacts on flora and fauna.
- Some bypass options, while avoiding impacts on the historic and Aboriginal heritage of Windsor, would still be likely to have adverse impacts on both Aboriginal heritage sites and other historic heritage sites.
- A bypass would cost substantially more than the budget allocated to the project by the NSW Government.

The preferred option satisfies the primary aim of the project, which is to maintain a safe and reliable crossing of the Hawkesbury River at Windsor. An alternative route around Windsor may be considered in the future depending on growth in traffic numbers and local congestion.

2.4.3 Other alternative crossing locations

Submission number(s)

16, 19, 27, 39, 57, 61, 63, 72 and 86.

Issue description

A number of submissions, while not specifically raising the issue of a bypass, suggested that an alternative location for the replacement bridge should be considered. In summary, the issues raised by the respondents included the following:

- The location of the crossing should be moved to protect the heritage and amenity of Thompson Square and the centre of Windsor.
- Option 7, via North Street, should be considered.

Response

In comparison to other options considered, the preferred option for the project performs best in terms of value for money and satisfies the majority of project objectives. The selected bridge design and southern approach road alignment also minimise the potential visual and construction impacts of the preferred option on the Thompson Square parkland. In comparison to the other options, adverse impacts on community amenity and traffic flows during construction would be relatively minor and there would be no significant long-term changes in access to Windsor for local residents or through traffic (although minor access changes include restrictions to 'left in/ left out' for properties on Old Bridge Street and traffic changes for turning movements into George Street). The new bridge would maintain the existing, historic linkage between the northern and southern sides of the river at Windsor and the continuity of Thompson Square as a link to the river and a civic park.

Option 7 was found to have a number of disadvantages that prevented its selection as the preferred option. In particular, option 7 would have adverse traffic impacts on residential areas that currently do not experience high levels of through traffic and associated amenity impacts. It would also have adverse impacts on long-established boating activities on the Hawkesbury River and heritage impacts on the old Court House located along this route.

The adverse impacts of the project have been considered in design and options development, and would be further mitigated and/or managed using the measures identified in the EIS. These include detailed management and conservation measures to avoid, minimise and mitigate impacts on historic heritage, as well as urban design and landscape treatments to integrate the new bridge with the existing environment.

2.4.4 Alternative bridge alignments

Submission number(s)

Heritage Council of NSW.

Issue description

The submission from the Heritage Council of NSW contended the following issues:

- The proposed road plan is inelegant and unresolved.
- The proposed road plan is too close to significant buildings, too wide where the slip road is proposed, and shows no balance between traffic space, pedestrian space, landscape and the physical definition of Thompson Square.

Response

One of the urban design principles that guided the design process was the need to maximise the available open space in Thompson Square by minimising corridor footprint. This is one of the reasons the road has been narrowed to the extent possible and located on the eastern side of Thompson Square. The balance of the different elements of the project has been developed to maximise the functionality of the project for pedestrians, traffic and Thompson Square users, while minimising its impacts on the heritage and character of Windsor. The proposal removes the incongruous diagonal road element from the park which jars with the deliberate rectilinear town plan created by Macquarie.

These considerations also guided the urban design options for Thompson Square open space.

2.4.5 Refurbishment of the existing Windsor Bridge

Submission number(s)

6, 11, 16, 17, 24, 27, 28, 38, 54, 66, 69, 79, 90, 91, 93, 94, 95 and the Heritage Council of NSW.

Issue description

Many community submissions contended that the existing bridge should be retained and refurbished. In summary, the respondents raised the following issues:

- The existing bridge should be maintained for light vehicles.
- The existing bridge should be preserved and maintained as a local road and a bypass provided to serve the major traffic needs of the region.
- The existing bridge should be repaired and renovated instead of construction of the project.

- An alternative refurbishment option for the existing Windsor Bridge has been developed by ex-RMS bridge engineers. The estimated cost of this refurbishment option, as provided by the ex-RMS bridge engineers, is substantially lower than the RMS cost estimate for bridge refurbishment.
- The existing bridge should be refurbished using the alternative bridge refurbishment methodology developed by the ex-RMS bridge engineers.
- There is more-than sufficient heritage justification for the current bridge to be restored and to remain *in situ*. Restored, Windsor Bridge provides a charming and ideal access point for light and local traffic access to Windsor. Restoration of Windsor Bridge would make a genuine and positive contribution to local economic conditions.

The Heritage Council of NSW noted that, in 2009 when an initial series of options were developed and exhibited, the Heritage Council identified refurbishment of the existing bridge as its preferred option. The next preferences of the Heritage Council were for a bypass (options 6 and 8). The Heritage Council also noted that additional studies undertaken since 2009 show that it may be feasible to rehabilitate and retain the existing bridge for another 20 years, subject to the completion of works to address strengthening and repair areas of deterioration.

Response

Options to rehabilitate the existing bridge were considered by RMS when condition assessments identified extensive deterioration issues. Bridge rehabilitation was further considered during the options assessment process in 2009 but was not favoured due to capital and on-going maintenance costs, and need to close the bridge during the rehabilitation works.

Since that time, two ex-RMS bridge engineers have submitted a detailed alternative option for refurbishment of the existing Windsor Bridge. This alternative refurbishment option is described in detail in **Chapter 4**. This option received considerable media coverage and was identified in a considerable number of submissions as a preferred alternative to the project. The alternative refurbishment option was costed by a highly qualified and experienced bridge consultant at below \$3 million, which is substantially less than the RMS refurbishment option (which was estimated by RMS to cost about \$18 million). Additionally, the alternative refurbishment option would require only minimal closures of the bridge during construction.

Much of the difference in costs between the alternative refurbishment option and the RMS refurbishment option can be explained by the differences in design standards that the refurbishment options would achieve. The alternative refurbishment option (as proposed by the ex-RMS bridge engineers) was proposed to provide a bridge suitable for light vehicles (up to 16 tonnes), whereas the RMS refurbishment option would provide a bridge suitable for all vehicles, including current heavy vehicles.

Additionally, the cost estimate for the RMS refurbishment option was the total cost to refurbish the bridge, including the costs of design, project management, environmental investigations, planning approvals, testing and construction monitoring, access and temporary works, contingencies and other incidentals. The costing of the alternative bridge refurbishment option did not include costs for these additional activities, which are required to ensure that the NSW Government is delivering a high quality, durable asset that complies with technical and

environmental requirements. For a complex, one-off project such as the refurbishment of Windsor Bridge, the contingency costs would be high.

An independent estimate of the alternative refurbishment option has since been undertaken by a third party. This costing has been based on the methodology and design standards of the alternative refurbishment option proposed by the ex-RMS bridge engineers (that is, to refurbish the bridge to a level that is suitable for light vehicles only) but uses current industry rates and the same parameters for contingencies and incidentals required by the RMS Estimating Manual. It also includes additional scope that was recommended in an independent appraisal of the ex-RMS bridge engineer's methodology. The results of this independent, more detailed costing indicated that the alternative bridge refurbishment methodology would cost around \$13 million, as opposed to the original estimate of less than \$3 million. Full details of the independent cost estimates are presented in **Chapter 4**.

The methodology of the alternative refurbishment option was independently reviewed to determine whether it was technically feasible and would achieve the desired outcomes. This independent review is discussed in **Chapter 4**. In summary, the results of the review indicate that, while it may be feasible to refurbish the existing bridge for 20 years using the ex-RMS bridge engineers' methodology, the refurbishment would not address the structural issues that contribute to the deterioration of the bridge and would require considerable additional works. It would also require significant ongoing maintenance that make it impracticable from a cost benefit aspect. As an outcome of the review, a revised alternative bridge refurbishment methodology that would satisfy RMS objectives was identified. The estimated cost of the revised alternative bridge refurbishment methodology was estimated at \$15.5 million.

The existing bridge requires extensive rehabilitation work if it is to be used and maintained into the future. In addition to deteriorating with age, the existing bridge does not meet current engineering and road safety standards and the intersections on the approach roads cause traffic delays and have a number of safety issues, such as lack of safe crossing locations for pedestrians and poor sight distances for vehicles. A further limitation of the existing bridge is that it is below the 1-in-2 year flood level while the approach roads have a higher level of flood immunity. The remaining safe life of the bridge cannot be accurately predicted due to ongoing deterioration, heavy use and risk of flooding. RMS has identified that the most effective solution to address these deficiencies is to replace the existing bridge with minimal changes to the bridge location and alignment of approach roads. It is not cost effective to provide both a replacement bridge and retain the existing bridge.

Comments received from agency and community stakeholders have been considered in the selection and refinement of the proposed preferred option. The preferred option addresses the project objectives and provides greater value for money than other options considered. However, compared to other options considered, it does not perform as well in relation to minimising impact on heritage and character. While other options have lower heritage impacts, the costs and other potential impacts of these alternative options are considered to exceed their benefits.

2.4.6 Construction of a tunnel

Submission number(s)

19.

Issue description

One submission contended that a tunnel should be considered instead of the proposed replacement bridge.

Response

A tunnel option was considered in Section 4.2.2 of the EIS, having been raised as a possible option by members of the community. This option was not favoured because it would:

- Require extensive widening of Bridge Street.
- Necessitate the acquisition and demolition of most properties on Bridge Street between Macquarie Street and the George Street.
- Not improve traffic efficiency and would result in substantial traffic impacts as a result of changes in the operation of Macquarie Street intersection.
- Require extensive road closures in the area during construction, including the Windsor Bridge over the Hawkesbury River for around two years. This would impact local and regional traffic, placing additional traffic loads on the North Richmond crossing of the Hawkesbury River.
- Not meet heritage, flood and cost objectives.
- Impact numerous heritage items along Bridge Street, as well as subsurface archaeology.

2.4.7 Upgrading intersections only

Submission number(s)

27, 69, 92 and 93.

Issue description

Four submissions raised the issue that most of the traffic flow benefits to be gained from the project could be achieved through intersection upgrades alone. In summary, the respondents raised the following issues:

- Intersection improvements alone would improve traffic safety and reduce accidents at a substantially lower cost.
- The traffic flow improvements generated by the project will be marginal and will be a result of replacing the George Street roundabout with traffic lights and installing a roundabout at Freemans Reach Road. Both these changes could be implemented without replacing the bridge.

Response

While most of the predicted improvements in traffic performance would result from upgrades to the Wilberforce Road/ Freemans Reach Road and the George Street/ Bridge Street intersections, it is the horizontal and vertical alignment of the proposed new bridge that enables these intersection improvements to be made.

Once traffic numbers increase, the provision of two southbound lanes across the bridge would provide additional traffic capacity in the morning peak and facilitate the safe and efficient operation of the roundabout at the Wilberforce Road/ Freemans Reach Road intersection. A wider bridge would also reduce the risk of traffic accidents and reduce the risk of total road blockage or closure associated with traffic accidents and breakdowns. The increased capacity of the new bridge would, however, only contribute a relatively minor proportion of the total improvement in traffic performance associated with the project.

Without the construction of the new bridge, however, the options to upgrade the northern and southern intersections would be limited. The realignment of the river crossing allows the proposed intersection types at either end of the project to be constructed and facilitates their efficient operation, as there would be a straight road between the Freemans Reach Road/ Wilberforce Road intersection and the George Street/ Bridge Street intersection. By contrast, the existing bridge approach roads are curved and steeper, and the existing bridge is much lower relative to the intersections. This is explained further in the following paragraphs.

For the Freemans Reach Road/ Wilberforce Road intersection, recent road design investigations have shown that construction of a roundabout with the existing road alignments would be exceptionally complex because of the short distance and differences in levels between the existing bridge and the intersection. While traffic lights could be installed, they would not provide the same level of service as a roundabout for all traffic movements and they would be subject to regular inundation by floodwaters (which would increase their cost and ongoing maintenance requirements).

At the George Street/ Bridge Street intersection, it would be exceptionally complex and potentially not possible to install traffic lights if the project was not constructed because the required safe sight line distances for traffic lights could not be achieved with the vertical curvature through the intersection to meet the existing bridge approach road. Furthermore, an additional traffic lane would be required to allow southbound vehicles to turn right into George Street west. This would require the acquisition of some of the upper parkland area of Thompson Square, resulting in some impacts on historic and Aboriginal archaeological resources and an overall reduction in open space within the square.

Additionally, if the project comprised only an upgrade of intersections, it would leave a bridge that does not meet current design standards and is structurally deteriorating due to age, and the ongoing effects of flooding.

2.4.8 Other alternatives

Submission number(s)

19, 24, 43, 59, 66, 70, 76, 84 and 95.

Issue description

Several submissions expressed a concern that the selected option was not the best option and that an alternative should be found. Others suggested that other alternatives had not been properly investigated. In summary, the respondents raised the following issues:

- The current proposal does not respond to the wishes of the local community who use the bridge up to six times a day.
- The current preferred option is not in the best interests of the community and a more sustainable solution should be found.
- The project will change the Windsor area too dramatically.
- The proposed preferred option has been selected because it is the cheapest.
- Viable alternatives have not been properly considered or investigated.
- There are other better options available that must be explored.
- Alternative options that incorporate retention and conservation of the existing bridge and protect the unique heritage of Thompson Square need to be identified.

Response

In comparison to other options considered, the preferred option for the project performs best in terms of value for money and would perform well in relation to most of the project objectives. The project would provide a new bridge, approach roads and intersections to current road design standards. It would also improve the flood immunity of the crossing to match that of the surrounding approach roads, and provide a safer crossing for vehicles, cyclists and pedestrians. The proposed intersection improvements and initial two lane bridge configuration would provide acceptable traffic performance immediately and into the future. The bridge has also been designed so that it can be subsequently reconfigured to a three lane bridge (with two southbound lanes and one northbound lane) to meet future traffic demands, as required.

A range of options were considered during the options selection process, including a number of options identified by the community. Additional assessment of the Rickabys Line option has also been undertaken since completion of the EIS (refer to Chapter 3). Consultation for the project began in July 2009 with input sought on ten options to rehabilitate or replace the existing bridge. Consultation continued on the preferred option to allow community issues to be considered in the design of the bridge, Thompson Square and surrounding project elements. RMS will continue to provide opportunities for the community to participate in the detailed design of Thompson Square. Issues raised in submissions about the consultation process are considered in **Section 2.13**.

The preferred option is the least expensive of the bridge replacement options available but it is not the cheapest in terms of the bridge type designs available. A range of bridge types were considered for the project. The incrementally launched bridge design has been selected for the project to minimise both construction impacts and the visual impacts on Thompson Square. In summary, an incrementally launched bridge design has the following advantages over other designs:

- A lower visual impact and ability to be architecturally enhanced.
- A relatively small number of piers, which minimises both flooding and visual impacts.
- The ability to be constructed and launched from the northern bank, which would minimise construction impacts on Thompson Square.

2.5 Issue – Bridge design

2.5.1 General objection to proposed bridge design

Submission number(s)

1, 8, 10, 13, 27, 47, 57, 64, 67 and 74.

Issue description

Many submissions expressed concerns relating to bridge design. The main issues raised related to:

- Bridge type and form.
- Bridge width and lane numbers, with a preference for more traffic lanes.
- The design speed limit for the bridge, with an implied preference for a higher speed limit.
- Clearance over The Terrace.

A general response to this issue is provided below. Further details of specific issues raised are provided in subsequent sections. Further details for issues relating to traffic and access are also provided in **Section 2.8**.

Response

The assessment of bridge type design options, and the selection of the preferred bridge design, followed the selection of the preferred option for the river crossing, being a replacement bridge 35 metres downstream of the existing bridge (option 1). The assessment of bridge design options took into account road design and safety standards, visual impacts on the landscape and heritage character of Windsor, direct environmental and heritage impacts associated with the scale of construction, and engineering and cost constraints. The selected bridge design option minimises the potential visual and construction impacts of the preferred option on the Thompson Square parkland, while still satisfying the project objectives for safety, traffic flow, flood immunity and community needs (including coach access to Windsor Wharf).

It is recognised that despite minimising visual impacts during the design process, the project will still have significant adverse impacts on the heritage character of Windsor. These remaining adverse impacts would be further mitigated and/or managed using the measures identified in this EIS and any additional measures identified in the conditions of approval. The measures identified in the EIS include urban design and landscape treatments to integrate the new bridge with the existing landscape.

2.5.2 Bridge type and form

Submission number(s)

1.

Issue description

One submission raised specific concerns about the bridge type and form. In summary, the respondent raised the following issue:

- To provide a better aesthetic design and a design more suited to flooding, the piers and superstructure of the replacement bridge should be modelled on the Colo River Bridge on Putty Road.

Response

The proposed design for the replacement bridge has been further developed since completion of the EIS. The EIS states that the new bridge would be an incrementally launched bridge, supported on piers with up to four columns. The preferred concept now comprises two columns for each pier, with the final design of the columns to be selected in consideration of aesthetics and flooding. A Double T superstructure has also been adopted rather than the double box girder design presented in the EIS. This is the same as the Colo River Bridge and is further discussed in **Chapter 5**. The depth of the bridge superstructure would also be marginally lower as a consequence of the Double T design. Further detailed flood modelling is currently being undertaken and will be used to inform further design refinements during the detailed design phase of the project. The proposed bridge design minimises the potential visual and construction impacts of the preferred option on the Thompson Square parkland, while still satisfying the project objectives for safety, traffic flow, flood immunity and community needs (including coach access to Windsor Wharf).

2.5.3 Bridge width and lane numbers

Submission number(s)

8, 10, 13, 47, 57, 64, 67, 74 and 95.

Issue description

Several submissions raised specific concerns about the proposed number of lanes for the replacement bridge. In summary, the respondents raised the following issues:

- The effect of new development on bridge lane requirements needs to be considered.
- A two lane bridge is not sufficient to cope with traffic volumes and will not result in any improvement in traffic flows.
- Replacing the existing two lane bridge with another two lane bridge will not resolve future traffic problems. A two lane bridge will not be sufficient to cope with future suburban development.
- The replacement bridge needs to have at least four lanes to allow for future traffic increases.
- The replacement bridge should have at least three lanes, with one fixed lane in each direction and a timed contra flow lane for southbound traffic in the morning and northbound traffic in the afternoon.
- The proposed third lane on the bridge should be installed immediately rather than some point in the future.
- Conversion of the bridge from two lanes to three lanes would result in road safety issues as the road shoulders would be removed.
- The bridge will be converted to four lanes in future.

Response

The assessment of bridge design options took into account road design and safety standards, visual impacts on the landscape and heritage character of Windsor, direct environmental and heritage impacts associated with the scale of construction, and engineering and cost constraints. The selected bridge design option minimises the potential visual and construction impacts of the preferred option on the Thompson Square parkland, while still satisfying the project objectives for safety, traffic flow, community needs (including coach access to Windsor Wharf), and flood immunity.

The project would open with an initial two lane bridge configuration which would provide acceptable traffic performance immediately and into the future. The bridge has also been designed so that it can be subsequently reconfigured to a three lane bridge (with two southbound lanes and one northbound lane) to meet future traffic demands, as required. The number of lanes provided on the new bridge at opening (ie either two or three lanes) would be decided closer to the opening date based on traffic numbers and road safety requirements, however traffic modelling undertaken as part of the EIS indicates this will not be required.

Traffic modelling has been undertaken to compare the performance of a four lane bridge and a three lane bridge with varying contra-flow arrangements (specifically two lanes southbound and one lane northbound in the morning peak and one lane southbound and two lanes northbound in the evening peak). The results of this modelling indicated that there was only a marginal improvement in travel times with two northbound lanes, even with the predicted traffic growth to 2026. This marginal improvement in travel times does not warrant the construction of a four lane bridge to provide an additional northbound lane. An extra lane on the bridge would also be undesirable due to additional land take within Thompson Square.

While the road shoulders would be reduced with the conversion of the bridge from two lanes to three lanes, if a breakdown or incident occurs on the bridge there would generally be still two lanes open to allow traffic to pass in each direction. This is a considerable improvement in comparison to the existing bridge.

It is noted that northbound traffic flow on the bridge would be controlled by the George Street/ Bridge Street intersection, which has only one through northbound lane. After crossing the new bridge and exiting the new roundabout on the northern bank, there would be no controlled intersections limiting traffic movements either on Freemans Reach Road or Wilberforce Road for a considerable distance so northbound traffic would be generally free flowing.

As discussed in the EIS, the Jacaranda Ponds development involves construction of up to 580 additional dwellings at Glossodia. It would be at least 10 years, however, before this development is completed. A 25 per cent growth in traffic movements (or an increase of 5000 movements per day) has been assumed for the 10 year planning period for the project. This is more than sufficient to cover the traffic generated by the Jacaranda Ponds development and other traffic generating development that may take place. This traffic growth estimate has been used in the latest network modelling, including an additional assessment of the Macquarie Street/ Bridge Street intersection. New information on the performance of the Macquarie Street/ Bridge Street intersection is presented in **Chapter 4**, together with further information on other traffic flow issues.

One submission raised the possibility that the bridge could be converted to four lanes in the future. While the new bridge would be theoretically wide enough to accommodate four lanes of traffic, as discussed previously there would be only a very marginal benefit in traffic performance with an extra northbound lane (which does not justify an additional lane). Additionally, taking up additional land in Thompson Square to provide a fourth lane on the southern approach road would not be acceptable.

2.5.4 Clearance over The Terrace

Submission number(s)

24, 27 and 93.

Issue description

Three submissions raised concerns that the height of the bridge clearance over The Terrace has not yet been confirmed and that this has implications for the information presented in the EIS. In particular, the respondents raised the following issues:

- If the bridge is raised a metre to allow coach access, the assessment presented in the EIS would be invalid.
- Raising the bridge height would increase the significance of impacts on sightlines between buildings in Thompson Square.
- Raising the bridge height would increase noise impacts.

A response to these issues is provided below. Note that other submissions, including the submission from Hawkesbury City Council, raised the contrasting issue that clearance under the bridge over The Terrace needs to be sufficient to allow large coaches to access the wharf. These submissions are addressed in **Section 2.8.14**.

Response

All project design changes since the completion of the EIS have been subject to further impact assessment, including (but not limited to) assessment of noise and visual impacts. The results of this assessment indicate that the changes in noise and visual impacts will not be significant and the overall conclusions made in the EIS regarding noise impacts, visual impacts, and impacts on historic views and vistas remain valid.

It is important to note here, however, that since completion of the EIS, a number of additional properties in Thompson Square have been identified as having residential uses. In undertaking the additional noise assessment for the proposed change in the bridge height to increase clearance over The Terrace, the impacts on these properties have therefore been re-assessed with reference to the appropriate residential noise criteria.

Details of the design changes, the additional impact assessment undertaken for the design changes, and the revised noise assessment results for the newly identified residential properties are presented in **Chapter 5** of this report.

2.6 Issue – Heritage

2.6.1 Adverse impacts on heritage

Submission number(s)

3, 6, 7, 9, 11, 16, 17, 19, 22, 24, 29, 30, 33-37, 40-42, 45, 47-49, 52, 54, 56-58, 60, 61, 64, 66-69, 71-73, 76-80, 84-88, 91, 93, 94 and 95.

Issue description

Many submissions raised the issue of adverse heritage impacts. The main heritage issues raised were as follows:

- General impacts on the heritage values and heritage character of Windsor.
- Impacts on Thompson Square.
- Impacts on the existing Windsor Bridge.
- Impacts on heritage buildings and structures.
- Impacts on archaeological records.
- Impacts on Aboriginal heritage.
- Impacts on maritime heritage.

A general response to this issue is provided below. Further details of specific issues raised, such as impacts on Thompson Square, are provided in subsequent sections.

Response

The EIS acknowledges that the project would have significant residual adverse impacts on historic heritage, as well as adverse impacts on Aboriginal heritage, and identifies measures to minimise, manage and/or mitigate these impacts to the extent possible. If the project is approved, it would be undertaken in accordance with these measures, as well as any additional measures identified in the conditions of approval. Measures that would be implemented to minimise heritage impacts include (but would not be limited to) the following:

- An archival record of the project footprint and the immediate vicinity would be made in accordance with Heritage Council guidelines for items of State significance, prior to, during and after completion of the construction and demolition works.
- The existing bridge would be dismantled in a manner that allows its construction methods and evolution to be appropriately documented as an archival record prior to, and during its demolition.
- A social record of Thompson Square and the building of the replacement bridge would be undertaken to capture community views on the change to the environment.
- Extensive salvage excavation would be undertaken to recover and record archaeological material within the project footprint prior to construction as detailed in **Appendix B**.
- Urban design and landscape treatments would be applied to Thompson Square and would be designed to be sympathetic with the heritage character of the township and in consultation with the community, Hawkesbury City Council, the Department of Planning and Infrastructure, and the Heritage Council of NSW.

The EIS also acknowledges that, despite minimising impacts on heritage as part of the design process, and implementing additional management measures during construction, the project would still have significant adverse impacts on heritage, including impacts on the form of Thompson Square, demolition of the existing Windsor Bridge, and impacts on historic views and vistas.

2.6.2 Impacts on Thompson Square

Submission number(s)

6, 7, 11, 16, 17, 19, 22, 24, 29, 30, 34, 35, 37, 41, 42, 45, 47-49, 52, 54, 56, 58, 61, 64, 66, 67, 69, 71, 72, 77-80, 84, 85, 87, 88, 91, 92, 93, 94, 95 and the NSW Heritage Council.

Issue description

Many community submissions specifically raised the issue of heritage impacts on Thompson Square. The main issues raised in the submissions included the following:

- Thompson Square is the oldest square in Australia and a place of national significance.
- The project would have significant long term and irrevocable adverse impacts on the heritage values of the Thompson Square precinct, including the form of the Thompson Square parkland, and historic views and vistas.
- The visual impact of a modern road through Thompson Square will have a significant adverse impact on the heritage character of the precinct.
- The arguments provided by RMS about the benefits of the project to Thompson Square treat Thompson Square as just a park rather than correctly treating it as a civic space defined by buildings on three sides and the natural boundary of the river bank.
- The proposed changes to Thompson Square parkland would not be in keeping with Governor Macquarie's vision.
- Consideration needs to be given to preserving the historical integrity of the square for future generations.

One community submission raised the following additional issue:

- Evidence was provided by RMS that Thompson Square is one of only two places in NSW (the other being The Rocks) where the form of the place demonstrates the “larrikin” and “anti-authoritarian” traits that many would consider to be a key factor in the development of our national character. The respondent contended that they were informed by RMS that the early residents of Green Hills were reluctant to comply with Governor Macquarie’s orders for a grid pattern to be imposed on the existing settlement and that evidence of this anti-authoritarian stance remains in the existing form of Thompson Square.

In addition to the community submissions, the Heritage Council of NSW raised the following additional issues:

- There has been inadequate recognition that the State Heritage Register listing for Thompson Square includes the open space and all of the buildings that surround it. Thus the entire setting of the square (including the relationship between the open space and the surrounding buildings, and the relationships between the buildings that surround the open space) is important to its heritage value.
- The placement of a new major road along the side of Thompson Square will sever the relationship between the buildings along Old Bridge Street and the square, and also between the buildings along Old Bridge Street and the buildings on the opposite side of the square.

Response

The selected bridge design and southern approach road alignment minimise the potential visual and construction impacts of the project on the Thompson Square parkland. Measures would also be implemented as part of the project to further minimise impacts on Thompson Square, as discussed in **Section 2.6.1** above.

The proposed location for the new bridge maintains the existing, historic linkage between the northern and southern sides of the Hawkesbury River at Windsor and the continuity of Thompson Square as a civic park and link to the river. The adverse impacts of the project on the heritage of Thompson Square would also be balanced to some degree by the removal of the existing 1934 road cutting and consolidating the remaining upper and lower sections of the Thompson Square parkland, which would increase the amount of continuous open space within Thompson Square. Access to the river foreshore from Thompson Square would also be improved, as would pedestrian and cycling access along the southern foreshore and across the river to Macquarie Park. The consolidation of the Thompson Square parkland, combined with improved pedestrian and cycle access, is expected to improve the amenity of the area for the community and visitors.

The State Heritage Register listing for the Square and what the listing incorporates is described in Section 7.1.2 of the EIS and the Historic Heritage Working Paper. The EIS and Working Paper also describe the importance of the relationships between the open space and the surrounding buildings and the impacts that the project would have on those relationships and the setting of the square in general. The EIS acknowledges that, despite minimising impacts on heritage as part of the design process and implementing additional management measures during construction, the project would still have significant adverse heritage impacts on Thompson Square, including impacts on its form and historic setting, the associated historic views and vistas, and historic archaeological records.

The EIS proposes an urban design and landscape concept for the square, which includes minor earthworks to improve the physical and visual connection from the park to the river. As discussed in the EIS, however, the final form of this area is subject further consultation and public comment, which could result in changes.

During development of the EIS, urban designers and architects identified a number of possible urban design and landscape opportunities for further consideration. These are discussed in Section 8.2 of Volume 3 of the EIS. Potential opportunities included the possibility of creating an amphitheatre with terracing and formalised seating. These opportunities are not currently proposed by RMS.

The EIS and Heritage Working Paper describe the process leading up to the State heritage listing of Thompson Square and articulate the heritage significance and values of the area and surrounding heritage items. The archaeological resource within Thompson Square was assessed to be of both State and local significance, with a potential for some aspects to be of National significance. It is noted, however, that Thompson Square is not currently listed on any national heritage registers. An emergency nomination for listing under the *Environment Protection and Biodiversity Conservation Act 1999* was not pursued by the Federal Minister. A standard nomination was received from a member of the public. It was not included in the Australian Heritage Committee's priority list for 2012-3, but is eligible for consideration in 2013-4. If not the nomination is not included in the 2013-14 priority list, the nomination will lapse.

2.6.3 Impacts on archaeological evidence

Submission number(s)

29, 33, 70, 80, 87, 91, 93, 95 and the Heritage Council of NSW.

Issue description

Several submissions raised the issue of archaeological impacts, including impacts on historic and Aboriginal archaeological evidence. In summary, the respondents raised the following issues:

- The project will have adverse impacts on State significant archaeological relics from the early settlement period.
- Significant archaeological evidence will be lost and/ or inadvertently destroyed as a result of the earthworks unless salvaged.
- Given the complexity of Thompson Square, there is a need to consider options for how extensive the archaeological investigation should be to maximise information recovery.
- RMS needs to state its commitments in undertaking the archaeological work to a best practice standard.

Response

The EIS acknowledges that the project would have adverse impacts on archaeological remains and archaeological evidence, both historic and Aboriginal, and identifies measures to avoid, manage and mitigate these impacts. If the project is approved, it would be undertaken in accordance with these measures, as well as any additional measures identified in the conditions of approval.

The measures identified for impacts on archaeology include salvaging archaeological information for both Aboriginal and historic heritage. These works would include extensive archaeological excavation and recording and protection of salvaged and *in situ* archaeological material.

For Aboriginal heritage, the salvage works would include two areas of open excavation: i) an area of about 100 square metres at the corner of George and Bridge Streets, extending along the length of the proposed approach road formation to The Terrace; and ii) an area of about 25-50 square metres between Bridge Street, Old Bridge Street and the wharf carpark. These areas have been identified as locations where there is a high probability of finding Aboriginal archaeological

material and as being of sufficient size to obtain the necessary archaeological coverage of the impacted area.

For terrestrial historic heritage, salvage works would cover all areas that would be disturbed by construction of the project. For maritime historical heritage, the salvage works would target the area of the old Windsor wharf, including the river banks and the water immediately around the old wharf, including underwater remains.

Since exhibition of the EIS, the project archaeologists have prepared an options paper that identifies potential archaeological excavation options. Three options were identified in the report, which is included in **Appendix F. Section 3.2** of this report provides an overview of the options identified and outlines RMS proposed strategy for archaeological excavations. The salvage excavation works would take place prior to the start of construction. The timing and cost of salvage excavation works has been accounted for in project planning and cost estimations.

2.6.4 Impacts on maritime heritage

Submission number(s)

29 and 87.

Issue description

Two submissions raised the issue that the project will have adverse impacts on maritime archaeology, including State significant archaeological remains associated with the former circa 1814 wharf.

Response

The EIS acknowledges that the project would have adverse impacts on maritime archaeology and identifies measures to avoid, manage and mitigate these impacts. If the project is approved, it would be undertaken in accordance with these measures, as well as any additional measures identified in the conditions of approval.

The measures identified for impacts on maritime archaeology include salvage excavation and recording and protection of salvaged archaeological material. The salvage works would target the area of the old Windsor wharf, including the river banks and the water immediately around the old wharf. Any archaeological material recovered from the salvage excavation works would be recorded and managed in accordance with heritage legislation and guidelines, and in accordance with the preliminary research methodology approved by the Department of Planning and Infrastructure and the Heritage Council of NSW.

It is likely that the actual impacts on the maritime archaeology would be considerably less than those predicted in the EIS. As discussed in Section 2.7.1, the requirements for scour protection on the southern bank may be considerably reduced or eliminated totally depending upon the results of further geotechnical investigation of the existing gabion scour protection. Also as discussed in Section 5.2, the southernmost bridge pier which directly impacts the maritime heritage site has been relocated further north by about four metres. While this does not eliminate impacts, it may reduce the area impacted, including the potential area requiring salvage.

2.6.5 Impacts on heritage buildings and properties

Submission number(s)

11, 16, 29, 39, 64, 91, 92, 93, 95 and the Heritage Council of NSW.

Issue description

A number of community submissions objecting to the project raised the issue of impacts on heritage buildings and properties. One additional submission, while expressing support for the project, commented on the need for impact mitigation measures to protect heritage buildings and properties. In summary, the respondents raised the following issues:

- The project will impact nearby heritage properties and all reasonable actions should be undertaken to mitigate the impacts.
- The dominance of the proposed replacement bridge will adversely affect the historical significance of the Georgian buildings surrounding Thompson Square.
- The project has the potential to cause vibration impacts on heritage structures by directing increasing volumes of through traffic and heavy vehicles through Windsor.
- Noise and vibration associated with the construction of the project will have adverse impacts on heritage buildings.

The Heritage Council of NSW raised the following additional issue:

- The EIS does not provide adequate information on the architectural treatments for noise mitigation to be applied to State listed heritage items.

Response

No heritage buildings would be demolished or otherwise directly impacted as a result of the project.

The results of the noise and vibration assessment undertaken as part of the EIS indicate that vibration generated by construction and operation of the project would not adversely affect the structure of heritage buildings or the comfort of building occupants. Monitoring would be undertaken during construction to verify the results of the vibration assessment and identify the need for any mitigation measures to prevent vibration impacts.

The EIS acknowledges that, despite minimising impacts on heritage as part of the design process, and implementing additional management measures during construction, the project would still have significant impacts on Thompson Square, including impacts on the form of the square and historic views and vistas both to and from the square.

During preparation of the EIS, specialist heritage advice was sought on appropriate noise mitigation treatments for 10 Bridge Street. The heritage advice is included in Appendix 8 of the Historic Heritage Working Paper appended to the EIS. Since that time, further investigations have been undertaken on a number of additional heritage properties that were incorrectly identified as commercial premises in the EIS. These properties are now recognised as residential properties and qualify for noise mitigation treatments. Follow-up advice on the appropriate noise mitigation treatments for these buildings has also been sought. This issue is discussed further in **Section 5.1.4** and **Section 5.3**.

2.6.6 Impacts on the existing Windsor Bridge

Submission number(s)

48, 72, 77, 86, 91, 93, 95 and the Heritage Council of NSW.

Issue description

The existing Windsor Bridge would be demolished as part of the project. A number of submissions specifically raised the issue of impacts on the existing bridge in their objection to the project. In summary, the respondents raised the following issues:

- The existing bridge is an integral part of the village of Windsor and should be preserved.
- Windsor Bridge has significant heritage value. In the event that the bridge is demolished, the mandatory archival recording of the State significant structure should be augmented by the preservation of at least one of the concrete beams for display and provision of appropriate signage.
- The current Windsor Bridge, in addition to its status as an item of State heritage significance, is an item of National historic and historical engineering significance.
- The demolition of the existing bridge is an assault on Australian engineering history and a heritage landscape icon, one that arguably contributes to the economic wellbeing of businesses in Windsor.

Response

The existing Windsor Bridge is listed on the Hawkesbury Local Environmental Plan 2012 as a local heritage item and on RMS' Section 170 Heritage and Conservation Register. While not listed on the State Heritage Register, the bridge has also been assessed as being of State significance.

The EIS acknowledges that, despite minimising impacts on heritage as part of the design process, and implementing additional management measures during construction, the project would still have significant adverse residual impacts, including demolition of Windsor Bridge. To mitigate the heritage impacts of bridge demolition, the 1874 bridge would be dismantled in a manner that allows its construction methods and evolution to be appropriately documented as an archival record. Additional heritage conservation measures, such as preservation of at least one of the concrete beams and/or cast iron piers for display and provision of interpretive signage, will be investigated during detailed design and implemented where possible.

2.6.7 Aboriginal heritage

Submission number(s)

29, 60, 69, 90, 95, Department of Primary Industries (DPI) Crown Lands division and OEH.

Issue description

Five community submissions specifically raised the issue of impacts on Aboriginal heritage in expressing their objection to the project. In summary, the respondents raised the following issues:

- The area is culturally sensitive in terms of its Aboriginal history.

- The project will have adverse impacts on heritage, including an Aboriginal site of high scientific value.
- The impacts on the Aboriginal archaeology of the Thompson Square area will be irreversible.

Two agency submissions also raised issues in relation to Aboriginal heritage as follows:

- OEH noted that, while, the test excavations undertaken for the EIS were adequate to establish the nature of the archaeological values of the area, the following mitigation measures be considered:
 - Identification and protection of another location (or locations) along the river that support similar significant Aboriginal archaeological and cultural material.
 - Comprehensive salvage of the site to enable 'conservation by record' as proposed in the EIS.
- The DPI Crown Lands division noted that early consultation should be undertaken with the local (Parramatta) Crown Lands office about the existence of Aboriginal Land Claims over the crown land proposed to be acquired.

Response

The Aboriginal heritage assessment undertaken for the EIS involved Aboriginal community consultation and a geoarchaeological and Aboriginal archaeological investigation. The assessment found that the project would impact six known Aboriginal archaeological sites. The assessment also determined, however, that the total impact on Aboriginal archaeology would be minor given that:

- Five of the sites that would be impacted are of low heritage significance.
- The remaining site has high scientific value but is not suitable for conservation due to the existing high level of disturbance within the project footprint.
- A portion of this site would be investigated and subject to salvage excavation works for the recovery of archaeological material prior to construction.

In terms of the integrity of the Aboriginal archaeological resources of the area, the project has been assessed as having a minor impact. Based on discussions with Aboriginal stakeholders, it is clear that the Windsor area has some Aboriginal cultural value because it demonstrates a connection to the (possible distant) past for contemporary Aboriginal people. There are, however, no particular places or items potentially impacted by the project that have high or special cultural significance.

Measures to mitigate impacts on Aboriginal heritage would be implemented as part of the project. These measures include salvage excavation works and recording and protection of salvaged archaeological material at identified archaeological sites prior to construction of the project. Removal of archaeological material from the excavation area would be carried out by hand and machinery until sufficient material has been recovered and recorded. The archaeological material recovered from the salvage excavation works would be used to provide information on Aboriginal culture and heritage within Windsor and the wider region, and guide the future identification, interpretation and management of more intact archaeological deposits that are likely to exist along the Windsor ridge.

It is noted that the additional impact mitigation measure raised by OEH, namely the identification and protection of another location (or locations) along the river that support similar significant Aboriginal archaeological and cultural material, is not practical to implement. It is also noted that the implementation of impact off-setting measures for Aboriginal heritage is not standard practice for infrastructure projects.

The two Crown land lots to be acquired for the project are currently subject to land claims under NSW legislation by the Deerubbin Aboriginal Land Council. These land claims are currently being considered by the Crowns Land office and RMS will continue to consult with the DPI.

2.6.8 Heritage approvals

Submission number(s)

68, 80, 84, 90, 92, 93, 95 and the Heritage Council of NSW.

Issue description

A number of submissions raised concern regarding approval of the project despite significant heritage impacts. In summary, the respondents raised the following issues:

- The Heritage Working Paper of the EIS states that, from a heritage conservation perspective, the most appropriate treatment of Thompson Square and Windsor Bridge is to avoid any further negative impact and take the opportunity identified by the Heritage Council to remove through traffic. The conclusions of the EIS therefore contradict the conclusions of the component Heritage Working Paper.
- The current proposal would not be supported by any responsible heritage consultant, although this factor does not appear to have been part of the decision making process.
- The project is not supported by the Heritage Council of NSW.
- The project has been classified as State Significant Infrastructure (SSI), which means it is exempt from heritage considerations.
- Thompson Square is listed on the State Heritage Register and has potential National significance.
- The EIS confirms that the project area is unique in its historical heritage significance and that the archaeological resource that underlies Thompson Square is potentially of National significance.
- The EIS should not be used as the basis for the NSW Government to over-rule its own Heritage Council advice.
- The National Trust of Australia (NSW) Hawkesbury Branch opposes the current preferred option on the grounds of heritage impact.
- The project should be rejected on the grounds of heritage impacts.

In addition to the community submissions, the Heritage Council of NSW raised the following issues:

- The Heritage Council is opposed to the project on the grounds of the “irrevocable damage” it will do to Windsor and Thompson Square.

- The Heritage Council recommends that the project should be refused on the grounds of heritage impacts.
- Heritage and archaeological resources of State significance are situated within the project area and would be detrimentally affected if the project proceeds.
- It is a long standing Heritage Council position that items of State significance should be retained and conserved. This does not preclude adaptive reuse but it does preclude substantial demolition. The proposed extensive archaeological salvage program is not conservation as it would result in the complete removal of the archaeology from the area (albeit in a professional manner).

Response

Under the NSW approvals process, an EIS is required for the project as it is likely to significantly affect the environment. Consequently the project is classified as SSI under Part 5.1 of the EP&A Act.

While a number of approvals that generally apply under NSW legislation are not required for SSI, including approvals under the *Heritage Act 1997* (Heritage Act), the agencies that administer these approval processes are all actively consulted on the issues within their jurisdiction and form a critical component of the project assessment process. That is, the classification of the project as SSI, while making it exempt from the need for heritage approvals under the Heritage Act, does not exempt it from heritage considerations. To the contrary, heritage impacts have been considered in the EIS to the same degree as they would have been had the project not been classified as SSI.

Detailed heritage assessments have been undertaken by recognised industry specialists in their fields. The historic heritage and archaeological assessment was robust and transparent, and concluded that the project would result in significant adverse impacts on heritage. Comments received from agency and community stakeholders have also been considered in the selection and refinement of the proposed preferred option.

The potential heritage impacts of the project have been minimised in the selection of the design for the replacement bridge. The EIS also identifies additional measures to avoid, manage and mitigate heritage impacts during future stages of the project, including detailed design and construction. If the project is approved, the project would be undertaken in accordance with these measures, as well as any additional measures identified in the Minister's Conditions of Approval. The Heritage Council of NSW would also be involved in providing advice to the Department of Planning and Infrastructure on the Minister's Conditions of Approval.

The EIS acknowledges that, despite minimising impacts on heritage as part of the design process, and implementing additional management measures during detailed design and construction, the project would still have significant adverse residual impacts, including demolition of Windsor Bridge, impacts on the form of Thompson Square, impacts on historic views and vistas, and impacts on archaeological records. The Department of Planning and Infrastructure will carefully consider the conclusions of the EIS and Heritage Working Paper, the heritage significance and values of the area, and any comments made by the community and government agencies (including the Heritage Council) during assessment of the project. The Minister for Planning and Infrastructure will then consider the Department's assessment in deciding whether or not to approve the project, and any conditions that should apply.

The EIS and Heritage Working Paper describe the process leading up to the State heritage listing of Thompson Square and articulate the heritage significance and values of the area and the surrounding heritage items. The archaeological resource within Thompson Square was assessed to be of both State and local significance, with a potential for some aspects to be of National significance.

It is noted, however, that Thompson Square is not currently listed on any national heritage registers. An emergency nomination for listing under the *Environment Protection and Biodiversity Conservation Act 1999* was not pursued by the Federal Minister. A standard nomination was received from a member of the public. It was not included in the Australian Heritage Committee's priority list for 2012-3 but is eligible for consideration in 2013-4. If the nomination is not included in the 2013-14 priority list, the nomination will lapse.

2.6.9 Director General's requirements for heritage assessment

Submission number(s)

84 and Hawkesbury City Council.

Issue description

One community submission contended that the EIS fails to meet the Director General's requirements for heritage, in particular it fails to "outline the proposed mitigation and management measures (including measures to avoid significant impacts and an evaluation of the effectiveness of the mitigation measures) generally consistent with the guidelines in the NSW Heritage Manual (1996)". In relation to this issue, the respondent raised the following points:

- The NSW Heritage Manual states that the Heritage Council will not consider applications for extensive alterations to an item of major heritage Significance unless it has already approved a Conservation Management Plan.
- Alterations or new works that have a major negative impact on the heritage significance of such items are usually not approved.
- A Conservation Management Plan has not been prepared for either Thompson Square or the existing Windsor Bridge.
- The EIS fails to outline any impact mitigation measures to provide for the ongoing usability of Thompson Square as a civic space.
- The EIS fails to address the landscape design issues associated with the significant changes in the slope.

Hawkesbury City Council noted that:

- A Statement of Heritage Impact (SoHI) should be prepared for the project in accordance with heritage assessment guidelines.
- The final SoHI should consider archaeological findings during construction.
- The final interpretative elements and structures should reflect those findings.

Response

Having reviewed the EIS as submitted, and considered RMS' responses to various matters on which the Department of Planning and Infrastructure required further information, the Department placed the EIS on public exhibition on 14 November 2012. The Department also requested further archaeological investigations to be undertaken. A summary of these investigations appears in **Section 3.1** of this report. It is anticipated that the conditions of approval for the project, if approved, can include requirements for the preparation of conservation management plans or detailed specifications of work and statements of heritage impact to assist in identifying the significance of individual heritage items and the appropriateness of particular conservation strategies and methods. Further, the requirements for conservation management plans will include the need for the plans to be prepared and approved by the Department of Planning and Infrastructure before the start of construction.

The final impact mitigation measures for Thompson Square, including the urban design and landscape treatments to be applied, will be further developed and refined during the detailed design phase of the project, if approved, in accordance with any relevant conditions of approval issued by the Department of Planning and Infrastructure. Additional information relating to the final form of Thompson Square is provided in **Section 2.7.4**.

A Statement of Heritage Impact has been prepared for the project and is attached to the EIS as Working Paper 1. A final SoHI would be prepared once the archaeological investigations are completed and the final design of Thompson Square and parkland and associated elements of the project are agreed in consultation with Council, other relevant agency stakeholders and the community. This will include considering retention of any archaeological remains or additional interpretation prompted through archaeological investigations.

2.7 Issue – Urban design and landscape

2.7.1 Visual impacts

Submission number(s)

24, 48, 70, 72, 92, 93 and 95.

Issue description

Several respondents raised the issue of visual impacts. In summary, the respondents raised the following issues:

- The aesthetic impacts of the project will be substantial, with a 'brutalist' concrete structure being rammed into the gentle fabric of a heritage precinct.
- Putting a modern road through Thompson Square will have an adverse impact on the visual amenity of the area.
- The project will have adverse visual impacts on the area, as the approach road and bridge will be level with or higher than Thompson Square and the sight line between buildings will be adversely impacted.
- The Thompson Square parkland is an established, popular area for picnickers and other recreational users. Instead of enjoying the present vistas, which include mature trees and heritage buildings, visitors will now see the parkland either sitting directly adjacent to a high, wide road carrying large volumes of traffic and heavy vehicles or sitting directly under the shadow of large abutments and retaining walls.
- The new abutment and retaining walls in Thompson Square will become a haven for graffiti.
- The scour protection proposed would be visually intrusive and inappropriate.
- The installation of traffic lights in a historic square (Thompson Square) is not appropriate.
- Visual impacts on 17 Bridge Street are described as “none”. This is incorrect as the cottage has a clear sight of the roundabout and parts of the square where the road and traffic lights are to be installed.
- Visual impacts on 62-64 George Street and 66-68 George Street have been underestimated.

Response

The assessment of bridge design options and selection of the preferred bridge design followed the identification of the preferred option for the river crossing, being a replacement bridge 35 metres downstream of the existing Windsor Bridge (option 1). The assessment of bridge design options took into account road design and safety requirements, visual impacts, direct impacts associated with construction, and engineering and cost constraints.

A range of bridge types were considered. An incrementally launched bridge was selected as the preferred bridge option because of its:

- Lower visual impact and ability to be architecturally enhanced.
- Relatively small number of piers in comparison to some of the other options.

- Ability to be constructed and launched from the northern bank, which would minimise construction impacts on Thompson Square.

The selected bridge design option minimises the potential visual and construction impacts of the preferred option on the Thompson Square parkland, while still satisfying the project objectives for safety, traffic flow, flood immunity and community needs. A Community Focus Group was established to assist in identifying and aiding the project team to mitigate impacts of the preferred option.

The EIS acknowledges that the project would have adverse visual and landscape character impacts as the replacement bridge and road infrastructure would have a greater footprint and scale than the existing infrastructure. The project would also have a substantial impact on some views, particularly viewpoints within open space areas close to the Hawkesbury River and viewpoints within and looking towards Thompson Square. The bridge and southern approach road would be higher than the lower parkland area of the consolidated Thompson Square, however would not be higher than any of the buildings around Thompson Square.

The project would, however, also result in long term benefits to the community as a result of:

- Consolidation of the upper and lower parkland areas of Thompson Square, which would provide a larger area of usable open space for the community and visitors and reinforce the existing connection with George Street.
- Improvements in pedestrian and cycle pathways, which would link previously isolated foreshore and parkland areas and provide improved access from Windsor to Macquarie Park.

The potential problem of graffiti has been considered in the design of the new bridge and road infrastructure. It is proposed that the abutment walls, for example, would be textured with relief features (such as ridges) to disrupt the planar surface (so that they better blend into the environment) and make them less susceptible to graffiti.

The project includes an urban design and landscape strategy that is designed to minimise visual impacts on the town's heritage character. The final scope and form of urban design and landscape treatments will be further investigated and confirmed during the detailed design phase of the project (if approved) in accordance with all relevant conditions of approval. The investigation and confirmation of the urban design and landscape treatments would be undertaken via a formal consultation process involving both community and agency consultation and input.

The design of the scour protection has yet to be finalised – and as with other elements of the project one of the key objectives during the design phase would be to minimise its visual impact. This would be achieved through the minimising the extent of scour protection, the selection of appropriate scour material and possibly planting of vegetation within the scour protection. The extent of the scour protection presented in the EIS was based on conservative assumptions and it is likely that during the detailed design process its extent would be able to be reduced. Scour protection around the bridge piers would not be required and it is likely that scour protection on the southern bank would be able to be reduced substantially or eliminated totally.

However, detailed geotechnical investigations on the gabion walls on the southern bank would be required before the additional scour protection requirements on the southern bank can be determined. Undertaking these investigations are difficult because they would need to be largely completed from a boat and would need to minimise any impacts on maritime heritage areas. The extent of scour protection of the northern bank would be similar to that presented in the EIS as this bank has limited existing scour protection and is composed of highly erodible soils.

The use of traffic lights to control the George Street and Bridge Street intersection would be unavoidable as other forms of intersection control would either not achieve traffic performance objectives (eg give way signs) or impact additional land in Thompson Square (eg a larger roundabout).

2.7.2 Tree removal

Submission number(s)

70, 95 and Hawkesbury City Council.

Issue description

Two community respondents specifically raised the issue of tree removal in Thompson Square. In summary, the respondents raised the following issues:

- The project will result in removal of the majority of the existing trees in the lower parkland area of Thompson Square.
- Even if new trees are planted, they will never reach the size of the current ones in the lifetime of existing residents and community members.

Hawkesbury City Council noted the following additional issues:

- The existing trees within and around Thompson Square have not been used to inform the proposed planting schedule or style of landscape approach, despite being culturally significant.
- Trees should be retained or relocated where possible. If the trees must be removed, the materials should be re-used for timber elements in the final design.
- To inform the species characteristics and overall layout of the final form of Thompson Square, further investigation is required to assess the significance and identify the history and progression of species culminating in the current collection of trees within Thompson Square.
- The landscape consultant should work with Council's landscape specialist and NSW Heritage Office's landscape specialist to determine the final planting design and species composition.

Response

Most of the trees to be removed from Thompson Square are located in the lower part of the parkland, while the majority of the mature trees in the upper part of the parkland would be retained and protected. Based on consultation with Council, RMS understands some of the trees to be removed from the lower parkland would need to be removed in the near future anyway, irrespective of the project, as they are nearing the end of their life and are at risk of falling because of shallow root systems (which have been established by self-seeding in the roadside batters).

Tree relocation would be considered for some younger trees in consultation with an arborist and would be implemented where it is feasible and there is a good chance of success.

New tree plantings would be provided in the lower part of the parkland after the cutting of Bridge Street has been filled in and re-graded. These new plantings would complement the new parkland design by improving visual character and allowing views to the river. Where feasible, semi-mature plantings would be provided in preference to seedlings.

While these new plantings may not reach the size of existing mature trees for 10 to 20 years, the landscape plan will include species similar to those existing in the parkland and would enhance the character while maximising views to the river.

The landscape plan will consider the contribution of trees throughout their growth life, their potential impact on remaining *in situ* archaeological evidence and contribution to reflecting the heritage of Thompson Square. RMS will continue to consult with Council, other stakeholders and the community on the design of Thompson Square, including the final planting design and species composition.

2.7.3 Landscape treatments

Submission number(s)

23, 39 and Hawkesbury City Council.

Issue description

Two community submissions, while expressing support for the project, noted the need for the integration of the works and landscape treatments to minimise impacts of the existing character of Windsor. In summary, the respondents raised the following issues

- The final design of the project should incorporate the following items:
 - Old fashioned looking lighting across bridge and in Thompson Square.
 - Stone gables or sandstone flagging for the bridge walls in the vicinity of Thompson Square.
 - Old fashioned looking fencing along the length of the bridge and around Thompson Square and old fashioned looking hand rails for steps.
 - Picnic tables, seating and recreation areas within Thompson Square.
- The project should include sympathetic finishes to Thompson Square (such as with the use of local sandstone) and existing sandstone gutters in Thompson Square, Bridge Street and George Street should be retained and/or enhanced.
- The bridge approach at the corner of George Street and Bridge Street should be integrated and improved with a town sign and eating area.

Hawkesbury City Council also noted the need for further details on landscape design and treatments as follows:

- The EIS should be providing sustainability principles for re-use of existing materials. For example timber removed from the site should be re-used in the site either in an interpretative way or in street furniture.
- There is insufficient information on urban design and final landscape materials for a number of areas affected by the project.

- The overall design strategy does not appear to encompass Indigenous design, interpretative elements and materials. These should be integral to the design concepts.
- The overall interpretation strategy (including flooding interpretation elements) needs to be developed in a way that reflects Council's adopted 'Interpretative Signage and Public Art Policy'.
- The retaining walls and abutment walls should be compatible with the colour and material of the existing elements of Thompson Square. The generic treatment of bridge elements on the southern bank is not considered appropriate. From the point at which the bridge lands on the southern bank, the materials of the bridge should be compatible with the elements of Thompson Square.
- Lighting, street furniture and other fixtures in Thompson Square and on the bridge elements on the southern bank need to be developed with a suitable architectural style in consultation with Council.
- The pedestrian pavement materials for the project should reflect the materials palette for Thompson Square. This should be identified in consultation with Council and the review of the draft Windsor Master Plan.
- The texture of the road pavement should be differentiated to indicate an arrival point into Windsor and the pedestrian environment.
- All services required for Thompson Square (such as power and water) should be considered and integrated into the design.
- The final road patterns should be agreed upon with Council and the Heritage Council of NSW. The road pattern in front of the Macquarie Arms Hotel should maintain its alignments for historical reasons.
- Council has an adopted Plan of Management for land around Windsor Bridge. The project should respond positively to the Plan of Management.

Response

The project incorporates an urban design and landscape strategy that is designed to integrate the project with the existing landscape and minimise adverse visual impacts on the town's heritage character. This recognises the contribution of the existing palette of materials and finishes, as well as the mix of original, recreated and new additions to the landscape.

Proposed new elements of the project such as lighting and other road and parkland furniture would be refined to integrate with the design and character of the bridge, approach roads and public domain. These integrated design elements would minimise potential visual impacts, as well as impacts on heritage views.

It is also noted that the urban design and landscape treatments presented in the EIS represent a concept stage design. The final scope and form of urban design and landscape treatments will be further investigated and confirmed during the detailed design phase of the project, if approved, in accordance with all relevant conditions of approval. Suggestions made in submissions will be considered as part of that process and further opportunities for community involvement will be identified, should the project proceed. The Council's Plan of Management would be considered in developing the final urban design and landscape plan for the project.

The George Street and Bridge Street intersection will be upgraded to improve traffic flow and pedestrian safety. The key change to this intersection will be the

replacement of the existing roundabout with traffic lights. Urban design and landscape treatments will also be applied to integrate the new intersection with the existing environment.

No changes to Thompson Square Road outside the Macquarie Arms are proposed.

RMS will continue to consult with Council, other stakeholders and the community on the final design of Thompson Square, including the final planting design, materials and finishes, and street and park furniture.

2.7.4 Final form of Thompson Square

Submission number(s)

23, 24, 84, 85, 91, 93, 95 and Hawkesbury City Council and the Heritage Council of NSW.

Issue description

A number of community submissions raised issues relating to the final form of Thompson Square. In summary, the respondents raised the following issues:

- The EIS does not contain sufficient information on the final appearance and layout of Thompson Square.
- The EIS fails to outline any impact mitigation measures to provide for the ongoing usability of Thompson Square as a civic space.
- The EIS fails to address the landscape design issues associated with the significant changes in the slope.
- Additional consultation is required to determine the final appearance and layout of Thompson Square.
- Urban design principles for Thompson Square should be based upon heritage principles rather than recreational principles.
- The look and feel of Thompson Square will be greatly damaged. It will not look like a square anymore – it will be stripped of most of its heritage characteristics and look like a pleasant urban park, just like thousands of urban parks in Sydney.

The Heritage Council of NSW noted that there is no final plan yet for the future consolidation and reinvigoration of Thompson Square and that the outcome for the square is therefore uncertain.

In expressing support for the project, Hawkesbury City Council noted the following:

- The EIS and design concept should explore a range of options to ameliorate negative impacts on Thompson Square.
- The redesigned Thompson Square should be capable of meeting the needs for an event space.
- A nomination request for State Heritage Listing of the conceptual five Macquarie town plans is currently being considered by the Heritage Branch.

Response

A number of submissions noted the current lack of detailed information on the final urban design and landscape features of the project, especially in relation to the Thompson Square parkland. While the EIS contained preliminary concept designs of Thompson Square parkland and conservation area, it was recognised in the EIS that further consultation and preparation of more detailed designs would be required.

The final urban design and landscaping of the Thompson Square parkland and associated areas would need to cater for the current and potential future uses of the area. Current uses include:

- Passive recreation – such as picnicking, sitting and resting.
- Accessing the river bank and the Windsor Wharf.
- Hosting community and tourist events – such as concerts associated with the Annual Blues and Roots Festival.
- Heritage appreciation – There are a number of heritage walks and tours which include Thompson Square and surrounding buildings. The Hawkesbury Regional Museum is also adjacent to Thompson Square.
- Retail, food and services premises – There are a number of premises retailing food, alcohol, services and other products.
- Residential premises – There are a number of residential premises surrounding Thompson Square parkland.

The submissions suggest that there may be different objectives for the design principles that would guide the final design of Thompson Square parkland. The Heritage Council, for example, have indicated that their preference is for the Thompson Square parkland to be a relatively informal space that reflects the history of previous landforms and uses of the area. Hawkesbury City Council, by contrast, has a preference for a more formal space that can cater for community events such as concerts and the annual sand sculpting festival.

While it may be possible to find common ground between the various preferences for the final form of Thompson Square parkland, the selection of the final design needs to be undertaken via a formal consultation and design process following approval of the project (if approved). This consultation process would also include consideration of potential events in the parkland. As noted above, RMS has made a commitment in the EIS to undertake this consultation.

2.7.5 Anti-social activities

Submission number(s)

95.

Issue description

One submission suggested that the design and location of the new bridge would provide an ideal location for anti-social activities.

Response

During the detailed design of the bridge and other adjacent areas, the likelihood and type of anti-social activities would be considered and appropriate mitigation measures included. These would include anti-graffiti coatings on large concrete surfaces and provision of appropriate lighting.

The introduction of this lighting, in addition to general lighting on the new bridge and shared use pathway, would in itself introduce new impacts due to light spill. These new light sources would be designed to strike a balance between illumination for safety and the context of the parkland and its adjoining areas – including minimising potential impacts on adjoining residents and within the parkland. While ensuring that the relevant design standard for roadway lighting (AS:1158) is met as a minimum RMS is also proposing specialist light diffusers such as “aeroscreen” which reduce glare.

2.8 Issue – Traffic and access

2.8.1 Through traffic and heavy vehicles

Submission number(s)

11, 41, 42, 49, 52, 56, 61, 63, 66, 72, 74, 82, 87, 92, 93 and 95.

Issue description

Many submissions raised concerns about increased volumes of heavy vehicles and through traffic passing through Windsor as a result of the project. In summary, respondents raised the following issues:

- The project will direct large volumes of traffic through Windsor and Thompson Square.
- Traffic data show that 70 per cent of vehicles using the bridge comprise 'through' traffic.
- The project will result in an increase in through traffic and heavy vehicles passing through Windsor and Thompson Square.
- The preferred option will promote and 'cement' the existing undesirable situation of having through traffic and heavy vehicles passing through the historic precinct of a small, quiet township that is valued for tourism and recreation.
- There is a need to consider what the traffic volumes through Thompson Square will be like in 20 or 50 years' time.
- The fundamental objective of the proposal appears to be to facilitate the movement of large volumes of traffic through Windsor. Given that plans to increase housing development around Windsor will result in increased traffic volumes, it is totally inappropriate for such traffic to be directed through the centre of such an important heritage area.

Response

The primary aim of the project is to maintain a safe and reliable crossing of the Hawkesbury River at Windsor. Traffic volumes using the crossing of the Hawkesbury at Windsor will increase over time as a result of population growth and regional development to the north. This increase in traffic volumes will occur regardless of the project.

Heavy vehicles contribute about eight per cent of all vehicle movements through Windsor, which is a relatively low proportion compared to other arterial roads. The project would not increase the volume of through traffic or heavy vehicles using the crossing to travel to and from the Hunter region as the length of road comprising the project is less than 0.5 per cent of the total distance between Singleton and Windsor. While the project may reduce travel times through Windsor during peak periods, this time saving would be insignificant in terms of the total time taken to travel between Singleton and Windsor. The project would therefore be very unlikely to generate additional heavy vehicle or through traffic movements. A substantial proportion of heavy vehicle traffic is likely to be generated locally.

The traffic modelling for the project assumed a 25 per cent increase in traffic movements (or an increase of 5000 movements per day) over the 10 year project planning period. The adopted 10 year timeframe for estimating traffic growth is standard practice for traffic impact assessment studies. There are too many variables to accurately estimate traffic growth over greater time periods. A bypass of Windsor may be considered in the future if growth in traffic warrants an alternative route.

2.8.2 Growth in traffic volumes

Submission number(s)

16, 62, 66, 70, 72, 92, 93, 95 and the Heritage Council of NSW.

Issue description

A number of submissions raised the issue of traffic growth and the impact of this growth on the project. In summary, the respondents raised the following issues:

- Project does not take account of the future Jacaranda Ponds development. This development would result in an increase of at least 1160 vehicle movements per day over the bridge (based on a single return trip from each dwelling per day). The traffic modelling does not seem to have included the impact of this traffic increase on the Macquarie Street/ Bridge Street intersection.
- Project does not take account of future development at Grose Vale Road, North Richmond.
- The project takes very little account of future traffic increases and needs.
- The proposed replacement bridge is inadequate even for existing traffic, let alone future traffic that will be generated by new development.
- The project is a short-term fix that does not address longer term traffic problems.
- The proposed replacement bridge does not have sufficient capacity to cope with future traffic increases. Ninety per cent of the traffic on the Bridge Street approach to the existing bridge is through traffic.

The Heritage Council of NSW noted the following:

- With the updated and wider bridge and its associated major heritage impacts, traffic congestion in Windsor is likely to remain. Once built, the new bridge is only likely to alleviate traffic flow problems for 10-15 years. A separate new Hawkesbury River crossing will still be needed in the future. Refusal of the current proposal and retention of the existing bridge would allow for a more comprehensive investigation of other options.

Response

As discussed in Section 3.1 of the EIS, the Jacaranda Ponds development involves construction of up to 580 additional dwellings at Glossodia. It would be at least 10 years, however, before this development is completed as:

- It has yet to receive full planning approval.
- Services for the new dwellings - such as roads, wastewater, stormwater, drinking water and power - would need to be designed, approved and constructed before the dwellings are occupied.
- Land releases would be staged based upon demand.

As discussed in **Section 2.8.1** above, the traffic modelling for the project assumed a 25 per cent increase in traffic movements (or an increase of 5000 movements per day) over the 10 year project planning period. This would easily cover the Jacaranda Ponds development and other traffic generating development. This traffic growth estimate has been used in the latest network modelling, including an additional assessment of the intersection. New information on the performance of the Macquarie Street/ Bridge Street intersection is presented in **Section 2.8.5**.

It is noted that the primary aim of the project is to maintain a safe and reliable crossing of the Hawkesbury River at Windsor. An additional specific project objective is to improve traffic and transport efficiency. In comparison to other options available, the project offers the most cost effective solution for maintaining a safe and reliable crossing, as well as providing some improvement to traffic and transport efficiency.

The project would provide a new bridge, approach roads and intersections to current road design standards. The project design would improve the level of flood immunity to match that of the surrounding approach roads, and provide a safer crossing for vehicles, cyclists and pedestrians. The proposed intersection improvements and an initial two lane bridge configuration would provide acceptable traffic performance immediately and into the future. The proposed new traffic lights at the George/Bridge Street intersection will be synchronised with the existing lights at the Macquarie Street/Bridge Street intersection to give priority to through traffic on Bridge Street during peak periods. This will contrast with the current situation where vehicles from George Street have equal priority at the roundabout. The bridge has also been designed so that it can be subsequently reconfigured to a three lane bridge (with two southbound lanes and one northbound lane) to meet future traffic demands, as required.

It is recognised that the project is not a long term solution to traffic congestion in Windsor. An alternative route around Windsor may be considered in the future depending on growth in traffic numbers and local congestion.

2.8.3 Right turn from Bridge Street north into George Street west

Submission number(s)

70, 24 and 95.

Issue description

Three submissions raised the issue of changes in access from Bridge Street north to George Street west for southbound traffic in the evening peak. In summary, the respondents raised the following concerns:

- The EIS states that the right turn from Bridge Street north into George Street west may be banned in the evening peak at some stage in the future when traffic numbers have increased. Once this occurs, southbound traffic on Bridge Street north would need to use Macquarie Street and Kable Street to access the town centre.
- This will place further stress on the Macquarie Street intersection. It will also prevent drivers from making a right hand turn into George Street. Southbound drivers currently access Windsor town centre without traffic lights. With the proposed project in place, they would have to go through three sets of lights. This may have impacts on George Street hospitality businesses.

Response

A right turn movement for southbound traffic on Bridge Street north to George Street west would initially be permitted, with a shared turning lane provided. This would allow southbound traffic to directly access the Windsor town centre via George Street. Banning of this right turn movement during the evening peak may, however, be considered if the Level of Service of the intersection becomes poor as a result of traffic growth. The number of southbound vehicles undertaking this movement during the evening peak is currently relatively low. Before the right hand turn movement is banned in the evening peak in the future, additional traffic monitoring and community consultation would be undertaken to confirm the level of impact and the need for impact mitigation.

2.8.4 Right turn from Bridge Street into Court Street

Submission number(s)

70 and 95.

Issue description

Two submissions raised concerns about the provision of a dedicated right turn bay for northbound traffic on Bridge Street turning right into Court Street. The respondents contend that the inclusion of this right hand turn lane would cause the loss of a lane on Bridge Street, safety risks and result in traffic delays, especially in the evening peak. One respondent also raised the issue that diagrams of the proposed intersection arrangement are not included in the EIS.

One respondent also raised the issue that this would further encourage the current “rat run” through east Windsor.

Response

The final design and layout of the Court Street/ Bridge Street intersection has yet to be determined. As such, layouts of the intersection were not presented in the EIS. Further assessment is required to determine whether a dedicated right turn bay would be required as the number of vehicles undertaking this movement is very low, even in the evening peak. The low number of vehicles making this turning movement may not justify a dedicated right turn bay and would be unlikely to cause substantial delays to northbound traffic on Bridge Street.

The use of Court Street and other streets in east Windsor by vehicles wanting to avoid congestion along Bridge Street would be reduced rather than increased with the project. While vehicles would still be able to turn right from George Street east to cross the bridge, they would no longer have priority over northbound traffic along Bridge Street as the roundabout would be replaced by traffic lights. The traffic lights would give priority to northbound traffic along Bridge Street and therefore any benefits from using streets in east Windsor streets to turn right from George Street east would be eliminated or greatly reduced.

2.8.5 Performance of the Macquarie Street intersection

Submission number(s)

70, 90, 92, 93 and 94.

Issue description

Three submissions raised the issue of the performance of the Macquarie Street intersection and its contribution to traffic congestion in Windsor. In summary, the respondents raised the following issues:

- The project does very little to address the Bridge Street/ Macquarie Street intersection, which causes most of the traffic problems in Windsor.
- The project relocates a problem from one intersection (George Street/ Bridge Street), to a second, busier and more important intersection (Macquarie Street and Bridge Street). The EIS completely disregards the impact of the Macquarie Street/ Bridge Street intersection on its modelling and does not consider the need for signal co-ordination between the Macquarie Street/ Bridge Street intersection and the George Street/ Bridge Street intersection.
- While the EIS provides Level of Service (LoS) information for existing conditions at the Bridge Street/ Macquarie Street intersection (which indicates that it is currently operating at maximum capacity), it does not provide equivalent LoS information for future (post project construction) conditions. It is questioned if this information has been omitted from the EIS because the LoS at this intersection will decline to unacceptable levels despite construction of the proposed project.
- The EIS notes that the existing Freemans Reach Road/ Wilberforce Road intersection has an unacceptable LoS in the morning peak but fails to state that this is often the result of traffic at the Macquarie Street intersection banking up across the bridge.
- The evening peak queue lengths at the Macquarie Street/ Bridge Street intersection for existing conditions (as presented in the appendix of the Traffic and Transport Working Paper) do not represent the actual lengths of traffic queues experienced.

Response

The LoS for major turning movements at the Bridge Street/ Macquarie Street intersection with the project in 2016 and 2026 is provided later in this report in **Table 4-1**. The EIS modelling supersedes the traffic modelling undertaken for the preliminary options report.

In 2016, the LoS for all turning movements at the Bridge Street/ Macquarie Street intersection in both peak periods would be good to fair with the project in place. There is likely to be an improvement over existing conditions as the traffic lights at the George Street/ Bridge Street intersection and the Macquarie Street/ Bridge Street intersection would be synchronised to provide priority to the peak movements depending upon the time of the day. The LoS in the 2026 morning peak would be also acceptable and the traffic queues that currently extend across the bridge to the intersection of Freemans Reach Road and Wilberforce Road would largely be eliminated. In the evening peak, however, the performance of the intersection would be poor, with an overall LoS of E for 2026, indicating the intersection would be operating at capacity. The project has never claimed to solve all traffic problems in this area, although some improvement (especially in the morning peak) would occur.

The queue lengths presented in Appendix A of the Traffic and Transport Working Paper for existing conditions in the evening peak at the Macquarie Street/ Bridge Street intersection were a by-product of the outputs of the SIDRA modelling. SIDRA modelling considers the performance of a single intersection and does not consider the interactions between different intersections. Consequently, queue lengths from VISSM network modelling were quoted and used in the main bodies of the EIS and Traffic and Transport working papers as VISSM modelling is more accurate for this purpose. The SIDRA modelling was used to compare the relative performance of different intersection options.

Also it is noted that there were some minor inconsistencies between Tables 7-17 and 7-18 in the main EIS document and Tables 5-3 and 5-4 in the Traffic and transport working paper. The tables in the working paper were correct. The minor inconsistencies do not change the outcomes of the impact assessment.

2.8.6 Performance of the Freemans Reach Road/ Wilberforce Road intersection

Submission number(s)

13, 53, 85 and 95.

Issue description

Four submissions raised the issue of the performance of the Freemans Reach Road/ Wilberforce Road. In summary, the respondents raised the following issues:

- Clarification is required regarding arrangements for the Freemans Reach Road/ Wilberforce Road intersection. If Freemans Reach comes into the roundabout as dual lanes, the left lane should be left turn only so that traffic on Wilberforce Road can get onto the roundabout.
- Vehicles coming together on the single lane bridge approach from the two lane roundabout at Freemans Reach Road will cause blockages, stopping flow in both directions and possibly causing collisions.
- The operation of the northern roundabout will be problematic if it funnels two lanes into one across the bridge. The result could be an increase in accidents.

Response

Traffic safety and merge issues for southbound vehicles at the northern roundabout and on to the bridge have been recognised and further investigations into the configuration of traffic lanes in this area of the project are currently ongoing. A road safety audit would be undertaken on the detailed design to ensure that the design and operation of the roundabout and merge meets current road safety requirements.

The project would open with an initial two lane bridge configuration which would provide acceptable traffic performance immediately and into the future. The bridge has also been designed so that it can be subsequently reconfigured to a three lane bridge (with two southbound lanes and one northbound lane) to meet future traffic demands, as required. The number of lanes provided on the new bridge at opening (ie either two or three lanes) would be decided closer to the opening date based on traffic numbers and road safety requirements, however traffic modelling undertaken as part of the EIS indicates this will not be required.

2.8.7 Safety at the George Street and Bridge Street intersection

Submission number(s)

70 and 95.

Issue description

Two submissions raised concerns about pedestrian and vehicle safety issues associated with the installation of traffic lights at the George Street/ Bridge Street intersection. In summary, the respondents raised the following issues:

- Rather than improving pedestrian and driver safety as stated in the EIS, the installation of traffic lights will allow the traffic to go over the crest of the hill at higher speed than the roundabout currently does, which will cause new safety problems, particularly given (as stated in the EIS) that the existing sight distances for vehicles at the intersection do not comply with current safety standards.
- There will also be a safety risk to vehicles turning right into Macquarie Street and vehicles turning left into George Street east as a result of vehicles speeding through the intersection.
- The configuration of the intersection would result in additional crash risks.

Response

As part of the project, the gradient of the bridge exit/ approach road between the new bridge and the George Street/ Bridge Street intersection would be reduced from around nine per cent to six per cent and the intersection would be lowered slightly with the removal of the elevated roundabout. This would improve visibility and sight lines to a point where they comply with current standards. The proposed speed limit for the project would be 50 kilometres per hour, which would further improve pedestrian and vehicle safety.

The vehicle crash risks identified apply to all signalised intersections. Given the improved sightlines and lower speed limits, it is anticipated that there would be a reduction in crashes at this location. New pedestrian crossing facilities would also be provided as part of the upgrade, improving crossing opportunities and pedestrian safety.

Similarly, the new traffic lights at the George Street/ Bridge Street intersection are not anticipated to increase safety risks for vehicles turning right into Macquarie Street and vehicles turning left into George Street east given the improved sightlines and lower speed limits.

2.8.8 Traffic performance of the project

Submission number(s)

6, 15, 24, 32, 34, 60, 62, 70, 85, 92, 93, 94 and 95.

Issue description

Several submissions raised the issue of the traffic performance of the project. In summary, the respondents raised the following issues:

- The project will not improve traffic congestion in Windsor.

- The new bridge will still only be two lanes for the foreseeable future.
- The project will not solve current traffic problems on the approaches to and through Windsor.
- The project will not improve traffic flow in the long term.
- Increased traffic delays will be caused by the no right turn from Bridge Street to George Street for southbound traffic and reducing Bridge Street to one lane between Fitzroy Bridge and Macquarie Street for cars travelling north.
- The additional set of traffic lights will cause traffic delays.
- Lights will not be coordinated for cars travelling east along Macquarie Street.

Response

While the project would not solve all existing traffic congestion issues in Windsor, the proposed intersection improvements and an initial two lane bridge configuration would provide acceptable traffic performance immediately and into the future. The proposed new traffic lights at the George Street/ Bridge Street intersection will be synchronised with the existing lights at the Macquarie Street /Bridge Street intersection to give priority to through traffic on Bridge Street during peak periods. This will contrast with the current situation where vehicles from George Street have equal priority at the roundabout.

Additionally, the bridge has been designed so that it can be subsequently reconfigured to a three lane bridge (with two southbound lanes and one northbound lane) to meet future traffic demands, as required. Northbound traffic flow is controlled by the George Street/ Bridge Street intersection, which has only one through northbound lane. Traffic modelling has been undertaken to compare the performance of a three lane bridge with varying contra-flow arrangements (ie two southbound lanes and one northbound lane in the morning peak and one southbound lane and two northbound lanes in the evening peak). The results of this modelling indicated that there was only a marginal improvement in travel times with two northbound lanes in the evening peak, even with the predicted traffic growth to 2026.

This marginal improvement in travel times does not warrant the provision of an additional northbound lane. An extra lane on the bridge would also be undesirable due to additional visual and flooding impacts. The number of lanes provided on the new bridge at opening (ie either two or three lanes) would be decided before opening, based upon traffic numbers and road safety requirements, however traffic modelling undertaken as part of the EIS indicates this will not be required.

2.8.9 Traffic speed and benefit cost ratio

Submission number(s)

27.

Issue description

One submission raised the issue of traffic speed and the benefit cost ratio (BCR) analysis. In summary, the respondent raised the following issue:

- Average traffic speeds with the project appear to be high, unachievable and unduly influencing the BCR analysis.

Response

The average traffic speeds identified in the EIS (and those used for the EIS BCR) included large sections of the network modelled with an 80 kilometre per hour speed limit. These areas were not considered for the original BCR in the options report. Being external to Windsor and strategic, these tend to be the busiest links on the network. Consequently, average model speeds are higher than if the network area focussed on only the town centre and Windsor Bridge areas.

A BCR analysis was also undertaken for option 6 using the same assumptions and network model for the project. The BCR for this option also increased compared to the original BCR for option 6 undertaken in 2011 although it was still lower than the BCR for the project.

2.8.10 Design speed of the project

Submission number(s)

95.

Issue description

One submission raised the issue that the design speed of 50 kilometres per hour may be a breach of traffic guidelines and is not appropriate for an arterial road.

Response

The design speed of a new section of road is primarily determined by road safety requirements. This includes considering the sightlines along the road alignment, the types of intersections, the speed limit of surrounding roads, and pedestrian and cyclist traffic. The 50 kilometre per hour design speed for the project was adopted to enable the height of the replacement bridge to be lowered while still meeting road safety guidelines and to reflect the speed limits of the surrounding streets.

2.8.11 Upgrade of the McGraths Hill section of Windsor Road

Submission number(s)

4.

Issue description

One submission raised the issue of the need to upgrade the McGraths Hill section of Windsor Road. In summary, the respondent raised the following issue:

- The project will not achieve the stated traffic objectives without an upgrade of the McGraths Hill section of Windsor Road.
- The McGraths Hill section of Windsor Road should be upgraded to avoid a bottle neck on the approach to the new bridge.

Response

This would involve widening the section of Windsor Road between Pitt Town Road, McGraths Hill, and Macquarie Street, Windsor including the South Creek Bridge.

While this would improve traffic flow through Windsor it is outside the scope of the project and would be significantly more expensive. It would also lead to a number of other issues such as potentially necessitating a widening of Windsor Bridge and the approach roads through Thompsons Square. It would also further impact heritage properties between George and Macquarie Streets, and also most likely the Jolly Frog Hotel.

The need for future upgrades to the surrounding road network would be considered separately and subject to a separate environmental assessment process. The need for such work would be based development drivers and other changes to transport infrastructure, such as a potential upgrade to Richmond Bridge.

2.8.12 Construction traffic impacts

Submission number(s)

39, 85 and 95.

Issue description

Three submissions raised the issue of construction traffic impacts. In particular, respondents raised the following issues:

- Parking for all construction personnel should be restricted to the parking area near the wharf or on the western side of the river to minimise impact on the businesses around Thompson Square.
- The EIS statement that the impacts of construction work on local traffic would be 'negligible' is optimistic at the extreme and most likely a reckless underestimation.
- The construction work will cause huge disruption to an already congested area for many months if not years.

Response

Parking for construction personnel would be limited to the site compound on the northern bank and the Wharf car park on the southern bank. Construction parking areas would be detailed in the project induction process and any workers found parking outside designated areas would be disciplined.

As all the bridge and the majority of the approach roads are off-line from the existing road network, their construction would not result in substantial road closures or changes in the road network. The only roads that would be closed initially are Old Bridge Street and The Terrace east of the existing bridge. These roads would be closed to general traffic but access would be provided for the occupiers of Number 4 and Number 6 Old Bridge Street and for service vehicles to the wharf. Overall, the impact of these road closures would be minor as the affected roads are not used by general or through traffic.

The traffic impacts during the initial stage of construction would mainly be related to the delivery of materials and earthworks. As discussed in the EIS, the increase in traffic movements from construction vehicles would be relatively small in comparison to average daily vehicle movements. Environmental management measures as detailed in the EIS would be implemented to minimise any impacts.

The greatest potential for traffic impacts would arise during the construction of the tie-ins of the new bridge approach roads to the existing network. These works would require temporary and partial road closures. Due to the high traffic volumes, any closures would be restricted to low traffic periods, which would mainly be during the night and weekends. While this would result in noise impacts, scheduling the works outside peak traffic periods would reduce construction impacts on traffic.

2.8.13 Impacts on access to properties

Submission number(s)

24, 92 and 95.

Issue description

Three submissions raised the issue of adverse impacts on property access. In summary, the respondents raised the following issue:

- The project will have significant adverse impacts on access for two properties.
- A pedestrian strip will be removed to make way for the left hand turn into George Street from Bridge Street. This will make it impossible for cars to turn into and out of the car park for 17 Bridge Street and 62-68 George Street (which is accessed via a driveway between the buildings on Bridge Street).

Response

Under the new bridge approach arrangements, vehicles would no longer be able to turn right into (or out of) two existing properties on the eastern side of Old Bridge Street (Number 4 and Number 6 Old Bridge Street). However, alternative access arrangements have been provided to ensure access is maintained to these properties.

Vehicle access to the properties would be available via the southbound carriageway of the southern approach road through 'left-in'/'left-out' turning movements. Drivers travelling from the south would need to cross the bridge, circle the roundabout and re-cross the bridge from the northern side to gain access to these properties. Drivers exiting these two properties and wanting to travel north would first need to turn left and make a right turn into George Street and make their way to Macquarie Street before turning left into Bridge Street and travelling north.

As explained in the EIS, if the bridge is remarked to three lanes in the future, the right turn from Bridge Street north into George Street west may be banned in the evening peak. This would require drivers from Numbers 4 and 6 to continue down Windsor Road past the Macquarie Street intersection, turn left into Court Street, then turn left at Arndell Street, left again at George Street, then right into Bridge Street and travelling north. This would be a comparable distance compared to the situation where the right turn to George Street west is permitted.

2.8.14 Coach access to Windsor Wharf

Submission number(s)

27, 50, 95 and Hawkesbury City Council.

Issue description

Four submissions raised concerns or requested clarification on coach access to Windsor Wharf via The Terrace. The respondents raised the issue that clearance under the bridge on The Terrace needs to be sufficient to allow access for large coaches.

Two submissions contrarily raised concerns that the increase in bridge clearance over The Terrace would render the assessment presented in the EIS as invalid and would increase the significance of impacts on sightlines between buildings in Thompson Square and would be a broken promise by RMS. This issue is responded to in **Section 2.5.4**.

Response

During the development of the project, the vertical alignment of the new bridge and approach road through Thompson Square was lowered to minimise impacts on heritage views and vistas. The alignment was lowered while maintaining a 3.6 metre clearance over The Terrace to allow small coaches, service vehicles and emergency vehicles to access Windsor Wharf.

In consultation with Hawkesbury City Council and in response to submissions received during the exhibition of the EIS, RMS has now increased the proposed clearance of the new bridge over The Terrace from a minimum of 3.6 metres to a maximum of 4.6 metres to allow large coaches to directly access Windsor Wharf. This is discussed in further detail and assessed in **Section 5.1**.

2.8.15 Loss of maritime navigational area due to scour protection

Submission number(s)

95.

Issue description

One submission raised a concern that the scour protection provided as part of the project would reduce the navigational area of the river.

Response

The banks and river bed where scour protection would be installed would be excavated before placement of the scour material. The final surface of the scour material would have a similar profile to the existing bed and banks, with no reduction in navigational area. The proposed scour protection around the piers is unlikely to be required based upon the latest design of the project. Overall, the project would result in an increase in navigational area as the new bridge would have less piers and a greater clearance over the river compared to the existing bridge.

2.9 Issue – Noise and vibration

2.9.1 Operational noise impacts

Submission number(s)

7, 11, 17, 18, 24, 31, 41, 42, 47, 52, 56, 66, 72, 85, 92, 93, 94, 95 and the Heritage Council of NSW.

Issue description

Several submissions raised the issue of operational noise impacts. The main issues raised were as follows:

- The project would increase traffic noise and congestion in the area, which will have adverse impacts on the ambience and amenity of the town.
- The increase in through traffic and heavy vehicles resulting from the project will lead to an increase in traffic noise impacts.
- Raising of the road level will result in increased noise levels in adjacent areas.
- It is impossible to draw comparisons between the current situation and the proposed situation on the basis of the EIS investigations. A basic topographic analysis reveals that the existing road dives down below the parkland, directing traffic into a sound-attenuating cutting well below the level of the parkland. It is this topographical relationship that currently provides enough attenuation to make the parkland useable.
- Noise generated by the project, will have adverse impacts on:
 - Thompson Square.
 - Restaurants, cafes and other eateries surrounding Thompson Square.
 - Residences above commercial premises.
- With the new roadway at the same level as the parkland, noise impacts on Thompson square parkland will be intolerable, as will noise impacts on outdoor dining areas.
- The full impact of the proposed road on Thompson Square's visitors is yet to be determined, as noise studies have not included the parkland of the square. If the square becomes an undesirable place for visitors, the flow on effect will be a downturn for local business owners in George Street.

Response

Seven residential properties may require architectural treatment to reduce traffic noise from 2026 traffic levels. Impact mitigation options for these properties would be investigated during the detailed design phase of the project and implemented where feasible and reasonable. Other residential properties in the vicinity of the project are predicted to experience a reduction in traffic noise due to improvements in the road surface and changes in the alignment of the southern bridge approach road.

The noise model used for the noise impact assessment has been developed for both the existing “no build” scenario and the “build” scenario to provide a comparison of the noise impacts between the two. This methodology of developing a noise model, which is then used for assessing noise impacts, is standard industry practice and is supported by the relevant approval agencies and authorities.

The model uses three dimensional data sets that take account of the existing terrain within the study area, including the current road cutting.

The results of the noise assessment indicate that there would be no significant changes in traffic noise levels within the Thompson Square parkland as a result of the project. Future (2026) noise levels in the parkland are predicted to exceed noise criterion for recreational use both with and without the proposed bridge replacement project as a result of increases in traffic volumes with population growth and development in the region. With the proposed replacement bridge in place, however, noise levels in the northern area of the parkland near the river would decrease slightly because the new southern approach road to the bridge would run along the eastern side of the parkland, rather than through the parkland.

The project would generally result in little change to noise levels experienced by commercial and entertainment premises around Thompson Square, except for those on the eastern side where the new alignment of the road is closer than the existing alignment. These premises would experience an increase in noise levels.

The proposed bridge replacement would not increase traffic congestion in Windsor. As noted in the EIS, there would be an increase in traffic volumes using the river crossing at Windsor as a result of regional development north of the Hawkesbury River, irrespective of the implementation of the project. The project is unlikely to encourage additional heavy vehicles and through traffic to use the Windsor Bridge as a route to the Hunter region as the length of road comprising the project is less than 0.5 per cent of the total distance between Singleton and Windsor. While the project would reduce travel times through Windsor during peak periods, the overall improvement in travel time between Singleton and Windsor would be negligible.

While growth in traffic volumes would result in an increase in noise levels over time, the project has the following design features that would reduce noise levels in comparison to the existing conditions:

- The grade of the southern approach road for the project would be considerably less than the existing bridge approach road, which would reduce engine noise generated by vehicles climbing to the George Street/ Bridge Street intersection.
- The replacement bridge and approach roads would have a new smooth asphalt surface, which would generate less noise than the different pavement types and the failed joints on the existing bridge and approach roads.

The project would also result in traffic flow improvements at the George Street/ Bridge Street intersection, which may help to alleviate traffic noise.

Additionally, the project is anticipated to result in long term benefits to the amenity of Thompson Square as a result of consolidation of the existing upper and lower parkland areas. The upper and lower parklands are currently dissected by the existing bridge approach road and would be amalgamated as a result of the project. The consolidation of the parkland would provide a larger area of usable open space for the community and visitors, while reinforcing the existing connection of the Square with cafes and restaurants on George Street. This would improve the amenity of the Thompson Square and river foreshore area for community and visitor use.

The current NSW Government and RMS policies and guidelines for road noise assessment and mitigation apply only to residential land uses and other uses defined as being noise sensitive, such as schools and hospitals. The current NSW Government and RMS policies and guidelines for road noise assessment and mitigation do not apply to commercial premises. For this reason, commercial premises were not specifically targeted in the noise assessment.

Noise impacts on the Thompson Square parkland area were, however, specifically assessed using the NSW Government's noise criteria for open space areas.

2.9.2 Operational vibration impacts

Submission number(s)

11, 92 and 93.

Issue description

Three submissions raised the issue of operational vibration impacts. The main issues raised were as follows:

- The project has the potential to cause vibration impacts on heritage structures by directing increasing volumes of traffic and heavy vehicles through the town.
- The vibration impacts of the project may result in historic buildings becoming redundant or no longer being suitable for their existing or other compatible uses.
- The potential for vibration impacts has been identified yet no dilapidation reports have been prepared.

Response

Based on assessment of existing vibration levels and prediction of future vibration levels with the new road alignment and the increase in traffic volumes with growth and development, vibration resulting from operation of the proposed replacement bridge and approach roads would not impact any building structures or the comfort of building occupants. Vibration generated by the project would not affect the structure of any heritage buildings.

The project itself would not result in an increase in the volumes of through traffic or heavy vehicles passing through Windsor. Rather, there would be an increase in traffic volumes using the river crossing at Windsor as a result of regional development north of the Hawkesbury River, irrespective of the implementation of the project. The project is unlikely to encourage additional heavy vehicles and through traffic to use the Windsor Bridge as a route to the Hunter region as the length of road comprising the project is less than 0.5 per cent of the total distance between Singleton and Windsor. While the project would reduce travel times through Windsor during peak periods, the overall improvement in travel time between Singleton and Windsor would be negligible.

2.9.3 Construction noise and vibration impacts

Submission numbers

29 and 93.

Issue description

Two submissions raised the issue of construction noise and vibration impacts. In summary, the respondents raised the following issues:

- Noise and vibration associated with the construction of the project will have adverse impacts on heritage buildings.
- The EIS acknowledges that vibration levels from vibratory compaction would exceed the human comfort criterion at adjacent sensitive residential receivers and would be just below the structural damage criterion for heritage structures at all sensitive heritage receivers. Yet the EIS provides neither remedy nor strategy to deal with vibration in excess of human comfort levels and there is no evidence to suggest Dilapidation Reports have been obtained for all sensitive heritage receivers.
- The effect during the construction phase of 'pile driving' appears to be understated. While most of the equipment used is of a relatively continuous nature, the pile driving is a series of short, sharp sounds. Using a $L_{Aeq, 15min}$ noise descriptor for the pile driving would underestimate the impact of this noise source.

Response

The EIS and the Noise and Vibration Working Paper provide an assessment of the potential construction noise and vibration impacts, and identify appropriate management and mitigation measures in accordance with the EPA's *Interim Construction Noise Guideline* (DECC, 2009). The *Interim Construction Noise Guideline* (ICNG) is considered the appropriate guideline for assessing construction activities in NSW and identifying the impact mitigation requirements.

The noise criteria in the ICNG are expressed as $L_{Aeq, 15min}$, with no criteria for L_{Amax} values. An assessment of L_{Amax} in Section 4.3 of the ICNG is only in reference to sleep disturbance. This relates to construction works undertaken at night where a high maximum noise level is more likely to disturb restful activities and sleeping patterns. The project would not involve undertaking high noise activities such as piling during night time periods.

Up to 30 sensitive receivers are anticipated to experience noise levels in excess of construction noise objectives at some point during the construction period (excluding the site establishment and early works phase of construction). Of these receivers, eight would be exposed to noise levels of 75dB(A) or greater during the later phases of construction (construction of the southern approach road and construction of the southern tie-in) and are therefore considered to be 'highly noise affected' in accordance with the ICNG. The implementation of noise mitigation measures during the construction period would be considered for all receivers where construction noise objectives are exceeded, with additional consideration given to 'highly noise affected' receivers. It should be noted that the construction noise assessment presented in the EIS is conservative and assumes the worst-case scenarios in terms of construction methodology and periods of impact. For example, based on the latest information on construction, pile driving would not be undertaken, rather piles for the bridge piers would be bored which has a considerably lower noise impact.

To assess the impact of construction vibration, activities that are known to cause substantial vibration were identified. For the project, these activities were identified as rock breaking (jack hammering) and vibratory rolling. The location where these activities would take place and the proximity of sensitive receivers and structures was then examined to estimate vibration impacts in the context of relevant criteria.

Rock breaking would be undertaken in close proximity to sensitive receivers, especially along the southern approach road, and the associated vibration levels generated would exceed the human comfort criterion at one sensitive receiver and the structural damage criterion at one heritage structure (the heritage wall at Number 4 Bridge Street) and one underground services corridor along Bridge Street (Receiver C2 – which is not shown on the Figure 7-30 of the EIS). Vibration levels from vibratory compaction would exceed the human comfort criterion at all adjacent sensitive residential receivers and would be just below the structural damage criterion at all potentially impacted heritage structures.

The heritage retaining wall at 4 Bridge Street has been recognised as particularly at risk from construction vibration impacts. If potential vibration impacts are not appropriately management during construction this could lead to damage of the heritage wall, as well as other heritage items. Specific mitigation measures would be detailed in the Construction Noise and Vibration Management Plan to minimise the risk of impacts and could include:

- Development of buffer zones where construction activities that may cause vibration are not permitted.
- Vibration monitoring.
- Pre and post construction dilapidation reports.
- Physical protection of the wall – For example where similar heritage walls have been encountered on other projects, one method used to protect them has involved constructing a temporary plywood enclosure around the wall and filling the void with sand. When construction works are complete, the plywood enclosure and sand are carefully removed.

The exact construction methods and construction locations for infrastructure projects, such as the Windsor bridge replacement project, are not typically defined in detail at the EIS stage. Rather, the construction methods and locations are typically subject to changes during detailed design and need to be confirmed prior to construction. The results of the construction noise and vibration assessment presented in the EIS are therefore considered to be indicative only and need to be confirmed during detailed design. In recognition of this, the EIS recommends that further detailed assessment is undertaken at sensitive receivers prior to the commencement of works. This would typically include confirming the types of construction equipment to be used and quantifying the associated noise and vibration impacts.

A Construction Noise and Vibration Management Plan would be prepared for the project and will contain detailed assessment methods for high-risk works, consultation protocols, and details of impact mitigation and monitoring requirements. Details of the proposed mitigation measures are provided in the EIS. With the proposed mitigation and monitoring measures in place, there would be no adverse impacts on heritage structures.

2.10 Issue – Socio-economic impacts

2.10.1 Severance of the town

Submission number(s)

17.

Issue description

One submission raised the issue of town severance. In particular, the respondent contended that:

- The project will split the town in half and completely alter the experience of visiting the town.

Response

The project will result in changes to access arrangements for some residents and properties but there will be no significant changes in access between the western and eastern sides of the township. If anything, the project will improve connectivity between the eastern and western sides of Windsor by reconnecting The Terrace to provide continuous access along the southern foreshore and by providing a pedestrian crossing at the intersection of George and Bridge Streets. Under the current situation, access along The Terrace is disrupted by the existing southern approach road to the bridge, and pedestrian access across Bridge Street is difficult due to the lack of pedestrian crossings facilities.

The proposed location for the replacement bridge minimises changes to the location of the Hawkesbury River crossing at Windsor and the associated bridge approach roads. The project will remove the existing road cutting that bisects Thompson Square and amalgamate Thompson Square's existing upper and lower reserves into one continuous open space area. It will also result in improvements to access between Thompson Square and the river foreshore and improvements in pedestrian and a cyclist access across the bridge. These benefits are expected to improve public amenity within Thompson Square and along the river foreshore. It will also assist in meeting Hawkesbury City Council's objectives for their Mobility Access Plan and Plan of Management for the Windsor Foreshore Parks Incorporating the Great River Walk.

2.10.2 Impacts on tourism

Submission number(s)

3, 17, 18, 38, 42, 45, 52, 56, 72, 88, 92, 93, 94, 95 and the Heritage Council of NSW.

Issue description

Several submissions raised the issue of adverse impacts on tourism in Windsor. In summary, the respondents raised the following issues:

- Rather than enhancing the economic potential of existing assets, the project will erase yet another part of our historic narrative and further reduce Windsor to a standard, banal outer ring suburb, indistinguishable from any other part of western Sydney.

- The project will adversely affect Windsor's heritage tourism potential and have significant adverse impacts on the tourism industry.
- The construction of a high-level motorway adjacent to Thompson Square will significantly reduce the appeal of the area to visitors and have a severe negative impact on the local economy.
- Heritage tourism is a significant component of the town's economic viability and will be significantly adversely affected by the project.
- The EIS did not properly consider the role of around 21 existing businesses in Thompson Square in contributing to tourism.
- One business, the Hawkesbury Paddle Wheeler, has been singled out by RMS for special attention to the detriment of all other businesses in Thompson Square. It is noted that the patrons of the Paddle Wheeler generally arrive at and depart from Windsor Wharf without having visited the town, and are therefore unlikely to contribute to tourism within the project area or be affected by impacts on the heritage precinct.

Response

Impacts on tourism are described in Section 7.8 of the EIS, with further detail provided in the Socio-economic Working Paper. The Socio-economic Working Paper identifies existing tourist attractions and facilities (Section 3.3 of the Working Paper), impacts on local businesses, including tourism businesses (Section 4.4) and impacts on tourism (Section 4.5.1). This includes assessment of the potential impacts of project construction and operation on tourism and tourist businesses that may occur as a result of changes in amenity (including visual amenity), access, connectivity, the visibility of local businesses, and expenditure by project workers. The socio-economic impact assessment recognises the importance of Windsor's heritage values to tourism in the region and notes that tourists are attracted to the region due to its heritage values, as well as its natural environment and lifestyle.

The working paper indicates that some temporary impacts on tourism in Thompson Square may be experienced during construction, which may result in a temporary reduction in patronage of Thompson Square, the Macquarie Arms Hotel and surrounding areas. Restrictions on access to Thompson Square during construction were also identified as a possible impact. Measures identified in the EIS to minimise impacts on tourism during construction include limiting construction activity during the peak tourist times (ie weekends) and implementing measures to mitigate dust and noise impacts. Consultation and communication with potentially impacted businesses, community groups and the Hawkesbury City Council would be undertaken during construction to allow businesses, community groups and the Hawkesbury City Council to plan around unavoidable construction impacts and to provide information to enable the construction contractor to minimise impacts. For example, during the Blues and Roots Festival, which is an important local event for attracting tourists, major construction works may cease.

The socio-economic working paper also identifies the potential for impacts on tourism from changes to the heritage vistas of Windsor and Thompson Square. However, it is recognised that there are many factors that influence the attraction and experience of visitors to Windsor and that it is unlikely that visitors would choose to not go to Windsor due to the project impacts. In the long term, the project also supports the ongoing viability of tourism in Windsor by providing improved access and connectivity to the region. The project will also provide a safe and efficient crossing for tourists

involved in various regional cultural tourism activities, such as the Hawkesbury Harvest, tourist drives, and heritage walks promoted in the area.

The impact of limiting coach access to the Hawkesbury Paddle Wheeler has been further considered in **Section 5.1** of this report.

The proposed location for the replacement bridge would maintain the existing, historic linkage between the northern and southern sides of the Hawkesbury River at Windsor and the continuity of Thompson Square as a civic park and a link to the river. The selected bridge design and southern approach road alignment also minimise the potential visual and construction impacts of the preferred option on the Thompson Square parkland.

The project is also expected to improve the amenity of the Thompson Square parkland by removing the 1934 approach road to the existing bridge, which currently dissects the parkland and divides it into two separate reserves. The project will unify the two separate reserves of Thompson Square, creating a larger area of consolidated open space. Additional improvements to pedestrian amenity and safety will be gained from:

- Improving pedestrian and cycle access between Thompson Square and the river foreshore.
- Providing a three metre wide shared pedestrian and cycle pathway across the new bridge, linking Thompson Square with Macquarie Park.
- Reconnecting The Terrace to provide continuous access along the southern foreshore.
- Providing a signalised pedestrian crossing at the intersection of George and Bridge Streets.

The increase in consolidated parkland area, combined with the proposed improvements to pedestrian and cycling pathways, will improve the amenity of the Thompson Square precinct for public use. This in turn is expected to enhance the existing connection between Thompson Square and businesses on George Street, which would provide additional potential opportunities to further develop the area's cultural, recreational and tourist uses.

The potential adverse impacts of the project have been minimised in design and would be further mitigated and/or managed with the proposed urban design and landscape strategy identified in the EIS. The strategy, which will be finalised during detailed design, includes urban design and landscape treatments to integrate the new bridge and road infrastructure with the existing environment. The local community including tourism based businesses and stakeholders groups would have the opportunity to contribute to the urban design and landscaping strategy to maximise any benefits to tourism from the project.

2.10.3 Impacts on local businesses

Submission number(s)

24, 45, 66, 72, 66, 69, 82, 85, 87, 92, 93, 95 and the Heritage Council of NSW.

Issue description

Several submissions raised the issue of the potential for adverse impacts on local businesses. In summary, the respondents raised the following issues:

- The project would have negative impacts on business around Thompson Square and within Windsor.
- Local businesses will be severely impacted by the construction process and permanently disadvantaged by the new traffic arrangements, which will limit access to shops and businesses in the area.
- There will be adverse impacts on George Street retailers if southbound traffic coming from the bridge can no longer turn right into George Street.
- The full impact of the proposed road on Thompson Square's visitors is yet to be determined. If the square becomes an undesirable place for visitors, the flow on effect will be a downturn for local business owners in George Street.
- Tourism and hospitality businesses in Thompson Square are already reporting a marked decrease in business over the last five years due to the increases in traffic through the square.

Response

The potential adverse impacts of the project have been considered in design and would be further mitigated and/or managed using the measures identified in the EIS and any additional conditions of approval. The project is not expected to have negative impacts on local business trade for the following reasons:

- The retention of the river crossing in the centre of Windsor will maintain the flow of traffic into the township.
- The project will improve the amenity of the Thompson Square parkland for community and visitor use, which will strengthen existing connections to businesses on George Street.

Vehicles travelling south on Bridge Street after crossing the bridge would initially be able to turn right into George Street west via a dedicated right hand turn lane. This would allow southbound traffic to directly access the Windsor town centre via George Street. At some point in the future, however, the banning of this right turn movement during the evening peak may need to be considered if the performance of the intersection drops below acceptable levels.

The number of southbound vehicles undertaking the right hand turn movement from Bridge Street north to George Street west during the evening peak is currently relatively low. Nevertheless, before any future evening peak ban is placed on this right hand turn movement, additional community consultation and traffic monitoring and modelling would be undertaken to confirm the level of impact and the need for impact mitigation.

Vehicles travelling north on Bridge Street towards the new bridge would be able to turn left into George Street west via a dedicated left hand turn lane, maintaining the existing level of access to businesses on George Street for northbound traffic.

Southbound vehicles under nine metres in length would be able to turn left into George Street east. Northbound vehicles would not, however, be permitted to turn right into George Street east as this would reduce the performance of the intersection to an unacceptable level. This movement according to traffic counts is also relatively low. For vehicles wanting to access east Windsor and Governor Phillip Park from the south, a dedicated right turn bay or alternative method would be provided at the intersection of Bridge Street and Court Street about 170 metres south of the George Street/ Bridge Street intersection. The staging and design of this intersection has yet to be confirmed.

As all the bridge and the majority of the approach roads are off-line from the existing road network, their construction would not result in substantial road closures or changes in the road network. The only roads that would be closed initially are Old Bridge Street and The Terrace east of the existing bridge.

These roads would be closed to general traffic but access would be provided for the occupiers of 4 and 6 Old Bridge Street and for service vehicles to the wharf. Overall, the impact of these road closures would be minor as the affected roads are not used by general or through traffic.

Parking for construction personnel would be limited to the site compound on the northern bank and the Wharf car park on the southern bank. Construction parking areas would be detailed in the project induction process and any workers found parking outside designated areas would be disciplined.

2.10.4 Impacts on the road freight industry

Submission number(s)

60.

Issue description

One submission raised the issue of impacts on the road freight industry. In summary, the respondent contended that the project will have long-term adverse impacts on the road freight industry as it will do nothing to improve the current traffic problems and does not provide a long-term solution for road transport.

Response

The preferred option satisfies the primary aim of the project, which is to maintain a safe and reliable crossing of the Hawkesbury River at Windsor. The project would provide a new bridge, approach roads and intersections to current road design standards. The project design would improve the level of flood immunity to match that of the surrounding approach roads, and provide a safer crossing for vehicles, cyclists and pedestrians.

The proposed intersection improvements and initial two lane bridge configuration would provide acceptable traffic performance immediately and into the future. The bridge has also been designed to meet current designs to accommodate freight so that it can be subsequently reconfigured to a three lane bridge (with two southbound lanes and one northbound lane) to meet future traffic demands, as required.

Alternative route options were explored during the options development phase of the project and an alternative route option raised by the community during the EIS display period (the Rickabys Line option) has also since been evaluated (refer to Chapter 3). The available alternative route options have several disadvantages in comparison to the preferred option. As discussed above, an alternative route around Windsor may be considered in the future depending on growth in traffic numbers and local congestion.

2.10.5 Impacts on agriculture

Submission number(s)

DPI (Agriculture NSW).

Issue description

Agriculture NSW noted that the retention of agricultural lands, including turf farming land, should be maximised through detailed attention to the overall design and rehabilitation measures following construction.

Response

The project would require acquisition of two rural commercial properties and part of two additional rural commercial properties on the northern bank of the river. These properties are currently used for turf farming. While it is acknowledged that they could also be suitable for higher value horticultural enterprises (such vegetable production) flooding risks would limit the viability of these alternatives. In summary, as discussed in Section 7.8 of the EIS, the acquisition of the turf farm land would be expected to have a minor impact on land use in the region given:

- The area of land acquired would be relatively small;
- There are other opportunities for turf farming and horticulture in the region;
- The land is flood prone (about the level of the three year flood event), which limits its potential uses and value to agricultural and horticultural enterprises.

The retention of agricultural lands would be maximised to the extent possible during detailed design. Due to the final configuration of the new roads in this area, however, it would not be practical to return any excess land to agricultural or horticultural production. Appropriate compensation in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991* would be provided for all land acquired as part of the project.

2.11 Issue – Flooding, hydrology and climate change

2.11.1 Flood immunity of project

Submission number(s)

8, 24, 69, 70, 93 and 95.

Issue description

A number of submissions specifically raised the issue of flood immunity. In summary, the respondents raised the following issues:

- The project would not improve flood immunity of the crossing.
- In August 2011 the options report stated that the option 1 bridge would have a one in five year flood immunity but the EIS states that the new bridge would only have about a one in three year flood immunity.
- The project does not meet the stated objectives for flood immunity and questions the claim that the project would improve the flood immunity of the crossing.
- RMS has made many promises regarding the flood immunity of the new bridge. These promises have now been revised.
- The road to Wilberforce and the flats between Windsor and McGraths Hill will continue to be affected by flooding, restricting access to Windsor from the northern side.

Response

The option 1 bridge presented in the August 2011 options report and associated community information was substantially higher than the bridge now proposed for the current preferred option (as described in the EIS). As described in Section 4.3 of the EIS, further design development was undertaken following the release of the 2011 options report to reduce the visual impact of the bridge on Thompson Square and the heritage character of Windsor. This further design development resulted in lowering the height of the proposed replacement bridge.

The decision to lower the bridge to reduce visual impacts was also made in consideration of the flood immunity issue, recognising that there was no benefit in providing a bridge that had a substantially higher flood immunity than Wilberforce Road and/or Freemans Reach Road. The flood immunity of the proposed replacement bridge is now consistent with the flood immunity of Freemans Reach Road. The lowest point on the new bridge and approach roads (about 9.8 metres AHD) is similar to the level where Freemans Reach Road is closed due to flooding. Raising the level of the existing bridge approach roads to increase their flood immunity is outside the scope of project.

As discussed in Section 7.9 of the EIS, the replacement bridge would still be higher than the existing bridge and would therefore have a higher level of flood immunity. The flood immunity of the existing bridge is below the one in two year flood level, whereas the flood immunity of the new bridge would be around the one in three year flood level (likely slightly lower than one in three). The flood immunity of the existing bridge is lower than that of Freemans Reach Road and Wilberforce Road, which sometimes results in these roads being open to traffic while the existing bridge is closed due to flooding.

It should be noted that the flood immunity of the bridges expressed in terms of recurring flood events (such as a one in three year flood level) would change over time due to inherent limits in the precise accuracy of the flood modelling process which includes the provision of additional and more accurate flooding data as it becomes available. Consequently the information presented on the flood immunity of the project in terms of recurring flood events is indicative and is intended to convey a typical inundation frequency based upon the data available. Also the exact flood immunity of the project in terms of recurring flood events has not been calculated as it would require modelling of a large range of flood events to produce a flooding frequency that would change over time. The most important consideration in the flood immunity for the project would be the difference in height between the existing Windsor bridge and the project. As the project would be about 2.8 metres higher than then existing bridge, this would reduce the frequency and duration of bridge closure due to flooding. As discussed in Section 7.7.4 of the EIS, using historical flood level data from 1987 to 2011 if the new bridge had been in place, the number of bridge closures would have been three instead of eight and the average duration of closures would have decreased from 43 hours to 19.5 hours.

2.11.2 Flood impacts of the project

Submission number(s)

24, 70 and OEH.

Issue description

Two community submissions raised the issue of the flood impacts of the project. In summary, the respondents raised the following issues:

- 360 land lots will suffer increased flooding as a result of the project, which is not a good outcome for the affected property owners.
- The EIS states that the project would potentially increase flood levels upstream on the flood plain, particularly in a one in five year flood. It is therefore possible there will be little or no improvement in flood immunity.
- Will the stated increase in flood levels upstream on the floodplain reduce the flood immunity of the North Richmond bridge?

In addition, the OEH raised the following issues in relation to the flooding impacts of the project:

- The potential increases in flood levels are of concern, especially in the five year ARI flood event and for those additional properties affected by over-floor flooding.
- Consultation should be undertaken with Hawkesbury City Council and State Emergency Services to develop a communication and mitigation strategy to minimise flooding impacts and risks.

Response

The flood modelling undertaken for the EIS, while suitable for assessing the potential impacts of the project, was conservative and is therefore considered to have provided an over-estimate of the potential flood impacts. Specifically, the flood impact assessment was based on:

- A one dimensional flood model that did not account for the full complexity of the river immediately upstream of the project and therefore had a tendency to over-estimate flooding impacts.
- An earlier design for the replacement bridge, comprising a larger superstructure and five in-stream piers (compared with the current proposal for four in-stream piers), giving it a larger cross-sectional area and greater potential to impede flood flows and cause increases in upstream flood levels.

A revised flooding assessment using a two-dimensional flood model and the updated bridge design has been undertaken and is discussed in **Section 3.2**. The revised modelling indicates that the project would result in no or negligible increases in flood levels upstream of the bridge and no additional flood mitigation works or investigations would be required.

2.11.3 Development on the floodplain

Submission number(s)

72.

Issue description

One submission raised the issue of development on the Hawkesbury Floodplain. In summary, the respondent raised the following issue:

- The State Government's infrastructure strategy recognises that the floodplain is already over-developed and yet more inappropriate sites are being contemplated by developers and the construction of the proposed replacement bridge will encourage and justify even more development in areas unsuited for housing.

Response

The issue of development on the floodplain is beyond the scope of the project and is a matter for Hawkesbury City Council and the Department of Planning and Infrastructure.

2.11.4 Hydrological impacts

Submission number(s)

DPI (Fisheries NSW).

Issue description

Fisheries NSW noted that the EIS has not adequately addressed the potential changes in flow direction arising from an increased area of bank scour protection. Once the scour protection design has been finalised, the designs should be referred to Fisheries NSW to allow an assessment of potential impacts due to flow refraction and/or reflection.

Response

Further consideration of the impact of the proposed scour protection works on flows and bank scour would be undertaken during detailed design. This would include detailed hydrological modelling on the final design of the replacement bridge and detailed design of the extent and type of scour protection. The final design for the scour protection works would be provided to the DPI - Fisheries for their comment.

2.11.5 Climate change considerations

Submission number(s)

OEH.

Issue description

OEH noted that, while the EIS should ideally have considered information on historical and projected future sea level rise with reference to the NSW Government's sea level rise benchmarks, the majority of the tasks for the EIS were completed before the announcement of the NSW Government's Coastal Management Reforms and the potential impacts of sea level rise were therefore assessed based on the sea level rise projections from the 2009 NSW Sea Level Rise Policy Statement.

OEH acknowledged that the assessment of the potential impacts of sea level rise in the EIS was based on the best available information at the time.

It is noted that the NSW Government announced its Stage One Coastal Management Reforms in September 2012. As a consequence of these reforms, the NSW Government no longer recommends State-wide sea level rise benchmarks for use by local councils, with councils having the flexibility to consider local conditions when determining local future hazards.

Response

While more up to date data on sea levels rise are now available, the inherent design features of the bridge allow it to cope with regular submersion under fast flowing flow waters.

2.12 Issue - Impacts on riparian vegetation

2.12.1 Impacts of the replacement bridge on riparian vegetation

Submission number(s)

DPI (NSW Office of Water).

Issue description

The NSW Office of Water noted that the bridge design should incorporate design features that improve riparian connectivity. The agency also made a number of recommendations regarding riparian zone rehabilitation:

Response

Historical land clearing has completely removed all original native riparian vegetation communities at Windsor. Existing riparian vegetation within the project footprint comprises a narrow strip along the southern bank of the Hawkesbury River bordered by the footpath of The Terrace, and a narrow strip along the northern bank of the river both east and west of the bridge. The existing riparian communities are in relatively poor condition, with the understorey and ground layers either absent or dominated by exotic species.

About 0.5 ha of riparian vegetation would require clearing for the project. As part of the project, all disturbed areas outside the road corridors will be stabilised and rehabilitated through a progressive planting and landscaping program that takes advantage of optimal growing conditions and is appropriate to the final land use. This would include planting within the riparian zone where possible and removal of weed species. Riparian zone rehabilitation will include appropriate native species where possible. However, some non-native tree species will also be considered as the replacement bridge would form part of the gateway to the existing historic township of Windsor. Overall, the condition and habitat value of the newly planted areas would be an improvement on the existing vegetation communities.

The area directly beneath the bridge is unlikely to be suitable for planting due to shading, lack of moisture, and the potential for scouring impacts during floods. Modifying the bridge design to improve growing conditions beneath the bridge would not be possible due to the height and width constraints resulting from the need to minimise visual impacts.

2.12.2 Riparian plantings for the water quality basin

Submission number(s)

DPI (NSW Office of Water).

Issue description

The NSW Office of Water noted that the perimeter of the proposed water quality basin should be planted with native riparian species in accordance with relevant guidelines.

Response

The water quality basin on the northern bank would be planted with native riparian species. A detailed landscape plan containing all details of planting including type of plants and their monitoring and maintenance would be prepared in consultation with relevant stakeholders. While rehabilitation of the riparian zone would be one of the objectives of the plan, other important objectives would include maintaining the historic vistas to and from Windsor and providing gateway and departure point from Windsor to the north.

2.13 Issue – Community consultation process

Many submissions raised concerns about the consultation process. In summary, the respondents raised issues in relation to the:

- Timing of the community consultation process.
- Integrity of the community consultation process.
- Scope of the community consultation process.
- Quality of responses to community correspondence.
- Statutory requirements of the consultation process.
- Quality of display material used in community displays for the project.
- Time allowed for submissions on the EIS.

One submission also raised concerns about the Design and Heritage Focus Group.

Further details of and responses to these issues are provided in the following sections.

2.13.1 Timing of the community consultation process

Submission number(s)

6, 54, 66, 77, 84 and 93.

Issue description

Several submissions raised concerns about the timing of the consultation process, in particular the timing of the start of consultation in relation to selection of the preferred option. In summary, the respondents raised the following issues:

- Decisions about the preferred option pre-dated the consultation process.
- Decisions about the preferred option were made as early as 2008, before the start of community consultation. RMS told land owners in Thompson Square as early as 2008 that option 1 would go ahead.
- The EIS states that it was not until 24 August 2011 that notification of the project was advertised in the local press. The project should have been advertised earlier and also advertised in the larger daily newspapers prior to the project decision being made.

Response

RMS has undertaken extensive consultation and followed an appropriate consultation process in line with the requirements specified by the Director General of the Department of Planning and Infrastructure. The consultation process has involved using a wide range of activities to provide information about the project to the community and stakeholders and obtain their input and feedback. Details of the consultation activities undertaken are provided in Chapter 6 of the EIS.

Section 2.16 of this report responds in detail to questions raised about the project development process. As discussed in **Section 2.16.1**, while the replacement of the existing bridge was identified by RMS asset managers as the preferred option to address identified structural issues, this option had not at that point received broader RMS consideration and was therefore not RMS' preferred option at that time. It was not until late 2008 and early 2009 that the project received wider consideration by other sections of RMS and the need for more thorough consideration of options for the bridge was identified. As a result, RMS considered a range of options to refurbish or replace the existing bridge. These options were subsequently presented to the community in July 2009 for feedback. A report documenting community and stakeholder feedback on the options was published in November 2009.

An assessment of the identified alternative options was subsequently undertaken and the community's comments considered. In August 2011, an options report was published, accompanied by various technical investigations used to inform the options selection process. The replacement of the existing bridge was confirmed as the preferred option. RMS used a range of consultation tools and activities to enable the community to be actively involved in the options selection process. This included consideration of additional options identified by the community.

Consultation continued on the preferred option to allow community issues to be considered in the design of the bridge, Thompson Square and surrounding project elements. RMS will continue to provide opportunities for the community to participate in the detailed design of Thompson Square and in further reducing project impacts.

2.13.2 Integrity of the community consultation process

Submission number(s)

47, 54, 66, 74, 87 93, 94 and 95.

Issue description

Many submissions contended that community opposition to the project has been ignored and that the consultation process was never intended to influence decisions on the project. In summary, the respondents raised the following issues:

- There were 12,000 people who signed a petition against the project.
- Community concerns about the project have been ignored.
- Statements made by RMS staff during the consultation process that followed the selection of the preferred option indicated that it was just a 'token' process that was never intended to influence decision-making.
- The consultation process has been deceptive and misleading rather than "clear and transparent" as claimed by RMS.

Additionally, one submission contended that RMS has not satisfied its own consultation process, as set out in *Community Involvement and Communications - A Resource Manual for Staff* or the protocols of the International Association for Public Participation (IAP2) *Public Participation Spectrum* document, which provides a promise to the public that "We will deliver what you decide".

Response

RMS has undertaken an appropriate level of consultation and followed an appropriate consultation process in line with the requirements specified by the Director General of the Department of Planning and Infrastructure. The consultation process has involved using a wide range of activities to provide information about the project to the community and stakeholders and obtain their input and feedback. Details of the consultation activities undertaken are provided in Chapter 6 of the EIS.

Throughout the consultation process, community expectations and concerns have been addressed in project planning and design to the greatest extent practicable. Ultimately, the selection of the preferred option takes into account transport needs, heritage impacts, environmental impacts and engineering and cost constraints.

RMS' Community Involvement and Communications - A Resource Manual for Staff (the Resource Manual) was developed to provide staff with a theoretical and practical guide to planning and managing community involvement activities for RMS projects. It includes a guide to relevant policies and plans with reference to community involvement and advice on developing a community involvement plan. The principles of the Resource Manual were applied throughout the community consultation process and were used to identify the various community participation activities adopted for the project.

The IAP2 Public Participation Spectrum was designed to assist with the selection of the level of participation that defines the public's role in any public participation process. The Spectrum shows that differing levels of participation are legitimate and depend on the goals, time frames, resources, and levels of concern in the decision to be made. The level of public participation applied to the Windsor Bridge replacement project is considered appropriate.

It is recognised that, despite the consultation undertaken, there are still people who oppose the project.

2.13.3 Scope of the community consultation process

Submission number(s)

12, 18, 66, 84, 91, 92 and 93.

Issue description

Several submissions contended that not all relevant local community members and business owners had been consulted and that the geographical area covered by the consultation process was not sufficient. In summary, the respondents raised the following issues:

- There was a lack of consultation with local residents and business owners.
- Local property and business owners directly impacted by the project were not consulted until late in the process.
- Some business owners have not been specifically consulted.
- The community consultation process failed to notify residents in Glossodia, Kurmond, Blaxland Ridge, Kurrajong, Kurrajong Heights, Kurrajong Hills and Colo Heights. These areas, which have been experiencing high population growth, contribute to traffic in Windsor and use of Windsor Bridge and it would

have therefore been appropriate to seek input from these areas. The EIS fails to acknowledge or address why these areas were excluded from consultation.

- RMS should have consulted more widely given the heritage significance of the project area. The project is a concern not only to the local residents of Windsor and the Hawkesbury region, but also to people outside of this area.
- The Community Involvement Plan excluded representative groups that may have an interest in the project, such as business operators, road users, people living in the vicinity of the project and the wider community.

Two submissions raised issues regarding the level of consultation undertaken for building owners in Thompson Square. These submissions contended that:

- The owners of three heritage buildings that are part of the Thompson Square heritage precinct (namely 62-64 George Street, 66-68 George Street, and 17 Bridge Street):
 - Have never been personally consulted or identified as key stakeholders at any stage of the project, even though the project will have a detrimental effect on the heritage, fabric, curtilage and economic value of the buildings.
 - Were not consulted prior to the identification of the 10 RMS options in 2008/2009 or when option 1 was declared the preferred option.
 - Were not informed about the Design and Heritage Focus Group meetings.
- The property owners in Thompson Square who were not residential owner occupiers, apart from not being personally consulted, did not receive the initial Community Update Newsletter outlining the options and inviting community comment.
- The owners of Number 4, Number 6 and Number 10 Bridge Street were informed in person of the preferred option in early 2009 (before information was provided to the wider community) but only because RMS was forced to inform them because the original option 1 severely restricted their property access. These owners were told that option 1 was the preferred option, that other options would be offered but this was “just part of a process” and that there were only sufficient funds for option 1.
- Given the above, the consultation undertaken for the EIS does not comply with the Director General’s requirements.

Response

RMS has undertaken an appropriate level of consultation and followed an appropriate consultation process in line with the requirements specified by the Director General of the Department of Planning and Infrastructure. The consultation process has involved using a wide range of activities to provide information about the project to the community and stakeholders and obtain their input and feedback. Details of the consultation activities undertaken are provided in Chapter 6 of the EIS.

A number of community involvement plans were prepared for the project, with each applying to a different phase. This is because different stakeholder groups need to be involved depending on the phase of project development. The community involvement plans were developed in accordance with RMS’ Resource Manual. The stakeholder groups identified in the community involvement plans included local residents and businesses, the local and broader community, commuter communities, and a range of others.

As part of the consultation process, various community updates were distributed to around 12,000 properties on both the northern and southern side of the Hawkesbury River. This included the Windsor Downs, Windsor, South Windsor, McGraths Hill and parts of Berkshire Park, Wilberforce, Pitt Town Bottoms, Freemans Reach, Glossodia and Ebenezer. The reason only parts of some areas were included in the distribution is due to their rural and, often, more remote nature, although attempts were made to cover as broad an area as possible.

The owners of a number of the properties identified above have been registered stakeholders since November 2011, receiving project material by mail. They have also been consulted individually on the project. Consultation activities undertaken during earlier stages of project development included shopping centre displays and a community workshop. These were advertised in local newspapers and advised in community updates distributed to 12,000 local residents, businesses and other interested parties. The Community Focus Group established in November 2011 was also advertised in local newspapers and advised in community updates.

In addition to direct community consultation, RMS held community displays, placed advertisements in local newspapers and provided a project website to raise awareness of the project during the early stages and encourage involvement in the options selection process.

RMS has attempted to consult with all affected business owners potentially directly impacted by the project, however, recognises that all business owners may not have had the opportunity to provide input during the options assessment phase. Subsequent to the selection of the preferred option, RMS has endeavoured to consult with all potentially impacted business and property owners around Thompson Square. In some cases, property and business owners have preferred not to engage with RMS and due to their opposition to the project. It is also possible that business owners and tenants may not have passed on community updates and letters. As detailed above, there have also been numerous forums and opportunities for business and property owners to engage with RMS.

2.13.4 Quality of responses to community correspondence

Submission number(s)

93 and 94.

Issue description

Two submissions referred to examples of what they believed to be inadequate responses provided by RMS officers to community correspondence and questions raised. They had anticipated that the responses or answers provided by RMS would have been accurate, precise, complete and written in a manner that was easy to read. Instead, they assert that the officers who provided the responses were either careless, incompetent, or deliberately attempting to conceal information.

Response

Throughout the development of the project, members of the project team responded to a significant volume of community correspondence, which often included detailed and complex questions. At all times, the project team endeavoured to respond as quickly and accurately as possible to the numerous requests for information. At times, however, the requested information may not have been immediately available to the RMS officer.

On many occasions this necessitated an interim response advising the respondent that further information would be provided in the future when available.

2.13.5 Statutory requirements for the consultation process

Submission number(s)

84 and 93.

Issue description

Two submissions questioned whether or not the statutory requirements for communication activities had been met.

Response

The Director General's requirements for the project include an appropriate and justified level of consultation with relevant parties during the preparation of the EIS.

Having reviewed the EIS as submitted and considered RMS' responses to various matters on which the Department of Planning and Infrastructure required further information, the Department placed the EIS on public exhibition on 14 November 2012.

The options development and selection process for the project has involved a comprehensive community and stakeholder participation process, with feedback included in the development of the design wherever possible. Details of the consultation process and communication activities undertaken for the project can be found in Section 6.2 of the EIS. Further opportunities to provide input to the final form of Thompson Square parkland will be provided in future project phases, should the project be approved.

2.13.6 Quality of display material used in community displays for the project

Submission number(s)

93.

Issue description

One submission questioned why a 3D model was provided instead of a scale model for the project, and suggests that a scale model would provide a more accurate representation of the project and its impacts.

Response

A variety of visual aids were used to assist the community in understanding the project and the potential impacts. A number of 3D models were presented, in addition to detailed concept design drawings, photomontages, artist impressions and schematic representations. These were provided variously on the project website, in community updates, in the EIS and working papers, and at a variety of community information sessions and presentations. RMS believes this provided a comprehensive and accurate representation of the project and its potential impacts.

2.13.7 Time allowed for submissions on the EIS

Submission number(s)

3.

Issue description

One submission contended there was insufficient time allowed for the public to make submissions on the EIS.

Response

The time provided for the public to make submissions during the EIS display period complied with the timeframe requirements established under NSW planning legislation. This Submissions Report also responds to issues raised in submissions received as late as 14 February 2013.

2.13.8 Design and Heritage Focus Group

Submission number(s)

93 and 94.

Issue description

Two submissions raised concerns about the Design and Heritage Focus Group. In summary, the respondents raised the following issues:

- Notes or records of the meetings were made public without agreement of participants, which breached the code of conduct for the group.
- The group appeared to be created and operated to meet RMS process, rather than as a forum for consultation and development of the project.
- The group was abruptly closed down in June 2012 with little explanation provided to participants.
- The information provided by RMS was not accurate or timely as per the code of conduct.

Response

The Design and Heritage Focus Group first met in late 2011 after selection of option 1 as the preferred option. The focus group was established on the following grounds:

The principal aim of the community focus group will be:

- *To work closely with the RMS project team and contribute to the concept design development and environmental assessment of the preferred option.*

The group will achieve this aim by:

- *Providing input into the concept design of the preferred option (option one), including areas such as urban design, landscape, archaeology, heritage and traffic.*
- *Ensuring transparent and effective communication arrangements are established with all interested and affected residents, businesses, interest and industry groups.*

- *Ensuring that individuals and groups affected by the project but who are not able to attend meetings still have opportunities to participate in its development.*
- *Providing a local perspective on project issues, particularly in relation to minimising impact on heritage.*

The group is an advisory group and does not have a final decision making or approval role.

The focus group included a wide cross-section of the Windsor community including members of a local community action group called Community Action for Windsor Bridge (CAWB). The objective of the Design and Heritage Focus Group was to further develop option 1 and obtain feedback about alternatives within option 1. The group was established on the understanding it would conclude following the winding up of this development input. Accordingly, RMS decided to conclude the Design and Heritage Focus Group in June 2012 as the EIS and concept design had progressed sufficiently to not require any additional feedback from the Design and Heritage Focus Group. This was explained to the participants in detail at the Design and Heritage Focus Group meeting and in correspondence. The following is an extract from correspondence sent to all members of the Focus Group:

"The information gathered through the focus group meetings has been used to inform the concept design and the development of the Environmental Impact Statement (EIS), which is due to go on public exhibition later this year.

Roads and Maritime Services appreciates the time you have taken to participate in these meetings.

The concept design has developed to a point where it can be taken through the remainder of the Environmental Assessment process and therefore, the formal focus group meetings no longer need to be conducted.

This does not mean the end of consultation for the project however. Consultation will continue throughout all stages of the project and we would encourage you to continue to stay involved in the next steps of the planning process."

As discussed in **Section 2.13.4**, the project team endeavoured to respond as quickly and accurately as possible at all times to the numerous requests for information. Occasionally, however, the requested information may not have been immediately available to the RMS officer. On many occasions this necessitated an interim response advising the respondent that further information would be provided in the future when available.

2.14 Issue – Accuracy and adequacy of information

Several community submissions raised the issue of the accuracy and/or integrity of information provided in the EIS and/or in community consultation publications or forums. The Heritage Council of NSW also contended that the EIS was not based on comprehensive and adequate assessment information and is therefore inadequate for decision-making. Hawkesbury City Council noted that the EIS did not provide sufficient detail regarding factors such as site stabilisation and remediation, and management and maintenance obligations during and following construction. The issues raised are identified in the following sections.

2.14.1 Accuracy and adequacy of information – Flooding

Submission number(s)

24, 66, 70, 77 and 84.

Issue description

A number of submissions raised concerns regarding the accuracy and integrity of information on flood immunity and flooding. In summary, the respondents raised the following issues:

- The information in the hydrology specialist report is not accurate.
- RMS has made many promises regarding the flood immunity of the new bridge. These promises have now been revised.
- The community consultation was undertaken with a commitment to improve flood immunity to the 1 in 5 year flood level. This commitment was re-iterated in the August 2011 community update. This criterion is not being met.

Response

The validity and accuracy of the hydrology specialist report has been questioned due to the type of model used in the analysis. It is noted, however, that the particular model used, combined with the assumptions applied, have resulted in conservative predictions of flooding impacts. As such, the flood impacts identified in the EIS are likely to be greater than the actual impacts that will be experienced during flood events. In line with standard RMS pre-construction processes, further flood modelling will be undertaken as part of the detailed design phase of the project, if approved.

The option 1 bridge presented earlier in the August 2011 options report was substantially higher than the bridge now proposed and therefore had a higher level of flood immunity. As described in Section 4.3 of the EIS, further design development was undertaken subsequent to the 2011 options report to reduce the visual impact of the bridge on the heritage character of Windsor. This resulted in lowering the height of the proposed replacement bridge. Note also that the decision to reduce the height of the bridge was made in consideration of the flood immunity issue, and recognised that there was no benefit in providing a bridge with a substantially higher flood immunity than that of the surrounding approach roads. The flood immunity of the proposed replacement bridge is now consistent with the flood immunity of Freemans Reach Road. Raising the level of the existing bridge approach roads is outside the scope of the project. The new bridge will still be higher than the existing bridge and will therefore provide a higher level of flood immunity.

As discussed in further detail in Section 5.1, the height of the southern end of the new bridge has been increased by about one metre to provide access for large coaches to Windsor Wharf. This increase in height of the southern end of the bridge does not change the flood immunity of the project as the lowest point is at the northern bank and is still substantially below the height of the bridge presented in the 2011 options report.

Further responses to issues raised in relation to flood immunity and flooding are provided in **Section 2.11**.

2.14.2 Accuracy and adequacy of information – Heritage

Submission number(s)

54, 92, 93, 94 and the Heritage Council of NSW.

Issue description

Four community submissions raised concerns regarding the accuracy and integrity of information on heritage. In summary, the respondent raised the following issues:

- The claim that the preferred option follows a historical alignment and "there has always been a road there" is not true, as is the claim that Bridge Street is the historic route to the river. Bridge Street was named after the bridge across South Creek and no one ever used the road known as "Old Bridge Street" to access the river.
- RMS is incorrectly claiming that the project re-instates an historical alignment between Old Bridge Street/ Bridge Street and a crossing of the Hawkesbury River and is using this claim to justify or gain support for the project.
- There is no evidence of an historical alignment between Old Bridge Street/ Bridge Street and a crossing of the Hawkesbury River and the claim that the project re-instates an historical alignment is false.
- Even if the claims regarding the historical alignment were true, the re-instatement of an historical alignment would not provide sufficient justification for the project.
- The presence of a wharf before 1815 is disputed.

The submission from the Heritage Council of NSW raised the following additional issue:

- The Heritage Branch of OEH has advised the Heritage Council Sub-Committee that the Heritage Branch was recently contacted by RMS to advise that further archaeological testing may be needed within Thompson Square to assess impacts. This implies that the current EIS has not been based on a comprehensive and adequate assessment and as such, is inadequate for decision-making.

Response

The Historic Heritage Assessment and Statement of Heritage Impact (Working Paper 1) was informed by substantial research, sourcing historic surveys, historical illustrations and photographs, and newspaper articles. As identified in the Working Paper, a survey record from 1842 (Armstrong's survey) provides the only evidence of a previous road running through Thompson Square.

The survey shows a curving road or track that led to the punt on the river and provided a connection to the path through the Government Domain. In contrast to Evans' 1809 image, which shows a track adjacent to the Government domain, the road to the river now commenced from the western side of the Square at the corner of George Street and the Macquarie Arms Hotel.

Evans' 1809 image shows a track going straight down the hill from the current location of the George Street/ Bridge Street intersection, although it should be noted that this is an illustration rather than an official plan. It is also shown on historic photographs dated 1923 and plans dated as early as 1855. There are also records of complaints about the state of Bridge Street down to the river.

Based on consideration of research by the heritage specialists, it was concluded that a single alignment crossed George Street and continued straight down the slope to the wharf and bridge from about 1855. What condition it was in, and whether this access was used regularly or if alternative routes such as Baker Street were preferred, is not known.

The heritage information on which the EIS is based is adequate for the purpose of assessing the potential significance of impacts of the project and the required impact mitigation and management measures, including the need for further archaeological testing. Having reviewed the EIS as submitted, and considered RMS' responses to various matters on which the Department of Planning and Infrastructure required further information, the Department placed the EIS on public exhibition on 14 November 2012. The Department also requested that further archaeological investigations be undertaken. A summary of the outcomes of these investigations, is provided in **Section 3.1** of this report.

2.14.3 Accuracy and adequacy of information – Restoration of Thompson Square

Submission number(s)

24, 66, 77 and 93.

Issue description

A number of submissions raised concerns regarding the accuracy and integrity of information on the restoration of Thompson Square. In summary, the respondents raised the following issues:

- The claim made in the EIS that the project will achieve a gentle slope from Thompson Square down to The Terrace needs to be questioned.
- Claims that the current bridge replacement proposal will improve Thompson Square are false.
- Statements made by RMS that Thompson Square will be restored to the form envisaged by Governor Macquarie over 200 years ago are false and misleading.

Response

While RMS presented a preferred option for the proposed urban design and landscape works for Thompson Square in the EIS, the design and landscape works that would be applied have yet to be finalised. The scope and final form of the urban design and landscape works for Thompson Square will be further investigated following planning approval (if approved) with input from Hawkesbury City Council, agency stakeholders and the community. The final form of the urban design and landscape works for Thompson Square will also be influenced by any conditions of approval that may apply to the project.

The statements relating to improvements of Thompson Square relate to improvements in the public amenity of the parkland area. The project is predicted to improve the amenity of Thompson Square by removing the existing road cutting that dissects the Thompson Square parkland and thereby increasing the amount of continuous, useable parkland within the square. The improvement in amenity resulting from consolidation of the Thompson Square parkland area will be further enhanced by improvements in pedestrian and cycling facilities.

Section 4.1.2 of the EIS outlines the assessment of options against the project objectives. As part of that assessment, the EIS states that the preferred option would increase the area of consolidated open space within Thompson Square and provide an opportunity to reinstate the typical Macquarie era grid street layout. It noted, however, that it would have a significant impact on historic heritage as it would directly impact the Thompson Square Conservation Area and remnants of the 19th century Windsor Wharf.

The EIS does not claim to restore Thompson Square to the form envisaged by Governor Macquarie. However, the extension of Bridge Street into a more parallel/straight configuration is consistent with Macquarie's approach to street grid designs. This order was very important to his town plans. Hence the statement that the preferred option would extend the typical Macquarie era grid street layout asserted in the EIS is consistent with Macquarie's approach to street grid designs.

2.14.4 Accuracy and adequacy of information - Noise and vibration impacts

Submission number(s)

24, 92 and 93.

Issue description

Three submissions raised concerns about the methods and criteria used to assess noise impacts. In summary, the respondents raised the following issues:

- The noise impact assessment did not cover commercial premises.
- Open space criteria have not been adequately assessed.
- The EIS fails to consider the impact of noise on the businesses that operate alfresco dining areas within the Heritage Precinct. These areas should be regarded as "Open Space" and the corresponding Road Noise Policy (RNP) criteria applied.
- The EIS failed to physically monitor current noise levels in the Heritage open space of the Thompson Square reserve. Instead it modelled a mere two points within the reserve.

- The EIS ignores the existing situation where noise levels in Thompson Square are already too high.
- There are five heritage buildings currently used as residences in Thompson Square. The EIS fails to monitor three of these residential heritage buildings and address potential impacts on these residences.
- The noise assessment, including the application of the Road Noise Policy, fails to take into account that the majority of buildings in Thompson Square were constructed well before traffic noise intrusion was a consideration and that the glass used in these buildings is therefore much thinner than that used in modern buildings. These structures are therefore more vulnerable to noise impacts and this should be considered in the noise assessment.

Response

The current NSW Government and RMS policies and guidelines for road noise assessment and mitigation apply only to residential land uses and other uses defined as being noise sensitive, such as schools and hospitals. The current NSW Government and RMS policies and guidelines for road noise assessment and mitigation do not apply to commercial premises. For this reason, commercial premises were not specifically targeted in the noise assessment. Noise impacts on the Thompson Square parkland area were, however, specifically assessed using the NSW Government's noise criteria for open space areas (see Section 7.5.1 of EIS). Where exceedances of the noise criteria are predicted, appropriate and practical mitigation measures have been discussed within the EIS. The NSW Government's Road Noise Policy recommends that where a 'mixed use development' exists, the criteria for each individual type of receiver is used for operational assessment. This assessment methodology has been adopted for the project.

The current NSW Government and RMS policies and guidelines for road noise assessment and mitigation do not differentiate between heritage and non-heritage structures or premises for the purpose of operational or construction noise. For the vibration assessment, the heritage nature of structures has been taken into account, in line with the NSW *Assessing Vibration: A technical Guideline*. The EIS (including the Noise and Vibration Working Paper) identifies Thompson Square as a sensitive receiver and provides a discussion on noise mitigation options for this area in accordance with the NSW Government's policy. The noise impact mitigation options identified for the project specifically consider the heritage significance of the area.

Since completion of the EIS, it has been brought to the attention of RMS that four of the properties identified as 'commercial' in the EIS may actually be used for residential purposes. These four properties have since been re-assessed as residential properties as part of an additional noise assessment carried out during the preparation of this Submissions Report. This additional noise assessment:

- Addresses the proposed design change to increase the clearance of the bridge over The Terrace (refer to **Section 5.1** and **Section 5.1.4**).
- Takes into account the identified corrections in property use, re-assessing the four newly identified residential properties against the relevant residential criteria of the Road Noise Policy.

The results of the additional noise assessment indicate that there will be little or no change in operational noise levels at sensitive receivers as a result of the proposed design change to increase the clearance of the bridge over The Terrace.

The newly identified residential properties will, however, qualify for noise mitigation treatments, in addition to those properties already identified for noise mitigation in the EIS. Residents will be contacted separately to discuss mitigation treatments in accordance with RNP requirements.

Baseline noise monitoring is not required to be undertaken at all receivers within a project study area, Monitoring is undertaken at a sufficient number of representative locations to allow the project noise model to be validated. The monitoring data obtained within the study area for the project is considered to provide a good representation of noise levels for receivers within the area. Two locations representative of different areas within the Thompson Square parkland were selected to represent indicative noise levels with the park.

2.14.5 Accuracy and adequacy of information - Traffic

Submission number(s)

24, 66, 70, 85, 93 and 95.

Issue description

A number of respondents raised concerns relating to the accuracy of traffic data and modelling. In summary, the respondents raised the following issues:

- There is an apparent discrepancy in information on vehicles numbers within the EIS. For example, the EIS states that there are around 13,000 vehicles per day on Wilberforce Road, 7,000 vehicles per day on Freemans Reach Road and 19,000 vehicles per day on the bridge. If there are 13,000 vehicles per day on Wilberforce Road and 7,000 vehicles per day on Freemans Reach Road, why are there only 19,000 vehicles per day using the bridge?
- The traffic flow improvement claims in the EIS seem strange given the pre EIS documents provided by RMS.
- RMS and politicians continue to make misleading statements about the project. Misleading claims made include that the project will solve the traffic issues associated with the current bridge.
- The EIS states that "Beyond the roundabout, traffic in both directions on Bridge Street generally travels at a slow speed, constrained by the narrow and steep road alignment and poor sight lines. Vehicle speeds do not substantially vary during peak and non-peak periods due to these road conditions and the narrow bridge configuration." The submission contends that this is incorrect. In particular, northbound traffic speed actually increases after it leaves the roundabout and crosses the bridge. Conversely, during peak periods, traffic is very slow due to the banking up across the bridge from the Macquarie Street intersection.
- The predicted traffic outcomes presented in the EIS are questionable. The Blues Festival shows that a slight increase in local traffic can cause serious bankups.
- The traffic data and modelling is suspect and should not be used as a basis for supporting the project.
- There appears to be inconsistencies in the EIS about permitted traffic movements to George Street west and east from Bridge Street.

Response

The apparent discrepancy in vehicle numbers arises because not all cars using Freemans Reach Road and Wilberforce Road cross the bridge. There is local traffic using Freemans Reach Road and Wilberforce Road to access properties along these roads, as well as cars going into Macquarie Park from Freemans Reach Road and Wilberforce Road.

Detailed traffic numbers for each road are presented in Section 3 of the Traffic and Transport Working Paper. The numbers presented in the Traffic and Transport Working Paper are the ones used in the traffic modelling.

The primary aim of the project is to maintain a safe and reliable crossing of the Hawkesbury River at Windsor. An additional specific project objective is to improve traffic and transport efficiency. The project would provide a new bridge, approach roads and intersections to current road design standards. The project design would improve the level of flood immunity to match that of the surrounding approach roads, and provide a safer crossing for vehicles, cyclists and pedestrians. While the project would not solve all existing traffic congestion issues in Windsor, the proposed intersection improvements and initial two lane bridge configuration would provide acceptable traffic performance immediately and into the future. The proposed new traffic lights at the George/Bridge Street intersection would be synchronised with the existing lights at the Macquarie Street/Bridge Street intersection to give priority to through traffic on Bridge Street during peak periods. This would contrast with the current situation where vehicles from George Street have equal priority at the roundabout. The bridge has also been designed so that it can be subsequently reconfigured to a three lane bridge (with two southbound lanes and one northbound lane) to meet future traffic demands, as required.

One submission disputed a statement in EIS that suggested that traffic speeds on Bridge Street after leaving the roundabout were slow. This statement was contained in the visual impact and landscape section and was based on visual observations of the traffic at the time of visiting Windsor. It was not a statement in the Traffic and Transport assessment section.

The traffic modelling does not use events such as the Blues Festival as a basis for the assessment - rather it is focussed on the daily peak commuting periods. The consideration of infrequent events such as the Blues Festival would be addressed through event traffic management plans and assessments prepared by Council and RMS if warranted.

The modelling and determination of future vehicle numbers conformed to RMS policies and procedures. Similar modelling and future traffic estimates would be used for any assessment of alternative options. As noted in the EIS, the estimated increase in traffic growth is considered conservative (ie an over-estimation rather than an under-estimation) and is based on a number of reputable sources (eg Sydney Strategic Travel Model).

At the George Street/ Bridge Street intersection, the right turn into George Street east for northbound vehicles on Bridge Street would be banned. For southbound vehicles on Bridge Street, the right turn into George Street would be permitted. This turning movement may, however, be banned at some stage in the future during the evening peak period only. Before this occurs, further consultation with the community and additional traffic assessments would be undertaken.

2.14.6 Accuracy and adequacy of information – Socio-economic impacts

Submission number(s)

92, 93 and 95.

Issue description

Three submissions contended that the socio-economic assessment undertaken for the project was deficient and flawed. In summary, the respondents raised the following issues:

- The information in the EIS on domestic tourist visitors is incorrect. Tourism Australia figures show an average of 363,000 people visited the Hawkesbury Region for the purposes of holiday or leisure, while approximately 198,000 were visiting friends or relatives. The EIS figures state a higher proportion of people were in the Hawkesbury region to visit family and friends.
- The method of data collection was inadequate, as directly affected commercial properties within the Thompson Square precinct were not consulted or surveyed, surveys were not undertaken on a Sunday (the area's busiest day for shoppers and tourists) and survey times were limited to between 9am and 5pm, which did not capture commuters.
- The survey data is not reliable because the person responding to the local business survey may not have had a clear grasp of the issues.
- The survey findings regarding business owners and attendants may not be objective or useful. These findings should not be used for decision making purposes.
- The assessment takes no real account of the opinions and plans of businesses.
- The level of assessment in the report does not meet the standards of other road projects with Goulburn, Gunning and Tarcutta quoted as examples.
- The Hawkesbury Regional Gallery is not located adjacent to Thompson Square as stated in the EIS.

Response

The tourism data presented in the EIS are correct. The information is from Destination NSW (a statutory authority established by the NSW Government) and is based on the National Visitor Survey and International Visitor Survey undertaken by Tourism Research Australia (a branch of the Australian Government Department of Resources, Energy and Tourism). The data presented in the EIS is the same as the information provided in the submission, although, the EIS presents data for the four years to September 2011, whereas the submission presents data for the three years to June 2007. The figure of 32.5 per cent of visitors visiting family and friends presented in the EIS relates to domestic overnight travellers. The figure for domestic daytrip travel is 28.6 per cent. In relation to holiday travellers, 50.5 per cent of overnight travellers visit the Hawkesbury Local Government Area for holidays, while holiday makers comprise 55.6 per cent of day trippers.

The outcomes of the surveys of local business and business patrons within the Windsor town centre were one input to the socio-economic impact assessment. The assessment was also informed by a range of other quantitative and qualitative information, such as:

- Data from the Australian Bureau of Statistics.
- Other relevant sources on population, demography, business and tourism.
- A visual survey of land uses and business near the existing bridge.
- Outcomes of community consultation undertaken by RMS for the project.

Community consultation for the project was undertaken between July 2009 and June 2012. This provided several opportunities for business owners and community members to provide input into the project development and EIS preparation. Community consultation included:

- Public information displays in August and September 2011, and September 2012.
- A community information session in August 2011.
- A community workshop in August 2012.
- An online discussion forum, in May-June 2012.
- Seven community focus group meetings, between November 2011 and 30 May 2012.

The socio-economic impact assessment was also informed by the findings of other technical studies, such as traffic and transport, heritage and urban design studies. The socio-economic impact assessment complied with RMS' guidelines for these types of assessments and met the Director General's requirements. The other road projects quoted as examples involved rural communities that were impacted by a highway bypass. Windsor is not being bypassed and is a peri-urban township that does not significantly rely on through traffic.

The decision making process for the project was based on a range of criteria, including those relating to the condition of the existing bridge, value for money, engineering standards and safety, flood immunity and community needs.

It is recognised that the single reference to the Hawkesbury Regional Gallery being located adjacent to Thompson Square is incorrect and that the correct reference should have been to the Hawkesbury Regional Museum.

2.14.7 Accuracy and adequacy of information - Project need

Submission number(s)

6, 24, 54, 66, 72, 77, 90 and 93.

Issue description

Many submissions raised concerns regarding the accuracy and integrity of information that has been provided in statements about project need. In summary, respondents expressed concern about the accuracy of information on:

- The condition and safety of the existing bridge.
- The cost of refurbishing the existing bridge.
- The cost of providing a bypass instead of the project.

The respondents contended that RMS and politicians have continued to make misleading statements about the project, including claims that the current Bridge is in danger of collapsing.

Response

As discussed elsewhere in this Submissions Report, RMS has acted with transparency and integrity throughout all stages of project planning and community consultation, from options development through to preparation and public display of the EIS.

The data presented in the EIS are accurate to the best of current knowledge. The data presented in the EIS are based on the best available information, including the results of studies carried out specifically for the analysis of project options and environmental impacts.

Further justification for statements made about the condition of the existing bridge is provided in **Section 2.15.3**. Further assessment of alternative bridge rehabilitation and bypass options is provided in **Chapter 4**.

2.14.8 Accuracy and adequacy of information - Project description

Submission number(s)

6, 70 and Hawkesbury City Council.

Issue description

Two community submissions raised concerns relating to information on the project presented in the EIS. In summary, the respondents raised the following issues:

- EIS does not contain adequate drawings of the proposed bridge.
- Figure 7-18 on page 237 of the EIS does not match the intersection configuration shown in the photomontage on the front page of the EIS. This is one of many examples on how the pictures provided by the RMS have the potential to mislead the public.

Hawkesbury City Council raised the following additional issues:

- The EIS contains conflicting information on the concept design alignment and footprint. As an example of this issue, Council noted that the concept design footprint depicted in Figure 7-39 of Volume 1 excludes some parts of the project (such as the existing bridge approach road through Thompson Square).
- The alignment of Thompson Square Road shown in Figure 8-1 of Volume 3 does not match the current road alignment outside the Macquarie Arms. The logic of re-positioning this section of road does not seem to have been justified.

Response

The EIS contains sufficient engineering drawings, photomontages and other diagrams to describe the project at its stage of development and to enable the assessment of environmental impacts. The level of detail in the EIS on the bridge and approach roads is greater than that presented in most other environmental impact assessments for similar projects.

The photomontage is correct and shows a dedicated left turn lane from George Street west to Bridge Street north. Figure 7-18 represents a simplified plan of the intersection for the purposes of the traffic assessment. Including the left turn lane in the traffic assessment would not have changed the results of the intersection analysis.

It is recognised that the project footprint shown in Figure 7-39 of the EIS is incorrect. This does not, however, change the conclusions of the assessment.

There are no proposed changes to Thompson Square Road outside the Macquarie Arms. This road will not be repositioned.

2.14.9 Accuracy and adequacy of information - Manipulation of data

Submission number(s)

3.

Issue description

One submission raised the concern that the data presented in the EIS have been manipulated. In summary, the respondent raised the following issues:

- The data presented in the EIS have been altered to achieve the desired outcomes.
- Members of the public are unable to access the raw data.

Response

The data presented in the EIS are accurate to the best of the current knowledge of RMS and the EIS consultant. The data presented in the EIS are based on the best available information, including the results of studies carried out specifically for the analysis of project options and environmental impacts. The data have not been altered in any way to present false or misleading information. Where relevant, raw data are contained in the technical working papers in Volume 2 of the EIS.

2.14.10 Areas of insufficient information

Submission number(s)

Hawkesbury City Council.

Issue description

Hawkesbury City Council expressed support for the project but noted that the EIS lacked detail in a number of areas. The specific issues raised by Hawkesbury City Council were as follows:

- The EIS contains insufficient details to make adequate comment about embankment stabilisation, materials, planting schemes and remediation following completion.
- The EIS provides insufficient details about the maintenance and transfer of acquired land back to Council including financial assistance and the period of time prior to handover.

- The EIS provides insufficient detail about the proposed water basin, the use of the wharf area during construction, and management and maintenance obligations following completion.

Response

The details presented in the EIS for rehabilitation and remediation works are at the concept stage only. These details would be further developed and finalised during the detailed design phase in consultation with Council and other relevant stakeholders. The details of the use of the wharf area during construction would also be confirmed in consultation with Council during detailed design.

All land outside the arterial road boundary would be handed over to Council at the completion of construction. Details of the land hand over process and the management obligations for the water basin would be confirmed during detailed design.

2.15 Issue - Project need

Many submissions questioned the statements made within the EIS regarding the need for the project. The main issues raised related to the following elements of the existing bridge:

- Lane widths and design standards.
- Load limits.
- Structural condition.
- Maintenance history.

Further details of and responses to the specific issues raised are provided in the following sections.

2.15.1 Lane widths and design standards of the existing bridge

Submission number(s)

24, 54, 69, 93 and 94.

Issue description

A number of submissions raised the issue that failure of the existing historic bridge to meet current design standards is not sufficient justification for project need or bridge demolition. In summary, the respondents raised the following issues:

- The current bridge has lane widths that are as wide or wider than those of many other bridges and roads in NSW.
- The lanes of the existing bridge are as wide or wider than those on the Harbour Bridge, ANZAC Bridge and Gladesville Bridge, and considerably wider than those on the Buttsworth Creek Bridge on Wilberforce Road, and yet none of these bridges have been described as requiring replacement in the interests of safety. Furthermore, truck widths have not increased over the past 25 years and newer trucks are easier to drive than older trucks.
- The proposed option 1 bridge, when configured for three lanes, also does not meet the current design standards. The EIS shows the traffic lanes will be 3.3m wide with no median strip (EIS Volume 1, Figure 5-4b).

Response

It is recognised that there are many other bridges and roads in Sydney with lane widths less than the design standard. Generally, this has resulted from the need to create additional lanes in congested road corridors or install concrete medians to prevent head on collisions. Apart from the Buttsworth Creek bridge, all other examples quoted in the submissions are roads or bridges with multiple lanes in each direction and therefore there is a less dangerous refuge in the adjoining outside lane to avoid head-on collisions or there are concrete medians crash barriers. For a two lane bridge such as Windsor Bridge, there are no outside lanes, road shoulders or median safety barriers to avoid head on collisions and breaching of the outside safety barrier would result in the vehicle going to the Hawkesbury River.

While they are generally unreported, RMS has been advised by Hawkesbury City Council of numerous minor accidents on the bridge involving trucks, such as mirror clippings.

Narrow lane width was one of the issues raised by the community and reported in local media as justification for RMS to replace the existing bridge. However, the substandard lane widths are only one of the reasons why RMS is proposing to replace the existing Windsor Bridge.

Road geometry, including lane widths, is only one component of a range of current engineering standards that a bridge must comply with to make it safe. The primary driver for replacing Windsor Bridge is because of other engineering standards such as structural integrity, load carrying capacity, durability and maintainability.

A number of extensive inspections, assessments and evaluations have concluded that the bridge requires replacement, as discussed in further detail in **Section 2.15.3**. In regards to its deck structure, inspection reports have identified cracking, spalling and corrosion of the reinforcement on the underside of the deck. Condition inspections have identified approximately 250 square metres of the bridge surface area affected by spalls, delamination or cracking, and exposed longitudinal reinforcement exhibits significant corrosion. In regards to its piers, underwater inspection reports have identified significant deterioration of the cast iron piers due to graphitisation, with measured effective wall thickness ranging from 27 millimetres to as low as two millimetres. Circumferential cracking has also been identified in both columns of pier 5 and the downstream column of pier 6. As a result of this structural deterioration, the safety factor for the bridge in its current condition is less than what is required by Australian Standards.

2.15.2 Load limits of the existing bridge

Submission number(s)

6, 24, 27, 69 and 93.

Issue description

A number of submissions raised issues regarding the load limits of the existing bridge, arguing variously that the load limits, or lack of load limits, were at odds with information provided by RMS on the structural condition of the bridge and the need for the project. In summary, the respondents raised the following issues:

- The existing bridge has had the weight limit increased to 68 tons, indicating that there is no danger of it falling down.
- RMS has stated that the existing bridge is in poor condition. This is at odds with the current situation, in particular that the existing bridge does not have a load limit and RMS has approved the crossing of the bridge by B-Doubles with heavy loads. There does not appear to be an urgent need to do anything.
- There is no load limit current on the bridge, suggesting that there is no immediate danger of the bridge falling down and thus no need to undertake the work immediately.
- The significance of statements made in the EIS regarding the structural integrity of the bridge are diminished by the absence of a current load limit.

Response

A number of submissions raised the issue that the load limits allowed on the existing bridge have increased in recent years and this is evidence that the existing bridge is in good condition and is suitable for use into the future. The granting of approval for various heavy vehicle types to use the existing bridge was provided as evidence that load limits have increased.

Since July 2006, Higher Mass Limits have been approved in NSW for certain road networks. Higher Mass Limits allow eligible vehicles to operate with loads in excess of statutory limits. The examples of increased load limits quoted in submissions include:

- In 2008, a 50 tonne 19 metre B-Double was approved to use the route that includes Windsor Bridge.
- In 2011, a 62 tonne 25 metre B-Double was approved to use the route that includes Windsor Bridge.

It is important to note that the load limits were not increased explicitly on the existing Windsor Bridge, rather higher mass and length vehicles were permitted on certain approved routes that included Windsor Bridge. Approval of B-Doubles to use certain approved routes does not mean the load safety factor or limits on the bridge have increased as:

- The load capacity and limits of a bridge are generally based upon the weight of the load on each axle of a heavy vehicle in relation to span length of the bridge – not the overall weight or length of the vehicle. The weight carried by each axle and stress transmitted by each axle when braking are key components in assessing the load capacity of the bridge. A 25 metre 62 tonne B-Double with eight axles, for example, applies less stress to the existing bridge than a typical 32 tonne semi-trailer with only four axles. For Windsor Bridge, semi-trailers are the heavy vehicle type that causes the greatest stresses on the bridge (see **Section 2.15.3** for a further discussion of load safety factors).
- Where the use of semi-trailers is already permitted, the approval of B-Doubles routes is generally based upon the road design and geometry of the route, rather than the load capacity or limits. B-Doubles have greater turning circles and require additional road pavement and therefore their safe approved use is limited by the design of existing road and intersections rather than weight.

The approval of B-Doubles on a route that included Windsor Bridge does not mean that the load limits or safe carrying capacity of the bridge has been increased.

2.15.3 Structural condition of the existing bridge

Submission number(s)

6, 24, 27, 54, 69, 84, 87, 90, 93 and 94.

Issue description

Many submissions contended that the poor condition of the existing bridge had been over-stated by RMS to support the claimed need to demolish the existing bridge and provide a replacement bridge. In summary, the respondents raised the following issues:

- Statements made by RMS that the existing bridge is in poor condition are at odds with the current situation, in particular the existing bridge does not have a load limit and RMS have approved the crossing of the bridge by B-Doubles.
- If the existing historic bridge is unsafe as stated in the EIS, why has nothing been done to make it safe as a matter of urgency and why has the bridge, an item of State significance, been allowed to deteriorate to the extent where it is reported as being unsafe?
- Investigations into the condition of the existing bridge in 2011 concluded that "the bridge in its present condition and loading will be safe for some time", which indicates that there is not an urgent need to have the bridge replaced on the grounds of safety. This information is at odds with statements made by RMS and statements made in the EIS.
- The existing bridge has had the weight limit increased to 68 tonnes, indicating that there is no danger of it falling down.
- RMS has stopped maintaining the existing bridge to allow its condition to deteriorate and thereby justify the need for its replacement.

Response

Many submissions disputed RMS' claim that the existing bridge is in poor condition and is substandard for the current loads and uses. This includes the alleged increase in the load limits for the existing bridge, which is discussed in **Section 2.15.2**.

As discussed in Section 3.2.1 of the EIS, the existing Windsor Bridge is rated as poor and, while the bridge is suitable for current use, would need extensive rehabilitation works if it was to be used and maintained into the future. A number of bridge condition investigation reports were also included in **Appendix C** of the EIS, demonstrating the significant deterioration of the structure.

In response to submissions questioning the condition of the existing bridge, RMS has included a more detailed chronology of investigations undertaken between 2003 and 2013 in **Appendix G** of this Submissions Report in addition to the information provided in the EIS. This more detailed information describes the investigations undertaken, the findings of the investigations, and the decisions made on the basis of these findings. These numerous reports and studies on the existing bridge include investigations to determine:

- The realistic load capacity of the bridge.
- The condition state of the bridge superstructure, in particular, the extent of carbonation of concrete and corrosion of steel along with short term and long term repair options.
- The condition of the cast iron piers and extent of their graphitisation.
- The rehabilitation options to restore the substructure capacity.
- Repair cost estimate and Life Cycle Cost Analysis of various rehabilitation options for the bridge to carry current legal loads.
- The performance of the bridge under the RMS test vehicle and ambient traffic for two weeks.

In 2002 the condition rating for the bridge identified increasing deterioration of precast concrete girders. In response to this condition rating a more detailed “Level 3” inspection was carried out (the output of which is included on the RMS website, in the EIS and summarised in **Appendix G**). The report recommended remediation of a number of deficiencies and also proposed the possibility of a bridge replacement.

In 2005 RMS Bridge Branch was commissioned to prepare a cost estimate to rehabilitate the bridge. The estimate to rehabilitate the bridge including project management and design was \$13,041,975 (in 2005 dollars). As the rehabilitation cost was high, RMS Senior Bridge Engineers and the Sydney Asset Manager agreed the more cost effective solution was to replace the bridge.

At the time this decision was made the expected timeframe for replacement of the bridge was within the next five years and accordingly the condition of the bridge could be managed without significant repairs provided a regime of routine monitoring was undertaken that include six monthly survey measurements and weekly walk through inspections by experienced inspectors.

This program of monitoring has been maintained since 2005 and has been supplemented with additional investigation reports including, underwater inspections, load assessments, and review of all reports and reassessment of the bridge. As discussed in **Section 2.13.1**, the consideration of alternative bridge crossing locations commenced some time later, following broader consideration on the project within RMS.

With regards to weight limit changes, as discussed in **Section 2.15.2** above, the approval of B-Doubles on a route that included Windsor Bridge does not mean that the load limits or safe carrying capacity of the bridge has been increased.

The load factor of a bridge is the primary performance measure of a bridge’s safe carrying capacity. The load factor is related back to a heavy vehicle type. Currently the heaviest vehicles allowed to use Windsor Bridge are 44.5 tonne semi-trailers, 62.5 tonne B-Doubles carrying general freight, and 68 tonne B-Doubles carrying livestock. A 44.5 tonne semi-trailer imposes the greatest stress on the bridge because they have a higher weight per axle compared to B-Doubles.

As required by rating section of the bridge code (AS5100.7), bridge structures are required to have a load factor of 2 for the stress applied by heavy vehicles. That is, the bridge should be capable handling two times the stress imposed by the largest legal heavy vehicle. This is to provide a margin of safety for illegal overweight loads, for occasional approved overweight loads and in case the bridge is damaged.

The load factor of a bridge is calculated using:

- The type of vehicles (ie weight, length and number of axles) using the bridge.
- The design of the bridge including span length and pier, superstructure and abutment design.
- Performance of the various elements of bridges when exposed to different types of loadings.

The existing bridge in its current condition has a load factor of about 1.5 for a 44.5 tonne semi-trailer. This indicates that the existing bridge can generally carry legal loads without risk, however, there is a considerably reduced margin of safety for illegal overweight loads or for events that cause stress or damage to the bridge (eg large flood events). Illegal overweight heavy vehicles are particularly a risk for Windsor Bridge as there is some evidence that overweight heavy vehicles travelling to and from the Hunter use Putty Road to avoid the heavy vehicle inspection station at Mount White on the F3.

As the load factor of the existing bridge is below 2 and does not meet the required rating for the bridge code, RMS has been required to implement the following measures:

- Weekly inspections by an experienced bridge inspector.
- More detailed, six-monthly monitoring of the deck profile by survey measurement.
- Intermittent monitoring of the bridge with strain gauges.
- Higher mass limit vehicles using the bridge must have low impact air suspension systems fitted and be enrolled in the Intelligent Access Program (involving compliance, monitoring and tracking technology).
- Speed limit for heavy vehicles has been reduced to 40 kilometres per hour.

As detailed in **Appendix G**, there have also been numerous reports and studies on the existing bridge over the past 10 years that drew initial attention to the bridges deteriorating condition and what measures were to be introduced to manage the potential risk including recommendation for replacement. The findings of these investigations led to conclusions about the deteriorating condition of the bridge.

In summary, these investigations concluded that rehabilitation would only restore the bridge to its original capacity with an assumed 25 year lifespan. The cost estimates for rehabilitation or strengthening did not take into account the community impact resulting from the closure of the bridge required during the process, or the ongoing maintenance cost that would be significantly higher than a new bridge. They also concluded that, with the original capacity, the bridge would only be capable of Higher Mass Limits (HML) subject to a stringent risk management strategy involving comprehensive monitoring by instrumentation and inspection, and only in the short-term until the bridge is replaced.

2.15.4 Maintenance history of the existing bridge

Submission number(s)

93.

Issue description

One submission contended that RMS has not been undertaking maintenance of the existing bridge, which has contributed to its deterioration and created risks to public safety. To support their argument that maintenance of Windsor Bridge has been lacking, the submission provided an example of another RMS heritage bridge that has been the subject of maintenance activities, arguing that the maintenance activities that have been applied to this example bridge do not appear to have been applied to Windsor Bridge.

Response

It is important to distinguish between regular and ongoing maintenance activities and major refurbishment works. The activities that have been undertaken on the other RMS heritage bridge described in the CAWB submission include replacing piles, cross girders, trusses and bridge decks. These are major refurbishment activities, not maintenance activities, and would be subject to a formal approval process. Some of the other activities described for the example bridge, such as painting and rot treatment, would be classified as maintenance activities.

In 2005, the need to replace the bridge was identified by RMS Asset Management Branch based on a number of bridge condition assessments, as discussed in **Section 2.15.3** above. (As discussed in **Section 2.16.1**, however, while the bridge replacement was favoured by the asset managers, it had not received broader RMS consideration at that time and did not form part of a more thorough consideration of options until later). At that time, it was also decided that major maintenance activities on the bridge would cease as an alternative crossing was anticipated to be open within five years. Minor maintenance activities and more regular inspections and assessments of the bridge were undertaken to ensure that the bridge remained safe for public use.

The cessation of major maintenance activities in 2005 did not contribute substantially to the current structural condition of the bridge and has not resulted in the existing bridge deteriorating beyond repair. The two major problems that that have been identified on the existing bridge are:

- Corrosion, graphitisation and cracking of the cast iron bridge piers.
- Spalling of the concrete deck girders, headstocks and other concrete elements.

No regular maintenance activities would have prevented deterioration of the piers as they are cast iron, have been submerged for over 100 years and have reached the end of their design life. The alternative bridge refurbishment methodology proposed by the ex-RMS bridge engineers recognises these issues and suggests that the piers be encased in steel jackets. This would duplicate the existing damaged sections of the piers and would be considered a refurbishment activity rather than a maintenance activity.

The spalling of concrete elements is a result of the some of the inherent historical design features and construction methodologies of the bridge (eg drainage from the deck was directed on to the deck girders), as well as the age of the bridge. The current extent of spalling of the concrete elements of the bridge could have been addressed to some degree by regular maintenance activities, although by 2005 it was recognised that the extent of spalling was so significant that only a refurbishment of the bridge could fully remedy and halt further spalling. The alternative bridge refurbishment methodology proposed by the ex-RMS bridge engineers suggests an approach to remedy the spalling, which has been further developed as described in **Section 4.3** of this report. In summary, while the extent of spalling may have increased due to the cessation of major maintenance activities, this could be remedied and halted through refurbishment of the affected concrete elements.

2.15.5 Need for demolition of the existing Windsor Bridge

Submission number(s)

16, 48, 54, 70, 72, 77, 86 and 93.

Issue description

Many submissions contended that the existing bridge should be retained and questioned the need for its demolition as part of the project. In summary, the respondents raised the following issues in relation to retaining the existing bridge:

- The existing bridge should be retained on the grounds of its State heritage significance.
- The existing bridge should be retained for light traffic and pedestrians to continue to serve the needs of the local community. A bypass should be constructed to cater for through traffic and heavy vehicles.
- The argument that the existing bridge might fail during a flood and consequently damage the new bridge is not sufficient justification for its demolition. This risk could be resolved by not building the new bridge so close to the existing bridge.
- A failure to meet current road design standards is not sufficient justification to demolish an historic bridge. No historic bridge would meet the most current road design standards.

Response

As discussed in the EIS, refurbishment of the existing Windsor Bridge was assessed as an alternative option to bridge replacement but was not selected as the preferred option due to the estimated substantial cost and construction phase impacts. The costs of bridge refurbishment have been further considered in this report in response to submissions on the alternative refurbishment proposal put forward by the ex-RMS bridge engineers. Responses to this issue and the results of additional costing carried out for the bridge refurbishment option are presented in **Section 4.4**.

Additionally, there are several reasons why retaining the existing Windsor Bridge does not form part of the preferred option for bridge replacement. Firstly, there are a number of issues associated with retaining the existing bridge that would apply to all alternative bridge replacement options, including the current preferred option and alternative bridge locations:

- If a replacement bridge is built and the existing bridge retained, the existing bridge would no longer be classified as an arterial road. As a non-arterial or local road, the bridge would be the responsibility of Hawkesbury City Council rather than RMS.
- Hawkesbury City Council have indicated that they will not take on responsibility for maintaining the existing bridge as future maintenance costs would be significant.
- While heritage trusts have been used in other locations to maintain bridges, they are costly and run into issues when founding members leave.
- The combined flooding impacts of two bridges would be greater than one bridge and may have significant impacts on existing properties on the floodplain.

For the current preferred bridge replacement option, there is the additional risk that the existing bridge could cause damage to the new bridge in the event of future damage or collapse during a large flood.

As discussed in responses above, a number of extensive inspections, assessments and evaluations have concluded that the bridge requires replacement. The primary driver for replacing Windsor Bridge is to meet engineering standards such as structural integrity, load carrying capacity, durability and maintainability.

2.15.6 Crash history

Submission number(s)

69.

Issue description

One submission raised the issue that the majority of traffic accidents in the project area have occurred on the approaches to the bridge, rather than on the bridge, and that the need to replace the bridge is therefore not justified on the grounds of crash history.

Response

The need for bridge replacement is not driven by crash history. The existing bridge requires extensive rehabilitation work if it is to be used and maintained into the future. The remaining safe life of the bridge cannot be accurately predicted due to ongoing deterioration, heavy use and risk of flooding. In addition to deteriorating with age, the existing bridge does not meet current engineering and road safety standards. Furthermore, the intersections on the existing bridge approach roads cause traffic delays and congestion, and have a number of safety issues, such as lack of safe crossing locations for pedestrians and poor vehicle sight distances. A further limitation of the existing bridge is that it is below the one in two year flood event level while the surrounding approach roads have a higher level of flood immunity. RMS has identified that the most effective solution to address these deficiencies is to replace the existing bridge.

2.16 Issue - Project justification

Many submissions raised concerns relating to project justification, including the claims made by RMS to justify the selection of the preferred option. The issues raised in these submissions related to the:

- Project development process.
- Director General's requirements for assessment of alternatives.
- Use of stated aims and objectives to justify the project.
- Cost effectiveness of the selected preferred option.
- Weighting given to heritage impacts in the assessment of alternatives.
- Weighting given to cost in the assessment of alternatives.
- Accuracy of cost estimates provided by RMS.
- Project objectives and benefits.
- Sustainability.
- The approval process and right to appeal the EIS.

2.16.1 Project development process

Submission number(s)

3, 6, 80, 92, 93 and the Heritage Council of NSW.

Issue description

Several community submissions questioned the transparency and integrity of the project development process, including the integrity of the EIS and the information conveyed to the community. One submission specifically criticised the project development process, arguing that option 1 was identified before community consultation began. This submission also questioned the merits of the alternative options that had been presented to the community and the message communicated about the bridge having deteriorated to the point where it could be closed at any time.

The Heritage Council of NSW contended that there is evidence to suggest that not all options were thoroughly considered prior to the selection of option 1 as the preferred option.

Response

RMS has acted with transparency and integrity throughout all stages of project planning, from options development through to preparation and public display of the EIS. The preferred option was selected following a robust process of identifying and assessing alternative options in consultation with the community and agency stakeholders. The EIS was prepared in consultation with agency stakeholders, has been reviewed by the Department of Planning and Infrastructure, and is considered to meet the Director General's requirements.

The data presented in the EIS are accurate to the best of current knowledge. The data presented in the EIS are based on the best available information, including the results of studies carried out specifically for the analysis of project options and environmental impacts.

Section 2.15.3 of this report discusses the condition of the existing bridge, including the various inspections undertaken, and the decisions made based on investigation findings. Responsibility for maintenance of RMS bridges and other structures lies with the Asset Management branch of RMS. As described in **Section 2.15.3**, the asset managers identified significant structural issues with the bridge that required action. Rehabilitation of the existing bridge was considered but was costed at around \$18 million and identified as requiring significant works, including the need for temporary bridge closures. At that time, the cost of a new bridge was estimated to be around \$25 million.

The replacement of the bridge was subsequently identified by Asset Management Branch as the preferred option to address the structural issues. However, while the bridge replacement was favoured by the asset managers it had not received broader RMS consideration at that time and was therefore not RMS' preferred option.

In late 2008 and 2009, the project received wider consideration by other sections of RMS and the need for more thorough consideration of options was subsequently identified. As a result, RMS considered a range of options, which were presented to the community in July 2009 for feedback. The nine options presented were considered appropriate at that time. Consideration of an exhaustive list of all potential options is simply not feasible. A report documenting community and stakeholder feedback on the options was published in November 2009.

An assessment of the identified alternative options was subsequently undertaken and the community's comments considered. In August 2011, an options report was published, accompanied by various technical investigations used to inform the options selection process. The replacement of the existing bridge was confirmed as the preferred option and the subject of the EIS. The process is discussed in detail in Section 4.1 of the EIS.

An assessment of various alternative options proposed by the community, including three options proposed by the ex-RMS bridge engineers, was presented in Section 4.2 of the EIS based on the information available at that time. Further detail on the Rickabys Line option proposed by the ex-RMS bridge engineers was provided during the exhibition of the EIS. Based on the additional available information on this option, a more detailed examination of the Rickabys Line option is presented in **Chapter 4** of this report.

2.16.2 Director General's requirements for assessment of alternatives

Submission number(s)

84.

Issue description

One submission contended that the Director General's requirements regarding project development and alternatives have not been met. In particular, the respondent contended that alternative options proposed by the community, including the Rickabys Line option developed by the ex-RMS engineers, were not rigorously assessed in the EIS.

Response

Having reviewed the EIS as submitted, and considered RMS' responses to various matters on which the Department of Planning and Infrastructure required further information, the Department placed the EIS on public exhibition on 14 November 2012.

A range of options were considered during the options selection process, including a number of options identified by the community. The options assessment process took into account transport needs, heritage impacts, environmental impacts and engineering and cost constraints.

The EIS included a brief assessment of the Rickabys Line option. It was not possible to provide a more detailed description of this option in the EIS as a clear description of the option was not presented to RMS during the EIS preparation period. As shown in Figure 4-1 in the EIS, three different routes of the Rickabys Line option were identified by the ex-RMS bridge engineers before a final route was selected and costed.

Based upon the information provided by the ex-RMS bridge engineers, a preliminary concept design of the Rickabys Line option has since been developed to enable a more detailed impact assessment and costing in response to submissions. The detailed impact assessment and cost estimates of the Rickabys Line option is presented in **Chapter 4**.

2.16.3 Use of stated aims and objectives to justify the project

Submission number(s)

93.

Issue description

One submission contended that the project aims and objectives, as stated in the EIS, have predetermined the selection of the project as the preferred option. In summary, the respondent raised the following issues:

- The overall project aim *to provide a safe and reliable crossing of the Hawkesbury River at Windsor* precludes consideration of a bypass.
- There was no benchmarking of project objectives or quantitative measurement of project performance against the objectives.
- The objectives are open to subjective interpretation and were changed to suit the project.
- Many of the objectives and associated criteria identified lack any objective measure of achievement. This is particularly problematic for an objective such as "minimises impact of noise" where existing noise levels in Thompson Square already exceed acceptable levels.
- The objective of minimising impact on heritage and the character of the local area fails to recognise the possibility of eliminating impacts altogether.
- No single solution could ever meet all of the objectives and cost was the overriding factor in option selection.

- Finally the failure to define 'cost effective' is a significant omission. If cost effective simply means 'cheapest option' there is little point in having any other objectives, as the cheapest project must in such a situation, always be the preferred option, regardless of the consequences.

Response

The overall project aim did not limit the consideration of a bypass option. As discussed in Section 4.2 of the EIS, a number of bypass options were considered but were discounted for various environmental and economic reasons.

It was recognised during the options assessment phase that the six project objectives did not provide sufficient scope or detail to assess the different options. In response, more detailed project criteria were developed for each objective. These criteria were used to compare the relative performance of each option. While it may have been possible to benchmark some of the project criteria, other criteria are difficult to benchmark as they are either largely qualitative measures or complex criteria with a large number of possible outcomes that cannot be summarised into a single quantitative figure (eg noise). Additionally, on other route options assessments, criteria or objectives have not been benchmarked.

The project criteria define attributes of an option that are highly desirable and it would not be expected that any specific option would fully satisfy all criteria. They have therefore been used to assess and compare the relative performance of the different options.

Cost was an important consideration in selecting a preferred option, especially given the cost differential between the project and a bypass option. Additionally, the project is not the cheapest option. There are a number of even cheaper options that could have been selected, including:

- Refurbishment of the existing bridge - this would not have resulted in the traffic benefits that the proposed option would provide the community and road users.
- Construction of a pre-cast plank bridge instead of an incrementally launched bridge. An incrementally launched bridge costs substantially more than a pre-cast plank bridge but was selected as the preferred bridge type as it would have less piers, less visual impact, and could be constructed predominately from the northern bank, avoiding more considerable construction impacts on Thompson Square.

2.16.4 Cost effectiveness of selected preferred option

Submission number(s)

69.

Issue description

One submission raised the following issues in relation to the cost effectiveness of the project:

- As project does not serve the needs of the community and road users in the long-term, it is not cost effective.

- The EIS suggests that the heritage impacts of the project are reversible because the replacement bridge and approach roads could be removed at a later date. This would not be cost-effective or affordable and does not represent responsible long term planning.

Response

The preferred option is the most cost effective way of achieving the primary aim of the project, being to maintain a safe and reliable crossing of the Hawkesbury River at Windsor. Parts of the existing bridge are over 130 years old and are substantially deteriorated due to age, flooding and heavy use. The existing bridge requires extensive rehabilitation work if it is to be used and maintained into the future. Despite ongoing maintenance, the bridge structure continues to deteriorate and the remaining safe life of the bridge cannot be accurately predicted. In addition to deteriorating with age, the existing bridge does not meet current engineering and road safety standards and the approach roads and intersections have a number of safety issues, such as lack of safe crossing locations for pedestrians and poor vehicle sight distances. A further limitation of the existing bridge is that it is below the one in two year flood event level while the surrounding approach roads have a higher level of flood immunity. RMS has identified that the most effective solution to address these deficiencies is to replace the existing bridge. In comparison to other options available, the preferred option for the project performs best in terms of value for money and satisfies the majority of project objectives.

Section 11.1.3 of the EIS states that conceivably the impacts on views and vistas are not fully irreversible as the replacement bridge and approach roads could be removed from the square at a later date, as has been demonstrated by the numerous redevelopments and reconfigurations of Thompson Square over the past 230 years. However, demolition of the existing bridge, which contributes to the heritage views and vistas, would be an irreversible impact.

2.16.5 Weighting given to heritage impacts in the assessment of alternatives

Submission number(s)

11, 16, 17, 24, 29, 44, 54, 66, 70, 80, 84, 85, 87, 88, 93, 95 and the Heritage Council of NSW.

Issue description

Many submissions suggested that the significant adverse impacts on heritage that would result from the project were not given sufficient weighting in the selection of the preferred option, and that the long-term and irreversible impacts on heritage are not justified given the project's minor benefits. In summary, the respondents raised the following issues:

- The location and scale of the proposed replacement bridge and southern approach road is totally inappropriate for such a significant heritage precinct.
- Sufficient weighting was not given to impacts on the heritage values of Thompson Square when assessing the cost effectiveness of the project.
- The heritage impacts of this project are not justified by its minor benefits and short-term traffic improvements.
- The heritage impacts of the project seem a high price to pay, especially given that the project will provide very few benefits and viable alternatives exist.

- The project as proposed is not supported by the Heritage Council of NSW or the National Trust of Australia (NSW) Hawkesbury Branch.
- The fundamental objective of the proposal appears to be to facilitate the movement of large volume of traffic through Windsor. Given that plans to increase housing development around Windsor will result in increased traffic volumes, it is totally inappropriate for such traffic to be directed through the centre of such an important heritage area.
- The disruption to the historic precinct of Thompson Square is proposed merely for the purpose of facilitating freight vehicles to pass through the town on the way to the Upper Hunter region. There is no reason for any of these vehicles to come anywhere near Thompson Square when their journeys begin and end far from Windsor.
- To claim that the option 1 site for the replacement bridge is the best site because it is the historical river crossing site is ridiculous. The option 1 site is only suitable for a small bridge, not one that accommodates heavy vehicles and meets current design standards. A bridge large enough to meet traffic requirements cannot be accommodated in Thompson Square without significant impacts on heritage.
- The historic value of Windsor to NSW and Australia will be realised in future years. Something of inestimable value will be lost if we look at this from a purely financial level today.
- The adverse heritage impacts of the project will constitute a significant and irretrievable loss of the heritage of Australia's most historic colonial town.
- Hawkesbury residents being given a half-baked, wasteful project that fails to provide any benefits while at the same time destroying one of the most precious areas of historic heritage.
- Probably the most disturbing aspect of the costings involved in this project is that at no time has the RMS placed a value on the heritage it is going to destroy. Heritage has value. This value is quantifiable. By not valuing Heritage the RMS and the Government is in breach of its commitment to the Burra Charter.

The Heritage Council of NSW also noted that the cost versus benefit analysis in the EIS does not adequately address or weight the value of the listed items in Thompson Square and Windsor as a unique and irreplaceable heritage asset for the State of NSW.

Response

The potential heritage impacts of the project have been minimised in the selection of the design for the replacement bridge. The EIS also identifies additional measures to avoid, manage and mitigate heritage impacts during future stages of the project, including detailed design and construction.

The EIS acknowledges that, despite minimising impacts on heritage as part of the design process, and implementing additional management measures during detailed design and construction, the project would still have significant adverse residual impacts, including demolition of Windsor Bridge, impacts on the form of Thompson Square, impacts on historic views and vistas, and impacts on archaeological records. The Department of Planning and Infrastructure will carefully consider the conclusions of the EIS and Heritage Working Paper, the heritage significance and values of the area, and any comments made by the community and government agencies (including the Heritage Council) during assessment of the project.

If the project is approved, the project would be undertaken in accordance with the impact mitigation and management measures identified in the EIS, as well as any additional measures identified in the Minister's Conditions of Approval. The Heritage Council of NSW would also be involved in providing advice to the Department of Planning and Infrastructure on the Ministers Conditions of Approval.

The decision regarding the preferred option was based on the outcomes of a detailed options assessment process, which involved engineers, urban designers and architects working collaboratively with environmental and heritage specialists and taking into account input from the community and stakeholders. The options assessment process took into account transport needs, heritage impacts, environmental impacts and engineering and cost constraints. The preferred option has been selected as the best option, on balance, to achieve the primary aim of the project, being to maintain a safe and reliable crossing of the Hawkesbury River at Windsor. In comparison to other options, the preferred option for the project performs best in terms of value for money and satisfies the majority of project objectives.

The cost benefit analysis in EIS is based upon the traffic performance and the whole of life cost of the project. While the economic analysis considers certain environmental impacts it does not include costs associated with heritage impacts. However, potential heritage impacts of the project were considered in the assessment of options against the project objectives and criteria.

2.16.6 Changes in the Benefit Cost Ratio methodology

Submission number(s)

95.

Issue description

One submission raised the issue that the methodology for the Benefit Cost Ratio (BCR) had changed between the options report and the EIS, and that this change was made to provide a more favourable outcome for the project.

Response

The EIS clearly states that the methodology for the BCR assessment changed between the options assessment phase and the EIS. One of the reasons for this is that more detailed information on traffic performance was available for the EIS in comparison to the options phase. The BCR for the options phase also assumed that, for the base case, the existing bridge would fail and all traffic would need to travel via Richmond. This scenario was considered unrealistic during the preparation of the EIS and the base case for the EIS BCR assessment therefore assumed that the existing bridge would be maintained. It is recognised that, with these changes in data availability and the base case, the BCR for alternative options to the project would also change and more than likely increase. **Section 4.5.1** of this report provides a BCR assessment for the project compared to the Rickabys Line option. This shows that, while the BCR for a bypass would be higher than that presented in the options report, it would still be considerably lower than the BCR for the project.

2.16.7 Weighting given to cost in the assessment of alternatives

Submission number(s)

24, 17, 68 and 93.

Issue description

A number of submissions contended that the selection of the preferred option was based largely on cost, with the preferred option being the cheapest option. There was also concern that predicted cost of the preferred option has risen. In summary, the respondents raised the following issues:

- The historic value of Windsor to NSW and Australia will be realised in future years. Something of inestimable value will be lost if we look at this from a purely financial level today.
- The selected preferred option is not the best available option. "It's all about a cash-strapped State Government looking for the cheapest possible option, without any regard for their responsibilities to the community they serve, or future generations"
- Financial costs have been used to eliminate alternatives to option 1 regardless of the social, environmental and historic and heritage costs imposed by option 1.
- Cost was the overriding factor in the selection of option 1 as the preferred option and has been given a higher weighting than any other selection criteria in the options selection process.
- The predicted cost of the preferred option has risen from \$23 million to \$60 million.

Response

In comparison to the other options considered, the project provides value for money and, while it does not address the project objectives of minimising heritage and visual impacts as well as other options that were considered, mitigation measures have been proposed to reduce these impacts to the extent possible. It is noted, however, that the impacts would not be eliminated.

It is also recognised that the cost of the project has increased since first proposed, however remains substantially less expensive than other options considered and provides the best value for money based on economic analysis.

2.16.8 Accuracy of cost estimates provided by RMS

Submission number(s)

6, 11, 66, 84, 93, 94 and 95.

Issue description

Several submissions raised concerns about the cost estimate provided by RMS for the refurbishment of the existing Windsor Bridge and the use of this cost estimate by RMS to dismiss the refurbishment option. In summary, the respondents raised the following issues:

- RMS have over-estimated the cost of refurbishing the existing bridge to justify the project.

- Independent bridge engineers say the existing bridge can be fixed for \$4 million and will last 100 years. This is substantially lower than the cost estimate provided by RMS (\$18 million).
- The discrepancy in the cost estimates for bridge refurbishment provided by RMS and the independent bridge engineers is grounds for a re-evaluation of all costing information provided to the public in relation to selection of the preferred option.
- Selection of the project is not justified when the existing bridge could be maintained and a bypass built for the same cost.
- There was no breakdown of costings for accurate comparison of options in the EIS.

Response

As discussed in the EIS, refurbishment of the existing Windsor Bridge was assessed as an alternative option to bridge replacement but was not selected as the preferred option due to the estimated substantial cost and construction phase impacts. The costs of bridge refurbishment have been further considered in this report in response to submissions on the alternative refurbishment proposal put forward by the ex-RMS bridge engineers. The results of additional costing carried out for the bridge refurbishment option are presented in **Section 4.4**.

2.16.9 Project objectives and benefits

Submission number(s)

2, 24, 32, 51, 54, 66, 68, 69, 72, 80, 84, 85, 86, 92, 93, 94, 95 and the Heritage Council of NSW.

Issue description

Many submissions contended that the benefits of the project were minimal and did not provide sufficient justification for the project to go ahead. In summary, the respondents contended the following:

- The project will benefit no one.
- The like for like replacement of the bridge is a waste of money.
- There has been little clarity as to what the project will achieve. Stated objectives and outcomes seem to keep changing and seem to be no more than public relations spin.
- The project will not substantially improve traffic flow or flood immunity so there is no practical reason for the project to go ahead.
- The preferred option is being promoted as the solution that best meets community needs and project objectives, although it will have little or no benefit for the community and have a permanent and highly detrimental impact on Thompson Square and surrounds.
- The impacts of the project on heritage are not justified as the project does not meet RMS' claimed project objectives.
- The EIS displays a lack of understanding of local community needs. It does not adequately reflect the loss of commercial, tourism, traffic improvement and flood management opportunities that would be caused by the project.

- The project will not meet the stated project objective to minimise impacts on heritage and the character of the local area.
- The project will not meet the stated project objective to improve safety and traffic efficiency for motorists, pedestrians and cyclists.
- The project will not meet the stated project objective to meet long term community needs.
- The “star” comparisons in Table 4-2 of Volume 1 of the EIS allocates option 1 (the preferred option) two stars for pedestrian safety and two stars for design codes. This is misleading because the hazardous roundabout at George Street would remain until Stage II (in the indeterminate future). These entries should therefore be zero stars.
- The assessment of the project against the objectives and criteria presented in the EIS is biased and incorrect.

The Heritage Council of NSW also noted that the project will not meet the stated project objective to minimise impacts on heritage and the character of the local area.

Response

In comparison to other options, the preferred option for the project performs best in terms of value for money and satisfies the majority of project objectives. The project would provide a new bridge, approach roads and intersections to current road design standards. The project design would improve the level of flood immunity to match that of the surrounding approach roads, and provide a safer crossing for vehicles, cyclists and pedestrians. The proposed intersection improvements and an initial two lane bridge configuration would provide acceptable traffic performance immediately and into the future. The bridge has also been designed so that it can be subsequently reconfigured to a three lane bridge (with two southbound lanes and one northbound lane) to meet future traffic demands, as required.

The existing bridge requires extensive rehabilitation work if it is to be used and maintained into the future. The remaining safe life of the bridge cannot be accurately predicted due to ongoing deterioration, heavy use and risk of flooding. In addition to deteriorating with age, the existing bridge does not meet current engineering and road safety standards. The intersections associated with the existing bridge approach roads cause traffic delays and congestion, and have a number of safety issues, such as lack of safe crossing locations for pedestrians and poor vehicle sight distances. These intersections cannot be upgraded to the same degree as proposed for the project without also constructing the proposed replacement bridge. A further limitation of the existing bridge is that it is below the one in two year flood event level while the surrounding approach roads have a higher level of flood immunity. RMS has identified that the most effective solution to address these deficiencies is to replace the existing bridge.

The adverse impacts of the project have been considered in design and options development, and would be further mitigated and/or managed using the measures identified in this EIS. These include detailed management and conservation measures to avoid, minimise and mitigate impacts on historic heritage, as well as urban design and landscape treatments to integrate the new bridge with the existing environment. The proposed consolidation of Thompson Square, combined with the new pedestrian and cycle facilities, would improve the amenity of Thompson Square and its connection to the river.

Staging of the project was considered during the project development phase and it is recognised that some initial project information stated that the project would be delivered in two stages. The first stage was to consist of the replacement bridge and northern intersection and the second stage the upgrade of the Georges Street/ Bridge Street intersection and the widening of the Fitzroy Bridge over South Creek. During the preparation of the concept design and EIS, and community consultation and feedback regarding the lack pedestrian safety in this area, RMS decided to incorporate the signalised intersection into the project so that the benefits of the upgraded George Street/ Bridge Street intersection would be realised and to minimise cost and construction impacts on the community.

2.16.10 Benefits to pedestrian and cyclist safety

Submission number(s)

69, 93 and 95.

Issue description

Three submissions argued that greater improvements in pedestrian and cyclist safety would be achieved by minor intersection modifications and by removing heavy vehicles and through traffic from the main tourist area of Windsor, rather than through the proposed bridge replacement project. For this reason, the respondents felt that the improvements in pedestrian and cyclist safety did not justify the project.

Response

The need for bridge replacement is not driven by the need to improve pedestrian and cyclist safety. This is just one of the benefits that would be achieved through the preferred option.

As discussed in **Section 2.4.7**, the intersection upgrades proposed as part of the project could not be undertaken without the replacement bridge also being constructed. This is because the levels and alignments of the approach roads to the existing bridge would not allow a roundabout to be constructed at the northern intersection or traffic lights to be installed at the Bridge Street/ George Street intersection. The only intersection upgrade that would be feasible would be the installation of traffic lights at the Freemans Reach Road/ Wilberforce Road intersection. This would provide some minor benefits to pedestrians accessing Macquarie Park but, without the construction of additional paths, it would not address any other issues with pedestrian and cyclist movements in and around Thompson Square or across the river.

Additionally, as noted in **Section 2.4.7**, if the project was not to proceed the options for the upgrade of the intersections at George Street/Bridge Street and Freemans Reach Road/Wilberforce would be limited due to the levels and location of the approach roads to the existing bridge. There would be no upgrade possible to the George Street/ Bridge Street intersection and only traffic lights would be feasible at the intersection of Freemans Reach Road and Wilberforce Road. Most of the benefits for pedestrians and cyclists that would be provided by the project would not be realised with alternative options.

Additional benefits include:

- A three meter wide shared path across the bridge.
- Relocation of the shared path to the upstream side of the bridge allows a better connection between Thompson Square/George Street and the Macquarie Park reserve, which is becoming more popular with tourist and the local community. This connection allows pedestrians and cyclist to enjoy both parklands on either side of the river without having to cross the road.
- An underpass will also be provided on the northern side where pedestrians and cyclist who have Wilberforce as a destination also make the connection without crossing a road or negotiating the dual lane roundabout.

2.16.11 Benefits of removing the 1934 road cutting

Submission number(s)

54, 70, 93 and the Heritage Council of NSW.

Issue description

Three community submissions refuted the claims made in the EIS that the adverse impacts of the project on heritage would be mitigated to some degree by the removal of the existing 1934 road cutting through Thompson Square and the consolidation of the upper and lower parkland areas. In summary, the respondents raised the following issues:

- The existing road cutting through Thompson Square was constructed by the RMS equivalent in the 1930s despite protests by the people and the Mayor on the grounds of impacts on Thompson Square. The current proposal is history repeating itself in terms of destruction of heritage by the roads authority.
- The claim that the consolidation of the upper and lower parkland areas would increase the area of usable open space within Thompson Square and improve access to the waterfront dismisses the following issues:
 - Extensively regrading the ground levels within the square will result in destruction of its heritage.
 - The existing 1934 road cutting also works well in Thompson Square, in that it hides the traffic from the view of people sitting in the upper parkland and absorbs most of the noise from the road making the area more attractive.
 - The bisection of Thompson Square by Bridge Street gives it an interesting character that will be lost with the new road and consolidation of the parkland. The upper parkland area has a close connection to George Street and is a focal point for the community, while the lower section of the park has an open feel and is a great area for people to stop and enjoy views of the river. Views to the river from the proposed consolidated parkland would not be as good as those currently provided by the existing lower parkland.

The Heritage Council of NSW raised the following additional issue:

- The contours, shape, appearance and layout of Thompson Square have altered over time, with various changes occurring over its 200 year life reflecting its role as a key public space in Windsor. It is therefore an incorrect argument to suggest that removing the existing road cutting provides an opportunity to 'reinstate' the square in a single and most 'correct' configuration.

Response

The EIS states that the benefits of the project would include removal of the existing bridge approach road through Thompson Square and subsequent unification or amalgamation of the upper and lower parkland areas that are currently dissected by this road. The EIS describes this component of the project as a benefit to community amenity, not a benefit to heritage values. The EIS describes the removal of the existing bridge approach road through Thompson Square as “reinstating” this area of land as part of the square. It also states that it provides an opportunity to reinstate the typical Macquarie era grid street layout and improve the relationship between the open space and the river. It does not state that unifying the upper and lower reserves reinstates the square in its 'correct' configuration. However, interestingly the SHR listing for Thompson Square states in relation to the cutting:

“The centre of Thompson Square is spoilt by a main road which slices diagonally through it and into a cutting, destroying the visual integrity of the space as was originally intended.”.

The existing diagonal cutting of Bridge Street through Thompson Square results in a strong physical split of the open space into two disconnected triangular shaped reserves. The division creates a distinct upper open space area adjacent to George Street (the upper parkland) and a lower open space area adjacent to The Terrace and river foreshore (the lower parkland). The existing road cutting and connection to the southern bridge abutment also severs The Terrace at the point where The Terrace meets Bridge Street. This prevents pedestrian, cycle and vehicle access along The Terrace between the main area of Windsor and the wharf. Not only does the existing road cutting and connection to the southern bridge abutment sever The Terrace, pedestrians have to use a dark passageway with a set of timber stairs to go under the existing bridge. Additionally, pedestrians wanting to access the river from George Street currently have the choice of either:

- Crossing the road at the roundabout without pedestrian crossing facilities and traveling down Old Bridge Street, which does not have a dedicated pedestrian path.
- Taking the long detour via Thompson Square Road, The Terrace, and the stairs under the bridge.

On these grounds it is concluded that the removal of the existing 1934 road cutting through Thompson Square, the corresponding consolidation of the upper and lower parkland areas, and the provision of new pedestrian and cyclist facilities would improve the amenity and safety of the area for community and visitor use.

2.16.12 Sustainability

Submission number(s)

6, 16, 42, 52, 56, 72, 74, 85, 86, 87 and 93.

Issue description

Many submissions contended that the project is not sustainable. In summary, the respondents raised the following issues:

- The current proposal is short-sighted and is not sustainable.

- The current proposal is a short-term solution - it will be an expensive and irreparable quick fix with long-term impacts on Windsor.
- Leaving the route through the Square area, at very best, can only postpone problems for future generations.
- The traffic modelling indicates that the new bridge will reach capacity by 2026. By the time the new bridge is constructed and opened to traffic, it would therefore be viable for only around 10 years. To spend such a considerable amount of money on a project that will only be suitable for a decade does not seem to be in the best interests of the local community or NSW taxpayers.
- At no time has RMS placed a value on the heritage it is going to destroy. Heritage has value that is quantifiable. By not valuing Heritage, RMS and the Government is in breach of its commitment to the Burra Charter.

Response

Section 11.1.3 of the EIS discusses the principles of Ecologically Sustainable Development, including the principle of intergenerational equity, which requires that the present generation should ensure the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations. Apart from heritage, the project would at a minimum maintain the health, diversity and productivity of the environment while also enhancing the amenity of the environment by increasing the area of continuous open space within Thompson Square and improving pedestrian and cyclist access, both between Thompson Square and the river, and across the river.

Where possible, the assessments of impacts from the project have taken into account future growth in traffic thereby determining whether the project would impact future generations. Based on these impact assessments, apart from the loss of heritage vistas and values, the project would not have significant additional impact on future generations. For heritage, a comprehensive archaeological investigation and salvage program would be undertaken before construction to enable archaeological recording of the historical development of the area for future generations.

Growth in traffic volumes is discussed further in **Section 2.8.2** of this report.

2.16.13 The approval process and right to appeal the EIS

Submission number(s)

3, 93 and 95.

Issue description

One submission contended that there is no right to appeal the EIS and two others challenged the declaration of the project as State Significant Infrastructure (SSI).

Response

The definition of what constitutes SSI is provided under Section 115U of the EP&A Act. In general terms, a development is declared SSI under Section 115U of the Act if one of the following two conditions apply:

1. The development on the land concerned is, by the operation of a State Environmental Planning Policy (SEPP), permissible without development consent under Part 4 of the EP&A Act, and the development is specified in Schedule 3 of the State and Regional Development SEPP.
2. The development is specified in Schedule 4 of the State and Regional Development SEPP.

The project is declared SSI because the first of the above-listed conditions apply. To explain further, the development specified in Schedule 3 of the State and Regional Development SEPP includes (but is not limited to) general infrastructure or other development by public authorities (other than a council or county council) that (but for Part 5.1 of the Act and within the meaning of Part 5 of the Act) would be an activity for which the proponent is also the determining authority and would, in the opinion of the proponent, require an EIS to be obtained under Part 5 of the Act.

The classification of the project as SSI under the EP&A Act, while making it exempt from the need for heritage approvals under the Heritage Act does not exempt it from heritage considerations. Heritage impacts have been considered to the same degree as they would have been had the project not been classified as SSI.

Judicial review proceedings are available under the EP&A Act.

2.16.14 Justification of the project using local and NSW plans and policies

Submission number(s)

95.

Issue description

One submission contended that the justification of the project using various local and NSW plans and policies was disingenuous as most of these plans and policies did not directly reference the project.

Response

One of the Director General's requirements issued by the Department of Planning and Infrastructure for the EIS was an assessment of the project against relevant local and NSW Government plans and policies. To provide a complying EIS, an assessment of the project against these plans and policies within the EIS document was required. These plans and policies were not used as a justification for the project, rather the project was assessed to largely meet some of the objectives of these plans and policies. It is recognised that the project is not explicitly mentioned in many of the NSW plans and policies but this does not negate the requirement to assess the project against their general objectives.

3 Additional assessment

A number of additional assessments have been undertaken since public exhibition of the EIS. These include:

- Additional historic heritage archaeological investigations at the intersection of George Street and Bridge Street.
- Archaeological investigation options for Thompson Square
- Revised flood modelling of the project.

Details of these additional assessments are provided below.

Further noise investigations were also undertaken to address design changes and include a number of additional residential properties identified during exhibition of the EIS. These are discussed in **Section 5.1.4**.

3.1 Additional historic heritage archaeological investigations

3.1.1 Scope and purpose of additional investigations

Following ongoing consultation with the Department of Planning and Infrastructure and Heritage Branch, RMS undertook further historic heritage archaeological investigations in the area that would be impacted by the George Street/ Bridge Street signalised intersection works. This section summarises the findings of the additional investigations. The full report of the investigations is attached in **Appendix B**.

The investigations focussed on the George Street/ Bridge Street intersection, including the footpaths and the south-eastern corner of the Thompson Square upper parkland area. The purpose of the investigations was to provide further information on the impacts of the proposed signalised intersection works on historic archaeology. (At the time of the archaeological investigations for the EIS, signalised intersections were not proposed). More specific objectives included:

- To determine if an archaeological profile survives in the project area and, if it does, the nature and chronological range of that resource and its potential depth.
- To investigate the presence or absence of physical evidence of the 1803 Commissariat building on the south-eastern side of the intersection.

The results of the investigation were intended to compliment the results of previous archaeological tests undertaken within Thompson Square. The results of the previous archaeological tests are presented in the EIS.

3.1.2 Archaeological evidence gained from the test excavations

The key information provided by the additional archaeological investigations is as follows:

- The topography recorded in the earliest nineteenth century images of the Green Hills settlement is accurate in its depiction of a high, exposed ridge line stepping steeply down to the river.
- The ancient sand dunes recorded in test pits on the northern side of the river do not appear to have covered the peak of the ridge that corresponds to the current

alignment of George Street. The peak of this ridge is likely to have been exposed bedrock or only thinly covered with sand or soil. Furthermore, if a thin soil cover existed, it may have been removed in the earliest days of settlement to provide a hard and impervious surface for pedestrian traffic and construction projects. The exposed bedrock in this location may have been cut and shaped in places for the construction of building foundations, drains or other structural works.

- No clear evidence was found of the 1803 Commissariat building. Furthermore, the impact of road works and laying of services in the footpath on the eastern side of Bridge Street make it unlikely that any evidence of this building remains. If, however, the technique of cutting and shaping bedrock was used to construct the building foundations, some evidence of this work could survive within the bedrock.
- By the mid-nineteenth century, the alignment of George Street had been altered at least twice and soils had been imported to build up the area in the vicinity of the George Street/ Bridge Street intersection. The accumulated soils at this location were removed in c. 1889 to allow for a major program of infrastructure, including installation of services and creation of a new road surface comprising a locally sourced clay base and a cobble stone surface. It is not possible based on current information to determine if this work was also carried out in Bridge Street.
- The same locally sourced clay appears to have been used to create a pedestrian area along Bridge Street adjoining the School of Arts when changes were made to the road alignment. There are similarities between this clay and that recorded in the test trench at the northern end of Thompson Square, where it was used to help raise the ground level for the new approach for the bridge when the bridge was raised in 1894.
- Based on information from document archives, there was a paved footpath on at least part of the southern side of George Street adjoining Stearn's premises. Some evidence of this surface might be preserved within the garden area at the junction of George Street and Bridge Street but insufficient archaeological investigation has been made here to confirm the date of this feature.
- A bitumen paved road was laid in George Street by 1938. This surface might remain as the present day surface or it may have been replaced later in the twentieth century. The paved footpath along Bridge Street probably dates from this same period and a comparable footpath did exist on the southern side of George Street. No evidence of this path was found and it is possible that the construction the present footpath and garden removed evidence of this development.
- The introduction of services in the footpaths has had a substantial impact on the preservation of archaeological evidence.

3.1.3 Potential impacts of the intersection works

The following conclusions have been drawn regarding the impacts of the proposed intersection works, in addition to the conclusions presented in the EIS:

- The information provided by the investigations, combined with the information from archival sources, allows for a reasonable interpretation of the pattern of development in the project area.

- Generally, any features that can be positively attributed to the earliest settlement of Green Hills and of the Macquarie period town would be of State significance. The evidence of later nineteenth and early twentieth century infrastructure, including the creation of roads and footpaths, would be of local significance for what it can document about the growth of the town. The paved area and garden created at the south-western corner of the intersection in the last thirty year period would have at best local significance.
- The excavation required for the intersection works will impact historical archaeological resources. The depth of the archaeological profile on the ridge top is shallow, being little more than half a metre. The works required for the project extend beyond that depth, including into the bedrock where it is possible that evidence of early nineteenth century building foundations could be preserved.
- The archaeological evidence that would be impacted by the project could include some works that predate c. 1810. This evidence would be of State significance.
- The majority of the soil profile revealed by the investigations dates from c.1889 onwards and this component of the profile will be the main component impacted by the works. This area is of local historic significance, with the possible exception of the most recent paved footpath and garden area at the south-western corner of the intersection.
- The project would result in the fragmentation of large units such as road surfaces and bedding. It is unlikely to completely remove all archaeological evidence because there are large areas of archaeology that probably extend beyond the areas of impact.
- While the excavation did not provide any evidence for the presence of the Commissariat Store of 1803, there is still a possibility that intact evidence exists outside the investigated road area. It is not possible from the investigations conducted to determine if the project would impact evidence of this type. Any remaining evidence of this building would be of State significance.
- It is difficult to assess the potential for the project to impact bedrock modifications that may have been made for historic building foundations. The practice of modifying bedrock for building foundation has not been confirmed, although the results of the test excavations provide some indication that it has occurred. Because of the random and largely undocumented location of many of the early structures, it is not possible to predict if the project would impact any historical bedrock modifications of this type.

3.2 Archaeological investigation options for Thompson Square

At the request of the Department of Planning and Infrastructure and Heritage Branch, RMS has also undertaken a detailed examination of options for the archaeological investigation of Thompson Square that would be undertaken should the project be approved. This examination expands on the need for open area salvage that was identified in the EIS.

The *Archaeological Investigation Options for Thompson Square* report is provided in **Appendix F**. An overview of the identified options is provided below, together with RMS' proposed approach. Additional detail on the management of archaeological resources is also provided, as well as details on proposed public interpretation.

3.2.1 Assessment of archaeological options

As discussed above, RMS engaged specialist archaeologists to identify potential archaeological investigation options for Thompson Square. The investigation identified three potential options as follows:

- Option 1 – which was restricted to the footprint of construction disturbance only, leaving ‘islands’ of deposit within the construction zone untouched.
- Option 2 – as above but seeking to maximize the recovery of information where disturbance was anticipated, removing all deposit including the ‘islands’ and service trenches to allow any archaeological evidence to be recorded. It would also include extensive continuous excavation across the junction of Bridge and George streets to understand the distinctive archaeology recovered from test pits in this area
- Option 3 – involving excavation of the entirety of the open space and roadways in Thompson Square.

RMS has considered the archaeological outcomes that each option offers, as well as anticipated community, environmental, traffic management, and construction impacts. Each option was shown to involve considerable excavation within Thompson Square.

Option 1 requires retaining standing pedestal ‘islands’ of archaeological deposit some metres high in a construction environment. Option 1 presents a real risk that these retained areas will sever or mask the evidence needed to make sense of the complex archaeological stratigraphy of the site, resulting in a less reliable and comprehensive understanding of the site’s history. The Option 3 proposal is contrary to archaeological ethics, which require minimising the loss of unique resources, maximising the results from the impact achieved and retaining sufficient archaeological evidence to allow future techniques and technologies to be used.

Option 2 represents the most effective means of realising the archaeological potential of Thompson Square, by predominately digging a large area as a single integrated investigation area, which is the appropriate means of investigating a complex, heavily dissected archaeological landscape. However, one element of the proposed design – extensive continuous excavation across the Bridge and George Street intersection – would cause unacceptable traffic closures, including access to the bridge.

To avoid these impacts, RMS proposes a “modified Option 2” involving staged investigations within George Street and adjoining areas of the intersection that leave Bridge Street trafficable and would provide comparable archaeological outcomes. The investigations in George Street will be planned to minimise impacts on traffic and access to adjacent businesses.

RMS requires that the research design specifies the appropriate methods of archaeological investigation outside the core area of the lower parkland and under what circumstances total recovery of archaeological evidence may be varied to sampling recovery. The proposed horizontal extent of archaeological investigations proposed by RMS is identified in **Figure 3-1**. Investigations within this area would include archaeological salvage or monitoring, as appropriate.

While complete recovery of all historic period deposits within the excavation footprint is desirable, this needs to be continually assessed as the most appropriate strategy while excavation is in process. The depth of excavation proposed should be considered in the archaeological research design. RMS proposes that the depth of

excavation will be:

- Within the lower parkland 'footprint' of the southern approach/ abutment – seek complete recovery of archaeological evidence to base of deposits.
- Outside this area – the depth of excavation is to be specified by the archaeological research design, taking into consideration the nature of known archaeological deposits, the construction impact and its depth, the desired and likely information to be obtained from different archaeological methods, including remote sensing, monitoring and salvage.

The research design should set out under what circumstances this approach should be varied to take advantage of unexpected ground conditions, archaeological deposits and so on.

3.2.2 Managing the archaeological excavation

RMS recognises that Thompson Square is a place of high State heritage significance, particularly for its archaeological potential. Approval of the Windsor Bridge replacement project will require, as a minimum, a major archaeological investigative program to realise the archaeological potential of the site. This will take place as a component of a broader Heritage Conservation Management Plan if approval is granted.

As the site requires the active participation of three strands of archaeology – terrestrial and maritime historical archaeology and Aboriginal archaeology, it is important that the project proceed as a single integrated investigation. Close cooperation with regulators, stakeholders and the archaeological profession will be essential to maximising the opportunity afforded to investigate this unique site. The significance of the site requires that interpretation be used both during and after the investigation to tell the story of the site and its human history.

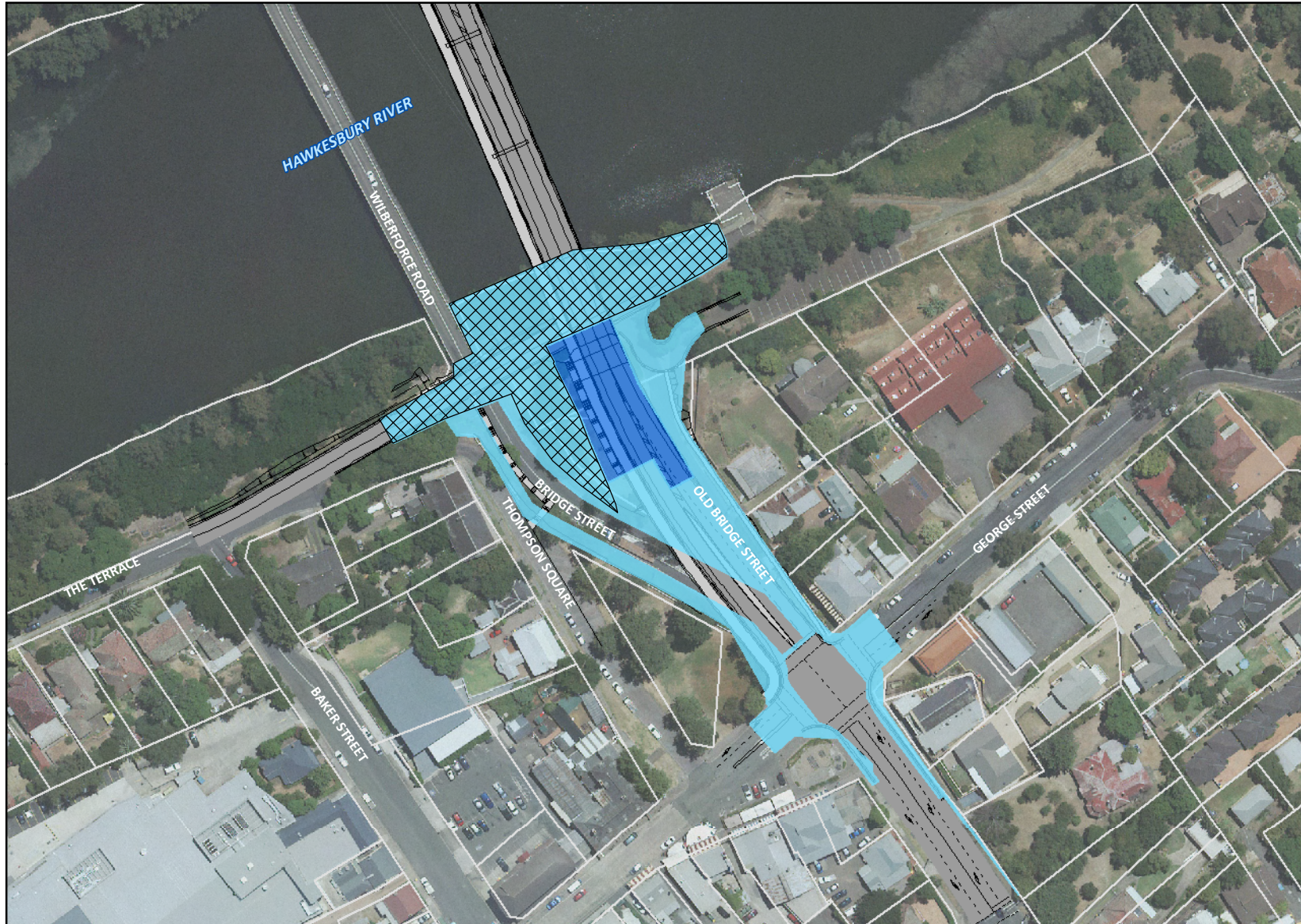
To achieve these aims RMS commits to the following archaeological program objectives:

- To maintain regular liaison with heritage stakeholders - Office of Environment and Heritage, Heritage Council of NSW, Department of Planning and Infrastructure and Hawkesbury City Council - to ensure they are fully informed about the progress of the excavation and analysis.
- To develop a single overarching research design that meets best practice standards, with relevant input from the three strands of archaeology for heritage stakeholder endorsement
- To conduct an archaeological excavation and salvage operation that is appropriate to the project footprint and its archaeological potential
- To put together an integrated archaeological team, including Aboriginal sites
- To make sure artefact analysis adheres to current archaeology digital database standards.






To ensure the proposed archaeological research design and salvage operation represents best practice standards, RMS will consider implementing the following initiatives:

- Hosting a specialist workshop to provide the most up to date current framework from comparable sites as part of research design preparation.

- Establishing an Archaeology Reference Panel consisting of three senior researchers in historical archaeology, Aboriginal heritage and early colonial history. The heritage stakeholders and the Archaeology Reference Panel may be used to review proposed variations to the research design, and consider proposals for retention of *in situ* archaeological evidence. They may also be used to review interpretation plans and other planning documents.

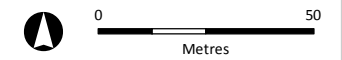


LEGEND

-  Windsor Bridge concept design
-  Cadastre
-  Lower parkland footprint of the southern approach/abutment - complete recovery of the archaeological evidence to base of deposits and bedrock
-  Depth of excavation to be specified by the archaeological research design, considering the nature of known archaeological deposits, the construction impact and depth, the desired and likely information to be obtained from different archaeological methods
-  Subject to further design assessment and consultation with community and stakeholders

Indicative only – subject to detailed design

DATA SOURCES
 Imagery: AUSIMAGE 2011
 Cadastre: LPI



Area of potential archaeological investigation



3.2.3 Public interpretation

In addition to the archaeological investigations proposed above, RMS proposes to develop a public interpretation program to maximise opportunities for people to understand the process of archaeology and witness revelation of the site's significance during and after the archaeological investigation program.

RMS has held preliminary discussions with the Hawkesbury Regional Museum, which is keen to be involved in archaeological interpretation programs that build on the interest generated by the archaeological work. RMS will also seek to work with Engineers Australia to develop suitable on-site interpretation to promote engineering education through the opportunity to observe a major civil construction project as it proceeds.

An interpretation plan will be prepared for the archaeological investigation program with the involvement of heritage stakeholders. It will consider a range of commonly used interpretation methods, including:

- Static explanatory signage erected at points around the work perimeter.
- Archaeological 'explainers' to interact with interested community members.
- Information sheets available as handouts and internet downloads.
- Scheduled open days when the archaeological site can be visited.
- A web-log that documents the progress of the dig.
- Time-lapse photography, video and other documentary research.
- Changing 'what's on' display in the Museum to alert visitors to the range of interpretation opportunities and the latest discoveries.
- Identification of any archaeological evidence to be retained *in situ* for permanent interpretation purposes.
- Talks by specialists on artefact topics.

Following the completion of the excavation an updated interpretation plan will be prepared, identifying what enduring elements of the archaeological investigation should be promoted. These may include display of *in situ* archaeological remains, the use of recovered materials or forms as design elements in the final landscaping and works as well as museum displays, and publications for a range of audiences.

3.3 Revised flood modelling

To respond to the concerns of the OEH, and to further assess the requirements for scour protection, the flood modelling for the project has been revised using a more accurate two dimensional hydrological model and the most up to date bridge design. The latest bridge design has a shallower profile, a lower number of piers in the river and less bulky piers compared to the bridge design used in the flood modelling for the EIS. It was recognised in the EIS the flood modelling presented in the document was conservative and tended to over-estimate potential flooding impacts. This has been confirmed by the results of the revised flood modelling

The EIS predicted increases in flood levels for the 5 year flood event of around 0.12 metres immediately upstream of the bridge and around 0.06 metres up to five kilometres upstream. The OEH raised concerns about these increases in flood levels in their submission on the EIS and it was recognised that flood mitigation works for affected properties would be required if these predicted increases were correct.

Preliminary results from the revised modelling using the latest design of the bridge indicates, however, that there would be no increase in upstream flood levels for events greater than the 20 year event and the maximum increase for smaller events would be 0.01 metres for the 10 year event (see **Table 3-1**). An increase of 0.01 metres is negligible and at the limit of the accuracy of the hydrological model. Based on the preliminary results from the revised modelling, no additional consideration of flood mitigation works would be required.

Table 3-1 Comparison of existing and proposed case flood levels upstream of the existing bridge

| Design event | Flood level (m AHD) | | Difference (m) |
|--------------|---------------------|----------|----------------|
| | Existing | Proposed | |
| 5 year | 11.00 | 10.98 | -0.02 |
| 10 year | 12.25 | 12.26 | +0.01 |
| 20 year | 13.80 | 13.80 | 0.00 |
| 50 year | 15.97 | 15.97 | 0.00 |
| 100 year | 17.77 | 17.77 | 0.00 |
| 2000 year | 23.19 | 23.19 | 0.00 |
| PMF | 26.76 | 26.76 | 0.00 |

4 Rickabys Line option

4.1 Overview and description of the option

Two ex-RMS bridge engineers have proposed an alternative option to the project. The alternative is known as the Rickabys Line option and involves refurbishing and retaining the existing bridge for light traffic and building an alternative river crossing route to the west of Windsor. The Rickabys Line option was considered in Section 4.2.2 of the EIS based on the information available at that time, although it was then referred to as one of the Hawkesbury Valley Way options (three in total). At the time of preparing the EIS, there was insufficient detail available to assess this alternative more thoroughly. A bypass option west of Windsor was not considered a viable option during the options development and assessment phase or in the EIS due to potential impacts on Macquarie Park, vegetation communities listed under the *Threatened Species Conservation Act 1995* and flooding levels upstream of Windsor.

Since the exhibition of the EIS, the ex-RMS bridge engineers have provided a more detailed submission outlining their Rickabys Line option. This alternative option received media publicity and was identified in many submissions as a preferred alternative to the project. To provide more detail on the option the following information is presented:

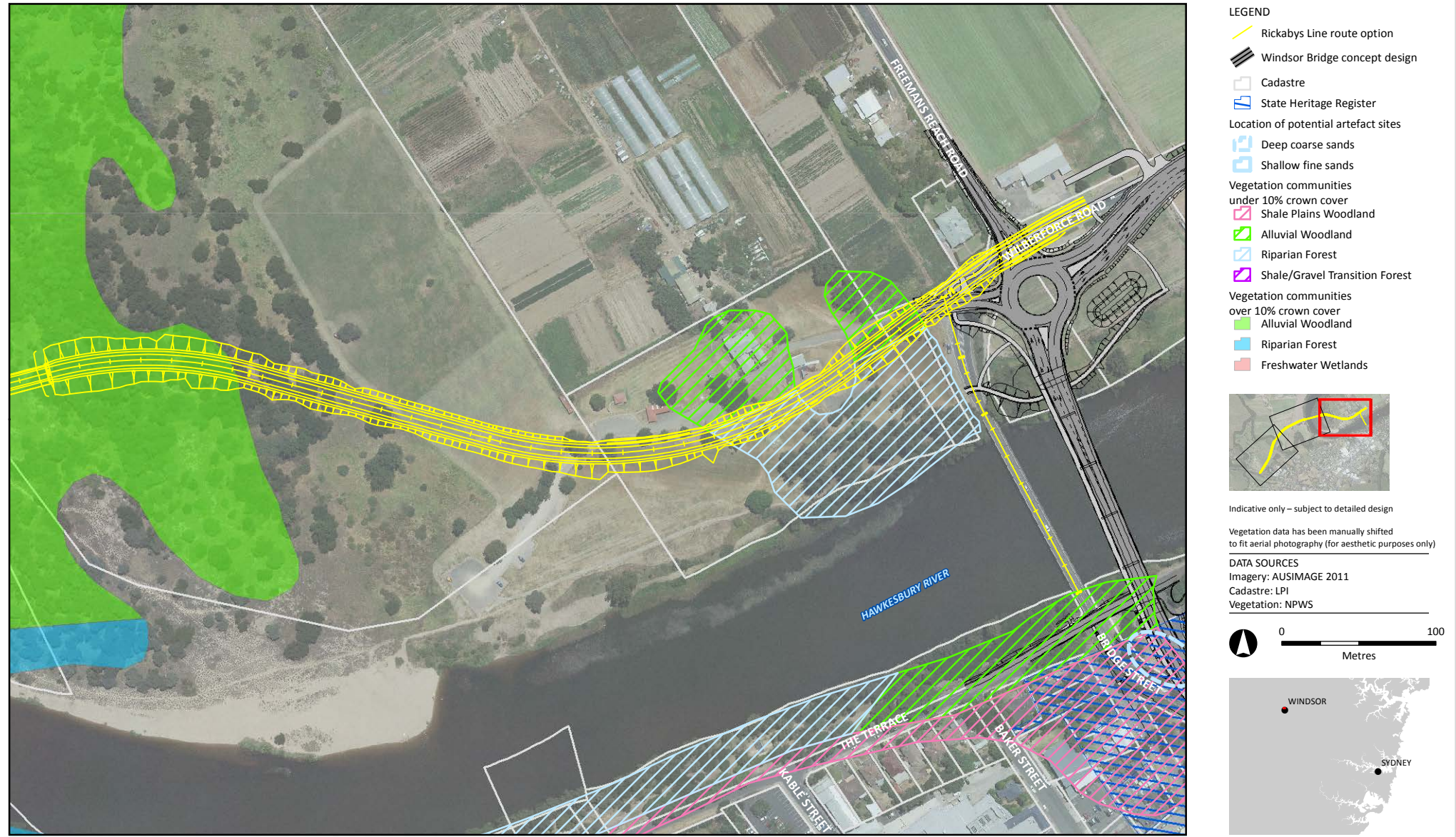
- A more detailed environmental impact assessment of the Rickabys Line option.
- A review of the alternative refurbishment methodology for the existing Windsor Bridge proposed as part of the Rickabys Line option.
- A review of the cost estimates supplied by the ex-RMS bridge engineers.
- Comparison of the Rickabys Line option against the project objectives and criteria.

The Rickabys Line option as presented in the submission includes:

- Rehabilitating and retaining the existing Windsor Bridge for light vehicles and pedestrian access. A cost estimate and overview of the proposed methodology to refurbish the existing bridge was also provided as part of the submission.
- Constructing a new two lane alternative route at AHD 11 metres to the west of Windsor, named Rickabys Line option. The Rickabys Line option would start at the intersection of Freemans Reach Road and Wilberforce Road, pass through Macquarie Park, cross the Hawkesbury River via a 200 to 240 metre long Super T bridge, head south west until Rickabys Creek where a 40 metre long bridge would be constructed and then head generally south between the Sebel Resort and Spa and the Rum Corps Barracks Golf Club before intersecting with Hawkesbury Valley Way.

To enable a more comprehensive environmental, cost and engineering assessment of the Rickabys Line option, a preliminary design of the alternative route was prepared based upon the description provided in the submission. In reviewing the description of the option as provided in the submission, a number of issues were identified as needing refinement to meet relevant design standards and mitigate significant impacts. These issues are outlined in the following sections. Based upon the refinements made to the proposed alternative a preliminary concept design was developed which is presented in **Figure 4-1** to **Figure 4-3**.

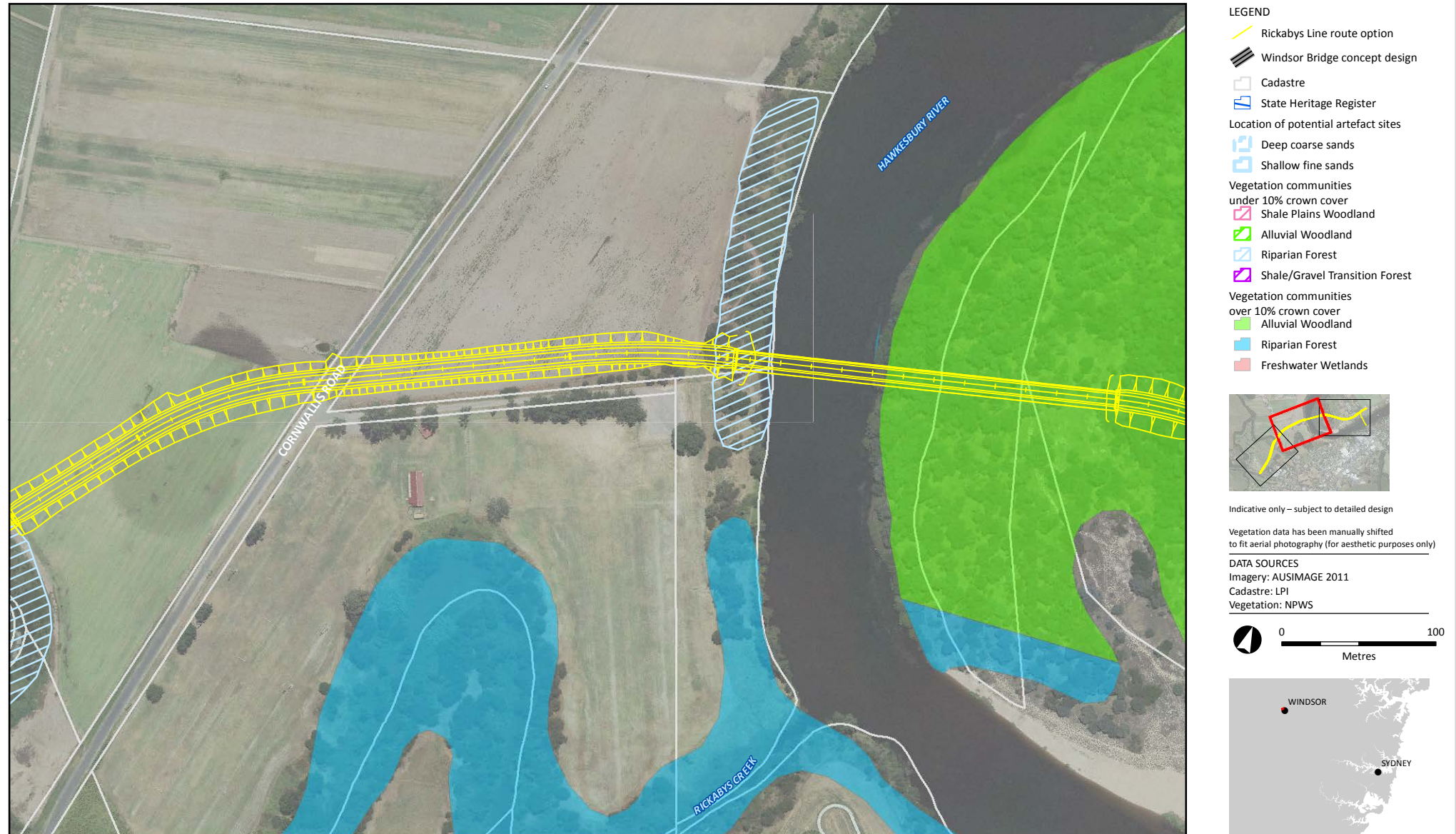
Figure 4-1 | Rickabys Line route option



Windsor Bridge replacement site layout plan



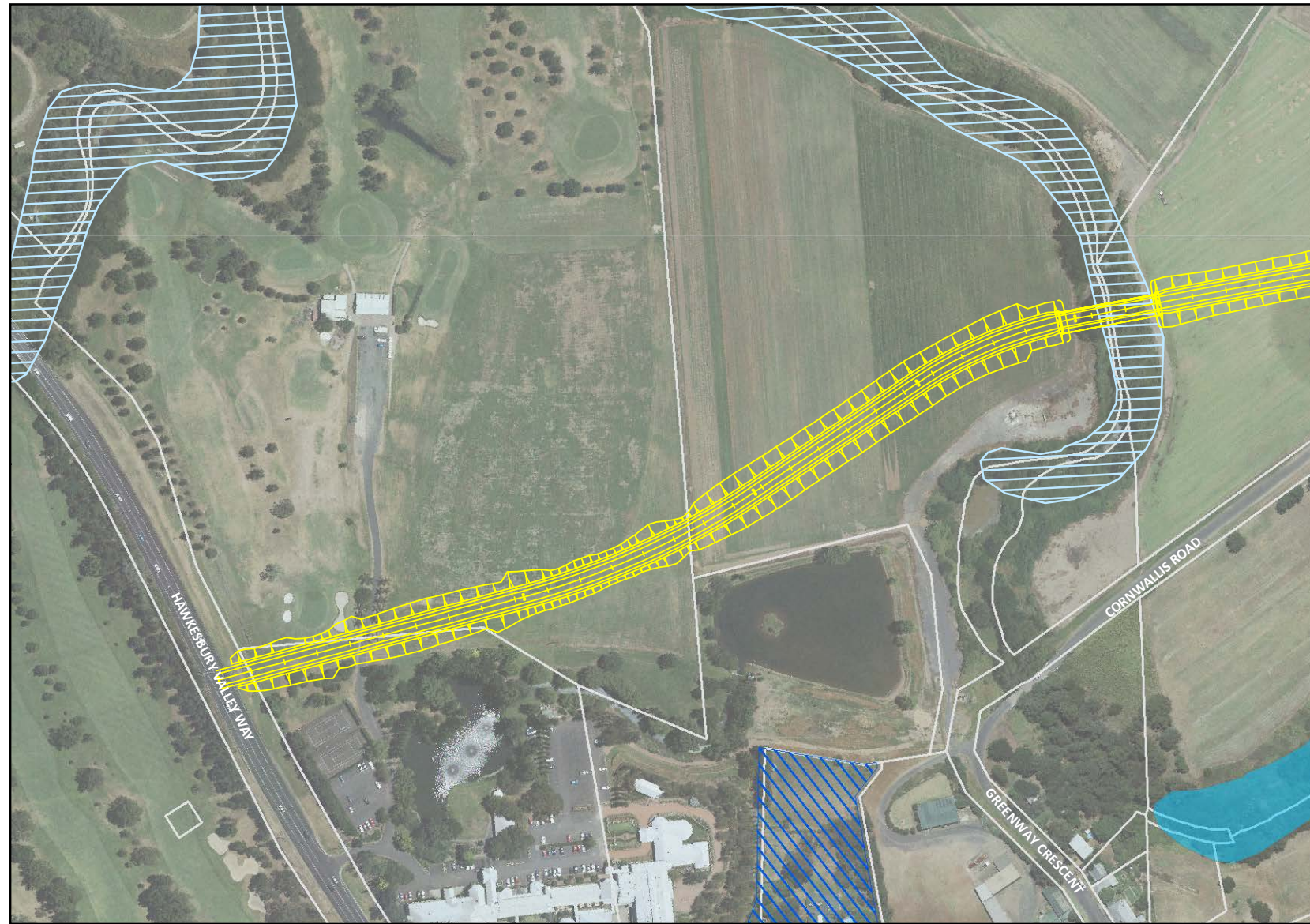
Figure 4-2 | Rickabys Line route option



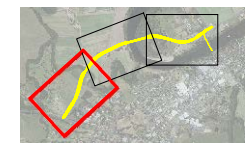
Windsor Bridge replacement site layout plan



Figure 4-3 | Rickabys Line route option



- LEGEND**
- Rickabys Line route option
 - Windsor Bridge concept design
 - Cadastre
 - State Heritage Register
- Location of potential artefact sites**
- Deep coarse sands
 - Shallow fine sands
- Vegetation communities under 10% crown cover**
- Shale Plains Woodland
 - Alluvial Woodland
 - Riparian Forest
 - Shale/Gravel Transition Forest
- Vegetation communities over 10% crown cover**
- Alluvial Woodland
 - Riparian Forest
 - Freshwater Wetlands



Indicative only – subject to detailed design

Vegetation data has been manually shifted to fit aerial photography (for aesthetic purposes only)

DATA SOURCES
 Imagery: AUSIMAGE 2011
 Cadastre: LPI
 Vegetation: NPWS



Windsor Bridge replacement site layout plan



4.1.1 Bridge structure

The submission nominated Super Ts for bridge construction using the Kempsey Bypass bridges as an example and the basis for determining costs for the bridges. However, due to buoyancy impacts, the RMS does not permit the use of Super Ts where the soffit of the bridge is less than the 1 in 50 year flood level. As the bridges for the Rickabys Line option are around the 1 in 5 year flood level, the use of Super Ts would not be permitted. Instead, a conventional Queensland precast plank bridge was assumed for bridge construction. As described in Section 4.4 of the EIS, precast plank bridges are relatively easy and cheap to construct and are able to withstand regular immersion by floodwaters but they have a higher visual impact in comparison to other bridge types. A Queensland precast plank bridge has a maximum span of about 25 metres, which means that additional piers in the river and floodplain would be required to support the bridge. An incrementally launched bridge is proposed by RMS for the Windsor Bridge replacement project due to its better aesthetic qualities, fewer piers in the river and the ability to predominately construct it from the northern bank hence minimising construction impacts in Thompson Square. This bridge type was not considered for the Rickabys Line option because the need to minimise visual impacts was not a major factor in bridge type selection (given the bridge would be outside of Windsor) and the higher cost of the incrementally launched bridge type would not be justified.

4.1.2 Bridge height and levels

The submission nominated an alternative route and bridge level of 11 metres AHD. Preliminary design of roads and bridges at this level indicated that substantial fill embankments would be required along the majority of the alternative route. Specialist hydrologists have indicated that fill embankments of this level within the Hawkesbury River and Rickabys Creek floodplains would substantially increase flooding of upstream areas for flood events up to the 1 in 10 year ARI flood. To mitigate this impact, large sections of the alternative route would need to be constructed on a viaduct or large banks of culverts would be required, which would substantially increase costs. Also, with the road surface at 11 metres AHD, the intersection of the alternative route with the existing Windsor Bridge approach roads would be expensive and difficult to design and construct (due to the differences in levels between the alternative route and the existing bridge approach roads). Additionally, there would be no advantage in constructing the alternative route at 11 metres AHD as this would provide a higher level of flood immunity than the approach roads of Freemans Reach Road and Wilberforce Road, which would be closed to traffic in such an event.

To provide a reasonable comparison with the project, the alternative route road level was set at 9.8 metres AHD, which is about the same level as the lowest point on the project and the maximum flood level for which Freemans Reach Road remains open. Reducing the height of the alternative route road would also reduce the cost of this option as not as much fill material would be required. The 11 metres AHD for the bridge over the Hawkesbury River was retained as this was the level of the western bank at the proposed crossing location and, if in the future it was decided to increase the height of roads on the northern bank to provide improved access during flood events, the bridge would not require modification.

4.1.3 Pedestrian and cycle access

The submission did not contain any details of cycleways or footpaths apart from a two metre shared path on the bridges. For the purposes of the design and cost estimates, it has been assumed that apart from the shared path on the bridges, no dedicated shared paths would be provided. This reduces the overall costs of the alternative route option. The shoulders of the road would be wide enough to safely accommodate cyclists on the road pavement. Pedestrians would be unlikely to use the alternative route as it does not link with existing pedestrian routes.

4.1.4 Intersections

A preliminary concept design was prepared for the intersections of the Rickabys Line option with Hawkesbury Valley Way (see **Figure 4-4**) and the existing bridge/Freemans Reach Road/ Wilberforce Road intersection (see **Figure 4-5**). At Hawkesbury Valley Way, a traffic light controlled intersection would be required and Hawkesbury Valley Way would need to be widened to provide turning and merge lanes for traffic travelling to and from the Rickabys Line option. The intersection on the northern bank of the Hawkesbury River would be more complicated because it would not be possible to build a roundabout or four legged intersection that complied with road design and safety standards due to the low level and location of the existing bridge approach road in relation to the other roads. Instead, two traffic light controlled T-intersections would be required. A less complicated and better performing intersection could be built if the heritage listed Bridgeview property was acquired and demolished but this was not considered to be feasible. Cornwallis Road would require a minor realignment near its intersection with the Rickabys Line option to meet road safety design codes. The intersection of Cornwallis Road and the Rickabys Line option would be controlled by stop signs for traffic on Cornwallis Road.

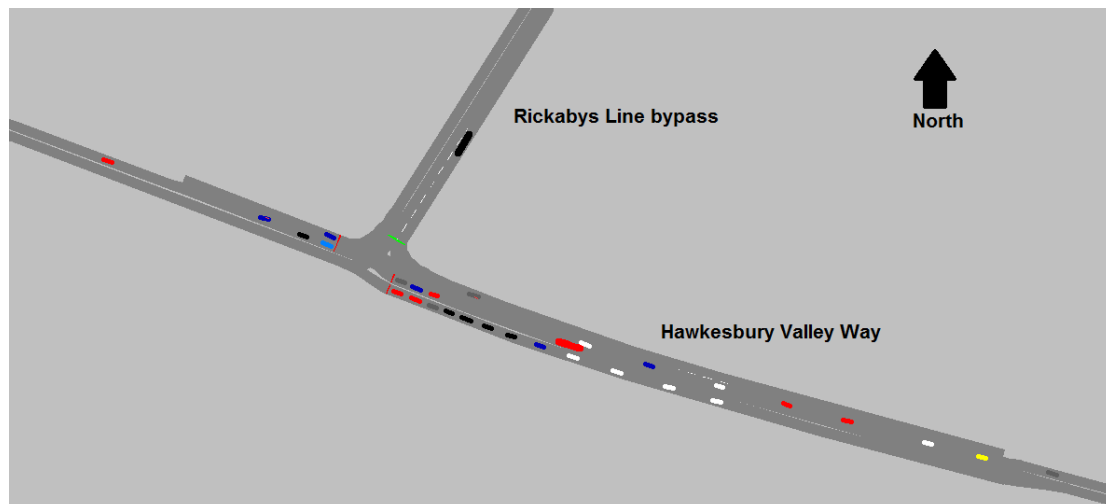


Figure 4-4 Hawkesbury Valley Way / Rickabys Line option intersection – traffic control signals

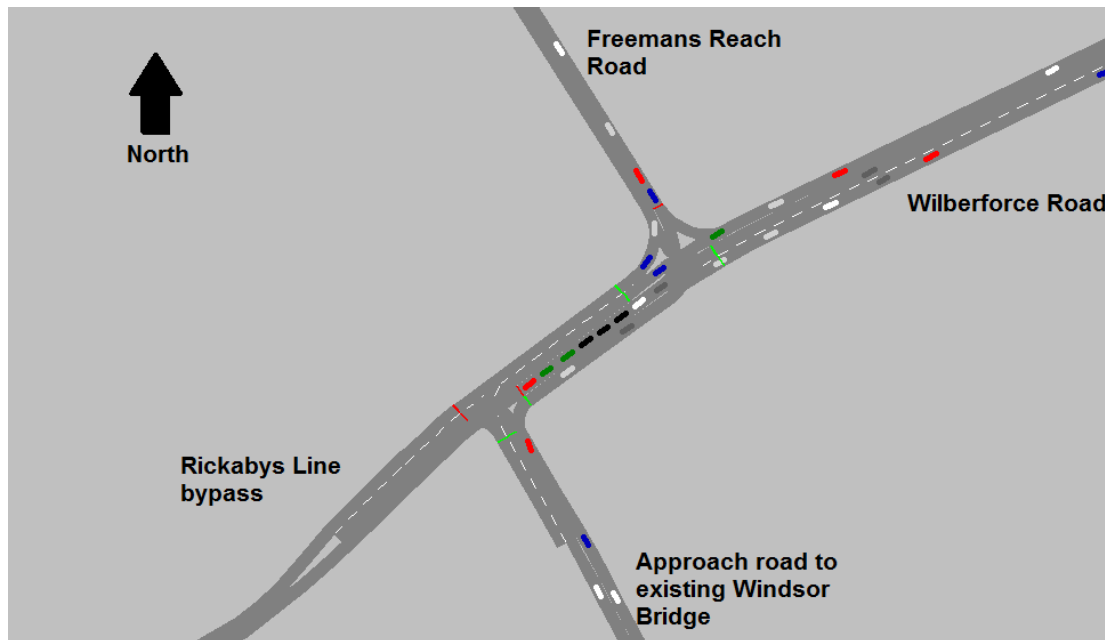


Figure 4-5 Wilberforce Road / Freemans Reach Road / Windsor Bridge / Rickabys Line option intersection – two signalised intersections

4.1.5 Route alignment

The Rickabys Line option described did not include a detailed description of the precise route proposed. For the purposes of this assessment, a more defined route has been identified. The route has been refined in some areas to minimise impacts and costs.

The route of the southern section (near Hawkesbury Valley Way) of the Rickabys Line option has been assessed based on the description in the submission, minimising the length (and therefore cost) of the alternative route, minimising property acquisition and minimising impacts on the Rum Corps Barracks Golf Course. The route of the Rickabys Line option in this section could be moved further to the west, although the cost of the option and impacts on Rum Corps Barracks Golf Course would be greater. It may, however, be preferable to move the route further west to minimise operational noise impacts on residential properties and the Sebel Resort and Spa.

Moving the route east of its current alignment is not considered feasible or desirable as land acquisition costs would be higher and operational noise impacts on about 100 residences would be potentially much greater. As these residences are currently not impacted by traffic noise, they would qualify for noise mitigation, which would substantially increase the costs of the option.

The route alignment of the bypass component of the Rickabys Line option is shown in **Figure 4-1** to **Figure 4-3**. As discussed above, the route could be modified within this corridor, however the route was identified to minimise potential impacts and reduce the cost of the option. While the environmental assessment included in the following sections is based on this alignment, it should be noted that the impacts identified would be broadly consistent with alternative alignments through this corridor.

4.2 Environmental Impacts

4.2.1 Historic heritage

A desktop level assessment of historic heritage has been undertaken for the alternative option. This assessment has identified there would be considerable construction and operational visual and amenity impacts on the heritage listed building in Macquarie Park and on a locally listed heritage building on the corner of Freemans Reach Road and Wilberforce Road (“Bridgeview”). The Rickabys Line option would pass very close to both buildings and these heritage listed buildings would experience a greater impact in comparison to what they would experience as a result of the project. There may also be other unknown historic sites to the west of Windsor that may be impacted by the alternative route option.

The Rickabys Line option would not result in any changes to the existing roads, parklands and heritage vistas of within Thompson Square Conservation Area. This is one of the significant impacts of the project that would be avoided by the Rickabys Line option. However, Thompson Square parkland would continue to be bisected by the 1934 approach road to the existing bridge and there would be around 10,000 vehicles a day still travelling through Thompson Square.

While heritage views and vistas within Thompson Square would not be impacted, the heritage vista from Thompson Square across the river would change with multiple traffic light controlled intersections and the start of the Rickabys Line option. This would change the heritage rural character of the landscape to one more urbanised and modern, although the northern roundabout proposed as part of the project would have similar impacts.

The archaeological remains below the ground surface in Thompson Square and on the southern bank and adjacent river bed would remain intact as there would be no need for works in Thompson Square and the archaeological investigation and salvage would not proceed.

The existing heritage listed Windsor Bridge would also remain *in situ*, rather than being demolished. This is another of the significant impacts of the project that would be eliminated by the Rickabys Line option.

Although the Rickabys Line option would have heritage impacts, it would undoubtedly have a lower impact on historic heritage than the project.

4.2.2 Aboriginal heritage

The impact of the Rickabys Line option on Aboriginal heritage cannot be assessed without undertaking additional detailed studies. Nevertheless, as much of the land impacted by the route has either been cleared and disturbed for agriculture or is below the 1 in 100 year flood level, the risk of encountering intact and significant Aboriginal archaeological sites during construction is likely to be low. There may, however, be sites containing isolated artefacts along the route and, if intact Aeolian sands are present, there may be locations with significant Aboriginal archaeological sites.

The impact of the Rickabys Line option on Aboriginal heritage is unknown.

4.2.3 Visual impact and urban design

A review of urban design and landscape impacts was undertaken for the Rickabys Line option. The review involved:

- Analysis of the existing study area conditions based on a desktop review of current background studies.
- Identification of the primary urban design and landscape issues and the likely key landscape character and visual impacts.

The major issues identified from the review are as follows:

- A large section of the bypass east of the Hawkesbury River would need to be constructed on a viaduct or large banks of culverts to mitigate potential flooding impacts. This section of the alignment would have a high physical and visual impact.
- The alignment traverses an area of Windsor that has few roads and would result in visual and landscape character impacts on areas not currently impacted by road infrastructure.
- The alignment would disrupt the existing landscape patterns by cutting across paddocks and parkland and intersecting local roads at a variety of angles.
- The alignment would have adverse physical and visual impacts on the important recreation areas of Macquarie Park and Deerubbin Park, with key issues as follows:
 - Macquarie Park would be bisected by the alignment, restricting access between the existing facilities and the river, including access from the playground, cafe and restaurant to the popular sandy beach area.
 - There would be extensive vegetation loss in the western section of Macquarie Park, which would have a potentially high impact on the park's character and amenity.
 - Adjustments would be required to a number of existing carparks and access roads within the park, which would affect the existing operations of the restaurant and cafe.
 - The alignment would run along the northern boundary of Deerubbin Park playing fields and may conflict with the existing carpark access road, in addition to having adverse effects on the recreational amenity of the park.
- The alignment would be highly visible from other important recreation areas, such as Howe Park and The Terrace.
- The alignment passes adjacent to the heritage listed residence, 'Bridgeview', and would have adverse impacts on the view of this building from the southern river foreshore.
- The road and embankment would be visible to motorists travelling along Cornwallis Road and from a number of farm buildings west of the river.
- The bridge over the Hawkesbury River and associated viaduct, would be potentially visible to motorists travelling south west along Freemans Reach Road, and from a number of farm buildings north of the river.
- The alignment would be highly visible when looking east from the carpark of the Rum Corps Barracks Golf Club.

- The alignment would potentially be visible from the grounds of the Sebel Resort and Spa, although its visibility may be reduced by the groups of existing trees along the western boundary of the resort.
- The alignment would generally not be visible from Thompson Square and George Street.

4.2.4 Traffic and access

Traffic performance

Traffic modelling of the Rickabys Line option was undertaken using the VISSM regional road network model to assess its performance. The key findings of the traffic assessment are summarised below. The level of service for each of the intersections is presented in **Table 4-1**.

At the Macquarie Street/ Bridge Street intersection, vehicles wanting to turn into Macquarie Street from Bridge Street north in the morning peak are predicted to experience a 'poor' level of service with the alternative option and 'good' level of service with the project. This is one of the major turning movements at this intersection in the morning peak. There would be little difference in the level of service for other turning movements between the project and alternative. During the evening peak, the levels of service for major turning movements for both the alternative and the project are predicted to be good in 2016. In 2026, however, the alternative would provide a considerably better level of service in the PM peak than the project for all major turning movements at the Macquarie Street / Bridge Street intersection.

At the George Street/ Bridge Street intersection, the level of service in 2016 and 2026 would be similar for both the project and the alternative, for all major traffic movements.

For the intersection on the northern bank, the project would have high levels of service in both the morning and evening peak in 2016 and 2026. The more complex double T-intersection for the alternative would perform at a similar level to the project for all major turning movements, but would provide a lower level of service for vehicles turning from Freemans Reach Road towards Windsor Bridge and Rickabys Line option in the morning peak and vehicles travelling from Rickabys Line option into Wilberforce Road or Freemans Reach Road in the evening peak. There would be a particularly poor level of service for vehicles travelling from Rickabys Line option into Wilberforce Road or Freemans Reach Road in the evening peak in 2026.

The alternative would have an additional intersection where the Rickabys Line option connects to Hawkesbury Valley Way. The level of service at this intersection is generally good to acceptable except for south bound vehicles turning right into Hawkesbury Valley Way in the evening peak. However, the number of vehicles undertaking this movement in the evening peak is relatively small.

Overall, the alternative and the project are predicted to provide similar levels of service for major turning movements at all intersections with the following exceptions:

- The project's northern intersection would generally have a better level of service especially in the PM peak than the alternative. This is because the project's northern intersection is less complex with a roundabout, rather than a double T intersection. The roundabout also performs better for traffic flow outside peak periods.
- The Macquarie Street/Bridge Street intersection would have a better level of service in the evening peak in the future with the alternative compared to the project. This is because there would be less vehicles using the Macquarie Street/Bridge Street intersection as about 50 per cent of vehicles would be using the Rickabys Line option. In general the queues at this intersection would lower indicating reduced congestion.
- Macquarie Street / Bridge Street intersection would have a poor level of service in the AM peak compared with a good level of service for the project.

While there would be about 50 per cent fewer vehicles using Bridge Street and Windsor Bridge, there would still be about 10,000 vehicles a day with up to a 16 tonne load limit using this corridor based on traffic modelling.

It is likely that Bridge Street north of Macquarie Street to the intersection of Wilberforce Road and the Rickabys Line bypass would revert to a local road and would no longer be a major arterial route or approved B-Double route. As a local road, the responsibility for maintenance and further works in this corridor would be transferred to Hawkesbury City Council. Hawkesbury City Council have indicated that they are not in a position to be able to provide the required ongoing maintenance.

Construction traffic impacts on Thompson Square and Bridge Street for the alternative option would be similar to that predicted for the project as the main bridge across the Hawkesbury River would likely be constructed from the northern bank.

Table 4-1 Traffic performance (Level of Service) of the project and the Rickabys Line option for key turning movements

| From | To | 2016 AM | | 2026 AM | | 2016 PM | | 2026 PM | |
|--|--------------------------------------|---------|-------------|---------|-------------|---------|-------------|---------|-------------|
| | | Project | Alternative | Project | Alternative | Project | Alternative | Project | Alternative |
| Macquarie Street/Bridge Street intersection | | | | | | | | | |
| Bridge Street N | Bridge Street S | A | B | A | B | A | A | A | A |
| Bridge Street N | Macquarie Street | B | D | B | D | C | D | C | D |
| Macquarie Street | Bridge Street N | A | A | A | A | B | B | F | D |
| Macquarie Street | Bridge Street S | C | C | D | C | C | C | F | E |
| Bridge Street S | Macquarie Street | A | A | A | A | A | A | F | A |
| Bridge Street S | Bridge Street N | B | B | C | C | B | B | F | C |
| George Street/ Bridge Street intersection | | | | | | | | | |
| Bridge Street N | George Street E | A | A | B | D | A | A | B | A |
| Bridge Street N | Bridge Street S | B | B | C | D | B | A | B | A |
| Bridge Street N | George Street W | B | A | C | D | D | A | F | A |
| Bridge Street S | George Street W | A | A | A | A | B | A | E | A |
| Bridge Street S | Bridge Street N | A | A | A | A | B | A | B | A |
| Bridge Street S | George Street E | - | A | - | A | - | A | - | A |
| Northern intersection | | | | | | | | | |
| Freemans Reach Road | Wilberforce Road W/ Bridge Street | A | C | B | C | A | D | A | E |
| Wilberforce Road W | Freemans Reach Road | A | A | A | A | B | A | A | A |
| Wilberforce Road | Rickabys Line | - | A | - | A | - | B | - | B |
| Wilberforce Road | Bridge Street | A | A | A | A | A | A | A | A |
| Bridge Street | Freemans Reach Road | A | - | A | | A | | B | - |
| Bridge Street | Wilberforce Road | A | C | A | D | A | B | B | B |
| Rickabys Line | Wilberforce Road | - | A | - | B | - | C | - | F |

Pedestrian access

Many of the benefits to pedestrians and cyclists that would be provided by the project would not be provided by the Rickabys Line option, including:

- The sub-standard one metre wide pedestrian path on the existing bridge would remain as the only pedestrian access across the river from Thompson Square. This pathway is not suitable for cyclists and does not provide access for individuals with limited mobility.
- Pedestrians from the town centre or the upper Thompson Square parkland would still be required to cross the busy northern approach road to the existing bridge to access Macquarie Park.
- There would be no reconnection of The Terrace to provide continuous water front access for pedestrians.
- The traffic lights at the intersection of George and Bridge Street would not be installed and therefore there would be no new safety benefits for pedestrians crossing at this location. Around 10,000 vehicles a day are predicted to continue to use the Bridge Street/ George Street intersection with the alternative option, which would continue to interact with pedestrians trying to cross these roads.
- In contrast to the project, the Rickabys Line option would not contribute to meeting Hawkesbury City Council's objectives for their Mobility Access Plan and Great River Walk.

While the Rickabys Line option would include a two metre shared path across the bridges, there would be no connection to existing pedestrian paths or cycleways and therefore would be unlikely to be used. A shared path would not be provided along the road sections of the Rickabys Line option.

Overall, the alternative would result in a poorer outcomes for pedestrian and cyclists in comparison to the project

Property access

There would be some changes in property access with the alternative option. The access for Bridgeview (Number 27 Wilberforce Road) and Number 33 Wilberforce Road would require some minor modifications, similar to those that would be required for the project (potentially left in and left out access only). Other properties may require minor changes to access but more consultation and design work is required to confirm the affected properties

The major impact on access would be for the Sebel Resort and Spa as the Rickabys Line option would sever the resort complex from their nine golf course. An underpass would need to be built to provide safe access for guests and workers from the resort complex to the golf course.

4.2.5 Noise and vibration

Noise modelling of the alternative option was undertaken using the preliminary strategic design (see **Figure 4-6** and **Figure 4-7**). It was not possible to undertake a full noise assessment as background noise data for west Windsor was not available.

With the Rickabys Line option, residential premises in west Windsor are predicted to experience additional traffic noise. Apart from some residences in Greenway Crescent and Claremont Crescent, however, the increase in traffic noise would be unlikely to be significant. For some residences in Greenway Crescent and Claremont Crescent, the increase in traffic noise would be greater as they would have a direct line of sight to the Rickabys Line option and would be between 150 metres and 250 metres away from the new alignment. Existing traffic noise at these locations would be relatively low due to the topography, shielding from other buildings and the distance to other traffic noise sources. The Sebel Resort and Spa would also experience considerably higher traffic noise with the alternative option.

While a proportion (about 50 per cent) of traffic would use the Rickabys Line option, there would still be a significant proportion of traffic (about 10,000 vehicles per day) using the existing bridge and travelling through Thompson Square. The properties along this route would still experience high levels of traffic noise, albeit lower than existing noise levels.

Macquarie Park would experience high traffic noise levels as the Rickabys Line option would bisect the park. As the Rickabys Line option would carry all of the heavy vehicle traffic that would otherwise pass through Windsor, and Macquarie Park does not currently experience significant traffic noise, the increase in noise levels within the park would be considerable and would reduce its amenity for recreational use.

Construction noise impacts would be lower for the Rickabys Line option than the project due to the greater distance between the road alignment and noise sensitive receivers such as residential properties. The only exception to this would be for the Sebel Resort and Spa, which is immediately adjacent to the new route alignment. The risk of vibration impacts during construction and operation would be negligible for the Rickabys Line option.

Overall, in comparison to the project, the Rickabys Line option would result in a minor reduction in noise levels in Thompson Square and at properties around Thompson Square. The alternative option would also result in new noise impacts, affecting Macquarie Park, some residential properties in west Windsor and the Sebel Resort and Spa.

4.2.6 Soil and water

For both the Rickabys Line option and the project, soil and water risks would be largely restricted to the construction phase in association with earthworks. The soil and water risks associated with the Rickabys Line option would be greater than those associated with the project as the Rickabys Line option involves two bridges and a longer length of road. For both the Rickabys Line option and the project, however, the soil and water risks can be effectively managed using standard environmental management measures and are not a major consideration for option selection.

The requirements for operational water quality control measures would be substantially greater for the alternative option (compared with the project) due to the length of the road and the presence of two bridges. While the cost of operational water quality controls has been included in the cost estimate for the project, this cost has not been included in the cost estimate for the alternative.

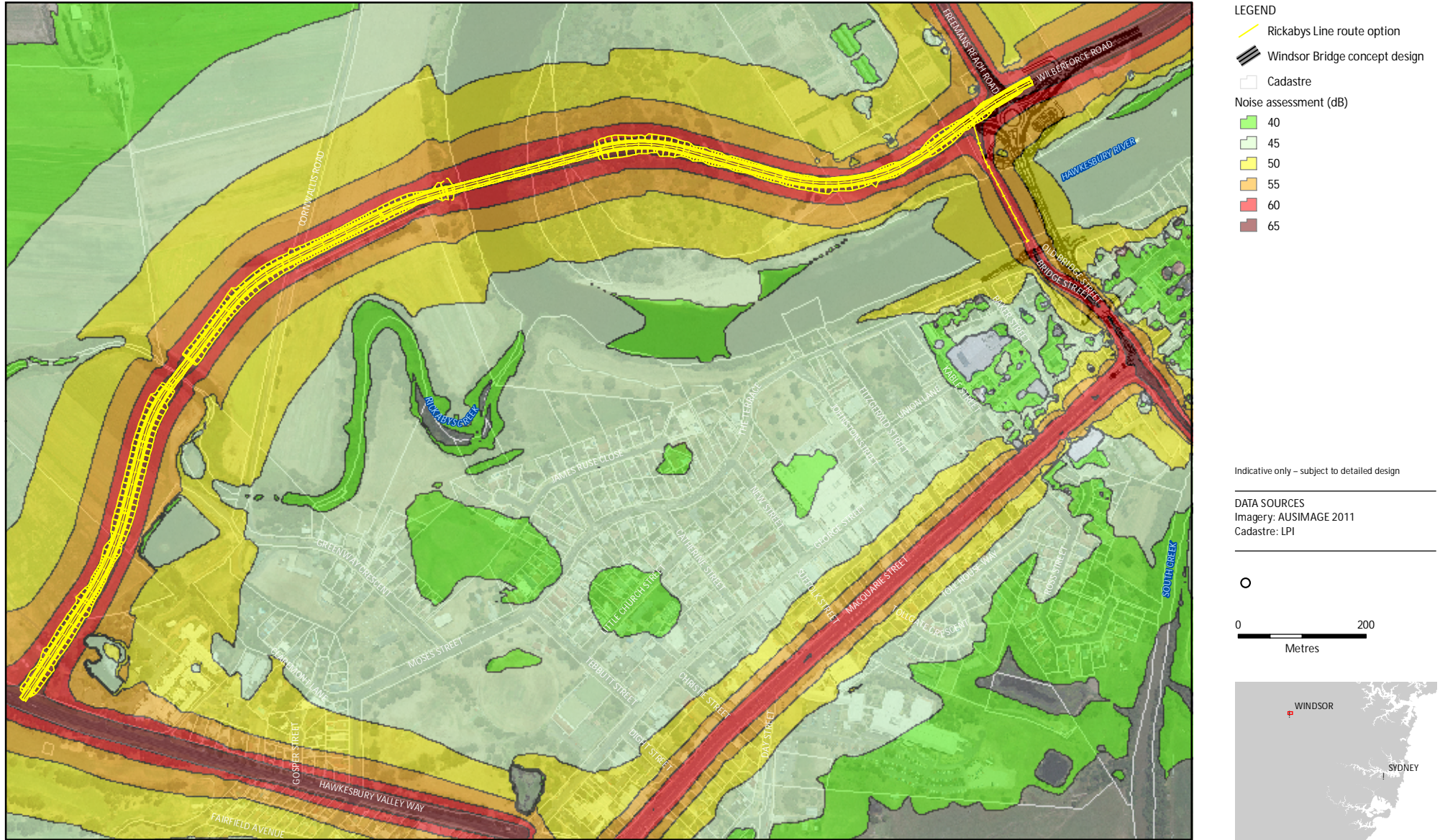
Figure 4-6 | Rickabys Line preliminary noise assessment - day



Windsor Bridge replacement site layout plan



Figure 4-7 | Rickabys Line preliminary noise assessment - night



Windsor Bridge replacement site layout plan



4.2.7 Flora and fauna

The Rickabys Line option would require clearing of around 1.6 hectares of woodland in Macquarie Park, the majority of which comprises *Forest Red Gum-Roughbarked Apple grassy woodland on alluvial flats*. This vegetation community corresponds to *River Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions*, which is listed as an threatened ecological community under the NSW *Threatened Species Conservation Act 1995* (TSC Act), with a listing status of *endangered*. The clearing required for the Rickabys Line option would result in substantial fragmentation of this community and RMS may be required to purchase biodiversity offsets to compensate for this clearing. Small areas of riparian woodland would also need to be cleared on the western side of the Hawkesbury River and on either side of Rickabys Creek.

As the project involves removal of very few trees and no threatened ecological communities, the alternative option would have a substantially greater impact on flora and fauna than the project.

4.2.8 Socio-economic impacts

Land use

The Rickabys Line option would have a greater impact on land use than the project.

Around 3.5 hectares of parkland in Macquarie Park, 3.4 hectares of land used for turf farming, 0.3 hectares of horticultural land, and 0.4 hectares of a golf course would need to be acquired for the Rickabys Line option. The area of Macquarie Park located to the north of the Rickabys Line option route would become unusable due to severance from main park area. As well the loss of parkland, the traffic noise levels in the park would increase substantially, reducing its amenity.

Overall, the Rickabys Line option would result in a reduction of public open space, while the project would result in an increase in public open space. The Rickabys Line option would also result in a greater loss of productive agricultural and horticultural land and require acquisition of more private property.

Business impacts

The Rickabys Line option may result in both positive and negative business impacts for Windsor. Most of the studies on the impacts of town bypasses have concerned highway bypasses of rural towns. Many of these towns were the most convenient or only location for the local and regional community to access shops and services and, consequently, the towns did not experience a significant loss of patronage or long-term economic impacts after the opening of the bypass.

Windsor is different from a typical rural town in that it has a number of other nearby townships that can provide shopping and other services. The Rickabys Line option would allow regional traffic to bypass the Windsor town centre and instead more easily access Richmond or Rouse Hill shopping areas. Studies have shown that economies of adjacent communities may grow at the expense of the bypassed community through two effects: 1) travellers may choose to stop at a centre on the highway instead of the bypassed town and 2) local residents have easier access to metropolitan centres and may tend to use these centres in preference to shopping

locally (Sivaramakrishnan and Kockelman, 2002; Handy *et al.*, 2000). While it is impossible to predict whether this would occur with a bypass of the Windsor town centre, it is a risk that needs to be considered.

While there would be a reduction in traffic in Thompson Square, this alone is unlikely to result in greater numbers of tourists or visitors to the local area. There would still be thousands of vehicles a day using the existing bridge and approach roads and the split of the Thompson Square parkland and poor pedestrian access around the local area would remain.

4.2.9 Hydrology

The ex-RMS bridge engineer's submission contained an assessment of the potential flooding impacts of the Rickabys Line option bridge over the Hawkesbury River based on data from the EIS. They concluded that the Rickabys Line option bridge over the Hawkesbury River was unlikely to result in substantial increases in flood levels upstream. Project hydrologists generally agreed with this assessment as the Rickabys Line bridge over the Hawkesbury River is at 11 metres AHD and this is the level where the breakout of floodwaters across Freemans Reach occurs.

The ex-RMS bridge engineers did not, however, assess the impact on upstream flood levels of the road component of the alternative option. The road component would need to be built on a fill embankment, which would present a barrier to flood waters across the flood plains of both Rickabys Creek and the Hawkesbury River.

Modelling of the hydrological impacts of the alternative option was undertaken using the same model used in the EIS for the assessment of the project. The modelling was based on the preliminary concept design of the alternative option, with a road height of 9.8 metres AHD and a Hawkesbury River bridge height of 11 metres AHD. As noted previously, the road height of 11 metres AHD nominated in the ex-RMS bridge engineer's submission was not used on the advice of project hydrologists, as it was considered that it would have an unacceptable flooding impact on properties upstream. The alternative option also includes retaining the existing Windsor Bridge, which would mean that there would be three bridges which may have an impact upstream on flood levels.

The changes in flood levels at upstream locations in the river and on the floodplain as a result of the alternative option are presented in **Table 4-2**. The locations are slightly different to those presented in the EIS, as the alternative option would also impact the Rickabys Creek floodplain.

Based on the modified Rickabys Line design (to minimise flooding impacts), impacts for modelled floods larger than the five year flood event would be relatively minor and could be managed without incurring substantial flood mitigation costs. For the 5 year flood event, levels would increase by about 0.10 metres at locations just upstream of the Hawkesbury bridge and about 0.05 metres at Yarramundi. These increases in flood levels are almost identical to those identified for the project in the EIS. For relevant locations, the increase in flood levels due to the project for the 5 year flood are presented in brackets in **Table 4-2**. As the increase in flood levels are so similar, the impacts presented in the EIS for the project would be similar for the alternative option. These impacts are as follows:

- Twenty two buildings would experience increased flooding levels greater than 0.01 metres. Of these 22 buildings, two have an existing over floor flooding level of greater than one metre. The average increase in flood levels for the other 20 buildings would be about 0.09 metres. There would be 15 buildings with an increase in flood levels of greater than 25 per cent, two of which are generally subject to low levels of flooding (less than 0.1 metre) under existing conditions. These two buildings would be at most risk of increased flood damage from increases in flood levels.
- There would be increased inundation of about 400 property lots upstream of the bridges. The vast majority of the property lots are agricultural, horticultural or Crown land without any buildings or residential dwellings. Land that is within the existing five year flood event extent has an average depth of floodwaters under existing conditions ranging from 1.8 metres to over six metres, with the average increase as a result of the project ranging from 0.03 metres to 0.09 metres.

Table 4-2 Change in peak flood level as a result of the alternative option

| | Hydraulic impacts of the alternative option (m) | | | |
|---|---|---------------|----------------|------------------------|
| | 5 year flood | 20 year flood | 100 year flood | Probable maximum flood |
| River locations | | | | |
| Downstream of Penrith Weir | 0.00 (0.00) | 0.00 | 0.00 | 0.00 |
| Yarramundi | 0.05 (0.04) | 0.02 | 0.00 | 0.00 |
| North Richmond | 0.06 (0.06) | 0.02 | 0.00 | 0.00 |
| Hibberts Lane | 0.08 (0.09) | 0.02 | 0.00 | 0.00 |
| Argyle Reach Road | 0.09 (NA) | -0.01 | 0.00 | 0.00 |
| Hawkesbury River upstream of proposed crossing | 0.09 (NA) | -0.01 | 0.00 | 0.00 |
| Cornwallis Road bridge over Rickabys Creek | 0.08 (NA) | 0.03 | 0.01 | 0.00 |
| Hawkesbury Valley Way over Rickabys Creek | 0.08 (NA) | 0.03 | 0.01 | 0.00 |
| Floodplain locations | | | | |
| Cupitts Lane | 0.08 (NA) | 0.03 | 0.00 | 0.00 |
| Cornwallis Road upstream of Hawkesbury crossing | 0.08 (NA) | 0.00 | 0.01 | 0.00 |
| Freemans Reach Road overflow path | -0.02 (NA) | 0.00 | 0.00 | 0.00 |
| Richmond | 0.00 (NA) | 0.00 | 0.01 | 0.00 |
| Agnes Banks | 0.04 (0.04) | 0.01 | 0.00 | 0.00 |

As discussed in **Section 2.11**, the increases in flooding levels predicted in the EIS were identified as a matter of concern by the OEH in its submission on the EIS. As such, more detailed flooding investigations have been undertaken.

To respond to OEH concerns and to further assess requirements for scour protection, the flood modelling for the project has been revised using a more accurate model and the most up to date bridge design (refer to **Section 3.2**). The latest bridge design has a shallower profile, a lower number of piers in the river and less bulky piers compared to the bridge design used in the flood modelling for the EIS. The preliminary results from revised modelling indicate that the project would have considerably less impacts than those presented in the EIS, with no or negligible increases in flood levels immediately upstream of the replacement bridge. There would be no additional costs to mitigate flood impacts.

While there may be a reduction in predicted flood levels for the alternative option with the use of the revised model, these reductions would be relatively small as:

- For the alternative option, the road embankments are causing the increase in upstream flood levels rather than the bridges. Unless the road level is lowered, which would reduce its flood immunity to below the project's, or flood waters are allowed to pass through the road alignment either via large banks of culverts or constructing sections of the road on viaducts, the change in upstream flood levels would be minimal. The cost of either providing large banks of culverts or constructing sections of the road on a viaduct are considerable and would be additional to the cost estimate for the alternative option provided in this report.
- One of the issues with the original hydrological model was that it did not accurately model the complex meander of the Hawkesbury River immediately upstream of the project. This resulted in an overestimation of upstream flood levels. As the alternative option is upstream of the meander of the Hawkesbury River, the tendency of the model used in the EIS to overestimate upstream flood levels would be reduced or eliminated.

Overall, the alternative option would have a greater impact on upstream flood levels for the five year flood compared to the project. The costs for flood mitigation of affected upstream properties or engineering solutions to allow water to pass through the road alignment are likely to be high and would be in addition to cost estimate for the alternative option presented in **Section 4.4**.

4.2.10 Air quality

The alternative option would reduce the number of vehicles travelling through Thompson Square by about 50 per cent and remove all vehicles greater than 16 tonnes. This would result in an improvement in air quality in and around Thompson Square. Nevertheless, there still would be about 10,000 vehicles a day travelling through Thompson Square and contributing to local air pollution.

The Rickabys Line option would be unlikely to result in exceedances of air quality criteria for residences and businesses given that, with the exception of the Sebel Resort and Spa, the closest residences and businesses are more than 100 metres from the road alignment.

Overall, in comparison to the project, the alternative option would reduce air pollution in Thompson Square but it would also create new localised air quality impacts along the alignment of the new bypass route. As presented in Section 7.10 of the EIS, however, the project would result in very few exceedances of air quality criteria based on conservative assumptions.

4.3 Alternative bridge refurbishment methodology

As part of their submission on the EIS, the ex-RMS bridge engineers detailed an alternative to the RMS methodology to refurbish the existing Windsor Bridge. Costs for the alternative bridge refurbishment methodology were also provided, which were considerably below the costs for the RMS methodology. The ex-RMS bridge engineers and many other submissions claimed that the RMS refurbishment methodology and associated costs were inflated and that these inflated costs were used as the basis for discarding the bridge refurbishment option.

The alternative bridge refurbishment methodology proposed by the ex-RMS bridge engineers is outlined in **Section 4.3.1**. The ex-RMS bridge engineers claimed that all works could be undertaken with only minimal closures of the existing bridge.

A comparison of the alternative refurbishment methodology and the RMS refurbishment methodology is presented in **Section 4.3.2**. An independent technical review of the alternative bridge refurbishment methodology is presented in **Section 4.3.3**. A review of the cost of the alternative bridge refurbishment methodology is presented in **Section 4.4**.

4.3.1 Outline of alternative bridge refurbishment methodology

The submission from the ex-RMS bridge engineers provided the following description of the alternative refurbishment methodology for the piers and superstructure.

Piers

"It is envisaged that the external plates would be in half section semi-circles with flanges for making a bolted connection between the half sections. Neoprene packing would give a uniform tight fit to the cylinders. The strengthening would only need to go for the depth of the cylinder that is severely affected by graphitization. The depth required for strengthening the cylinders would need to be determined (assumed 3.35m). It is envisaged that 16mm thick plates would be satisfactory for the strengthening covers"

Superstructure

"It is envisaged that the underside of the reinforced concrete deck could be restored by:

- a) Using high pressure water blasting of the underside surfaces from barges under the deck to ensure traffic using the deck is not disrupted;*
- b) Inspecting the reinforcement for possible loss of cross sectional area and determining if supplementation of the reinforcement is required;*
- c) If supplementation of the reinforcement is required it can be readily achieved by using carbon fibre epoxy bonded to the final concrete surface;*
- d) Replace the blasted concrete using "gunniting" or "shotcreting" process;*
- e) Provide a protective coating to the repaired and/or strengthened concrete"*

4.3.2 Comparison of alternative and RMS bridge refurbishment methodology

Many of the differences in methodology and costs between the RMS and alternative bridge refurbishment methodology are due to the differing load limits achieved by each method. The alternative bridge refurbishment methodology aimed to provide:

- A low up front cost to refurbish the bridge. While the initial cost of alternative refurbishment method is low, the long term maintenance costs would be high and the refurbishment method would not address some of the design features of the existing bridge that are causing it's the deterioration. This is further discussed in **Section 4.4**.
- A refurbished bridge with load limits and that is suitable for light vehicles use only. The refurbished bridge would not meet the required load factor for the current maximum legal load limits. An alternative methodology to strengthen the bridge to the current maximum legal load limits was proposed. However the costs of this were not estimated but would necessarily exceed the costs presented below.
- A refurbished bridge that is part of a regional road upgrade which includes an alternative route.

The RMS bridge refurbishment methodology aimed to provide:

- A low long term maintenance cost – as generally maintenance and access costs for repairs to heritage bridges are considerably higher than more modern bridges. This requires additional initial refurbishment works and costs compared with the alternative methodology.
- A refurbished bridge that would meet the required load factor for the current maximum legal load limit.
- A refurbished bridge that would not include any other regional road upgrades and would be the primary crossing of the Hawkesbury River at Windsor.

The different objectives of the two refurbishment methods explain most of the differences in work elements and costs. Additionally, unlike the RMS cost estimate, the cost estimate provided for the alternative methodology did not include incidentals, such as RMS costs and contingencies. This is discussed further in **Section 4.4**.

The work elements for each of the bridge refurbishment methodologies are described in **Table 4-3**.

Table 4-3 Comparison of work elements

| 2009 RMS refurbishment methodology | Alternative refurbishment methodology |
|--|--|
| Concrete encasement of piers | Steel jacket around piers |
| Re-Alkalisation and patch and repair of damaged concrete | Conventional patch and repair of damaged concrete |
| Other minor works to replace bracing and repair headstocks | None |
| Strengthening of bridge deck using steel girders | None as strengthening not required for light vehicles. If strengthening was proposed to meet current maximum legal load limits, carbon fibre strips would be used. |

4.3.3 Technical review of alternative bridge refurbishment methodology

An independent technical review of the alternative bridge refurbishment method was undertaken by an industry-recognised specialist in bridge rehabilitation. This included reviewing the alternative bridge refurbishment method to provide comments on the:

- Technical merits of the solutions.
- Constructability of the alternative bridge refurbishment method in terms of impacts on traffic.
- Completeness of the alternative bridge refurbishment method with respect to the items and quantities identified in the bill of quantities.
- Durability of the alternative bridge refurbishment method.

A summary of the review is presented below. The full report is presented in **Appendix C**.

Substructure

The review concurred with the approach of steel jacketing of the existing piers but recommended a number of modifications to improve the long term durability and performance of the method including:

- Increasing the length of the pier covered by the new steel jackets to protect the integrity of existing iron and to ensure that there is adequate coverage of sections of the piers that are cracked, damaged or experiencing graphitisation which continued to the river bed level.
- Increasing the thickness of the steel jackets from 16 millimetres to 20 millimetres to allow for corrosion over time.
- Rather than relying on neoprene packing alone, grouting the space between the iron piers and the steel jackets to ensure that there is effective load transfer into the steel jackets. The grout would also prevent water ingress between the cast iron piers and the steel jackets and reduce further corrosion of the iron piers.
- Repair and treat pier diaphragms.
- Replacing all corroded sections of the horizontal bracing between the piers.
- Removal of the lead-based paint and repainting of the above water metal components of the substructure would be required to preserve the cast iron and steel work. Repainting would be required approximately every 15 - 20 years.

The design life of the refurbished piers would be 100+ years. The steel jacketing of the piers can be undertaken without any impact on the traffic using the bridge.

Superstructure

The review concluded that the alternative methodology for the refurbishment of the bridge deck would successfully repair the current damage to the concrete deck to return the bridge deck to an “as is” condition. The alternative methodology does not, however, address some of the causes of deterioration in the concrete deck and would have high long term maintenance costs and access requirements. Access to areas below the existing bridge deck is difficult as, unlike modern bridges, the design of heritage bridges does not consider maintenance access requirements.

To minimise long term maintenance costs and remedy the causes of the deterioration in the concrete deck, the review proposed a number of additional activities to complement the alternative bridge deck refurbishment methodology including:

- Re-alkalisation of the concrete – which would protect the existing concrete and reduce the amount of patch repair of the concrete in the longer term.
- Repair the deck joints – mainly to limit the ingress of water into the joints to limit the corrosion the steel reinforcing in the concrete beams.
- Minor repairs to the headstocks – to remove and replace spalled concrete.
- Minor modifications to bridge deck drainage – to remedy the current problem where water collected from the bridge deck drains directly on the concrete beams of the bridge and cause corrosion of the steel reinforcing.
- Placing a waterproof layer and asphalt on the road surface of the bridge deck – to again limit water ingress into the concrete elements beneath.

If the works described above were implemented, the long term maintenance would generally consist of minor concrete patch repairs and application of an anti-carbonation coating every ten to twelve years. The design life of the superstructure would be 50+ years.

If only the works described by the ex-RMS bridge engineers were undertaken, regular major patch repairs of the deck would be required and it is likely that the other works identified by the reviewers would have to be undertaken in the short to medium term. This would be unacceptable to RMS and would have longer term whole of life costs than the approach suggested by the reviewers. It is also noted that if a bypass is constructed and the existing bridge is retained for light traffic, the existing bridge would no longer be part of an arterial route. Instead, it would become a local road and responsibility for maintenance would be transferred to Hawkesbury City Council. Under this scenario, low cost maintenance would be a key criterion in determining the most appropriate method for refurbishment.

Most of the works could be undertaken with no impact on traffic. Some works (eg repair of the bridge deck joints) would require partial closure of the bridge. These works would be undertaken at night or during other low traffic conditions. As the bridge would need to be reopened every day to cater for peak traffic movements, the progress of these works would be relatively slow and could take up to three months to complete. Full closure of the bridge and diversion of traffic to an alternative river crossing would only occur for short periods (less than half a day at a time).

Strengthening of the existing bridge deck

The alternative methodology proposed by the ex-RMS bridge engineers would result in a load factor of about 1.5 for current legal maximum loads (42.5 tonne semi-trailer and 62.5 tonne B-double vehicles). The additional works proposed by the technical reviewers would increase the load factor to about 1.87, which is still below the required safe load factor of 2. If load limits were placed on the existing the bridge, a load factor of 2 would be achieved.

If, however, the bridge was required to have a load factor of 2 for the current legal maximum loads or the T44 standard, additional strengthening of the bridge would be required. The alternative methodology proposes the use of carbon fibre strips which are bonded to the existing concrete deck beams to provide them with additional strength. Apart from potential long term maintenance issues if the carbon fibre strips are incorrectly applied, their use to strengthen the bridge would be suitable and is

likely to result in the bridge having a load factor of 2 or greater for the current legal maximum loads or the marginally higher T44 standard. The carbon fibre strips alone are unlikely to be able to achieve a load factor of 2 or greater for the M1600 standard. This is the current standard that all new bridges are required to achieve. Further, because of the possible future recurrence of carbonation of the repaired concrete, the long-term performance of carbon fibre strips cannot be guaranteed.

Summary

The alternative bridge refurbishment methodology is a viable approach to restoring the existing bridge, although additional works (in addition to those proposed by the ex-RMS bridge engineers) would be required to remedy some of the causes of bridge deterioration and reduce long term maintenance costs. These additional works would increase the cost estimates provided by the ex-RMS bridge engineers. This is further discussed in **Section 4.4**.

The refurbished bridge would be capable of achieving a load factor of 2 if load limits on the bridge were introduced. The bridge could be further strengthened to have a load factor of 2 for the current legal maximum loads or the marginally higher T44 standard through the use of carbon fibre strips.

The works associated with refurbishment could be undertaken with only minor closures of the bridge. Full closure of the bridge over an extended period would not be required.

4.4 Review of cost estimates for Rickabys Line option

In their submission, the ex-RMS bridge engineers presented cost estimates for both the bypass and the refurbishment of the existing Windsor Bridge, the two components of the Rickabys Line option. Based on their cost estimates, the ex-RMS bridge engineers claim that the Rickabys Line option could be delivered for a similar cost to the project. The cost estimates for each component have been reviewed and are discussed in further detail in the following sections.

4.4.1 Costs estimates for the alternative route

The cost of the alternative route component of the Rickabys Line option estimated by the ex-RMS bridge engineers was approximately \$61 million. The cost estimate for the alternative route was based upon press releases and media articles detailing the costs, length and type of bridges used for the 3.4 kilometres Kempsey Bridge and costs for the road component of Kempsey Bypass. This information was then prorated to provide an indication of the approximate costs per square metre of bridge and metre of road for the Rickabys Line option. There are, however, a number of reasons why the Kempsey Bridge and Kempsey Bypass projects do not provide a realistic basis for cost comparison. These reasons are as follows:

- The Kempsey Bridge project was constructed using Super Ts. As discussed above, Super Ts would not be permitted for the Rickabys Line option bridge due to their poor flood performance.
- The majority of the Kempsey Bridge was across the floodplain and the construction contractor was able to use land-based construction methods, which are generally 30 per cent cheaper than marine based construction. While some of the spans of Rickabys Line option bridge could be constructed via land-based construction, a greater proportion of construction would be marine based.

- The construction contractor undertook the piling themselves rather than subcontracting this activity, which reduced the costs of the Kempsey bridge. This is relatively uncommon and is only cost-effective for large bridge projects. For the Rickabys Line option, there would be insufficient piles to justify self-performing pile installation and therefore this activity would be subcontracted and would cost more than for the Kempsey bridge.
- The Super T girders were supplied at or near cost to maintain the operational viability of a pre-cast facility.
- There are considerable efficiencies of scale in constructing over three kilometres of bridges compared with about 0.3 kilometres of bridges for the Rickabys Line option.

Consequently the cost of the Kempsey Bridge project was low in comparison to typical costs for bridges. Typical recent rates for similar bridges have ranged between \$3,500 and \$6,000 per square metre. While the alternative costs addressed some of these issues and used a cost of \$3,500 per square metre of bridge, this is still in the lower range for bridges and does not reflect the construction complexity of the bridge across the Hawkesbury River.

Additionally, the alternative costing did not contain incidentals (such as environmental approvals), RMS costs and other option specific costs such as additional turning lanes on Hawkesbury Valley Way and traffic lights at intersections. While there was a considerable contingency included in the alternative costings, this was not sufficient to cover all additional costs and was compounded by the under-estimation of base rates for bridge and road construction (as discussed earlier).

RMS also used a different methodology for pricing the project. This methodology includes all components of the project and is based upon the RMS Project Estimation Manual. A direct comparison of the project cost in the EIS with the alternative cost is therefore misleading as the project cost in the EIS includes more aspects of project delivery. If the alternative costing methodology was used to cost RMS's preferred, the cost estimate would be substantially lower than the cost presented in the EIS.

To provide a more realistic comparison of the cost of the alternative option and the cost of the project, the preliminary design of the alternative option was priced using the same methodology applied in the EIS for the costing of the project (the methodology in the RMS Project Estimation Manual) with current market rates. The revised cost of the alternative option was also reviewed by an independent cost estimator.

The revised cost estimate for the Rickabys Line option using the RMS Project Estimation Manual methodology is about \$117 million (see **Table 4-4** for a breakdown of costs). This excludes a number of items that were too difficult to cost at the preliminary concept design stage including:

- Excavating, managing and disposing of soils unsuitable for construction.
- Cross-drainage.
- Adjustments to services and utilities.
- Biodiversity offsets from the clearing of the Endangered Ecological Community in Macquarie Park.
- Upgrade to Hawkesbury Valley Way to provide additional turning and merge lanes.

- Flood mitigation works.
- Noise mitigation works.
- Any other environmental management measures that may be required such as archaeological salvage.

Table 4-4 Cost estimate for the Rickabys Line option – bypass only

| Item | Cost estimate (including contingency) |
|--|--|
| 1. Project development | |
| 1 (a) Route/Concept/EIS or REF | \$2,596,832 |
| 1 (b) Project Management Services | \$155,810 |
| 1 (c) Client Representation | \$15,581 |
| Sub total | \$2,768,223 |
| 2. Investigation and design | |
| 2 (a) Investigation and Design | \$7,163,674 |
| 2 (b) Project Management Services | \$429,820 |
| 2 (c) Client Representation | \$42,982 |
| Sub total | \$7,636,476 |
| 3. Property acquisitions | |
| 3 (a) Acquire Property | \$6,211,376 |
| 3 (b) Professional Services for Property | \$0 |
| 3 (c) Project Management Services | \$124,228 |
| 3 (d) Client Representation | \$6,211 |
| Sub total | \$6,341,815 |
| 4. Public utility adjustments | |
| 4 (a) Adjust Utilities | \$0 |
| 4 (b) Project Management Services | \$0 |
| 4 (c) Client Representation | \$0 |
| Sub total | \$0 |
| 5. Construction | |
| 5 (a) Infrastructure | \$92,530,784 |
| 5 (b) PAI | \$508,919 |
| 5 (c) Primary Testing | \$0 |
| 5 (d) Project Management Services | \$5,551,847 |
| 5 (e) Client Representation | \$555,185 |
| Sub total | \$99,146,735 |
| 6. Handover | |
| 6 (a) Refurbish old route | \$0 |
| 6 (b) Project data and performance | \$925,308 |
| 6 (c) Project Management Services | \$55,518 |
| 6 (d) Client Representation | \$5,552 |
| Sub total | \$986,378 |
| TOTAL COST | \$116,879,627 |

In contrast, the estimated RMS preferred project cost is about \$65 million, including all relevant items listed above. The project cost has increased since the EIS was prepared and following further community consultation. This has resulted in a more developed design that now includes additional scope such as signalised intersection at George and Bridge streets, scour protection, an incrementally launched bridge and renewal of Thompson Square. However, the revised cost of the alternative route component of the Rickabys Line option is still about double the project cost.

This revised cost of the alternative route is lower than strategic RMS cost estimates for a bypass provided previously by RMS (which were between \$150-200 million) but over double the project budget. The long term operational costs of the Rickabys Line option would also be substantially higher as there would be three bridges to maintain, one of which is already over 130 years old, around 1.6 kilometres of additional roads within the floodplain, and two additional sets of traffic lights, both in the floodplain.

RMS has also incurred considerable costs to date in the development of the project, including costs associated with the options assessment and development phase, the preparation of the concept design and environmental impact assessment, the selection of a construction contractor, and the development of the detailed design of the project. While some of the work already undertaken could be used for the Rickabys Line option, most of the work and associated costs are not possible to recover. While these incurred costs have not been presented in the above table, they would be in addition to the costs for the Rickabys Line option presented in the table.

4.4.2 Cost estimate for the alternative bridge refurbishment methodology

The ex-RMS bridge engineer's submission provided a cost estimate of \$3 million for their alternative bridge refurbishment methodology. This compared to RMS's cost estimate of \$18 million for bridge refurbishment. As discussed in **Section 4.4**, however, the objectives and outcomes of the two bridge refurbishment methodologies were different, so the two cost estimates are not appropriate to compare directly to each other.

There were a number of issues with the cost estimate provided by the ex-RMS bridge engineers in the submission that detailed the alternative bridge refurbishment methodology as part of the Rickabys Line option. These issues are as follows:

- The proposed construction methodology is unlikely to be acceptable for safety and environmental reasons. Rather than all superstructure works being undertaken from a barge, a purpose built platform would need to be constructed and installed to provide a safe working location and to capture all debris from the concrete removal process. The platform would be moved from span to span as the works progressed across the bridge. This platform was not included in the cost estimate for the alternative bridge refurbishment.
- The cost estimate was not based on the latest standard RMS and market rates.
- The costing methodology did not follow the methodology in RMS's Project Estimation Manual and substantially underestimated the contingency requirements and incidental costs. All cost estimates prepared and presented by RMS comply with their Project Estimation Manual.

An additional factor considered in the revised cost estimate is that RMS requires carbon fibre strengthening of the superstructure to achieve the safe load factor for illegal overweight heavy vehicles that may use the bridge.

Additional costs over the actual construction costs include:

- Contingency for additional works - Budgets for works on heritage bridges generally have a high contingency because additional works are generally identified during construction due to age of the structure and the difficulty in inspecting all components and areas of the bridge before construction commences. For example the amount of concrete that requires treatment on Windsor Bridge is likely to increase as the works progress.
- Heritage and environmental planning approval and compliance costs.
- Design costs – though not likely to be substantial, some design work needs to be completed to verify that the methodology would have the required outcomes.
- RMS costs – which would include project development and management, quality inspections of the works, preparation and implementation of environmental management plans, and testing once work has been completed.
- Some environmental management works – for example the management of the lead based paint on some components on the bridge has not been costed.
- Community liaison and information during construction.

The technical review of the alternative bridge refurbishment methodology concluded that, while the alternative methodology was generally suitable, a number of additional works would be required to provide a better structural solution and minimise long term maintenance costs. While the alternative bridge refurbishment methodology proposed by the ex-RMS bridge engineers may result in a functional bridge in the short term, it would still require substantial regular maintenance and many of the issues that would contribute to ongoing deterioration would not be addressed. It has been estimated that, with the incorporation of the additional works identified in the technical review, long term maintenance costs would be almost halved relative to the long term maintenance costs of the methodology proposed by the ex-RMS bridge engineers.

The revised cost estimate of the alternative bridge refurbishment methodology presented in this report was therefore based on a modified version of the alternative bridge refurbishment methodology. This modified alternative bridge refurbishment methodology included:

- The scope of works and activities recommended detailed in the technical review of the alternative bridge refurbishment methodology, including the additional works required to minimise long-term maintenance costs.
- Current market rates for the works and materials.
- The methodology for cost estimation contained in the RMS Project Estimation Manual.

The revised costs for the modified alternative bridge refurbishment methodology is presented in **Table 4-5**. The overall cost estimate for the modified alternative bridge refurbishment methodology is about \$16 million, including contingency.

Table 4-5 Cost estimate for the modified alternative bridge refurbishment methodology

| Item | Estimate (including contingency) |
|---|---|
| 1(a) Route/Concept/EIS or REF | \$564,725 |
| 1(b) Project management | \$45,178 |
| 1(c) Client representation | \$4,518 |
| 1(d) Community liaison | \$108,000 |
| Sub-total | \$722,421 |
| 2(a) Investigation and design | \$752,967 |
| 2(b) Project management | \$60,237 |
| 2(c) Client representation | \$6,024 |
| Sub-total | \$819,228 |
| 5(a) Infrastructure | |
| Establish/ demolish | \$152,380 |
| Environmental (including monitoring) | \$319,760 |
| Supply steel collars to existing piers | \$1,152,811 |
| Install steel collars to existing piers | \$1,253,507 |
| Repainting, cross bracing and diaphragm beams | \$218,895 |
| Replace dowelling and defective concrete | \$1,114,325 |
| Remediation of existing bridge soffit | \$8,285,954 |
| Deck repair work | \$434,229 |
| Sub-total | \$12,931,861 |
| 5(b) PAI insurance | \$71,125 |
| 5(c) Primary testing | \$129,319 |
| 5(d) Project management | \$1,034,549 |
| 5(e) Client representation | \$103,455 |
| Sub-total | \$14,270,308 |
| 6 (a) Refurbish old route maintenance | \$0 |
| 6 (b) Project data and performance | \$117,128 |
| 6 (c) Project management services | \$9,370 |
| 6 (d) Client representation | \$937 |
| Sub total | \$127,436 |
| TOTAL | \$15,939,393 |

4.5 Assessment of the Rickabys Line option

To provide an overall assessment of the Rickabys Line option, the results of an economic analysis are presented and the option has been assessed against the project objectives and criteria in the context of the key findings of the environmental assessment from **Section 4.2**.

4.5.1 Economic analysis

An economic analysis was undertaken for the project as part of the EIS (Section 3.3). The analysis returned a BCR of 14.6 and concluded that the project would create benefits that would be realised by the general community and would outweigh the initial upfront construction and ongoing operational costs. The options analysis also included a BCR comparison for different options.

Since the economic analysis was undertaken for the EIS the capital cost of the project has been updated. Accordingly, the economic analysis has been updated.

The benefit cost analysis for the Rickabys Line option was based on two different methodologies as follows:

- Rickabys Line option, with refurbishment of the existing bridge using the re-alkalisation method with carbon fibre bridge strengthening (option R1).
- Rickabys Line option with refurbishment of the existing bridge using the conventional 'concrete patch repair' method but excluding carbon fibre bridge strengthening (option R2).

The economic analysis uses the same methodology as used for the EIS, including adoption of a seven per cent discount rate to the present value.

The analysis compares the project, Option R1 and Option R2 to the base case option (ie the 'do nothing' option). The assessment assumes that in the base case, the existing Windsor Bridge would remain open to traffic and there would be no modifications to intersections. Traffic modelling for the base case indicates that by 2026 there would be considerable congestion and the average travel times and speeds would decrease substantially, especially in the evening peak period.

Costs already incurred by RMS have been excluded from the analysis.

A summary of the economic analysis for the project is provided in **Table 4-6** below.

Table 4-6 Benefit cost ratio for project and Rickabys Line options

| | Project | Option R1 | Option R2 |
|--------------------------------|-------------------------|-------------------------|-------------------------|
| Costs | | | |
| Capital costs [#] | \$ 52.0 million | \$ 116.9 million | \$ 116.6 million |
| Maintenance costs | -\$ 0.3 million | \$ 1.4 million | \$ 2.5 million |
| Total costs | \$ 51.7 million | \$ 118.3 million | \$ 119.1 million |
| Benefits | | | |
| Travel time savings | \$ 548.8 million | \$ 494.4 million | \$ 494.4 million |
| Vehicle operating cost savings | \$ 119.0 million | \$ 87.8 million | \$ 87.8 million |
| External savings | \$ 0.6 million | -\$ 5.2 million | -\$ 5.2 million |
| Safety savings | \$ 3.7 million | - | - |
| Total benefits | \$ 672.1 million | \$ 577.0 million | \$ 577.0 million |
| Benefit cost ratio | 13.0 | 4.9 | 4.8 |
| Net present value | \$ 620.3 million | \$ 458.7 million | \$ 457.9 million |

The results of the economic analysis indicate that while the revised BCR has decreased to 13.0 from 14.6, it still provides a considerably better economic return than the Rickabys Line options of around five. While the Rickabys Line options both produce a BCR of greater than two (which indicates that these options offer value for

money) they require considerably more upfront capital and ongoing maintenance and achieve less economic benefits than the project. Key findings are as follows:

- The Rickabys Line options would reduce the total vehicle travel time compared to the base case. The reduction in travel time achieved by the Rickabys Line options would, however, be slightly less than achieved with the project.
- The total vehicle operating costs for the Rickabys Line options would be lower than the base case but higher than they would be for the project.
- As the Rickabys Line options would result in an increase in vehicle kilometres travelled, the projected externality costs for the Rickabys Line options would be higher than in the base case.
- The Rickabys Line options would have much greater on-going maintenance and operating costs compared to the base case (for three bridges) while the project would not have high on-going maintenance costs and would decrease operating costs as compared to the base case (as indicated by the negative maintenance cost for the project in **Table 4-6** above).

4.5.2 Assessment of Rickabys Line option against project objectives and criteria

As discussed above, the Rickabys Line option is assessed as one of the “Hawkesbury Valley Way” community options in Section 4.2.2 of the EIS. The objectives against which the options are assessed are identified in Section 3.4 of the EIS.

The assessment of the Rickabys Line option in the EIS identified benefits to traffic efficiency and pedestrian safety within Windsor due to a reduction in the number of vehicles travelling through the area. This more detailed assessment has further identified that the Rickabys Line option would perform better than the project on the objective to improve traffic and transport efficiency by minimising traffic queue lengths, improving the performance of the road network and providing efficient connections for regional and local traffic. However, unlike the assessment in the EIS, the current assessment identified the Rickabys Line option would not perform as well as the project on pedestrian and cyclist safety and accessibility.

Rickabys Line option was also shown to perform better on the objective to minimise impacts on heritage and the character of the local area by reducing impacts on Thompson Square and the existing Windsor Bridge. However, consistent with the assessment of the option in the EIS, potential impacts were identified on the local character of the area along the proposed route, including a number of recreational areas and businesses. The assessment concluded that the option would perform poorly against the cost objective, with high costs associated with two bridge structures, unknown additional costs associated with flood mitigation, considerable property acquisition and costly maintenance.

The Rickabys Line option would also have additional impacts that are not specifically addressed by the objectives. These include:

- The loss of about 1.6 hectares of a threatened ecological community listed under the *Threatened Species Conservation Act 1995*.
- Increases in upstream flood levels that would necessitate expensive flood mitigation measures, which would further increase the cost of the Rickabys Line option.

While the Rickabys Line option has some clear advantages compared to the project in terms of minimising heritage impacts and improving traffic performance, it would have greater impacts on significant vegetation, the amenity of Macquarie Park, increasing flood levels upstream and would impact other properties and businesses. Further, around 10000 vehicles a day would continue travelling through Thompson Square. This continued traffic would limit any amenity improvements to the area, while also introducing new traffic related impacts to the amenity of an area that is not currently impacted by traffic. Some of the benefits of the project would also not be realised with the Rickabys Line option, such as improvements in pedestrian and cyclist access and safety, and consolidation of the Thompson Square parkland.

Finally, the preliminary cost estimate of the Rickabys Line option is over double the cost of the project and is likely to increase as the cost of items unable to be estimated at this preliminary stage are included.

4.6 Conclusion

This assessment has reconfirmed the replacement of Windsor Bridge 35 metres downstream of the existing bridge as the preferred option for the Windsor Bridge replacement project. The Rickabys Line option is not favoured as an alternative to the project due to:

- The impacts on Macquarie Park and its associated threatened ecological community.
- The predicted increase in upstream flood levels and the unknown associated costs with mitigation of this impact.
- It's less than optimal traffic performance. Other bypass options would be likely to have better traffic performance in comparison to the Rickabys Line options.
- The high capital and operational costs of the option.

5 Preferred infrastructure report

The EIS noted that refinements could be made to the design features and construction methods for the project during the detailed design phase. This section identifies and assesses the minor design modifications to the concept design that have been made since preparation of the EIS, and describes the reasons for these modifications.

All proposed design modifications would generally minimise the environmental impact of the project. Ongoing investigations will be carried out as required to further progress detailed design, or as committed to assist the implementation of management and mitigation measures during the construction and operation of the project.

Ongoing refinements may continue during detailed design development.

5.1 Increase in the clearance of the new bridge over The Terrace

5.1.1 Description

During the development of the project, the vertical alignment of the new bridge and approach road through Thompson Square was lowered substantially to minimise impacts on heritage views and vistas. This was achieved by lowering the design speed from 60 kilometres per hour to 50 kilometres per hour. The alignment was lowered while maintaining a 3.6 metre clearance over The Terrace to allow small coaches, service vehicles and emergency vehicles to access Windsor Wharf.

In consultation with Hawkesbury City Council and in response to submissions received during the exhibition of the EIS, RMS has now increased the proposed clearance of the new bridge over The Terrace from a minimum of 3.6 metres to a maximum of 4.6 metres to allow large coaches to directly access Windsor Wharf. Large coach access along The Terrace is required to allow the patrons of the Hawkesbury Paddle Wheeler to have easy access to Windsor Wharf.

Many of the patrons of the Hawkesbury Paddle Wheeler are elderly, disabled and/or have limited mobility and would find it difficult or impossible to access the wharf if large coaches were forced to park in Thompson Square road or Baker Street. The Windsor Paddle Steamer business has been operating for 14 years, with the main source of income being the provision of leisure cruises for the elderly and disabled. The viability of the Hawkesbury Paddle Wheeler business is reliant on large coaches being able to transport patrons to Windsor Wharf.

To provide the additional clearance over The Terrace, the height of the southern end of the bridge would be increased. This would result in a one metre higher bridge and abutment at the southern end, and a marginally higher 45 metre long section of the southern approach road through Thompson Square between the driveways of Number 4 Bridge Street to the southern abutment. South of the driveway of Number 4 Bridge Street and in front of the heritage listed properties of Number 6 and Number 10 Bridge Street, the height of the southern approach road would remain the same as that presented in the EIS. The grade of the bridge would also increase slightly from 1.6 to 1.9 per cent.

Figure 5-1 and **Figure 5-2** presents the difference in heights of the modified project in comparison to the project presented in the EIS.

Given the sensitivity of the environment in which the project is located, the potential changes in environmental impacts resulting from the design change were assessed in consideration of the key environmental issues identified in the Director General's Requirements. The results of the assessment are summarised in **Table 5-1**. In the following sections, a more detailed assessment is provided for those key issues most likely to be affected.

Table 5-1 Changes in environmental impact resulting from proposed increase in clearance over The Terrace

| Key issues | Change in environmental impact |
|------------------------------------|--|
| Historic heritage | The proposed design change would result in a slight increase in the visual and physical presence of the bridge as seen from Thompson Square and adjacent properties. With respect to the overall impact on the existing cultural landscape and heritage views and vistas, however, the difference between the exhibited bridge design and the modified bridge design would be minimal. The visual impact of the project would remain substantial. Further details of the effect of the design change on historic heritage are provided in Section 5.1.2 . |
| Aboriginal heritage | The design change would not increase the area disturbed by the project or result in disturbance of any new areas. The Aboriginal heritage impacts and associated environmental management measures required would therefore remain as described in the EIS. |
| Traffic and transport | The design change would not result in any changes to the alignment or capacity of the bridge or the impacts of the project's construction and operation on traffic and transport. The traffic and transport impacts and associated environmental management measures required would therefore remain as described in the EIS. The design change would improve access to Windsor Wharf compared to the design presented in the EIS, with the design change allowing large coaches and service vehicles direct access to the wharf. With a higher bridge, there would be increased clearance under bridge especially towards the southern bank. This would also improve the safety of on-river navigation. |
| Visual, urban design and landscape | The design change would result in a minor increase in the visual and physical presence of the southern end of the bridge within the landscape and a minor increase in the magnitude of visual impacts. The change would not, however, be sufficient to increase the landscape character impact ratings or the overall visual impact ratings identified in the EIS. The impact ratings would remain "high". Further details of the effect of the design change on visual amenity, urban design and landscape are provided in Section 5.1.3 . |

| Key issues | Change in environmental impact |
|---|---|
| Noise and vibration | <p>The design change would not alter the duration or extent of construction works or the types of construction equipment used. The construction noise and vibration impacts and the corresponding mitigation measures required would therefore remain as described in the EIS. Additional impact assessment has been carried out to assess the impacts of the proposed design change on operational noise. This additional assessment also addresses the additional residential properties that have been identified since completion of the EIS. The results of the additional assessment indicate that, while there would be little or no increase in operational noise and vibration impacts as the result of the revised bridge design, four additional residential properties (in addition to those identified in the EIS) require consideration for noise mitigation treatments. Further details are presented in Section 5.1.4.</p> |
| Soils, sediments and water | <p>The design change would not result in any changes to the erosion and sedimentation risks of the project. The erosion and sedimentation risks and associated environmental management measures would therefore remain as described in the EIS. The design change would not result in any change to the flood immunity of the project. The northern abutment and approach road would remain at the height described in the EIS and, as the lowest points on the bridge, would determine the flood immunity of the project. There may be a very small change in the flooding effects of project, however the effect of these changes on land use and property would be negligible and the conclusions regarding flooding impacts would remain as described in the EIS. More detailed modelling of flooding impacts would be undertaken during the detailed design phase of the project. The design change would not have any significant effect on hydrology. More detailed modelling of hydrological impacts would be undertaken during detailed design.</p> |
| Land use, property and socio-economic impacts | <p>The design change would not result in any additional land take or any additional changes to property access. The design change would prevent adverse socio-economic impacts on the Hawkesbury Paddle Wheeler business. Further details of the effect of the design change on land use, property and the socio-economic environment are provided in Section 5.1.5.</p> |
| Flora and fauna | <p>The design change would not result in any changes to the flora and fauna impacts of the project. The flora and fauna impacts and associated environmental management measures required would therefore remain as described in the EIS.</p> |
| Air quality | <p>The design change would not result in any changes to the air quality impacts of the project. The air quality impacts and associated environmental management measures required would therefore remain as described in the EIS.</p> |

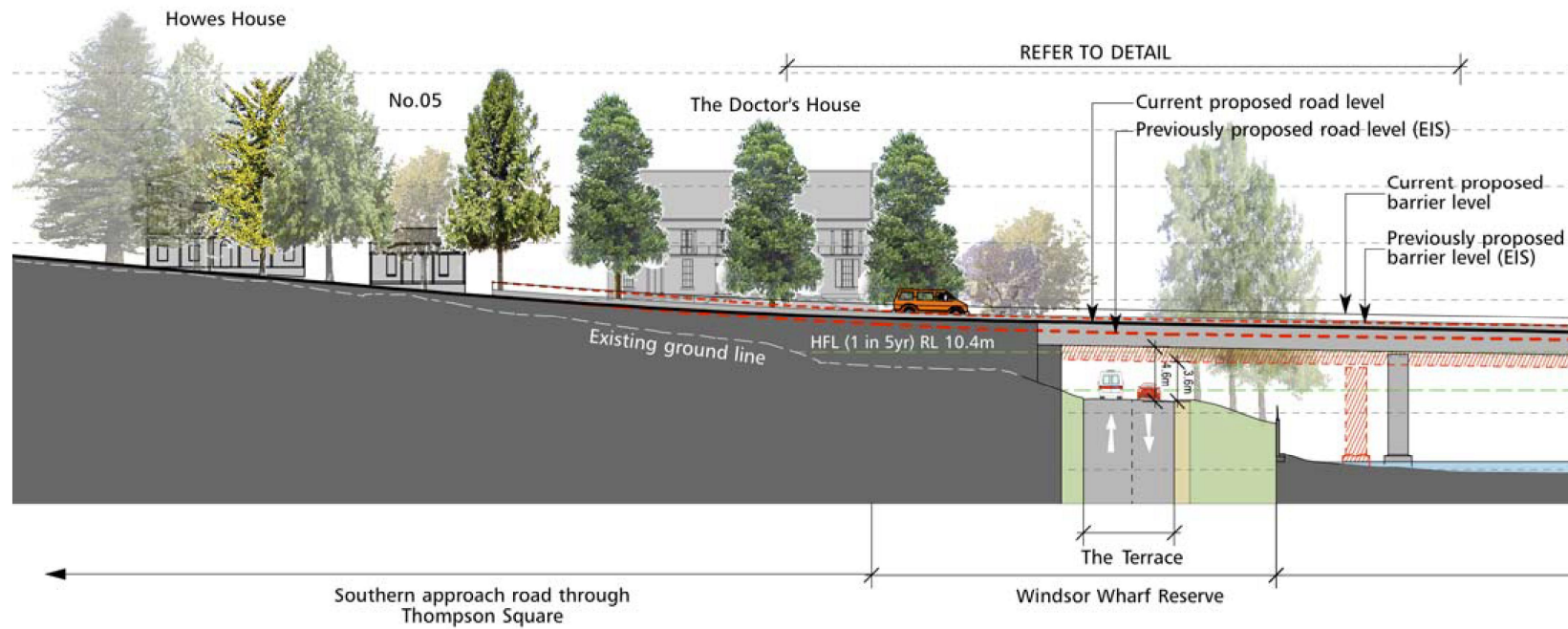


Figure 5-1 Change in height of bridge and approach road – southern bank

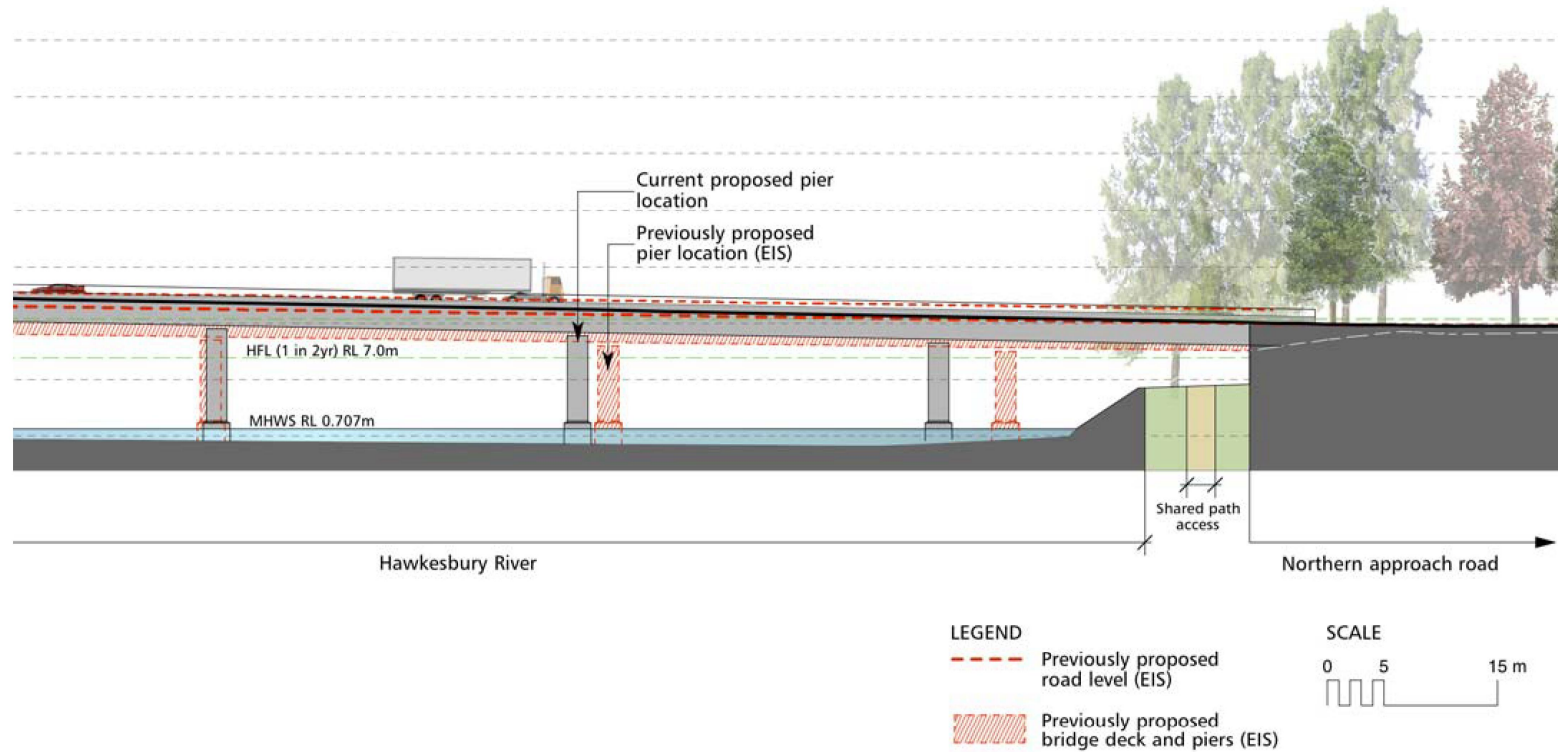


Figure 5-2 Change in height of bridge – northern bank

5.1.2 Historic heritage impacts

A detailed assessment of the impacts of design changes is included in the Heritage Addendum in **Appendix B**. A summary of the assessment is provided below.

With the proposed design change, the location and horizontal alignment of the proposed replacement bridge would remain the same as described in the EIS. The level of the bridge deck would, however, increase by a maximum of one metre at its southern end where it crosses The Terrace. The level of the approach road would rise gradually from the northern side of the driveway at 4 Bridge Street until the high point is reached along the section of the alignment between the southern bridge abutment and the crossing of The Terrace. Beyond the high point, the level of the bridge would gradually decrease until it reaches the same level described in the EIS at a location between pier 3 and pier 4.

Increasing the clearance of the new bridge over The Terrace would not increase the area disturbed by the project, result in disturbance of any new areas or introduce any other new physical impacts. As such, the design change would not increase the disturbance of archaeological resources or heritage items. The physical impacts of the project, including the impacts on the existing heritage listed bridge, Thompson Square Conservation Area and subsurface archaeological resources, would remain as described in the EIS.

On the western side of the southern approach road, the height of the road (and therefore the retaining wall to the parkland) would increase slightly but this would not have a significant impact on the visual impact of the retaining wall. The wall would not be any more noticeable than with the original design presented in the EIS.

With respect to the overall impact of the proposed design change on the existing cultural landscape and heritage views and vistas, the difference between the exhibited bridge design and the modified bridge design would be minimal. The visual impact of the project would remain substantial and, in combination with the other elements of the project, the overall findings with respect to the significance of heritage impacts remain as described in the EIS.

5.1.3 Visual, urban design and landscape impacts

A detailed assessment of the landscape and visual impacts of increasing the clearance of the new bridge over The Terrace has been undertaken. The results of this assessment are presented in **Appendix D**. A summary of the main findings is presented below.

Landscape character impacts

Increasing the clearance of the new bridge over The Terrace would affect the following two landscape character zones (LCZs) identified in the EIS:

- LCZ 1 - Thompson Square.
- LCZ 2 - Hawkesbury River and River Banks.

The impacts on these LCZs are summarised in **Table 5-2**. Overall, the proposed design change would not change the landscape character impact ratings for the affected LCZs. The impact ratings would remain “high”.

Table 5-2 Changes in landscape character impacts resulting from proposed increase in clearance over The Terrace

| LCZ | Effects of design change | Effect on landscape character impact rating |
|----------------------------------|--|---|
| Thompson Square | The design change add to the vertical scale of the bridge, which would result in a slight increase in the physical and visual presence of the southern approach road and bridge abutments within the lower section of Thompson Square and when viewed from the buildings along Thompson Square road. The change would slightly improve the spatial experience of The Terrace, with slightly increased headroom and increased amounts of natural light. It would also further improve vehicle connectivity along The Terrace, although this may result in increased pedestrian and vehicle conflicts. | The design change would not change the landscape character impact rating for this LCZ. The impact rating would remain “high”. |
| Hawkesbury River and River Banks | The design change would increase the scale and height of the bridge, making it a slightly more dominant structure in the landscape. It would also, however, increase the perception of space along the foreshore and under the bridge on The Terrace. | The design change would not change the landscape character impact rating for this LCZ. The impact rating would remain “high”. |

Visual impacts

A total of eighteen viewpoints formed the basis of the original visual impact assessment presented in the EIS. Increasing the clearance of the new bridge over The Terrace would affect eight of these viewpoints. The impacts of the proposed design change on the magnitude of visual impacts and the overall visual impact rating for these viewpoints are summarised in **Table 5-3**. In summary, while the proposed design change would result in a minor increase in the magnitude of visual impacts, the degree of change would not be sufficient to increase the magnitude rating or the overall impact rating. The proposed design change would not affect the visual sensitivity ratings of the viewpoints.

Table 5-3 Changes in visual impact resulting from proposed increase in clearance over The Terrace

| View point | Description | Previous impact ratings | | Effect of design change |
|------------|--|-------------------------|---------|--|
| | | Magnitude | Overall | |
| 5 | Foreground view from Bridge Street, looking north west. Overlooks the southern approach road. | Moderate | High | The southern approach road would be slightly higher as a result of the design change. The change would not be sufficient to increase the 'magnitude' rating or the overall visual impact rating as the changes viewed from this location would be minor and the majority of the works would be obscured by existing buildings along Bridge Street. |
| 7 | Foreground view from Thompson Square, looking north. Overlooks the southern approach road and the bridge itself. | Moderate to High | High | The bridge abutments would be slightly more prominent from this viewpoint, and would further obscure views to the water. The change would not be sufficient to increase the 'magnitude' rating or the overall visual impact rating as the changes in this view would be minor due to the angle of the view. |
| 8 | Foreground and mid distance view from Bridge Street, looking north west. | High | High | The slightly raised southern approach road and raised abutments and deck would increase the visual dominance of the structure from this location and would further obscure views of the river. The magnitude impact rating and overall visual impact rating would remain High, the highest rating on the impact assessment grading matrix. |
| 9 | Foreground and mid distance view from Thompson Square, adjacent to the Doctor's House, looking north. | High | High | This viewpoint overlooks the river and the changes would clearly be visible from this location. The magnitude impact rating and overall visual impact rating would remain High, the highest rating on the impact assessment grading matrix. |

| View point | Description | Previous impact ratings | | Effect of design change |
|------------|--|-------------------------|------------------|---|
| | | Magnitude | Overall | |
| 11 | Foreground view from the small carpark near The Terrace, looking north west. Viewpoint is located under the replacement bridge. | High | High | The increased height of the bridge would reduce the sense of enclosure under the bridge along this section of The Terrace and would slightly open the view over the river. The magnitude impact rating and overall visual impact rating would remain High, the highest rating on the impact assessment grading matrix. |
| 12 | Foreground view from Windsor Wharf, looking south west. Provides extensive views along the river towards existing bridge. | High | High | The increased height of the bridge and abutments would be noticeable on the already prominent structure. The magnitude impact rating and overall visual impact rating would remain High, the highest rating on the impact assessment grading matrix. |
| 17 | Foreground view from Wilberforce Road, west of Freemans Reach Road, looking south. Viewpoint looks towards Windsor and the bridge replacement works. | Moderate to High | Moderate to High | The increased height of the bridge would be visible from this location, although the view would not be substantially different to the previous proposal. The change would not be sufficient to increase the 'magnitude' rating or the overall visual impact rating due to the distance between the works and the viewpoint. |
| 18 | Foreground view from Wilberforce Road, east of Freemans Reach Road, looking south. Viewpoint looks towards Windsor and the bridge replacement works. | Moderate to High | Moderate to High | The increased height of the bridge would be visible from this location. The change would not be sufficient to increase the 'magnitude' rating or the overall visual impact rating due to the distance between the works and the viewpoint. |

5.1.4 Operational noise impacts

Additional impact assessment has been carried out for the proposed design change to assess the effects of the change on operational noise and vibration. This additional assessment takes into consideration not only the proposed design change, but also new information from site visits and zoning information on residential property use that has become available since completion of the EIS. Specifically, four residential properties that were incorrectly identified as commercial properties in the EIS have now been re-assessed as residential properties to determine the need for impact mitigation in accordance with the Road Noise Policy. The revised list of residential receivers for the project is presented in **Table 5-4**.

The properties that have been re-classified as residential receivers since completion of the EIS are R16, R17, R18 and R19.

Table 5-4 Revised list of residential receivers for the project

| ID | Receiver location | Details | Distance from existing road |
|-----------|--------------------------|---|------------------------------------|
| R1 | 27 Wilberforce Road | Single storey residential dwelling | 17 metres |
| R2 | 4 Bridge Street | Single storey residential dwelling. Lightweight brick and weatherboard construction. | 27 metres |
| R3 | 10 Bridge Street | Double storey mixed residential upper floor and commercial lower floor, heritage building. Masonry construction | 10 metres |
| R4 | 53 George Street | Double storey residential building. Masonry construction | 40 metres |
| R5 | 12 The Terrace | Single storey residential dwelling. Masonry construction | 145 metres |
| R6 | 14 The Terrace | Single storey residential dwelling. Masonry construction | 160 metres |
| R7 | 16 The Terrace | Single storey residential dwelling. Masonry construction | 172 metres |
| R8 | 18 The Terrace | Single storey residential dwelling. Masonry construction | 190 metres |
| R9 | 20 The Terrace | Single storey residential dwelling. Masonry construction | 205 metres |
| R10 | 22 The Terrace | Single storey residential dwelling. Masonry construction | 223 metres |
| R11 | 45 George Street | Single storey residential dwelling. Masonry construction | 120 metres |
| R12 | 43 George Street | Single storey residential dwelling. Masonry construction | 133 metres |
| R13 | 41 George Street | Single storey residential dwelling. Masonry construction | 150 metres |
| R14 | 39 George Street | Single storey residential dwelling. Masonry construction | 178 metres |
| R15 | 29 George Street | Single storey residential dwelling. Construction unknown | 250 metres |
| R16 | 3 Thompson Square | Double storey residential dwelling. Heritage building. Masonry construction | 10 metres |
| R17 | 64-68 George Street | Double storey commercial, heritage building. Masonry construction | 18 metres |
| R18 | 14 Bridge Street | Single storey commercial/residential dwelling. Heritage building. Masonry construction | 7 metres |
| R19 | 16 Bridge Street | Single storey residential dwelling. Masonry construction | 8 metres |

A summary of the key findings of the additional noise assessment is presented in the following section. The full details of the assessment are attached in **Appendix E**.

Effects of the design change on operational noise and vibration

The modeling of noise impacts for the revised project design was based on the same traffic data used in the EIS. The results of the modeling indicate that there would be little or no increase in operational noise or vibration as a result of the proposed design change.

At the previously assessed residential receiver locations, the results of the noise impact assessment, including the identified impact mitigation requirements, remain as described in the EIS. For the four residential receivers that have been identified since completion of the EIS (R16, R17, R18 and R19), the modeling results indicate that these properties are currently exposed to acute traffic noise levels from the existing alignment and would continue to be impacted by acute noise levels during operation of the project. These properties would therefore be considered for noise mitigation treatments as described below.

Additional noise mitigation measures

As detailed in Section 7.5 of the EIS, installation of noise barriers and application of road surface treatments are not feasible noise mitigation options for the project. The noise mitigation options for the project would be limited to the application of architectural treatments to affected individual properties.

The four additional residential properties identified since completion of the EIS (R16, R17, R18 and R19) have been re-assessed against the project criteria in accordance with the Road Noise Policy. The results of this assessment indicate that the properties are affected by noise levels in excess of the project criteria and therefore qualify for noise mitigation.

Three of the additional residential dwellings that would require noise mitigation measures (R16, R17 and R18) are located around Thompson Square and have been identified as having heritage values. These properties would therefore be subject to appropriate architectural treatments that reduce the effects of traffic noise while minimising adverse impacts on heritage. This is discussed further in **Section 5.3**.

Properties further south of the project (eg. Corner of Macquarie Street and Bridge Street) do not qualify for noise mitigation as the road corridor in this area would not be redeveloped by the project and the project would not result in the generation of additional traffic along the road corridor.

There has been some suggestion that the building at R2 (4 Bridge Street) is a listed item on the State Heritage Register (SHR). While this is correct insofar as the property is listed as part of the Thompson Square Conservation Area (SHR listing 00126), like many other properties that form the Thompson Square Conservation Area it is not listed as an individual item on the SHR. The results of an online search of the state heritage register indicate what appears to be an individual listing, it is not listed individually. Heritage items that are located within the historical entity of Thompson Square and are listed separately from the Conservation Area (that is, these items have different listing identifiers) are the "Macquarie Arms Hotel" (00041)

and the "house and outbuilding" at number 5 Thompson Square (00005). All other properties are listed as part of the Thompson Square Conservation Area. Further the Lot and DP numbers identifying 4 Bridge Street in the register are incorrect and the Lot and DP number are attached to a vacant block of land in west Windsor.

The building at 4 Bridge Street is a weatherboard bungalow built in 1955 which has been subsequently modified and has no significant heritage value. However the land on which the bungalow is constructed has high archaeological potential and visible heritage items such as the sand stock brick retaining wall, and may retain evidence of earliest phase of the settlement. Thus while any potential architectural noise mitigation measures would be sympathetic to the building's construction and age, they do not require identification at this stage.

5.1.5 Land use and socio-economic impacts

Increasing the clearance of the new bridge over The Terrace would not result in any additional land take or any additional changes to property access. The effects of the design change on noise would be negligible, with construction and operational noise impacts remaining as described in the EIS.

Increasing the clearance of the new bridge over The Terrace would, however, minimise the adverse socio-economic effects that the project may otherwise have on the Hawkesbury Paddle Wheeler business. Without this proposed design change, the project may result in loss of income for this business.

The Hawkesbury Paddle Wheeler is a commercial river cruise boat that has been operating from Windsor Wharf for around 14 years. The Paddle Wheeler conducts about 100-150 charter cruises annually, attracting an average of about 50 passengers and a maximum of 90 passengers per trip. The main source of income for this business is providing leisure cruises for the elderly and disabled, with about 70 per cent of cruises being for this market sector. In recognition of this river usage, Windsor Wharf was upgraded in 2011-2012 to provide easier access for people with limited mobility. These patrons also need direct vehicle access to Windsor Wharf and typically arrive by large coach services. The viability of the Paddle Steamer business therefore requires all sizes of coach to have direct access to Windsor Wharf.

Demand for cruises fluctuates throughout the year, with February, July and October to December identified by the Paddle Wheeler operator to be popular times for cruises. Many of the bookings for charter cruises originate from multiple tour operators, with a number of operators incorporating the cruise into tours of the Windsor town centre and the wider Windsor region. The operator of the Hawkesbury Paddle Wheeler indicated that some charter cruises attracted two to three tour coaches.

Vehicle access to the wharf is currently via Bridge Street. Following the implementation of the project, however, the Bridge Street access would not be available and access to the wharf would need to be via The Terrace, which runs underneath the proposed replacement bridge. If the clearance under the proposed replacement bridge on The Terrace remains at 3.6 metres as described in the EIS, large coaches would not be able to access the wharf, which would lead to considerable financial impacts on the Hawkesbury Paddle Wheeler business.

Alternative sites for operation of the Hawkesbury Paddle Wheeler have been examined and are not considered to provide viable alternatives. During the upgrade of Windsor Wharf, for example, the Hawkesbury Paddle Wheeler operated from a temporary pontoon at South Creek, downstream of the bridge. Concerns were raised by the paddle wheeler operator about the use of this site on a more permanent basis, due to its distance from Windsor town centre. Service access for the paddle wheeler was also identified as a challenge for the South Creek site.

Maintaining direct access to the Windsor Wharf for bus coaches has been identified as important by the Paddle Wheeler operator. Concerns were also raised by the operator that preventing or restricting large bus and coach access to the Windsor Wharf will also have adverse impacts on the multiple tour operators who organise charter cruises, which may in turn have wider impacts on tourism in Windsor. There is also the potential that restricting vehicle access to Windsor Wharf would have a direct impact on general access for people with mobility difficulties. The proposed design change is therefore important to the Hawkesbury Paddle Wheeler, the wider tourism industry of Windsor, and a large sector of the community.

5.2 Minor changes in bridge pier location and bridge type

5.2.1 Description

Since the EIS was exhibited, there has been further development of the design of the replacement bridge. This has resulted in two minor changes to the design of the bridge namely:

- Instead of a double box girder bridge as shown in Figure 5-4 of the EIS, a double T bridge would be constructed. A double T bridge would have a slightly shallower superstructure than a double box girder bridge but would otherwise have similar features to those described in the EIS. It would be incrementally launched as described in the EIS. **Figure 5-3** shows a cross section of the double T bridge.
- To accommodate the double T bridge, the location of the bridge piers in the Hawkesbury River would change slightly from those presented in the EIS. The changes in pier locations are presented in **Figure 5-4**. The southern and northern piers closest to the respective river banks would be located further from the banks and there would be a minor change in location for one of the central piers.

5.2.2 Environmental impacts

As a double T bridge would have a slightly shallower superstructure than a box girder bridge, it would have less visual impact and less impacts on upstream flood levels in comparison to the bridge described in the EIS. The reduction in impacts would, however, be minor. All other impacts would remain as described in the EIS.

The change in the location of the bridge pier closest to the southern river bank would result in a minor reduction in direct impacts on maritime archaeological remains and may reduce the scour of the southern bank during flood events. Additionally, the proposed location and spacing of the piers away from the river bank, combined with the proposed increase in the clearance of the bridge over The Terrace, would enhance the perception of space along the foreshore and under the bridge and open up the views from The Terrace. This is explained further in the Landscape Character and Visual Impact Assessment Addendum in **Appendix D**.

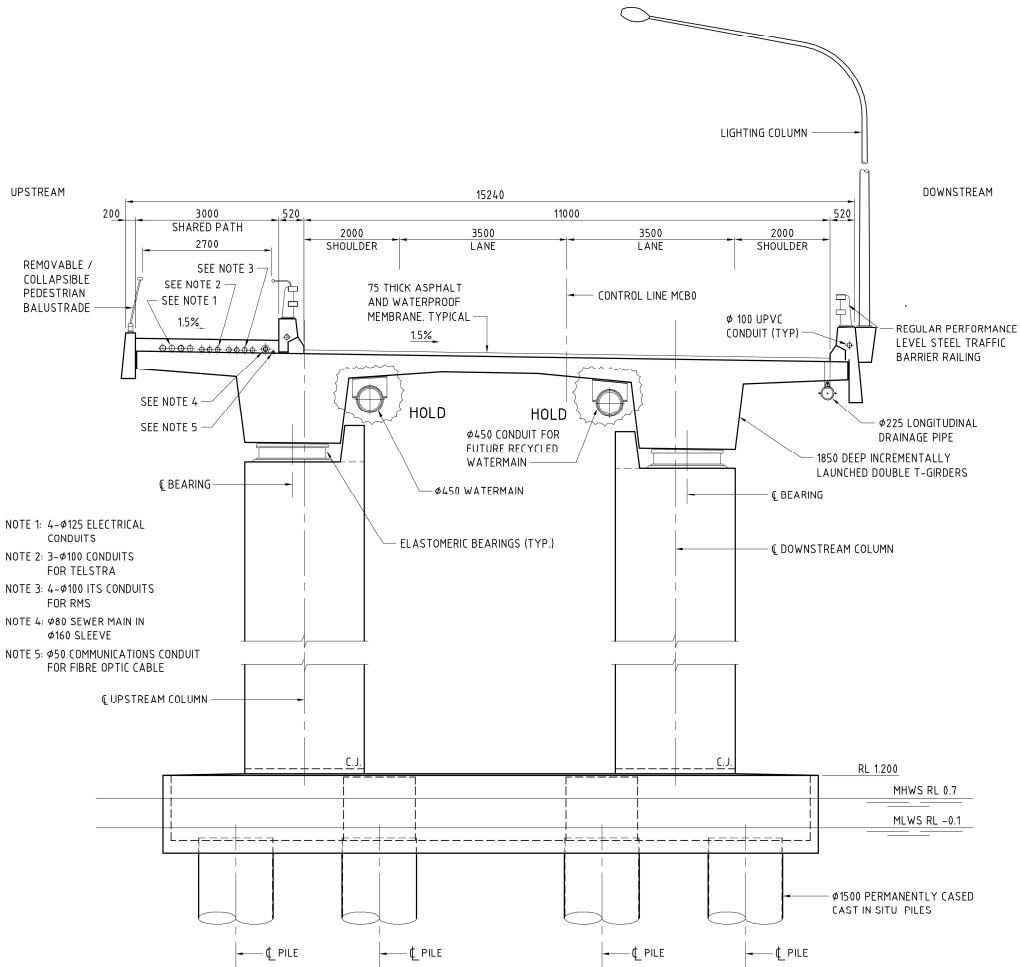


Figure 5-3 Cross-section of double T bridge

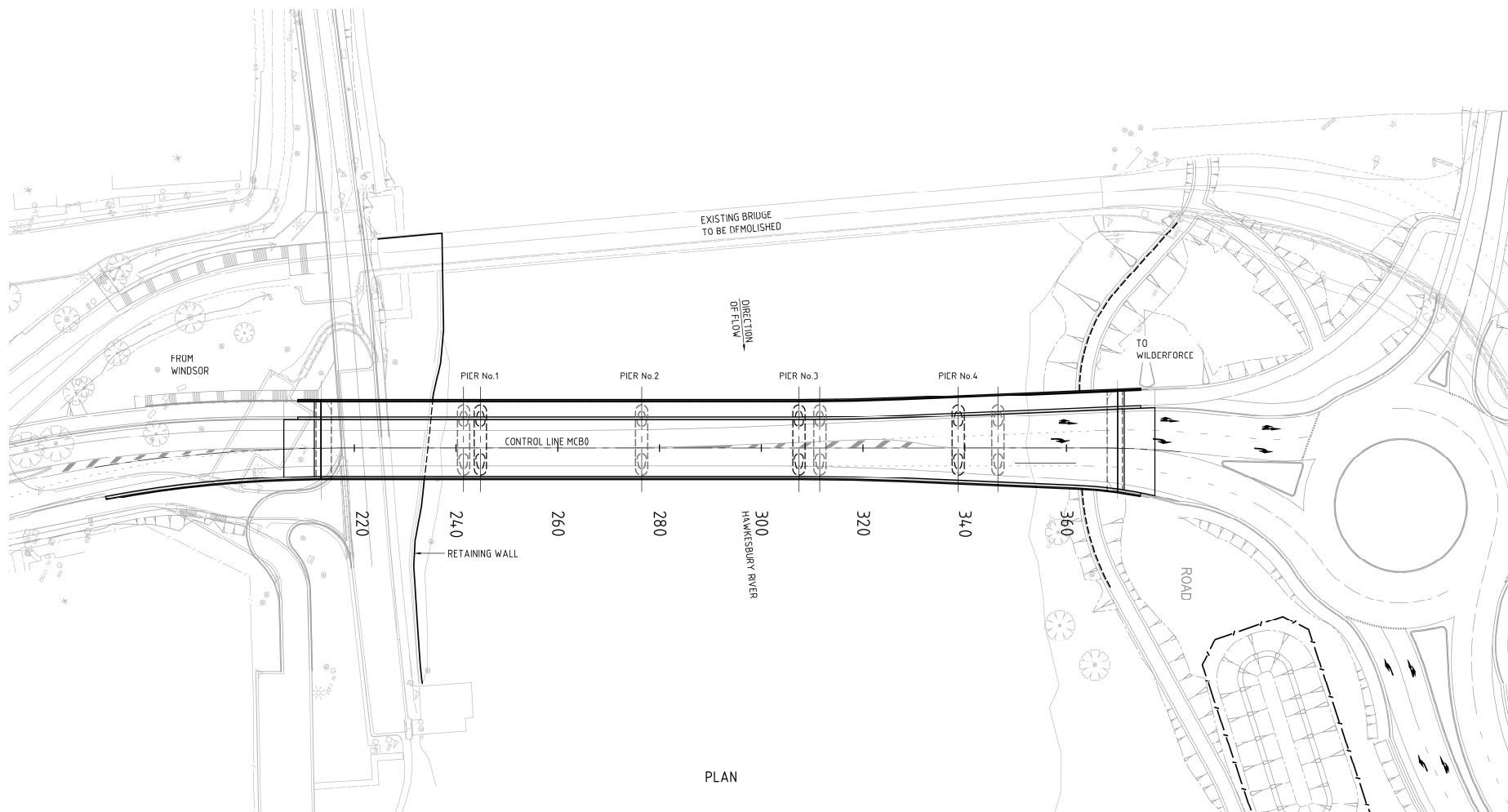


Figure 5-4 Changed pier locations – Note grey indicates original pier location and black indicates new pier location

There would be no significant changes to other environmental impacts as a result of the proposed change in pier location, with all other impacts and associated management measures remaining as described in the EIS. The new pier locations have been assessed for potential maritime heritage impacts and would not result in any impacts on maritime heritage.

Given that the potential changes in environmental impacts associated with the change in pier locations would be negligible or minor, detailed environmental assessment of the modification is not required.

5.3 Additional heritage properties requiring noise mitigation

5.3.1 Background

A total of eight residential properties have been identified as needing to be considered for architectural noise mitigation treatments as a result of the project. This includes four residential properties identified in the EIS, and four additional residential properties identified since completion of the EIS (refer to **Section 5.1.4** above). Of the eight residential properties identified as needing to be considered for architectural noise mitigation treatments, four have been identified as having heritage value of State significance. These properties comprise 10 Bridge Street, which was identified as a residential property in the EIS, and the following three additional residential properties that have been identified since completion of the EIS:

- The Doctors House, 3 Thompson Square (two residences).
- 64-68 George Street (three first floor residences).
- 14 Bridge Street (one residence).

Note that the above-listed three properties were not identified as residential properties, but rather commercial businesses, during preparation of the EIS and were therefore not considered for noise mitigation treatments at that time. The Doctors House has been reclassified as a residential premise since the completion of the EIS, while the properties at 14 Bridge Street and 64-68 George Street were incorrectly identified as commercial properties in the EIS and have since been confirmed as residential. As residential premises, these properties would qualify for noise mitigation treatments if the project proceeds given that traffic noise levels exceed the relevant Road Noise Policy criteria under existing and future conditions, both with and without the project. The additional noise assessment that has been carried out since completion of the EIS, which accounts for all design changes and considers the above-listed properties as 'residential' premises, is discussed in **Section 5.1.4** and presented in **Appendix E**. The need to consider architectural noise mitigation treatments for the property at 10 Bridge Street was identified in Section 7.5.4 and Section 7.5.5 of the EIS, while the need consider architectural noise mitigation treatments for the remaining three residential heritage properties was identified through the additional noise assessment (refer to **Section 5.1.4** and **Appendix E**).

All residential heritage properties that have been identified as requiring consideration for architectural noise mitigation treatments as a result of the project have been subject to additional assessment to assist in identifying appropriate treatments that minimise adverse impacts on heritage. Specifically, a qualified heritage architect, CityPlan Heritage, has been engaged to provide advice on the types of noise mitigation treatments that may be appropriate for these buildings. This is discussed further in the following section.

5.3.2 Advice on architectural treatments for noise mitigation

A letter of heritage advice for noise mitigation treatments for the heritage building at 10 Bridge Street was provided on 9 August 2012 (City Plan Heritage, 2012). This advice was considered and documented in the EIS (refer to Section 7.5.5 of the EIS). A second letter of advice, which builds on the previous advice, was provided on 18 March 2013 (City Plan Heritage, 2013) and presents specific recommendations for the three additional residential heritage buildings identified since completion of the EIS, namely:

- The Doctor's House at 1-3 Thompson Square.
- The former School of Arts building at 14 Bridge Street.
- The former Hawkesbury Stores building at 64-68 George Street.

This submissions report presents the findings of the heritage advice for the above-listed three properties.

Note that the letter of heritage advice for 10 Bridge Street (City Plan Heritage, 2012) was prepared following inspection of the exterior and interior of the building. The letter of heritage advice for the three additional residential heritage properties listed above was prepared based on external inspection of the properties from the street, with no internal inspections being carried out. Nevertheless, the information obtained from the internal inspection of 10 Bridge Street provided a good understanding of potential intactness and detailing of the windows and doors of the three additional heritage buildings identified as requiring noise treatments.

5.3.3 Appropriate noise mitigation treatments

General considerations

In selecting appropriate architectural treatment options, the type, condition and fabric of the building needs to be considered to provide the optimum internal noise benefit. The subject heritage buildings feature timber joinery characteristic of their construction periods and architectural styles. The joinery of these buildings is considered significant and any architectural noise treatments should therefore be applied to the interior of the buildings to prevent altering the appearance of the building exteriors.

The upper residential parts of the two-storey buildings (the Doctors House and the Hawkesbury Stores) feature French doors opening onto the front balcony from each room facing their respective street frontage. The internal configurations of the residences are unknown and it is assumed that each room relies only on the French doors for ventilation and daylight. Noise mitigation treatments therefore need to provide for easy operation of the doors. The windows of all three buildings are assumed to be operational and the majority of the existing glazing on both doors and windows is anticipated to be original.

General approach to noise mitigation

Given the need to preserve the original fabric of the existing joinery and the operational requirements of the windows and doors, the alternatives for noise mitigation treatments are limited.

A range of potential treatment options has therefore been identified to provide a basis for the future selection of the most appropriate treatments for the various types of doors and windows within the buildings.

The final selection and design of noise mitigation treatments should be determined on a case-by-case basis in consultation with a Heritage Architect following an internal inspection of the buildings, including a closer inspection of the existing joinery detailing. Consideration also needs to be given to maintenance of ventilation. Further discussion of potential treatment options and ventilation considerations is provided in the following sections.

Potential noise mitigation treatment options

The following have been identified as potential treatment options:

- Installing acoustic seals to existing windows.
- Increasing the thickness of glazing.
- Installing double glazed windows.
- Providing a new secondary window.

Acoustic window seals

Acoustic seals around the perimeter of a window will help to reduce noise by providing a tight seal when the window is shut. Rubber seals are best, although it is also possible to fit brush seals with a vinyl fin down the middle (which provides better noise protection than traditional brush seals). It is important to install and adjust the seals so that the window and frame both contact the seals when closed. The tighter a seal is, the better the noise reduction, provided it is not too thick to prevent the window from being able to be closed properly.

For existing windows that cannot be fitted with acoustic seals (for example singlehung and double-hung windows), secondary glazing may be installed. Secondary glazing products (either permanently fixed or removable) provide an airtight seal without the need to modify the existing window. Any secondary glazing must match the existing windows mullions and pane configuration or be a single-pane glazing to ensure no changes occur to the external presentation.

Thicker glazing

Most standard windows would have three millimetre thick glazing. Thicker glazing (ideally six or 10 millimetre) reduces lower frequency road traffic noise. Using thicker glass, however, typically requires new window frames, as standard/ traditional residential frames may not be able to bear the additional glazing weight.

Where the window frames are clearly identified as not being original, their replacement with a matching frame but thicker glazing can be considered. The authenticity of the existing frames must be based on documentary and physical evidence and must be confirmed by a Heritage Architect and a suitably qualified carpenter with knowledge of traditional joinery. Where replaced, the new frames must be well sealed to the building structure. The frame material does not play a substantial role in reducing noise penetration but it must be strong enough to hold the weight of the glass.

Note this treatment may not be suitable for many existing windows of the heritage items.

Double glazing

Double glazed windows comprise two panes of glass separated by a gap. The noise reduction through the window is controlled by the thickness of the glass, the width of the air gap, and the gasses, if any, within that gap. The use of thicker glazing and a wider gap, particularly if forming a vacuum, will increase the noise reduction. The thickness of each glass pane should be selected in accordance with manufacturer's recommendations. More noise reduction can be obtained with two panes of different thickness (eg a six millimetre thick pane and a 10 millimetre thick pane). For better noise reduction, it is noted that the space between the panes of glass should be at least 75 millimetres. The type of double-glazing optimised for thermal insulation is not as effective at reducing noise. As with single glazed windows, it is critical that window seals are provided around the perimeter.

Note this treatment may not be suitable for many existing windows of the heritage items.

Providing new secondary windows

An alternative to double-glazing is to retrofit a new secondary window with an air gap between the existing window, which will allow for the provision of a double glazed window without modifying the existing window. The secondary window should always be provided with acoustic seals. It is preferable, though not essential, that the existing window is also fitted with acoustic seals along the perimeters. Secondary windows may be glass or acrylic. Some are sealed magnetically, allowing for easy removal of panels for cleaning. Others can be designed to be sliding, which allows the window to be opened.

Note this treatment will generally be suitable for many existing windows of the heritage items depending on the depth of the internal window reveals.

Recommended solutions for internal ventilation

For any of the recommended noise mitigation treatments to be effective, the treated doors and windows will need to be kept closed. Some form of alternative ventilation system will therefore be necessary to allow fresh air into the subject rooms

The following alternative solutions, which were explored and noted for the heritage item at 10 Bridge Street, can also be considered for the subject residential heritage properties. As the internal configuration and ceiling detailing is unknown at this stage, it has been assumed that the ceilings of the subject buildings are similar to those of 10 Bridge Street and the following solutions would therefore be suitable and easily adopted.

The existing ceilings are assumed to be original and intact. Any future air-conditioning (ventilation) system should therefore be carefully installed in a manner that minimises the number of the air outlets (vents) on the ceilings. One option is to place the ceiling vents at the corners of the ceiling, rather than randomly in the centre of or in other panels of the ceilings. The ventilation system ducts and cabling can be placed within the roof cavity with only minimal openings required for the ducting registers. Consultation should be undertaken with an appropriately qualified Heritage Architect to establish the locations for ducting registers.

5.3.4 Recommendations for noise mitigation treatments

Considering the streetscape, internal presentation and importance of the existing joinery, the following option is anticipated to be the most appropriate form of treatment for windows and French doors:

- Windows - Installation of custom made individual glazed timber framed panels to each glass pane of the double-hung sashes.
- French doors - Installation of casement window frames with single glass panel (internal).

The custom made frames will create double glazing with a sealed air cavity and can be fitted without any damage to the existing original glazing panels. The appearance of the joinery, and thus the aesthetic significance of the heritage item, will not be affected. The windows, regardless their single-hung or double-hung system, will be operable. Furthermore, it will be possible to remove the new frames without damage to the existing fabric if required in the future.

A Magnetite Retrofit double glazing system should also be checked for suitability in consultation with an appropriately qualified carpenter with traditional joinery expertise.

As noted earlier, further close-up inspection of the subject windows and doors should be undertaken before starting any works so that the most suitable type of treatment is implemented without detrimental effects on the existing joinery. Replacement of timber frames and any extant joinery is not acceptable and should be the last option.

Regardless of the option implemented all work should be designed in consultation with and carried out under the supervision of a suitably qualified heritage consultant.

6 Revised environmental management measures

The EIS for the Windsor Bridge replacement project identified a range of environmental management measures that would be required to avoid or reduce the environmental impacts. After consideration of the issues raised in the public submissions, three of the 125 environmental management measures identified in the EIS (refer to Chapter 10 of the EIS) have been revised or deleted.

The three revised management measures are presented in **Table 6-1**. In the table, the revisions to environmental management measures are presented as follows:

- Revised text is shown in italics.
- Measures or parts of measures that have been deleted are struck out.

Should the project be approved, the environmental management measures in Chapter 10 of the EIS, including the revisions identified in **Table 6-1**, would guide the subsequent phases of project development.

Various NSW government agencies also proposed specific conditions of approval that the Department of Planning and Infrastructure and the Minister for Planning would consider if the project is approved. These proposed conditions of approval have not been included in the table below. Most of the proposed conditions of approval are similar or identical to the environmental management measures presented in the EIS.

Table 6-1 Summary of revised environmental management measures

| Environmental issue | Revised environmental management measures | Reason for change modification |
|------------------------------|---|---|
| Traffic and transport | | |
| T11 | <i>Consultation with maritime operators will be undertaken so that impacts are minimised.</i> | Original environmental management measure was not complete |
| Hydrology | | |
| H5 | Flood impact mitigation requirements and options for buildings potentially impacted by increased flooding will be investigated during detailed design in consultation with the landholder. Appropriate measures would be identified, developed and implemented, as required, to minimise impacts on the building structure, building access and business opportunities. | Duplication of subsequent environmental management measure and revised flood modelling indicates that flooding no longer an issue |
| H6 | During the detailed design of the new bridge, detailed flood modelling will be undertaken on the final design of the project to identify any additional impacts. This will include collecting survey data at potentially impacted properties with buildings upstream of the bridge. Where impacts are identified, appropriate measures will be identified, developed and implemented, as required, to minimise impacts on the building structures, building accesses and business opportunities. | Revised flood modelling indicates that flooding no longer an issue |

7 Conclusion

This Submissions Report and PIR has been prepared to assist the Department of Planning and Infrastructure with preparation of the Director-General's environmental assessment report. The Submissions Report and PIR identifies the issues raised during exhibition of the EIS and provides responses to those issues. It also includes information on additional studies carried out since exhibition of the EIS, further details of an alternative option (the Rickabys Line option) proposed by ex-RMS bridge engineers, and a description of changes to the project since the EIS exhibition.

Most community submissions objected to the project on the grounds of significant impacts on the heritage of Thompson Square and the demolition of the existing Windsor Bridge, both items of heritage significance. Other community submissions raised issues around the justification for the project and the integrity and transparency of the project development and community consultation processes. Some submissions expressed a preference for an alternative option to avoid heritage and traffic-related impacts on Thompson Square, while others supported the project as a cost-effective and reasonable solution for a replacement bridge identifying benefits to local traffic, flood immunity and pedestrian safety.

Agency and council submissions identified a range of construction and operational phase issues that would need to be addressed by the project, including potential flooding impacts, urban design, and impacts on riparian vegetation and agricultural land. Notably, the Heritage Council of NSW objected to the project, raising significant concerns on the grounds of long-term irrevocable and serious negative impacts on the Thompson Square heritage conservation area and the heritage of Windsor.

RMS has considered each of the issues raised and the implications for the project. This has resulted in a number of further investigations, including a more detailed assessment of the alternative option (the Rickabys Line option) proposed by ex-RMS bridge engineers and mentioned by many respondents. This alternative comprised an alternative methodology for rehabilitation of the existing bridge for light traffic and an alternative route carrying traffic around the Windsor township. The assessment in this report identified the need to amend the alternative route option, as presented, to meet relevant design standards and mitigate significant impacts. Third party cost estimates were also undertaken.

The assessment concluded that the alternative bridge refurbishment methodology is a viable approach to restoring the existing Windsor Bridge, however, some works in addition to those proposed by the ex-RMS bridge engineers would be required to remedy some of the causes of the deterioration of the bridge and to reduce long term maintenance costs. These additional works would increase the costs estimated for the refurbishment of the bridge.

In comparing the costs and benefits of the Rickabys Line option to the Windsor Bridge replacement project, the assessment concluded that while the alternative would minimise heritage impacts and provide a more efficient connection for regional traffic, it would not provide the same pedestrian and cyclist benefits, would require substantially more private property acquisition and would introduce visual, noise and amenity impacts to areas that are currently not impacted by road infrastructure. The Windsor Bridge replacement project also provides greater value for money than the alternative option, with the alternative option requiring substantially greater capital, operational and maintenance expenditure.

This Submissions Report and PIR also proposes a number of changes to the project in response to issues raised in submissions and to minimise environmental impacts including:

- An increase in the clearance of the new bridge over The Terrace from 3.6 metres to 4.6 metres to allow large coaches to directly access Windsor Wharf.
- Changes in bridge pier location.
- Noise mitigation treatments for additional properties, including heritage properties.

The assessment of the proposed design changes demonstrates that they would reduce specific adverse impacts in comparison to the project presented in the EIS. While the design changes would also result in adverse impacts these have been assessed as minimal, with only a minor or negligible change compared with the impacts of the project identified in the EIS.

Finally, this report describes additional flooding and historic heritage investigations that have been undertaken since exhibition of the EIS. These further clarify potential impacts of the project.

RMS has now considered the issues raised in submissions and the conclusions of the additional investigations undertaken as part of this report in the context of the benefits that the project would provide. These project benefits include the provision of a cost-effective, efficient and safe route for local and regional traffic with a higher flood immunity than the existing bridge and appropriate for the surrounding road network. The project would also consolidate and create a larger green space area in Thompson Square parkland and improved pedestrian and cyclist paths and crossings linking Thompson Square with Macquarie Park, The Terrace and east Windsor.

8 References

CityPlan Heritage, 2012. Heritage advice on noise reduction mitigation measures associated with Windsor Bridge replacement project. CityPlan Heritage: Sydney.

CityPlan Heritage, 2013. Heritage advice on noise reduction mitigation measures associated with Windsor Bridge replacement project. CityPlan Heritage: Sydney.

DECC, 2009. *Interim Construction Noise Guideline*. Department of Environment and Climate Change (DECC): Sydney, NSW.

Handy, S.L., Kubly, S., Jarrett, J. and Srinivasan, S. 2000. Economic effects of highway relief routes on small and medium-sized communities: Literature review and identification of issues. Centre for Transportation Research. The University of Texas at Austin. Report No. 1843-1.

Sivaramakrishnan, S. and Kockelman, K.M. (2002) The impacts of bypasses on small and medium sized communities: an econometric analysis. *Journal of Transportation and Statistics*, Vol 5. No. 1, 57-69.

Appendix A - List of submissions

| Submission number | Description of submitter |
|--------------------------|---|
| 1 | Individual |
| 2 | Individual |
| 3 | Individual |
| 4 | Unknown – Name withheld |
| 5 | Unknown – Name withheld |
| 6 | Individual |
| 7 | Individual |
| 8 | Individual |
| 9 | Individual |
| 10 | Unknown – Name withheld |
| 11 | Individual |
| 12 | Individual |
| 13 | Individual |
| 14 | Individual |
| 15 | Individual |
| 16 | Individual |
| 17 | Individual |
| 18 | Individual |
| 19 | Individual |
| 20 | Unknown – Name withheld |
| 21 | Unknown – Name withheld |
| 22 | Unknown – Name withheld |
| 23 | Unknown – Name withheld |
| 24 | Individual |
| 25 | Individual |
| 26 | Individual |
| 27 | Company/ Business - Christopher Hallam and Associates |
| 28 | Individual |
| 29 | Individual |
| 30 | Individual |
| 31 | Individual |
| 32 | Individual |
| 33 | Individual |
| 34 | Individual |
| 35 | Individual |
| 36 | Individual |

| Submission number | Description of submitter |
|-------------------|---|
| 37 | Individual |
| 38 | Individual |
| 39 | Unknown – Name withheld |
| 40 | Individual |
| 41 | Unknown – Name withheld |
| 42 | Individual |
| 43 | Individual |
| 44 | Unknown – Name withheld |
| 45 | Individual |
| 46 | Unknown – Name withheld |
| 47 | Unknown – Name withheld |
| 48 | Individual |
| 49 | Unknown – Name withheld |
| 50 | Company/ business - Lee Bralee of Hawkesbury Paddlewheelers |
| 51 | Unknown – Name withheld |
| 52 | Unknown – Name withheld |
| 53 | Unknown – Name withheld |
| 54 | Individual |
| 55 | Company/ Business - Glen Kanawati of Blooms the Chemist Windsor Market Place |
| 56 | Individual |
| 57 | Individual |
| 58 | Individual |
| 59 | Individual |
| 60 | Individual |
| 61 | Unknown – Name withheld |
| 62 | Individual |
| 63 | Individual |
| 64 | Unknown – Name withheld |
| 65 | Individual |
| 66 | Unknown – Name withheld |
| 67 | Company/ Business - Christian Steinbach of Freemans Reach Greenhouses PTY LTD |
| 68 | Individual |
| 69 | Unknown – Name withheld |
| 70 | Individual |
| 71 | Individual |

| Submission number | Description of submitter |
|-------------------|---|
| 72 | Individual |
| 73 | Individual |
| 74 | Individual |
| 75 | Individual |
| 76 | Group/ Organisation - Annette Hogan of Cronulla Dunes & Wetlands Protection Alliance |
| 77 | Unknown – Name withheld |
| 78 | Individual |
| 79 | Individual |
| 80 | Individual |
| 81 | Unknown – Name withheld |
| 82 | Individual |
| 83 | Individual |
| 84 | Group/ Organisation - Carol Edds of Hawkesbury Branch of the National Trust of Australia (NSW) |
| 85 | Individual |
| 86 | Group/ Organisation - Ian Bowie of the Engineering Heritage Committee of Sydney Division, Engineers Australia |
| 87 | Individual |
| 88 | Group/ Organisation - Dr Anne Maree Whitaker of the Royal Australian Historical Society |
| 89 | Individual |
| 90 | Individual |
| 91 | Individual |
| 92 | Individual |
| 93 | Group/ Organisation – Community Action Against Windsor Bridge (CAWB) |
| 94 | Individual |
| 95 | Unknown – Name withheld |

Appendix B - Additional heritage investigations

**Windsor Bridge Replacement Project
Addendum to the Historic Heritage Assessment
and Statement of Heritage Impact**

Addendum B

Report for Roads and Maritime Services NSW

March 2013

Ballarat:

506 Macarthur Street Ballarat 3350

Ph: (03) 5331 7000 Fax: (03) 5331 7033

email: ballarat@biosisresearch.com.au

Brisbane:

Suite 4 F11 72 Wickham Street

Fortitude Valley 4006

Ph: (07) 3831 7400 Fax: (07) 3831 7411

email: brisbane@biosisresearch.com.au

Melbourne:

38 Bertie Street Port Melbourne 3207

Ph: (03) 9646 9499 Fax: (03) 9646 9242

email:

melbourne@biosisresearch.com.au

Canberra:

Unit 16 / 2 Yallourn Street Fyshwick 2609

Ph: (02) 6228 1559 Fax: (02) 6280 8752

email:

canberra@biosisresearch.com.au

Sydney:

Unit 14, 17-27 Power Ave, Alexandria, 2015

Ph: (02) 9690 2777 Fax: (02) 9690 2577

email:

sydney@biosisresearch.com.au

Wangaratta:

26A Reid Street Wangaratta 3676

Ph: (03) 5721 9453 Fax: (03) 5721 9454

email:

wangaratta@biosisresearch.com.au

Wollongong:

8 Tate Street Wollongong 2500

Ph: (02) 4229 5222 Fax: (02) 4229 5500

email:

wollongong@biosisresearch.com.au

Project no: 14020

Authors:

Biosis & Cultural Resources
Management

Mapping:

James Shepherd (Biosis)

BIOSIS Pty Ltd

The document may only be used for the purposes for which it was commissioned and in accordance with the Terms of the Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

BIOSIS Pty Ltd

ACKNOWLEDGMENTS

Biosis Research acknowledges the contribution of the following people and organisations in preparing this report:

| | |
|--------------------------------------|-------------------------------|
| Dalene Amm | Roads and Maritime Services |
| Jonas Ball | SKM |
| Matt Faust | SKM |
| Braith Gilchrist | SMEC |
| Denis Gojak | Roads and Maritime Services |
| John Steele | SKM |
| Roy Surace | Roads and Maritime Services |
| Wendy Thorp | Cultural Resources Management |
| Windsor Bridge Alliance Project Team | |

ABBREVIATIONS

| | |
|----------|---|
| CHL | Commonwealth Heritage List |
| DGRs | Director General's environmental assessment requirements |
| DUAP | Department of Urban Affairs and Planning (former); now Department of Planning and Infrastructure |
| EIS | Environmental Impact Statement |
| EP&A Act | NSW <i>Environmental Planning and Assessment Act 1979</i> |
| ICOMOS | International Council on Monuments and Sites |
| km | Kilometre |
| LEP | Local Environmental Plan – for the purposes of this report, also refers to the <i>Hawkesbury LEP 2012</i> |
| LGA | Local Government Area |
| MGA | Map Grid of Australia – unless otherwise specified all coordinates are in MGA |
| m | Metre |
| mm | Millimetre |
| NLA | National Library of Australia |
| NHL | National Heritage List |
| NT | National Trust of Australia (NSW) |
| OEH | NSW Office of Environment and Heritage, Department of Premier and Cabinet |
| RMS | Roads and Maritime Services NSW |
| RTA | Roads and Traffic Authority (former) – now Roads and Maritime Services |
| SHI | State Heritage Inventory |
| SHR | State Heritage Register |
| SL NSW | State Library of NSW |

SL VIC State Library of Victoria
SoHI Statement of Heritage Impact
SPF Small Pictures File, Mitchell Library (State Library of NSW)

DOCUMENT CONTROL SHEET

| | |
|--------------------------|--|
| PROJECT | Windsor Bridge Replacement ADDENDUM B |
| BIOSIS PROJECT NO | 14020 |
| REPORT FOR | Roads and Maritime Services NSW |
| REPORT TITLE: | Windsor Bridge Replacement Project Historic Heritage Assessment & Statement of Heritage Impact |
| AUTHOR(S): | Pamela Kottaras, Wendy Thorp |
| GIS | James Shepherd |

| REVISION | PREPARED | INTERNAL REVIEW | EXTERNAL REVIEW |
|-----------------|-----------------|--------------------------|---|
| 1 | 29/01/2013 | | Braith Gilchrist; Denis Gojak; Roy Surace |
| 2 | 13/03/2013 | | Braith Gilchrist |
| 3 | 19/03/2013 | Gary Vines (part-review) | Braith Gilchrist |
| 4 | 20/04/2013 | Martin Lawler | Braith Gilchrist, Denis Gojak |

| REVISION | ISSUED | NAME | SIGNED |
|-----------------|---------------|-------------|---------------|
| 1 | 30/01/2013 | P Kottaras | <i>PK</i> |
| 2 | 13/03/2013 | P Kottaras | <i>PK</i> |
| 3 | 19/03/2013 | P Kottaras | <i>PK</i> |
| 4 | 23/04/2013 | P Kottaras | <i>PK</i> |

EXECUTIVE SUMMARY

Roads and Maritime Services NSW (RMS) is proposing to replace the existing bridge over the Hawkesbury River at Windsor with a new bridge about 35 metres downstream. The existing Windsor Bridge would be demolished as part of the proposal and new approach roads and intersections would be constructed.

Archaeological and historic heritage impacts of the project were assessed in the working paper *Windsor Bridge Replacement Project Historic Heritage Assessment & Statement of Heritage Impact (Biosis Research Pty Ltd and Cultural Resources Management Pty Ltd) November 2012* (Working Paper 1), which was exhibited in November-December 2012. The assessment identified impacts associated with the removal of the existing Windsor Bridge, removal of relics, impacts to views and vistas and the cultural landscape as a result of the construction of the replacement bridge and other associated works.

RMS also proposes a number of changes to the design exhibited in the EIS, which are addressed in this report. The proposed design changes are:

- increase in bridge clearance height over The Terrace from 3.6 metres to 4.6 metres
- reconfiguring of the form and position of the bridge piers
- installation of additional noise mitigation works to some heritage properties.

The need for these design changes and an assessment of the heritage impacts can be found in Section 2 of this addendum.

Further assessment has also been undertaken to more thoroughly address the following issues:

- Assessment of impacts of the proposed urban design and landscaping components of the project, including consolidation of the two parkland areas on the heritage values of the Thompson Square
- Consideration of visual impacts on heritage items from the proposed lighting on the bridge (both for traffic and the shared user pathway)

RMS also undertook additional archaeological investigations near the George Street / Bridge Street intersection to understand the potential archaeological impact of signalling the intersection. This further archaeological investigation was undertaken in February 2013. The results of this excavation are included in Attachment 1 of this document.

Additional noise mitigation measures have been considered in a separate report to SKM. The advice was prepared by City Plan Heritage and is included in the submissions report. The sites were not physically accessed and advice was general in nature but appropriate for items of high significance. In summary, noise mitigation measures are proposed for an additional three buildings, which are the Doctor House at 1-3 Thompson Square, the former Hawkesbury Stores at 64 – 68 George Street and the former School of Arts at 14 Bridge Street, Windsor. The assessment concluded that as the buildings were rare and of high significance, two options should be considered: custom made individual glazed timber framed panels and; magnetic double glazing, which should first be assessed for suitability when a site inspection is possible.

This Statement of Heritage Impact found that there will be minimal additional impact resulting from the design changes to the replacement bridge to that which was assessed in the technical working paper. The impact of the replacement bridge, approach road and associated other works will have a major negative impact on the archaeological resource, the views and vistas, setting and cultural landscape in which Thompson Square sits. The overall statement of heritage impact remains unchanged from the original heritage working paper.

CONTENTS

| | |
|--|-----------|
| Executive Summary | i |
| Contents | ii |
| 1 Introduction | 1 |
| 1.1 Background to this addendum..... | 1 |
| 1.2 Objectives of this Report | 2 |
| 1.3 The Focus of the current investigations | 2 |
| 1.4 Study Team | 2 |
| 2 Statement of Heritage Impact | 4 |
| 2.1 Introduction..... | 4 |
| 2.2 Description of the changes | 4 |
| 2.2.1 Change 1 – Increase in the clearance of the new bridge over The Terrace | 4 |
| 2.2.2 Change 2 – Change in bridge pier location | 5 |
| 2.2.3 Additional property requiring noise mitigation | 5 |
| 2.3 Description of the Urban Design and Landscape Concept..... | 10 |
| 2.3.1 Landscaping the parkland areas | 10 |
| 2.3.2 Lighting | 10 |
| 2.4 SoHI..... | 10 |
| 2.4.1 Identification of impacts | 10 |
| 2.4.2 Bridge Deck Height..... | 11 |
| 2.4.3 Replacement Bridge Piers..... | 11 |
| 2.4.4 Soil Compression and Archaeological Sites..... | 11 |
| 2.4.5 Consolidation of the two parkland areas | 12 |
| 2.4.6 Parkland landscaping | 13 |
| 2.4.7 Consideration of the visual impacts to heritage items from the proposed lighting on the bridge..... | 14 |
| 2.4.8 SoHI Questions..... | 14 |
| 2.5 Alternative to the Current Bridge Design..... | 14 |
| 2.5.1 Southern Bridge Abutment | 14 |
| 2.5.2 Change in Bridge Height | 15 |
| 2.6 Impacts of the design-change on Thompson Square, Bridge Street and The Terrace..... | 18 |
| 2.6.1 Setting and Views | 18 |
| 2.6.2 Physical impacts..... | 18 |
| 2.7 Impacts of a proposed landscape design..... | 21 |
| 2.8 Impacts of the proposed lighting on the approach road..... | 22 |
| 2.9 Summary Assessment of Heritage Impact | 22 |
| 2.9.1 Introduction | 22 |
| 2.9.2 Major Negative Impacts | 22 |
| 2.9.3 Moderate Negative Impacts..... | 23 |
| 2.9.4 Minor Negative Impacts | 23 |
| 2.9.5 Negligible or Neutral Impacts | 23 |
| 2.9.6 Minor Positive Impacts | 23 |
| 2.9.7 Moderate Positive Impacts | 23 |
| 2.9.8 Residual Impacts | 23 |
| 2.10 Statement of heritage impact | 24 |

3 Conclusions & Recommendations 25
4 References..... 27

TABLES

Table 1: Impact minimisation measure undertaken through the iterative design process..... 19
Table 2: Inadvertent impacts to relics through compression by plant and stockpiles..... 20
Table 3: Impacts of future landscaping and lighting..... 22

FIGURES

Figure 1: The Project Area..... 3

ATTACHMENTS

Attachment 1: Excavation Report 29

1 INTRODUCTION

1.1 Background to this addendum

Roads and Maritime Services NSW (RMS) is proposing to replace the existing bridge over the Hawkesbury River at Windsor with a new bridge about 35 metres downstream. The existing Windsor Bridge would be demolished as part of the proposal and new approach roads and intersections would be constructed.

Archaeological and historic heritage impacts of the project were assessed in the working paper *Windsor Bridge Replacement Project Historic Heritage Assessment & Statement of Heritage Impact (Biosis Research Pty Ltd and Cultural Resources Management Pty Ltd) November 2012* (Working Paper 1). The assessment identified impacts associated with the removal of the existing Windsor Bridge, removal of relics, impacts to views and vistas and the cultural landscape as a result of the construction of the replacement bridge and other associated works. The working paper formed part of the EIS for project.

Having reviewed the EIS and working papers as submitted, and considered RMS' responses to various matters on which the Department of Planning and Infrastructure required further information, the Department placed the EIS on public exhibition on 14 November 2012. The Department also requested further archaeological investigations to be undertaken, as documented in this report. A number of design changes to the project are also proposed, which are assessed in this report.

The archaeological investigations were required to better understand potential archaeological impacts associated with the signalised intersection proposed at Bridge and George streets (replacing the existing roundabout at that location). While a research design was approved by the Heritage Branch, OEH and the Department of Planning and Infrastructure in April 2012 and informed the archaeological investigations described in the EIS the treatment of the intersection was not fully detailed at that time. With this information, the need for additional investigations was identified and a S60 application for additional archaeological work was submitted to Heritage Branch for approval in December 2012.

The additional archaeological investigations and key findings are discussed in detail in Attachment 1 of this addendum. Attachment 1 also provides more detailed consideration of other potential impacts of the project, including compressive impacts on archaeology.

The proposed design changes are:

- increase in bridge clearance height over The Terrace from 3.6 metres to 4.6 metres
- reconfiguring of the form and position of the bridge piers
- installation of additional noise mitigation works to some heritage properties.

The need for these design changes and an assessment of the heritage impacts can be found in Section 2 of this report.

Advice pertaining to the installation of additional noise mitigation works has been addressed by City Plan Heritage and is appended to the Submissions Report.

Further assessment has also been undertaken to more thoroughly address the following issues:

- Assessment of heritage impacts of the proposed urban design and landscaping components of the project, including consolidation of two parkland areas into one space;
- Consideration of visual impacts on heritage items from the proposed lighting on the bridge (both for traffic and the shared user pathway).

This addendum updates the findings of the *Windsor Bridge Replacement Project Historic Heritage Assessment & Statement of Heritage Impact* (Working Paper 1) report and should be read in conjunction with that report. It also forms an appendix to the Submissions Report for the Windsor Bridge replacement project.

1.2 Objectives of this Report

The objectives of this report are:

1. Assess the heritage impact of the proposed design changes;
2. Assess the heritage impacts of the landscape design and landscaping concept including consolidation of two parkland areas into one space;
3. Assess the heritage impacts of the proposed lighting on the bridge for traffic and pedestrian use;
4. Present the findings of the additional test excavations (Heritage Act Permit approval 2013/S6/006, issued 12/2/2013).

1.3 The Focus of the current investigations

The current areas of investigation lie within the Project Area (Figure 1). Archaeological test excavations were conducted at the intersection of George Street and Bridge Street. The replacement bridge design modification is concerned with the area along the alignment of the proposed bridge.

The archaeological test excavation results are appended to this document. The SoHI in response to the modification of the bridge design is presented from Section 2.

1.4 Study Team

This report was prepared by Pamela Kottaras and Wendy Thorp. It utilises information presented in the Working Paper 1 and the associated research design (Biosis and CRM December 2012). The report was reviewed by Braith Gilchrist (SMEC) and Denis Gojak (RMS) and Roy Surace (RMS).

Biosis and Cultural Resources Management would like to acknowledge the assistance of the design team for providing plans and elevations for the additional statement of heritage impact and the archaeological options paper.

Figure 1: The Project Area

2 STATEMENT OF HERITAGE IMPACT

2.1 Introduction

The following section assesses the predicted impacts associated with the design changes proposed for the project. Refer to the *Windsor Bridge Archaeological Options Paper* appended to this report for a detailed discussion on the predicted impacts of the two southern abutment options.

As discussed in Section 1.1, design changes include:

- Increased clearance over The Terrace
- Changes to the location and form of the bridge piers
- Noise mitigation treatments to heritage properties.

In addition to the design changes discussed in this report, the effect of compressive impacts exerted by plant and stockpiles on the archaeological resource are also considered. Recommendations have been formulated to reduce the risk of inadvertent damage to relics during the site preparation and construction process.

Noise mitigation treatments to three additional properties will be required. The properties are The Doctors House at 1-3 Thompson Square, the former Hawkesbury Stores at 64-68 George Street and the former School of Arts building at 14 Bridge Street, Windsor. These buildings were assessed by City Plan Heritage using photographs of each building; Biosis did not undertake a separate assessment and makes reference to the report advising of the most appropriate noise mitigation measures for the buildings as assessed by City Plan Heritage.¹

This statement of heritage impact has been assessed in accordance with the guiding document published by the NSW Heritage Office & Department of Urban Affairs & Planning (2002) *NSW Heritage Manual – Statements of Heritage Impact*.

2.2 Description of the changes

2.2.1 Change 1 – Increase in the clearance of the new bridge over The Terrace

During the development of the project, the vertical alignment of the new bridge and approach road through Thompson Square was lowered substantially to minimise impacts on heritage views and vistas. The alignment was lowered while maintaining a 3.6 metre clearance over The Terrace to allow small coaches, service vehicles and emergency vehicles to access Windsor Wharf.

In consultation with Hawkesbury City Council and in response to submissions received during the exhibition of the EIS, RMS has now increased the proposed clearance of the new bridge over The Terrace from a minimum of 3.6 metres to a maximum of 4.6 metres to allow large coaches to directly access Windsor Wharf. Large coach access along The Terrace is required to allow the patrons of the Hawkesbury Paddle Wheeler to have easy access to Windsor Wharf.

Many of the patrons of the Hawkesbury Paddle Wheeler are elderly, disabled and/or have limited mobility and would find it difficult or impossible to access the wharf if large coaches were forced to park in Thompson Square road or Baker Street. The Windsor Paddle Steamer business has been operating for 14 years, with the main source of income being the provision of leisure cruises for the elderly and disabled. The viability of the Hawkesbury Paddle Wheeler business is reliant on large coaches being able to transport patrons to Windsor Wharf.

To provide the additional clearance over The Terrace, the height of the southern end of the bridge would be increased. This would result in a one metre higher bridge and abutment at the southern end, and a marginally higher 45 metre long section of the southern approach road through Thompson Square between the driveway of No. 4 Bridge Street to the southern abutment. South of the driveway of No. 4 Bridge Street and in front of the heritage listed properties of No. 6 and No. 10

¹ City Plan Heritage March 2013.

Bridge Street, the height of the southern approach road would remain the same as that presented in the EIS. The grade of the bridge would also increase slightly from 1.6 to 1.9 per cent.

2.2.2 Change 2 – Change in bridge pier location

The location of the bridge piers in the Hawkesbury River would change slightly from those presented in the EIS to accommodate the specific type of incrementally launched bridge. The modified location of the bridge piers in comparison to in the exhibited design are presented in Plate 1 to 4 of this document. The southernmost pier will now be 9 metres from the bank, and approximately 2 metres from the position of the original Pier 1.

The modified location of the bridge pier closest to the southern bank may result in a minor reduction in direct impacts to the early wharf site and may reduce scour of the southern bank during flood events. Other environmental impacts would be similar to those presented in the EIS.

2.2.3 Additional property requiring noise mitigation

Four residential properties that were incorrectly identified as commercial properties in the EIS have now been re-assessed as residential properties to determine the need for impact mitigation in accordance with the RMS Road Noise Policy. The properties that have been re-classified as residential receivers since completion of the EIS are:

- Thompson Square – Doctors House – two residences
- 64-68 George Street – three first-floor residences
- 14 Bridge Street – one residence.

The results of the revised noise assessment are presented in Section 4.1.2 of the submissions report. The Doctors House currently experiences "acute" noise levels from the existing alignment and while the noise levels would be reduced slightly as a result of the project, noise levels would still exceed the RNP criteria and therefore would qualify for architectural treatment of reduce noise levels inside the premises.

In selecting appropriate architectural treatment options, the type, condition and fabric of the building needs to be considered to provide the optimum internal noise benefit. For heritage buildings generally, the implementation of architectural treatments is not straightforward due to the need to determine the significance of fabric, finishes and appearance, and consider a range of options that are non-impacting and reversible but also acceptable for residential amenity. Any architectural treatment options must be sympathetic to the character, style and heritage value of the building.

A qualified heritage architect, Kerime Danis of City Plan Heritage, was engaged to recommend potential architectural treatments for the three additional buildings. Appropriate architectural noise environmental management measures for heritage listed buildings will be developed based on these recommendations and in agreement with property owners. In summary, the report advised that two types of noise mitigation measures for buildings as significant as the three subject items. The first is custom made individual glazed timber framed panels. These types of frames would create an air cavity sealed and fitted to reduce noise and will not damage existing original glazing panels.² The second type that has been suggested in magnetic double glazing systems that require suitability assessments prior to installation.³

The treatments will be installed by qualified professionals. The assessment of appropriate architectural treatments included in the Submissions Report.

² City Plan Heritage March 2013: 15.

³ City Plan Heritage March 2013: 15.

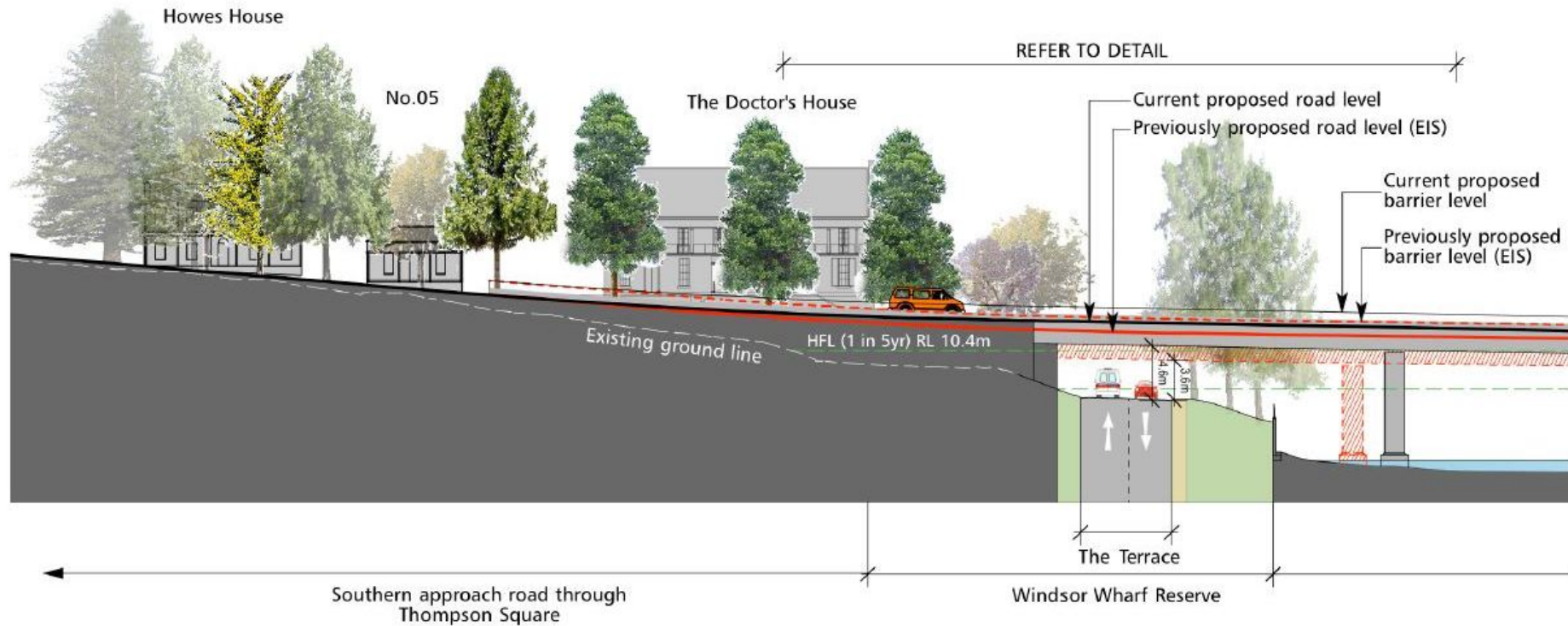


Plate 1: Longitudinal section of the proposed changes to the replacement bridge deck height (and barriers) and the proposed new location of the piers (in grey). View north- west from the Windsor bank. Source: Spackman Mossop and Michaels.

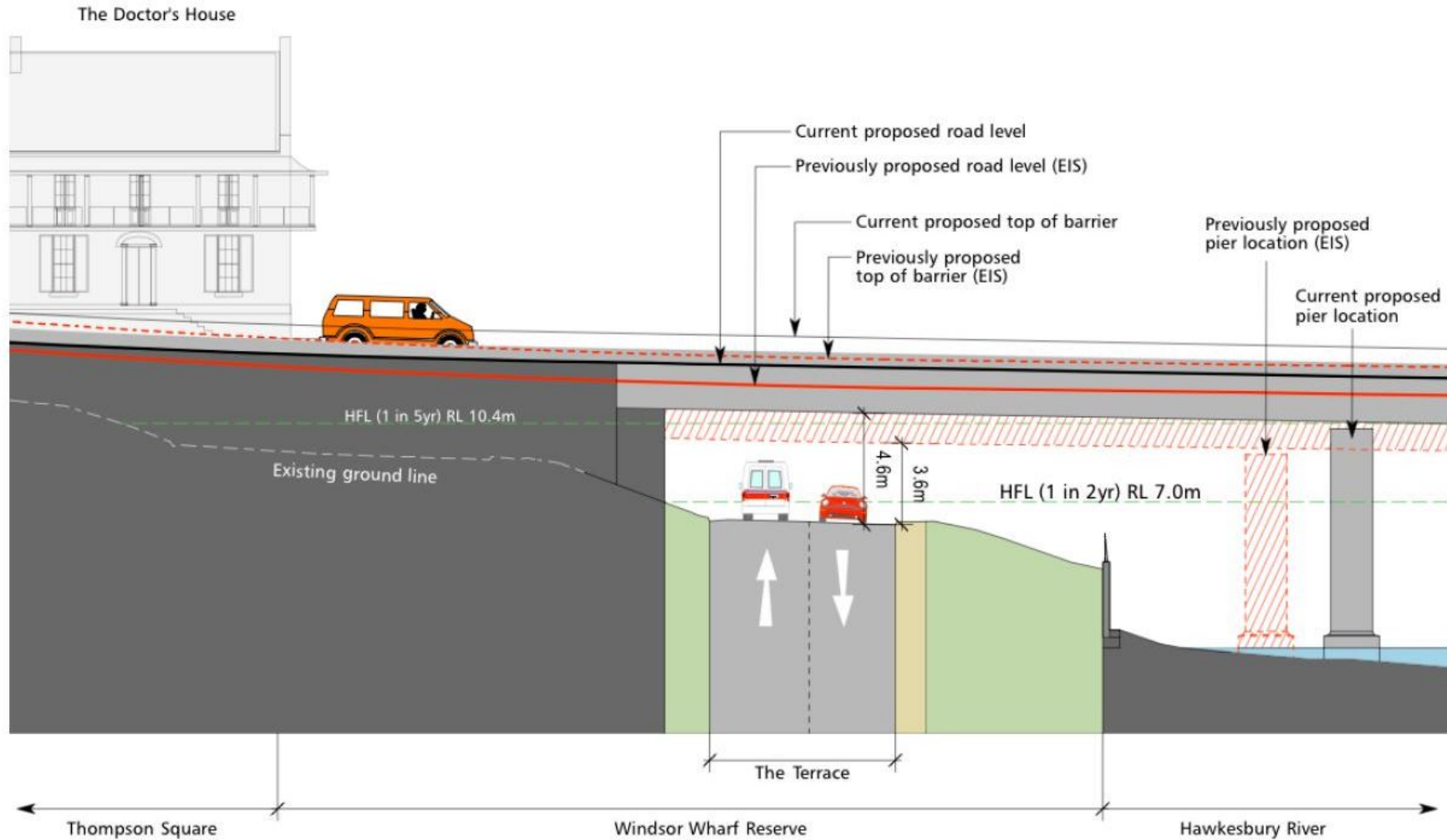


Plate 2: Detail of the longitudinal section illustrating the proposed changes. Note that trees are not shown in this diagram. Source: Spackman Mossop and Michaels.

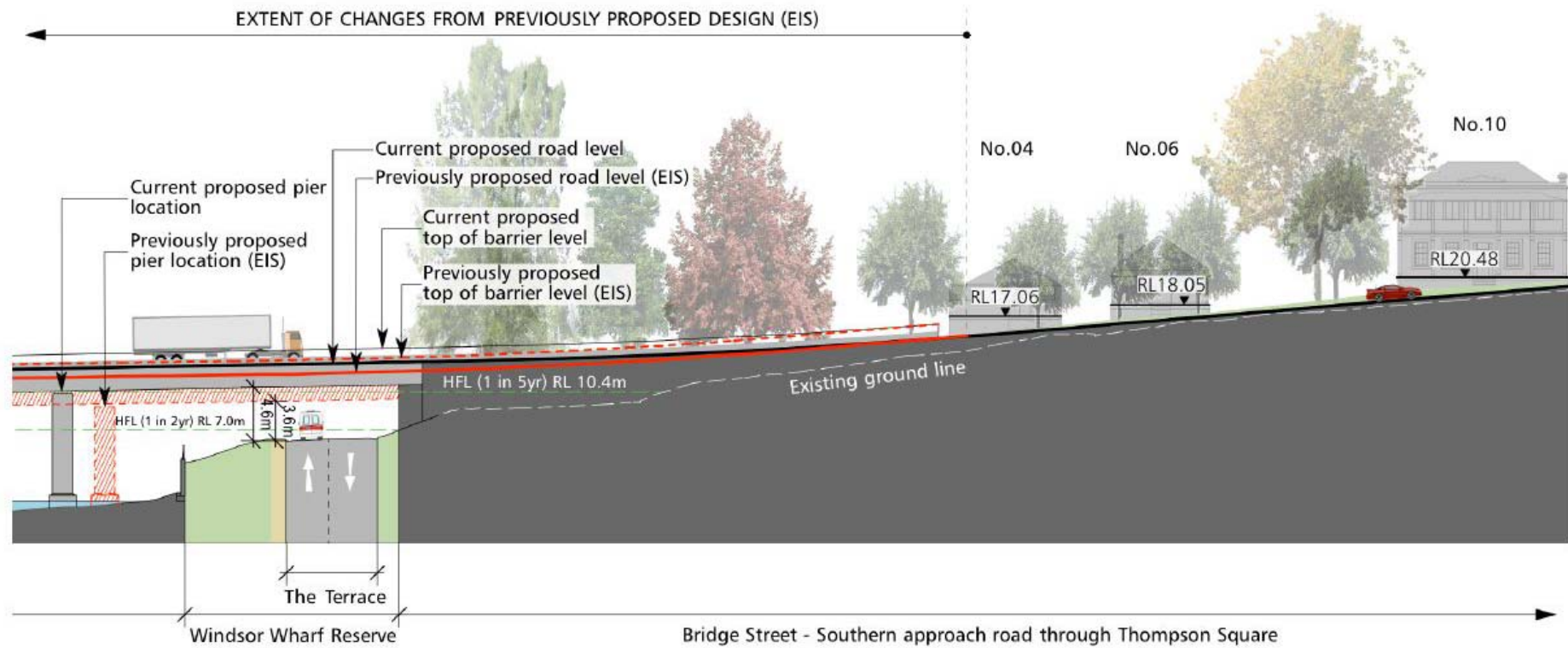


Plate 3: Longitudinal view to the east from Thompson Square of the proposed changes. Source: Spackman Mossop and Michaels.

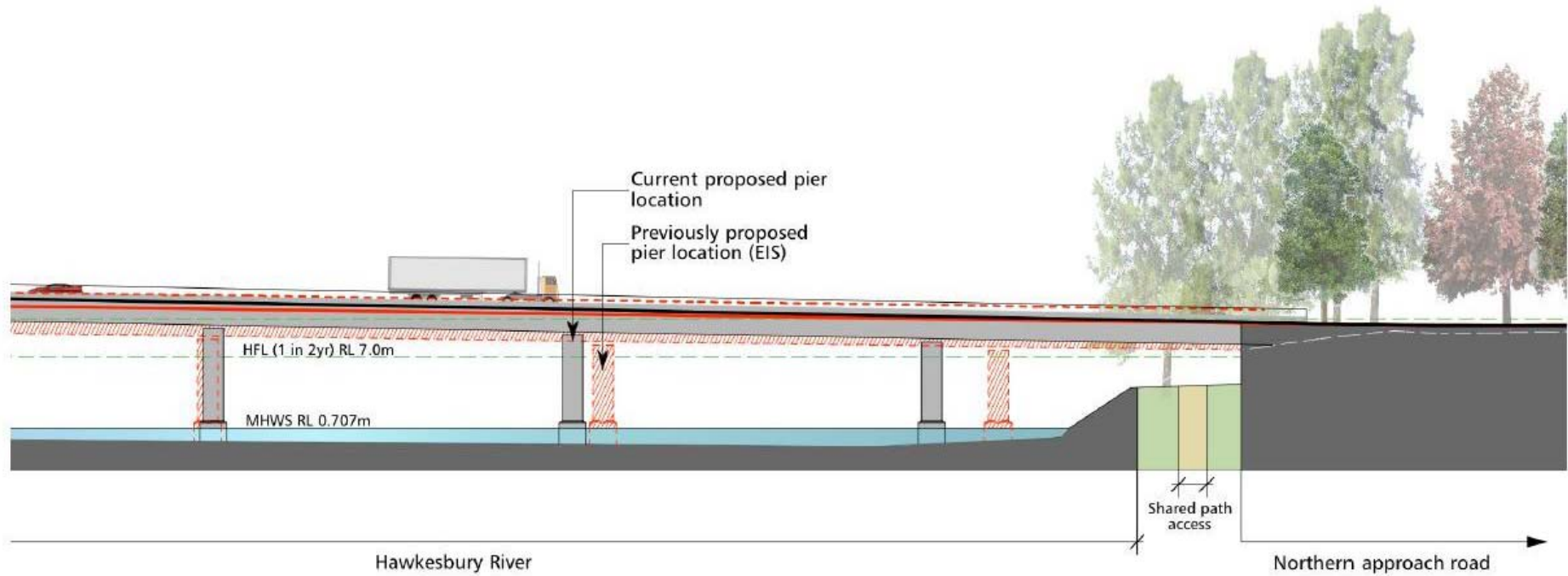


Plate 4: Longitudinal section of the replacement bridge showing the elements that have been redesigned. The level of the replacement bridge and barriers is minor on this side of the bridge. The amended locations of the proposed piers are shown in grey.

2.3 Description of the Urban Design and Landscape Concept

2.3.1 Landscaping the parkland areas

The concept design envisages the two parkland areas joined to form one cohesive space by relocating the current bridge access road and infilling the alignment as part of the landscaping for the project. In order for this to be achieved the road pavement would be milled to create traction and erosion barriers that would be covered by the infill material. The purpose of the erosion barriers is to halt slippage of the fill.

The assessment of heritage impacts associated with landscaping of the parkland areas is general in nature. An urban design and landscaping concept (UDLC) design prepared by Spackman Mossop and Michaels (Nov 2012) provides visual examples of possible finishes and is intended to illustrate the potential for landscaping the public spaces at the completion of the project. The final elevation of the fill and its treatment as part of the consolidated park has not yet been decided but it will have had an appropriate level of consultation with the relevant authorities (refer to Section 11.8.5 Heritage Working Paper).

The example used is of terracing at Bradley's Head (Mosman) NSW. However, it is unlikely that terracing will be incorporated into the final urban design and landscape plan. The parkland is proposed to be graded down from the upper parkland area to the foreshore, consistent with the changing height of the proposed stairs to the bridge.

2.3.2 Lighting

The proposed approach road, replacement bridge and shared path will require lighting in accordance with relevant road safety standards (AS: 1158). The project has not progressed to a stage where the bridge design has been finalised but it is acknowledged that the outcome of the detail design must continue to respond to the heritage sensitivity of the project area. The new light sources would be designed to strike a balance between illumination for safety and the historic context of the parkland and its adjoining areas. It is proposed to achieve this by using specialist light diffusers such as "aeroscreen", which are designed to reduce glare.

2.4 SoHI

2.4.1 Identification of impacts

All heritage impacts resulting from the Project are discussed in the heritage working paper and the EIS (November 2012). The discussion in this section is in terms of a comparison of the current design with the design exhibited for the EIS.

Impacts associated with the design change would be visual impacts associated with operation of the replacement bridge. They are:

- The visual impact of the project and its constituent elements including:
 - The proposed southern approach to the replacement bridge as a new element
 - The height of the southern approach
 - Compression of the archaeological resource by plant and stockpiles

The design changes assessed in this report include two elements; they are bridge deck height and the re-location of the bridge piers.

The location of impacts within the riverbed has also changed with the re-positioning of piers; however, the statement of heritage impact for maritime archaeological resources (Cosmos Archaeology 2012), assessed the corridor within the river. The assessment found that impacts to significant heritage would be anticipated with the original location of Pier 1. With its re-location two metres to the north of the original position, impacts to the wharf remnant

from the placement of Pier 1 have been removed, although scour protection on the southern bank will remove this relic.

2.4.2 Bridge Deck Height

The height of the current design rises incrementally gradually starting at the driveway of 4 Bridge Street, and reaching a maximum height of 1 metre higher over The Terrace than the exhibited design. Once over The Terrace, the deck height gradually slopes down to meet the exhibited deck height between Pier 3 and Pier 4.

The previously unassessed impacts associated with this particular design change are solely visual.

2.4.3 Replacement Bridge Piers

Physical impacts on the shore are generally unchanged. The position of the proposed piers have been moved with the most substantial changed being that Pier 1 has moved 2 metres to the north. Impacts to potential maritime archaeological resources along the entire corridor of the replacement bridge were assessed in the maritime heritage report (Cosmos Archaeology November 2012). Substantial physical impacts to the river bed are anticipated; maritime relics will be managed through an archaeological salvage program, therefore further assessment of the changed location of Pier 1 has not been undertaken in this report.

2.4.4 Soil Compression and Archaeological Sites

Section 2.4.4 was prepared by Denis Gojak (RMS) and reviewed by Gary Vines and Pamela Kottaras (Biosis). Additional text was added by Gary Vines and Pamela Kottaras

Compression of soil through work activities has been proposed as a potential threat to archaeological deposits and particularly to artefacts. Possible risks arising from the use of heavy machinery, placement of stockpiles or other load pressures on land surfaces could potentially include the compression of soils, the deformation of strata, the movement of artefacts between depositional layers, and potentially artefact breakage.⁴

A review of international literature on the subject plus RMS sponsored test excavation however suggests that such effects are limited in extent. In the context of an actively used urban environment that has been a major movement corridor for more than two centuries, and has been subject to major landscape modifications, the impacts from soil compression are likely to be relatively minor contributors to disturbance.

The key result of examinations of the effects of loading on archaeological sites is that compression will occur, and artefacts within the matrix will tend to move down with the deposits as they are compacted.⁵ However, this mechanism does not result in them moving differentially to surrounding sediment, regardless of particle size, meaning they normally do not relocate from one stratigraphic unit to another. The one clear exception to this is that artefacts will tend through time to achieve a horizontal position within the deposit, regardless of their initial orientation.⁶

Some risk of displacement has also been suggested where layers with very different characteristics overlie each other, and where the archaeological item, in this case structural timber, had sufficient inertia to withstand movement.⁷ Site processes that are known to relocate artefacts between deposits include bioturbation such as plant roots, from small shrubs to tree-size, plant clearance through grubbing out or tree-throws and faunal disturbance by burrowing animals, for instance worms, cicadas, reptiles, small mammals.⁸ The impacts of flooding on Aboriginal deposits and potentially many post-European settlement deposits are also likely to have resulted in disturbance of the relationship between

⁴ For example Wood and Johnson 1978; Wildesen 1982; Schiffer 1987.

⁵ Nickens 1999; Andrews 2006

⁶ Andrews 2006.

⁷ Huisman 2012.

⁸ For example Darwin 1882; Morin 2006.

artefacts and the deposits in which they were originally buried.⁹ Trampling and surface movement also contribute to mixing artefacts and strata, although mainly in looser deposits.¹⁰

Soil deposits compress primarily by reducing the volume of air cavities and voids within the sediment. Direct pressure will lower soil by compressing the sediment, which will contain less air. In an experiment aimed at determining effectiveness of 'hardstand' surfaces a site was prepared with a barrier material, 10 cm of sand and then clay and gravel, all sealed by bitumen. The effects of this covering, once removed were to note that compression of the upper deposit was clearly evident. This resulted in denser, more compact deposit. No impact was observed on artefacts or the soil morphology. The research suggested that the main impact would be following the removal of hardstand, where the compacted surface would shed rather than absorb rainfall, and be slow to return to normal structure.¹¹

While the study above did not observe any impacts on artefact materials, other studies have observed potential breakages for different materials at a range of ground pressures from moving machines, although the use of hard-stand covering significantly reduced the eventual ground pressure. Ardito stresses the need to have sufficient coverage to ensure the dispersal of pressure over a wide area.¹²

Another important consideration is the depth of the archaeological resource where it is not covered by hardstand or where the hardstand has failed; ground surfaces will become heavily disturbed. Tracked vehicles and tight manoeuvring can also damage sub-surface deposits and accelerate erosion.

Heavy machinery will also be required for the archaeological excavation program. In this instance, care will need to be taken with movement on uneven surfaces such as in the lower reserve. An archaeologist will be monitoring the bucket scrapes and the effect the machinery has on the ground surface during the archaeological work. Heavy machinery is regularly used on archaeological sites beyond the depth of paving and road base without noticeable compressive impacts prior to the removal of deposits and artefacts. If disturbance to the ground occurs through the movement of machine wheels/tracks or due to muddy ground, the ground will require preparation to distribute the load. Material such as timber slats or steel plates may need to be laid down for the machine or work may need to be re-located to a less vulnerable area of the site until a solution is found or the ground dries.

Substantial portions of the Windsor Bridge Replacement construction area consist of paved roadways or car parking. These are also likely to have borne the brunt of much previous heavy machinery movement, and should be considered as offering the best locations where loads can be carried on the site, whether static such as stockpiles or vehicles. Recommendations to reduce the risk of compression impacts to the archaeological resource prior to its archaeological excavation or to resources that are not proposed for removal, refer to Section 3 of this report.

2.4.5 Consolidation of the two parkland areas

The impact of re-joining the two parkland areas on the familiar character of Thompson Square as it exists today is included in the Heritage Working Paper and is expanded upon here. Either retaining the current configuration or consolidating the two separate parks can be argued on heritage grounds with each presenting its own positive and negative heritage impacts.

The *ad hoc* development of Thompson Square has resulted in its current informal character. Additions such as picnic tables and the Pioneer's Memorial in the upper parkland area and the yacht club (now removed) in the lower parkland area, which also now includes picnic tables and the lower car park, are all superficial changes to the historic entity. Mature trees in both parks are a mixture of deliberate plantings and self-seeded individuals.

⁹ Hofman 1986; Petraglia and Nash 1987

¹⁰ Gifford-Gonzalez et al 1985

¹¹ Player and Kelleher 2012

¹² Ardito 1994; Dain-Owens et al 2012; McBride and Mercer 2012

The single-most, recent substantial impact to the historic character of Thompson Square was the excavation, in 1934, of Bridge Street from George Street to the existing bridge, the approach road. When initially constructed, the current approach road to the existing bridge was excavated through the historic landscape of Thompson Square and what was once the Green Hills public space. Although carefully constructed for practical purposes, the approach road is another element of the *ad hoc* nature of the development of the modern Thompson Square. It is also an integral part of the development of the modern Thompson Square. Constructed in 1934 during the Great Depression, it is very possible that the program was unemployment relief aimed at replacing the existing winding access to the bridge. The increase in motor vehicle use, the development in motor vehicle technology and greater settlement west of the Hawkesbury River demanded a safer and more efficient approach road to the bridge. It is an important part of the story of Windsor and the Hawkesbury.

Construction of the current alignment to the bridge was a substantial change to the square. It divided the open park into two smaller areas and removed a large area of usable land. The road separates one side of the conservation area from the other. There is no evidence to suggest that, when the road was being built, attention was paid to the detrimental impact that the construction of the road would have had on the archaeological resources, or on the character of square as one open space.

The approach road carries heavy, loud traffic that disrupts the historical connection between the two parkland areas when viewed from certain locations. It creates a physical barrier between the upper and lower parklands and restricts pedestrian access from one to the other as crossing the approach road can be dangerous. As a result, the lower parkland area is less used than the upper parkland area due to its poor accessibility. It was also noted during community consultation that the traffic noise can be distressing and interferes with the quiet enjoyment of both parks.

The dominant heritage impacts of infilling the current bridge approach that cuts through the historical entity of Thompson Square would be that evidence of a significant event will be obscured. The road cutting is part of the events that formed Thompson Square as it is today. A positive aspect of infilling the existing cutting would be that the potential to reconnect the two grassed spaces could provide a platform for clearer interpretation of phases of Thompson Square that are more significant than the creation of the road in 1934.

2.4.6 Parkland landscaping

This section further considers the concept landscape design of the consolidated park in the context of what could be considered an informal character of the existing parkland.

Through time there has been a fluctuating level of formality within the park, expressed by deliberately planted trees, provision of fencing on all road boundaries, declaration of status as a 'square' within the townscape, uses such as picnics. The concept design in the UDLC Working Paper is not "formal" in the sense that Hyde Park, for instance, demonstrates a formal landscape scheme, although it is less *ad hoc* than the development of the square that exists now. A final design for the space will be the subject a subsequent process involving extensive consultation between Hawkesbury Council, the Heritage Council and the Department of Planning and Infrastructure.

There is potential for landscaping within the two parkland areas to impact on significant archaeological resources; this issue is discussed in detail in the Archaeology Options Report (Biosis and CRM Feb 2013).

The lower parkland area would be negatively impacted to a large degree through the construction of the proposed approach road. A small portion of the western side of the lower park is also likely to be impacted by heavy machinery/plant during the construction excavation process.

Improving access to The Terrace will require modification of the existing park surface levels. It may require removal of deposit. As a general principle, all design options that do not result in impact to archaeologically sensitive areas should be thoroughly investigated first. How this will be achieved is yet to be determined and will necessarily be the topic of a detailed statement of heritage impact.

2.4.7 Consideration of the visual impacts to heritage items from the proposed lighting on the bridge

The detailed design of the all project elements has not been finalised thus it is difficult to assess the impact of lighting furniture and light spill. Light standards on the bridge approaches will be relocated so there is likely to be a change. New lighting technology has the potential to meet required levels of safe lighting without additional light spill for residents and, as discussed above, will be required to meet to strike a balance between illumination for safety and the context of the parkland and its adjoining areas. As discussed, RMS is also proposing specialist light diffusers such as "aeroscreen" which reduce glare. Both the lighting furniture and levels of change to existing conditions will require assessment during the design phase and prior to the design's finalisation.

2.4.8 SoHI Questions

Questions relevant to the project have been applied to the modified bridge design. Relevant questions are as follow:

- *Will the additions tend to visually dominate the heritage item?*
- *Are the additions sited on any known, or potentially significant archaeological deposits? If so, have alternative positions for the additions been considered?*
- *How has the impact of the new work on the heritage significance of the existing landscape been minimised?*
- *How does the work impact on views to, and from, adjacent heritage items?*
- *What are the potential effects of heavy machinery of an archaeological site?*

2.5 Alternative to the Current Bridge Design

2.5.1 Southern Bridge Abutment

Construction of the replacement bridge has been assessed to have major, moderate and minor impacts to heritage resources within the Project Area. Impacts would be most noticeable in Thompson Square in Windsor and would include the removal of significant archaeological evidence, disruption to significant views and vistas, and the current setting of Thompson Square, as well as a cultural landscape that has evolved gradually since Green Hills was established.

The design process has considered the issues surrounding construction of the bridge abutment in Thompson Square. Two types of construction were considered and the decision to build a land bridge over piers was made because of the archaeological implications and consequent remediation works that would be required.

In considering the issues, including heritage, surrounding construction of the southern bridge abutment, the design team prepared two construction methods:

1. A land bridge comprising piers at 8 metre centres inserted into the ground around the perimeter of the wall; then from that, building a bridge structure over the void;
2. A concrete abutment comprising of two "L-shaped" walls facing inwards, then infilling with material upon which the road is built.

The finished appearance of the two options would be similar. The L-Shaped retaining wall has a lower initial construction cost and ongoing routine maintenance cost and will require less maintenance intervention after a large flood event when the structure becomes partially or fully submerged in the flood waters. The land bridge was proposed as alternative to the L-shape wall option due to the potential to minimise the excavation in Thompson Square. The extent of this advantage is dependent on the extent of archaeological excavation required to clear the site for the piling. The land bridge also has some construction program advantages and avoids the need for the engineered backfill material to be brought to site and be compacted between the walls.

The implication of impact to archaeological resources influenced the decision to choose the "L-shaped wall design. These two options are discussed in more detail in the *Windsor Bridge*

Replacement Project Archaeological Options Paper (Biosis and Cultural Resources Management, 2013) which is appended. In summary, two options were considered: a land bridge that comprises piers and solid cast in situ walls with infill. The additional excavation, vibration and movement of machinery required for each construction option was included in the considerations by RMS.

The conclusion of the SoHI with respect to the assessed impact to the archaeological resource was that it is complex but fragmented and would require an open area archaeological excavation to collect meaningful data and adequately address research questions.

Constructing the southern approach using the land bridge option with the piled foundations would avoid disturbing/excavating the area between the walls, but would impact relics to a high degree where the piles would be built without the opportunity for archaeological data extraction, further fragmenting, isolating and destroying it permanently. For health and safety as well as logistical reasons it is not feasible to undertake localised archaeological excavation at each of the pile locations. Excavation at this depth would require substantial stepped benching around each pier location, resulting in a larger excavation footprint that would negate any advantage that this approach had to localising impact;

The land bridge option is only commercially viable if the extent of archaeological excavation could have been limited to shallow localised excavation. As a result of the high degree of impact from the proposed archaeological excavation program for both options, the L-shaped wall option was adopted for the abutment.

The L-shaped wall would be constructed in the following sequence: open area archaeological excavation, protection and stabilisation of any archaeological material to remain in situ (either for permanent conservation or for later recovery), further mechanical excavation to bedrock, levelling with approximately 50 mm of concrete base. The L-shaped wall footings would be cast, followed by the walls themselves. The area between the walls would then be backfilled and the pavement built. Both options would result in the removal of archaeological resources in the immediate area; these options and their implications are discussed in more detail in the Archaeological Options Report (Biosis and Cultural Resources Management).

2.5.2 Change in Bridge Height

With respect to the change in bridge deck level, alternatives considered to increase the clearance over The Terrace other than raising the height of the bridge included lowering the road along The Terrace. This was investigated but was not favoured due to:

- The presence of services in the area that would require relocation;
- The requirement to extend road modifications into the upper car park at Windsor Wharf to provide a road grade suitable for buses and other vehicles.

To provide additional clearance over The Terrace, the height of the southern end of the replacement bridge will be increased. This will result in a marginal increase in road deck height of the southern approach road through a small section of Thompson Square; however for the majority of the southern approach road through Thompson Square (that is, south of the driveway of No. 4 Bridge Street), the vertical alignment and height of the road would remain unchanged from that presented in the EIS (refer to Plate 1 of this document). Visually, the scale of change in the overall form of the bridge will not be noticeable.

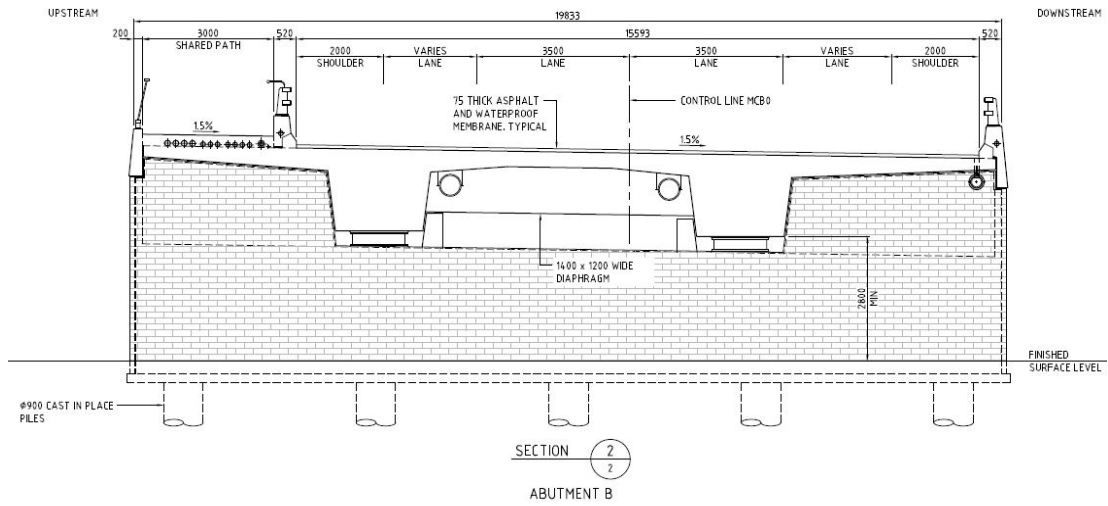
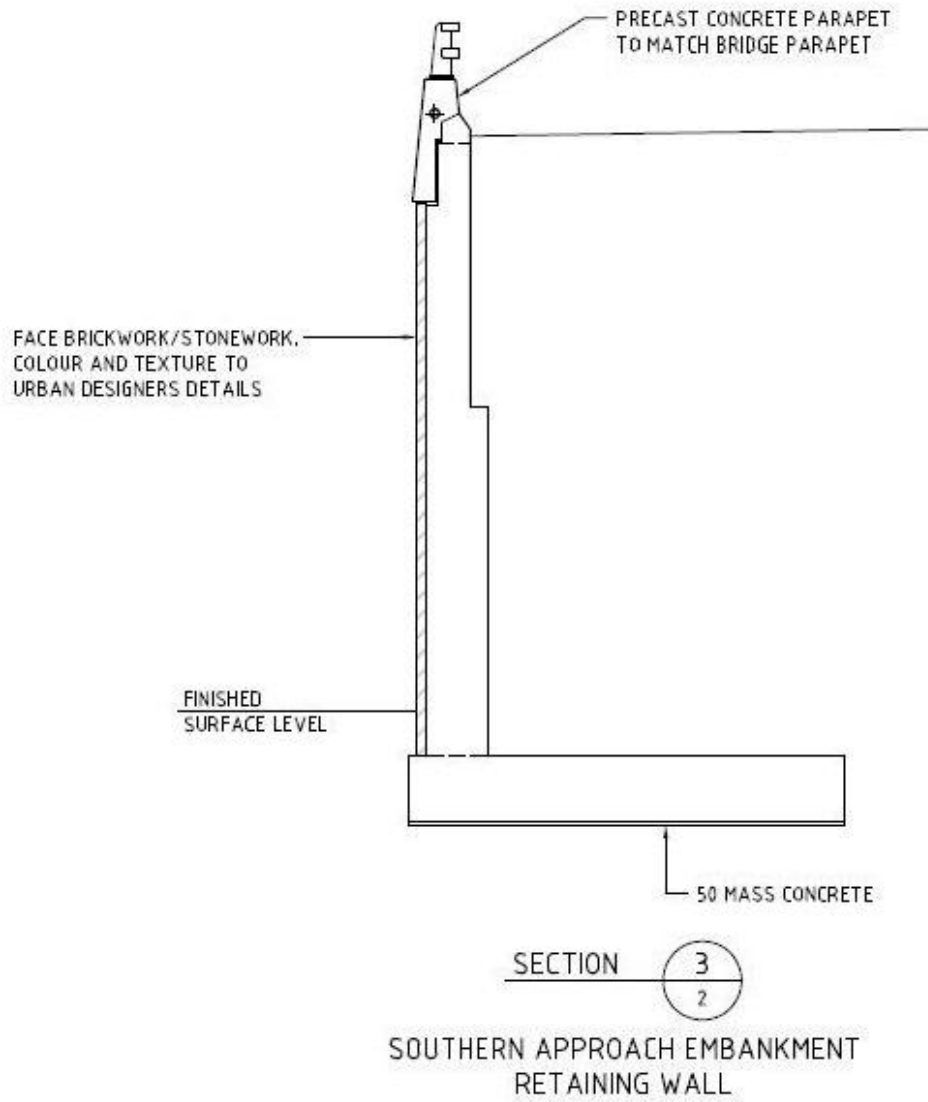


Plate 5: Cross section of the replacement bridge in Thompson Square with the Land Bridge option showing the piles across the structure. An additional six piles along each side also formed part of this design. Source: SKM Plan DS2012/000155 Sheet 3.



GENERAL NOTES


SCALE  OR AS SHOWN
FOR GENERAL NOTES REFER TO SHEET No 2

Plate 6: Diagram of one side of the L-shaped retaining walls proposed for the bridge abutments in Thompson Square. This design will be constructed if the project is approved. Source SKM Plan DS2012/000155 Sheet 3.

2.6 Impacts of the design-change on Thompson Square, Bridge Street and The Terrace

2.6.1 Setting and Views

The location and horizontal alignment of the proposed replacement bridge remains the same as described in the EIS and Working Paper 1.

However, the level of the bridge deck would increase by one metre over The Terrace. The level of the approach road would rise gradually from the northern side of the driveway at 4 Bridge Street until a high point at the southern bridge abutment and over The Terrace, after which the level drops again gradually until it reaches the same design level as described in the EIS and Working Paper at a location between Pier 3 and Pier 4.

The effect of proposed design change when compared to the exhibited design is to gently continue the fall from the approach as it travels across the river but with a maximum height increase of one metre for part of the alignment.

The difference between the exhibited bridge design and the modified bridge design is minimal with respect to the overall impact to the existing cultural landscape, archaeological resources and views, vistas and setting. Some advantages are gained with the new design with the placement of Pier 1 approximately 2 metres from the bank allowing views from The Terrace that are slightly more open than those shown in the exhibited design. However, the overall visual impact of the modified replacement bridge design remains substantial.

A visual assessment from an urban design perspective has been undertaken by Spackman Mossop + Michaels (February 2013).

2.6.2 Physical impacts

The physical impacts associated with the modified replacement bridge design that were identified in Working Paper 1 are unchanged. The increase in bridge deck level would not introduce any new physical impacts to the Project Area.

On the western side of the southern approach road, the height of the road (and therefore the retaining wall to the parkland) would be about 3.5 m from 2.5 metres at its highest level. This increase in height is not considered to be any more noticeable than the original height of the proposed retaining wall.

During the design development process, the vertical alignment was lowered along the southern approach to the bridge. The height of the bridge was also lowered to match the level of flood immunity of the northern side. While the proposed design change will increase the vertical alignment by up to one metre above The Terrace, the bridge will decrease in height from there until it reaches its original design level between Piers 3 and 4 approximately halfway across the bridge.

The benefits that were achieved by minimising the height of the bridge deck slightly reduced. The visual impact of the replacement bridge remains substantial and in combination with the other elements of the Project, the overall assessment remains the same.

Table 1: Impact minimisation measure undertaken through the iterative design process

| Project Element | Impact Minimisation Measures Through Iterative Design | SoHI After Minimisation Measures |
|---|---|---|
| <p>Raising the height of the replacement bridge deck from 3.6 metres to 4.6 metres</p> | <p>The benefits achieved by lowering the height of the bridge and approach roads during design development have been slightly reduced by the increase in bridge clearance over The Terrace.</p> <p>The design development process aims to design a structure that conforms to safety standards, while achieving overall the highest engineering and aesthetic standards.</p> <p>The increase in proposed bridge deck height has allowed the opportunity to re-locate the bridge piers away from the Windsor bank. This will modify the viewing experience from The Terrace by opening up those views to some degree and making opportunities for a land-river connection.</p> <p>The design of the piers will remain curved, giving them a more refined appearance than piers with straight edges.</p> <p>The design of the replacement bridge has considered the heritage sensitivity of the surrounding cultural landscape. An incrementally launched bridge has been selected to achieve:</p> <ul style="list-style-type: none"> • Pier design that would be curved, giving them a more refined appearance than piers with straight edges. • A 50 km/hr speed limit on the approach roads and replacement bridge, which has also enabled the design of a lower approach roads and replacement bridge and a lower southern approach road. | <p>The impact of the replacement bridge to the existing significant cultural landscape is anticipated to be high.</p> <p>Physical impacts associated with the construction of the replacement bridge are anticipated to be very high.</p> <p>The choice of an incrementally launched bridge and lowering of the design speed limit would be a visual and physical improvement compared to a plank bridge, which would necessarily be higher and less aesthetically refined.</p> |
| <p>Thompson Square</p> <p>The existing character of Thompson Square will be affected by the introduction of the southern approach road affecting archaeological resources and the setting.</p> | <p>The height of the southern approach road was lowered by between 1 to 2 metres (in the exhibited design it was 2 – 3 metres lower) through the reduced design speed in the exhibited project design. Responses to the project design have initiated a re-design of a section of the replacement bridge to increase clearance on The Terrace.</p> <p>The justification for increased clearance is to allow coaches and garbage trucks to reach the Windsor Wharf for access to the Windsor paddle steamer once access down Bridge Street ceases.</p> | <p>The visual impact of the project on Thompson Square is anticipated to be very high.</p> <p>The physical impact on relics within Thompson Square is anticipated to be very high.</p> <p>The predicted impact of the southern approach road would</p> |

| Project Element | Impact Minimisation Measures Through Iterative Design | SoHI After Minimisation Measures |
|-----------------|--|--|
| | <p>For most of the alignment, the southern approach road remains level with the pedestrian path adjacent. The increase in road level commences gradually from the driveway of 4 Bridge Street and reaches the maximum height increase of one additional metre over The Terrace. The predicted views directly across Thompson Square and the overall impact of the replacement bridge, associated with the demolition of the existing bridge, will change negligibly from the exhibited design.</p> | <p>be high; however, it has been reduced by the lowering of the level by approximately 1 - 2 metres (one metre higher above The Terrace than the exhibited design. This modification is an improvement on the original road design, which would have obscured views across Thompson Square significantly more.</p> |

Table 2: Inadvertent impacts to relics through compression by plant and stockpiles

| Project Element | Impacts | SoHI After Minimisation Measures |
|------------------------------------|---|--|
| <p>Plant and stockpiles</p> | <p>Impacts to the archaeological resource are a risk during site preparation and construction. Vehicles with tracks on unprotected ground will churn the topsoil and will have a detrimental effect on archaeological deposits, with an even greater effect on archaeological fabric such as the Macquarie-era drain.</p> <p>The effects on the archaeological resource beneath existing hardstand are predicted to be minimal as paved areas within the project boundary are underlain by road base, which distributes the loads above.</p> <p>Archaeological resources have survived in good condition beneath existing roads as demonstrated by the test excavations for the project. As comprehensive test excavation has not been undertaken in parkland areas where the deposit is not protected by paving, it must be assumed that stockpiles and plant will damage the ground surface.</p> <p>The known impact to the archaeological resource will be archaeological excavation that will be conducted in compliance with project conditions.</p> | <p>The risk of inadvertent impacts to the archaeological resource will be reduced by implementing the management measures in Section 3. Ensuring that stockpiles and heavy plant utilise hardstand areas, and the only heavy machinery to utilise unpaved areas will be those that are part of the archaeological excavation should ensure that impacts to the archaeological resource, that are not part of the approved excavation program, will be minimised.</p> |

2.7 Impacts of a proposed landscape design

The project would have a significant detrimental impact on the physical, aesthetic and archaeological values of Thompson Square and thus on the significance of the square. The landscape design needs to be considered within this context.

Within the context of the approved project however, the most noticeable impact of the proposed landscape design will be the consolidation of the two parkland areas. The existing 1934 approach road would be obscured by traffic being relocated and the cutting being infilled. The form of the remaining segment of the lower parkland area would need to be shaped so that it would be incorporated into the landscape of the proposed park.

Consolidation of the two park areas would be achieved by infilling the existing approach road by milling the pavement and installing erosion barriers by placing them within small excavations within the road base. The footings of the erosion barriers would be between 300 and 400 mm deep and therefore it is not anticipated that they would exceed the depth of the of the existing road base.

The infilled road will be shaped to connect the currently separated parkland areas with each other and is considered to be a minor negative impact to the significance of Thompson Square as it will remove an element that provides another layer of the development of the square as well of the development of the region. The greater impact of infilling the existing cutting, will however, be positive as it will remove what has been and still is, considered to be an intrusive element to the historic character of Thompson Square, which has managed to retain its legible connection to the early history of Windsor.

Other potential negative impacts associated with the UDLC design are limited to the effects of new plantings on the archaeological resource but these are not considered to be major impacts..

The two key impacts to Thompson Square will result from consolidating and landscaping the surviving parkland area. The project will impact on the archaeological resources within the lower parkland area and the south east corner of the upper parkland area. Subsequent landscaping is also likely to impact on archaeological resources to a lesser degree.

The approach to managing the loss of archaeological information is detailed in a separate document.¹³ Three options for archaeological excavation have been discussed, which outlines the advantages and disadvantages of archaeological programs that propose varying degrees of archaeological intervention. RMS is awaiting comment from the Heritage Branch and DP&I on the preferred archaeological option; however Option 3 is not proposed by RMS.¹⁴

Firstly consolidation has the very real potential of completely obscuring the 1934 approach road, which in itself is a problematic "heritage item". The road is an element of the modern Thompson Square¹⁵ and is recognised as having an adverse impact on the historical integrity of Thompson Square, which *is spoilt by a main road which slices diagonally through it and into a cutting, destroying the visual integrity of the space as was originally intended.*¹⁶ Conversely it represents another stage in reconfiguring access to the bridge to account for different types of vehicles. It may¹⁷ demonstrate the government's intervention in reducing or poverty by providing employment during the Great Depression. The road is also an intrusive element into Thompson Square.

The 1934 bridge approach is undoubtedly part of the historical story, but it is also an intrusive element within the square that has managed to retain elements of the "Macquarie-era character". Infilling may be achieved without obliterating the alignment, and it could be interpreted by incorporating its location into the landform of the final design.

¹⁴ EIS, Section 3.2.

¹⁵ Although not of the Thompson Square Conservation Area as defined by the SHR.

¹⁶ David Sheedy, 1975 in SHR listing 00126.

¹⁷ "May" because although a substantial amount of time was spent reviewing the annual reports of the Public Works Department, no entries about this road being unemployment relief were found.

Any landscaping design should firstly consider arrangements that do not result in impacts to archaeologically sensitive areas.

2.8 Impacts of the proposed lighting on the approach road

As discussed, the final design of the approach road elements, including lighting, has not been determined. In general however, existing upright light poles would be removed from the current road and change the appearance of lit area on the approaches. Lights on the replacement bridge will be higher and more visible than those on the current bridge. As discussed above, specialist lighting would be proposed which minimises glare and light spill while meeting the relevant Australian standard.

Light spill can also be controlled and directed away from or towards heritage items while lighting furniture may be obscured by plantings as they mature to the extent that they meet minimum safety and functionality requirements. These aspects would be subject to further detailed discussion and consultation with the relevant stakeholders when the details are being formed.

Table 3 is a summary of the impacts arising from a future landscape design in Thompson Square.

Table 3: Impacts of future landscaping and lighting

| Project Element | Identified impacts | Magnitude of negative heritage impacts |
|------------------------|---|---|
| Future landscaping | <p>Alteration of the current topography of the two parkland areas.</p> <p>Obscuring the 1934 alignment from George Street to the existing bridge.</p> <p>Consolidating the upper and lower parks.</p> <p>Removal of archaeological resources.</p> | <p>Major (lower park)</p> <p>Minor (upper park)</p> <p>Moderate to minor</p> <p>Moderate</p> <p>Major</p> |
| Lighting furniture | <p>The presence of upright lamp posts on the view lines across the park and in front of heritage items.</p> <p>Lighting fixtures within the road and footpaths or pedestrian barriers would remove the need to light poles.</p> | Minor to none |

2.9 Summary Assessment of Heritage Impact

2.9.1 Introduction

The summary assessment of heritage impacts in this section is a response to the modified replacement bridge design and an assessment of effects of compression on archaeological resources. For the summary assessment of all other aspects of the Project on historic period cultural heritage, reference should be made to the heritage working paper and the EIS.

2.9.2 Major Negative Impacts

(Affects fabric or values of State significance)

- Impacts to the significant historical view from the northern bank from Bridgeview
- The re-location of the piers from the banks of Thompson Square will remove them from the immediate location of the early wharf; however other project-associated works are likely to impact on the archaeological site

- Impact to archaeological resources surviving in and around the lower reserve
- Impact to archaeological resources surviving in the George and Bridge Street intersection
- Inadvertent impacts to the archaeological resource through compression and ground damage by plant and stockpiles
- Impacts to the cultural landscape through:
 - Substantial modification to the setting of Thompson Square as well as significant views and vistas to and from it
 - Visual intrusion of the replacement bridge and roads into the historic landscape, increased with the increase in replacement bridge deck height

2.9.3 Moderate Negative Impacts

(Irreversible loss of fabric or values of local significance)

- Views and vistas to Bridgeview
- Change to the current layout of Thompson Square, which is identified by many in the Windsor community as an authentic representation of historical Windsor.

2.9.4 Minor Negative Impacts

(Reversible loss of local significance or fabric where mitigation retrieves some value of significance; loss of fabric not of significance but which contributes to local significance values)

- Lighting furniture on the proposed approach road and replacement bridge
- New tree plantings on the archaeological resource
- Impact to archaeological resources in the south east corner of the upper reserve

2.9.5 Negligible or Neutral Impacts

(Does not affect heritage values either negatively or positively)

- Slightly opens up views beneath the bridge from The Terrace.

2.9.6 Minor Positive Impacts

(Enhances access to, understanding or conservation of fabric or values of local significance)

- None

2.9.7 Moderate Positive Impacts

(Enhances access to, understanding or conservation of fabric or values of State significance)

- None.

2.9.8 Residual Impacts

(Impacts that cannot be mitigated against or ameliorated through avoidance, design changes or alternative methods prior to development approval)

- Physical modification of the current cultural landscape - replacement of the existing bridge with another larger bridge in a different position
- Visual impacts of the project within the current cultural landscape - presence of a larger bridge, new bridge in an old setting, larger footprint for traffic on northern side

2.10 Statement of heritage impact

SoHI for design changes since exhibition of the EIS

The overall statement of heritage impact related to the increase in bridge height remains unchanged from the original heritage working paper.

The modified design of the replacement bridge over the Hawkesbury River at Windsor diverges from the exhibited design in that it incorporates an increase in deck height of 1 metre starting in the location in line with The Terrace to approximately the location of Pier 1. The rise from the driveway of 4 Bridge Street to Pier 1 is gradual as is the fall to the north. The difference in height and therefore the heritage impact of the modification is considered to be minor with respect to the overall impact that a replacement bridge would have on the existing and significant cultural landscape, views, vistas and setting.

Negative impacts on the archaeological resource in the location of the proposed southern abutment are predicted to be major. The two abutment construction options provide the opportunity to archaeologically excavate the resource prior to construction commencing. The land bridge option, which initially appears to result in the least impact, would either destroy relics without the opportunity for archaeological excavation, or require a larger area than the footprint of the piers would require archaeological excavation for work health and safety reasons.

The potential to damage archaeological resources poses a risk to areas that are not protected by hardstand on road base. Compression impacts on the archaeological resource are possible in areas away from the existing paved roads and would be a negative result if not managed. Resources such as the Macquarie-era brick drain are particularly vulnerable to damage by uncontrolled plant and stockpiles and any more inadvertent damage to this item would be a major negative impact.

SoHI considering further assessment of the project

The area of the reserve that will not be physically impacted by the proposal will be separated from its historic context and a significant landscape will be irreversibly impacted. Moreover, as archaeological excavation of the entire upper parkland area is one of the archaeological options considered¹⁸ (although not favoured by RMS) the final design of the upper parkland area will require careful consideration if excavation goes ahead.

The negative impact of the project on the built environment of Thompson Square, the aesthetic values of the surrounding cultural landscape, including the Thompson Square Conservation Area, and the removal of a significant archaeological resource will change a familiar and valued space irreversibly. The Heritage Working Paper concluded that the project would negatively impact the heritage values of the project area and surrounding landscape to a high degree. It is difficult to see how leaving the remaining space untouched will enhance or even retain significance.¹⁹ In the overall context of the project, which will result in the loss of much of a significant and valued landscape, the landscape of the final park will have to be carefully and thoughtfully designed to interpret the significance of remaining elements and illustrate those elements that have been removed.

It is also considered that the impacts associated with the fundamental elements of the project cannot be mitigated to retain the strong sense of the past that is currently evident there. Furthermore, the opportunity to remove through traffic entirely and enhance the significance of Thompson Square and the existing bridge by creating a more usable and pedestrian-friendly community space will be lost permanently.

¹⁸ Windsor Bridge Replacement Project Archaeology Options Paper, Biosis and CRM 2013.

¹⁹ Discussed in the Archaeology Options Paper

3 CONCLUSIONS & RECOMMENDATIONS

The design of the replacement bridge has evolved through a collaborative process between the designers, engineers, urban design team and the heritage specialists. The assessment and discussion presented in the heritage working paper has not changed significantly and therefore the overall conclusions and recommendations remain the same:

While the potential impact has been tempered through iterative design and input from heritage specialists, predicted impacts on the heritage significance of Thompson Square, Windsor Bridge and the northern bank of the project area will be too great to completely mitigate or ameliorate resulting in a residual impact that is discussed below.

However, the changes in the replacement bridge design that have been assessed in this document do not justify a modification of the conclusion and recommendations of the original historic period heritage Working Paper (Biosis November 2012).

By proceeding with the project in this form RMS will reconfigure Thompson Square, removing the current bridge approach road through the cutting, which will be backfilled, and placing it on the eastern margin of the square. The existing low level bridge would be demolished and a new higher structure built. This will be a major heritage impact as it will irreversibly affect the significance of Thompson Square and Windsor Bridge as State significant heritage places, and the State significant vista from the northern bank looking back towards the town. It is also likely to have a major impact on the surviving archaeological resource, particularly that component that reflects the earliest phase/period of European occupation.

The project would have unavoidable impacts on the significance of Thompson Square. The changes to the space that are proposed and necessary to achieve the project would adversely impact the heritage significance of Thompson Square without effectively mitigating that impact. Mitigation measures proposed in the Heritage Working Paper are for the purpose of collecting and interpreting data, and avoiding inadvertent impacts would not retain significance.

The primary recommendation is for all components of Thompson Square to be retained; this recommendation includes retaining the existing bridge.

Reference should be made to the Heritage Working Paper 1 (Biosis 2012) for the conclusions and recommendations arising from the heritage impacts of the project.

To minimise the impact of compression, ground loading needs to be minimised through the following measures:

Recommendation B1

Make use of existing sealed roads and car park areas to place stockpiles or stand machinery.

Recommendation B2

Enforce the large grassed areas within the construction area as exclusion zones for heavy machinery until they are required. Include areas close to the edges of hardstand areas in the exclusions zones.

Recommendation B3

When not on hard-stand (paved roads) use machinery that exerts the least ground pressure such as pneumatic tyres and smaller vehicle size.

Recommendation B4

Where work off the current roads and car parks cannot be avoided, protect it with hardstand or a prepared surface to minimise and dissipate ground pressure. Separate the newly constructed hardstand from the existing surface using geofabric in addition to road base material and asphalt.

Recommendation B5

Where work of the current roads and car parks is proposed and the measures in Recommendation B4 have been implemented, where practicable²⁰, ensure that the effects of the vehicle on the ground are monitored and work ceases as soon as ground disturbance is observed. An alternative must be sought prior to re-commencing work.

Recommendation B6

Ensure that the noise mitigation advice prepared by City Plan Heritage is included in all considerations of noise mitigation measures for the three additional heritage items. All additions to heritage items are to be undertaken by qualified professional with demonstrated experience in their field and supervised by a suitably qualified heritage consultant. Reference must be made to the report prepared by City Plan Heritage.

Recommendation B7

Interpret the 1934 alignment of Bridge Street (the approach road) so that its location and value is clearly understood within the altered landscape. Include this recommendation in any future landscape designs.

Recommendation B8

Minimise visual impacts associated with light poles (furniture) through judicious selection of appropriate materials in consultation with relevant stakeholders.

²⁰ In the event that the machine is being used in the archaeological program, preparing a hardstand area is not practicable.

4 REFERENCES

- Andrews, B.N. 2006 'Sediment consolidation and archaeological site formation', *Geoarchaeology*, 21, pp. 461–478.
- Ardito, A.J. 1994 'Reducing the effects of heavy equipment compaction through in situ archaeological site preservation', *Antiquity*, 68, pp. 816-820.
- Biosis Research Pty Ltd with Cultural Resources Management, 2012, *Windsor Bridge Replacement Project Historic Heritage Assessment & Statement of Heritage Impact*. Report for Roads and Maritime Services NSW, November 2012.
- Cosmos Archaeology Pty Ltd, *Proposed Windsor Bridge Replacement Windsor, NSW Maritime Archaeological Statement of Heritage Impact Final Working Paper Report*. Report prepared for Roads and Maritime Services NSW, October 2012.
- Dain-Owens, A., M. Kibblewhite, M. Hann and R. Godwin 'The risk of harm to archaeological artefacts in soil from dynamic subsurface pressures generated by agricultural operations: experimental studies', *Archaeometry*, accepted for publication – pre-release manuscript.
- Darwin, C.1881 *The formation of vegetable mould through the action of worms, with observations on their habit*, D. Appleton and Company, New York.
- Gifford-Gonzales, D., D.B. Damrosch, D.R. Damrosch, J.Pryor, and R. Thunen 1985 'The third dimension in site structure: an experiment in trampling and vertical dispersion', *American Antiquity*, 50, pp. 803–818.
- Hofman, J.L. 1986 'Vertical movement of artifacts in alluvial and stratigraphic deposits', *Current Anthropology*, 27, pp. 163–171.
- Huisman, D. J. 2012 'Deep impact: what happens when archaeological sites are built on?', *Conservation and management of archaeological sites*, 14 pp. 60–71.
- Kelleher Nightingale Consulting Pty Ltd, *Windsor Bridge Replacement Project Aboriginal Cultural Heritage Cultural Heritage Assessment Report*. Report prepared for Roads and Maritime Services, September 2012.
- McBride, R.A. and G.D. Mercer 2012 'Assessing damage to archaeological artefacts in compacted soil using microcomputed tomography scanning', *Archaeological Prospection*, 19, pp. 7–19.
- Morin, E. 2006 'Beyond stratigraphic noise: unravelling the evolution of stratified assemblages in faunal-turbated sites', *Geoarchaeology*, 21, pp. 541–565.
- Nickens, P.R. 1999 'Technologies for in-place protection and long-term conservation of archaeological sites', *Archives and Museum Informatics*, 13, pp. 383–405.
- Petraglia, D. and D. Nash 1987 'The impact of fluvial processes on experimental sites', in D. Nash and D. Petraglia (eds.), *Natural formation processes and the archaeological record*, British Archaeological Reports International Series 352, Oxford, pp 108–130.
- Player, S. and M. Kelleher 2012 'Does covering an archaeological site protect the objects?: Physical effects of a storage compound on an archaeological site', Paper to Australian Archaeological Association conference, Wollongong.
- Schiffer, M. (1987) *Formation processes of the archaeological record*, University of New Mexico Press, Albuquerque.
- Spennemann, Dirk HR. 1989 Of wheels and tracks: experiences with heavy excavating equipment, *Australian Archaeology*, 29, pp. 69-73.
- Thorne, R.M. 1991 *Intentional site burial: a technique to protect against natural or mechanical loss*, US Department of the Interior: National Parks Service, Archaeological assistance Program Technical Brief 5, revised edition.

Wildesen, L. 1982 'The study of impacts on archaeological sites', in M. Schiffer (ed.), *Advances in archaeological method and theory*, Academic Press, New York, 5, pp. 51–96.

Wood, W.R. and D.L. Johnson, 1978 'A survey of disturbance processes in archaeological site formation' M. Schiffer (ed.), *Advances in archaeological method and theory*, Academic Press, New York, vol. 1, pp. 315–381.

Attachment 1: Excavation Report

Cultural Resources Management

WINDSOR BRIDGE REPLACEMENT PROJECT

TEST EXCAVATION TO INFORM TRAFFIC SIGNALS AND CABLE TRENCHES INCLUDING EVIDENCE FROM GEOTECHNICAL CORES

March 2013



CONTENTS

| | | |
|------------|---|-----------|
| 1.0 | PRECIS | 04 |
| 2.0 | PROJECT SCOPE | 09 |
| 2.1 | The Site | 09 |
| 2.2 | Project Initiation | 09 |
| 2.3 | Description of Proposed Work | 09 |
| 2.4 | Objectives | 12 |
| 2.5 | Research Design | 12 |
| 2.6 | Methodology | 13 |
| 2.6.1 | Locating the trenches | 13 |
| 2.6.2 | Excavation | 16 |
| 2.6.3 | Recording | 17 |
| 2.6.4 | Artefacts | 17 |
| 2.7 | Approvals | 17 |
| 2.8 | Authorship and Applicant | 17 |
| 3.0 | TRENCH 10 | 19 |
| 3.1 | Location and Dimensions | 19 |
| 3.2 | Excavation Evidence | 21 |
| 4.0 | TRENCH 11 | 23 |
| 4.1 | Location and Dimensions | 23 |
| 4.2 | Excavation Evidence | 25 |
| 5.0 | TRENCH 12 | 29 |
| 5.1 | Location and Dimensions | 29 |
| 5.2 | Excavation Evidence | 30 |
| 6.0 | NORTHERN SIDE OF GEORGE STREET | 33 |
| 6.1 | ATP A | 34 |
| 6.2 | ATP B | 35 |
| 7.0 | GEO-TECHNICAL EVIDENCE | 36 |
| 7.1 | Core Locations | 36 |
| 7.2 | Profile | 36 |
| 7.3 | Discussion | 37 |
| 7.3.1 | Sampling and Interpretation | 38 |
| 7.3.2 | Landform | 38 |
| 7.3.3 | Land-forming | 39 |
| 8.0 | INTERPRETATION OF EVIDENCE | 41 |
| 8.1 | Topography and Geology | 41 |
| 8.2 | First European Land Use | 43 |
| 8.3 | Commissariat Stores | 45 |
| 8.4 | George Street in the Nineteenth Century | 46 |
| 8.4.1 | Before c.1870 | 46 |

| | | |
|------------|--|-----------|
| 8.4.2 | The 1880s – c. 1900 | 49 |
| 8.4.3 | In the Twentieth Century | 52 |
| 8.5 | Footpaths | 54 |
| 8.5.1 | Bridge Street | 54 |
| 8.5.2 | George Street | 55 |
| 8.6 | Bridge Street | 57 |
| 8.7 | Conclusions | 58 |
| 9.0 | RESPONSE TO THE RESEARCH DESIGN | 61 |
| | Appendix 1 | 64 |

1.0

PRECIS

This report describes a small program of archaeological testing at the intersection of Bridge Street and George Street, Windsor. The work was undertaken at the specific request of the Department of Planning and Infrastructure to provide additional information for the evaluation process concerning the construction of a new bridge across the Hawkesbury River, from Thompson Square to the northern riverbank.

The work was intended to provide information that would help to determine the impacts on archaeological resources of the construction of new traffic signals at this intersection on each corner, and the underground cabling in the road that would supply these new signals.

A specific assessment and research design was prepared for the work and an S60 application was made for approval to the Heritage Branch of NSW. Generally, the research questions posed for this program may be summarised as follows:

- Is it possible to determine the nature, chronological span, integrity and significance of any archaeological evidence within this area?
- Will the proposed work impact on archaeological evidence?

Specifically, the work was intended to determine if possible the presence or absence of physical evidence of the 1803 Commissariat building on the south-eastern side of the intersection as well as the more general profile of soils and deposits and what evidence they provided for the evolution of this area at the southern end of Thompson Square. It was intended to complement the evidence and conclusions made from an earlier program of testing undertaken within Thompson Square.

With a stated objective of minimising impacts to the profile while still meeting the project objective the work was confined to the southern side of the intersection. Evidence from test trenches excavated in the first program of investigation located close to the northern side of the intersection provided sufficient evidence for the purposes of the present objectives.

For the present program of work one trench was excavated in the footpath on the eastern side of Bridge Street, south of the George Street intersection (Trench 10). A second trench was excavated in the George Street footpath on the western side of the intersection

(Trench 11). A third trench was commenced in the garden area of this corner (Trench 12). This was immediately closed down, backfilled and the area made good when RMS was made aware that it had been leased by Hawkesbury Council to an adjacent property owner.

The information acquired from this test program has been supplemented by the results of several geo-technical cores that have been excavated into the road pavement of George Street and two in Bridge Street. These cores were made to provide information for the bridge design.

The conclusions that may be drawn from the evidence recorded in this program of work in conjunction with that from the earlier program of investigation are as follows:

- That the topography recorded in the earliest nineteenth century images of the Green Hills settlement is accurate in its depiction of a high exposed ridge line stepping down steeply to the river; it may have been more extreme than those images suggest with gullies cutting through the ridge line and uneven outcrops of rock;
- That the ancient sand body recorded in test trenches on the northern side of the road do not appear to have covered the peak of the ridge or extended further south than the northern side of George Street;
- That this peak or ridge, the later alignment of George Street, may have been exposed bedrock or only thinly covered with sand or soil. It may have been cut through by a gully at the line of present day Bridge Street;
- That this thin soil cover, if it existed, may have been removed in the earliest days of settlement to provide a hard and impervious surface for both pedestrian traffic and construction projects;
- That the exposed bedrock in this location may have been cut and shaped in places to be used in the construction of building foundations, drains or other structural works. If this is the case then evidence of this work could be found in the roads; the work would have been undertaken before the formalisation of those road corridors;
- That there is no clear evidence of the Commissariat building of 1803 and the impact of road works, paving and the introduction of services in the footpath on the eastern side of Bridge Street

make it unlikely that much or any remains here. However, if the technique of cutting and shaping bedrock was used in the construction of this building then some evidence of this work could survive at the face or the bedrock. It is unlikely that evidence of the building will be found in the road because of the impact of road widening and the formation of the most recent road surface;

- That by the mid-nineteenth century the alignment of George Street had been altered at least twice and soils had been imported to build up this area possibly higher at the southern end of Thompson Square than the street level immediately adjacent to the Macquarie Arms Hotel; this conclusion is based on archival evidence;
- That these accumulated soils were comprehensively removed in c. 1893 to allow for a major program of infrastructure that entailed laying service pipes in the street and possibly creating a new road surface comprised of a bedding deposit of locally sourced clay topped with a cobbled stone road. If this is not a road then it might be a linear drainage feature. If so a tar paved surface found in trench 12 might be evidence of an associated road surface. The evidence suggests that the latter is more likely to be later twentieth century in origin but there is insufficient physical evidence to make connections between the features in trenches 11 and 12;
- The same locally sourced clay found under the stone cobbling in trench 11 may have been used to create a pedestrian area along Bridge Street adjoining the School of Arts but there is no evidence for how it was finished or paved and the sample is too small to make a positive identification;
- By the 1920s the surface of George Street appears to have comprised silty soil that was laid or accumulated over the stone cobbling;
- Asphaltic concrete footpaths were laid in George Street from 1938 onwards and the physical evidence suggests that the work entailed cutting down the existing road, possibly removing much of the stone cobbling if it was a road surface and any later surfaces and introducing fill along the northern side of the road to help level it for the new concrete surface although this fill could have been introduced for an earlier program of works on the road in the nineteenth century; there is insufficient evidence to date it;

- Three separate resurfacings of this road are shown in the cores along George Street. Test trench 11 also records layers of asphalt concrete; until the c. 1990s this land was within the street;
- The paved footpath along Bridge Street might date from this same period of the 1930s or it is a later replacement;
- The bitumen paved surface in trench 12 could be a remnant road surface of the later nineteenth century but its form and evidence from archival sources suggests that it could be a very late pavement surface from the 1980s that immediately predated the development of the present alignment and garden at this south-western corner of the George and Bridge Street intersection;
- The 400mm of topsoil in trench 12 was introduced for the development of this pedestrian area in the c. 1990s;
- The introduction of services in the footpaths has made a substantial impact on the preservation of archaeological evidence.

With respect to the significance of the evidence revealed by test trenching and the impacts of the proposed works the following may be concluded:

- The depths of excavation required for the traffic signals and trenching will impact on archaeological resources. The depth of the archaeological profile on the ridge top is shallow, little more than half a metre in places and all the works required for this project extend beyond that depth including into the bedrock where it is possible that early nineteenth century works undertaken to modify the rock for building purposes could be preserved;
- The archaeological evidence that will be impacted by these works could include some works that predate c. 1810. This evidence would be of state significance based on the associations and rarity evaluated for evidence of a similar period in the statement of significance prepared for Thompson Square;
- The excavation did not provide any evidence for the presence of the Commissariat Store of 1803 but there is still a possibility of intact evidence outside the road and paths; modifications to the bedrock might provide clues to its location but this requires further investigation. It is also impossible to determine on this basis whether the proposed works will impact evidence of this

type. If evidence was found that could be directly attributed to this building it would be of state significance;

- What occurred in the period between c. 1810 and c.1870 can be inferred from a comparison of archival sources and the absence of physical evidence. It is possible to develop a reasonably consistent and feasible pattern of development for this area from a combination of evidence, lack of evidence and archival sources;
- The majority of the profile evidenced by the test excavation dates from c.1893 and onwards. This will be the subject of the principal impact of the proposed works. This component of the project area is of local significance;
- This impact will entail the fragmentation of large archaeological units such as road surfaces and bedding for them. It is unlikely to completely remove all evidence because these types of historic work encompass large areas and they will probably extend beyond the areas of impact;
- More difficult to assess is the potential for impacting modifications that may have been made to the bedrock to facilitate early buildings works. In the first instance this is a practice that is yet to be positively confirmed; the test result provides an indication but other examples would have to be found to make this a reliable identification. Further, because of the random and largely undocumented location of many of the early structures it is impossible to determine if the proposed works will impact any improvement of this type until it is uncovered;
- Generally, any features that can be positively attributed to the earliest settlement of Green Hills and of the Macquarie period town would be of state significance. Evidence of later nineteenth and early twentieth century infrastructure, the creation of roads and footpaths would be of local significance for what it can document about the growth of the town.

2.0 SCOPE

2.1 The Site

The focus of the current investigation is the George Street and Bridge Street intersection at Windsor including the footpaths. This is the site proposed for new traffic lights that would be required for the construction of the Windsor replacement bridge. Excavation for works associated with the lights could also impact portions of Bridge Street from close to Macquarie Street to the commencement of the bridge. There would also be trenches placed in George Street close to the lights and some parts of footpaths in this area (Refer to Figure 1).

2.2 Project Initiation

This work has been undertaken to specifically address issues raised by the Department of Planning and Infrastructure. It is intended to provide additional information to inform the evaluation process of this project. This document is an addendum to the working paper *Windsor Bridge Replacement Project Historic Heritage Assessment & Statement of Heritage Impact* prepared by Biosis Research Pty Ltd and Cultural Resources Management in November 2012.

2.3 Description of Proposed Work

The proposed work for this infrastructure generally entails the construction of traffic lights at each of the four corners of the George Street and Bridge Street intersection, the introduction of cables that link these lights and the connection by cabling of this system to the sub-station in Bridge Street close to Macquarie Street. Specific works proposed are as follows:

- The construction of eight traffic light units, two at each corner of the intersection. Two different types of signals are required for this intersection: Type 9 and Type 2.
- Type 9 signals require the following works for installation: excavation of footings 1400 mm deep x 900 mm long x 760 mm wide. The pit would be connected to the conduit trenches on two sides
- Type 2 signals require the following works for installation: excavation of footings 750 mm deep x 900 mm long x 600 mm wide (the total footing depth may need to be increased for

posts installed in unpaved areas with unstable soil). The pit would be connected to the conduit trenches on two sides

- The traffic signals would be connected by cables that run in the road
- The installation of feeder cables from the existing traffic controller at the termination of Macquarie Street to the traffic signals on the south east corner of Bridge Street to connect the two signalised intersections (the conduits would be installed through open trenching within the existing pedestrian pathway; the exact location however is to be informed by the location of existing cabling)
- An additional action may be required dependant upon the final project approval but at this stage it is not confirmed: the existing 33 kV (overhead) electricity cable may also be buried underground within the Bridge Street alignment between the Macquarie Street and George Street intersection.

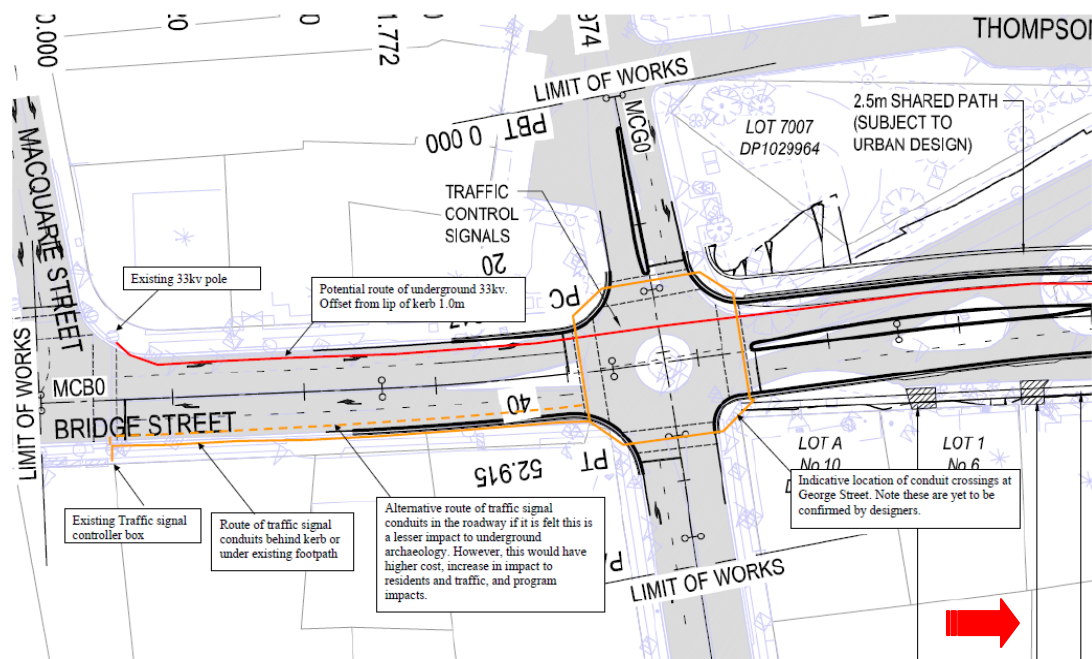
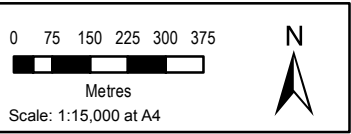


Plate 1: The proposed position of conduits and trenches. Source: RMS



Figure 1: Location of the Study Area in a Regional Context

Date: 31 August 2012 Matter: 14020
 Checked By: PBK Drawn By: JMS
 Location: P:\14000s\14020\Mapping\14020_SoHIF1_Locality.mxd




Biosis Research Pty. Ltd.
 18-20 Manidale Street
 Alexandria
 NSW, 2015

Offices also in: Wollongong,
 Ballarat, Melbourne,
 Canberra, Wangaratta.

2.4 Objectives

The overall objectives of the archaeological work were as follows:

- To determine if an archaeological profile survives in this project area and, if it does, the composition and chronological range of that resource and its potential depth. The latter is relevant to the range of impact depths proposed for the construction work from approximately 600 mm to 1500 mm. This testing program is intended to provide a generic view of the scope of information that is likely to be found within this project area
- As well as assessing the integrity, scope and chronological range of the profile that is likely to characterise this ridge-top area this program will also focus on one specific site, that of the 1803 Commissariat Stores building. This is a site of potential state significance that can be identified from primary archival sources. The work will address the issue of its survival as well as the general archaeological profile that might survive above and below this level of occupation.

These objectives are designed to address issues with respect to the impact of the proposed construction work on archaeological evidence.

2.5 Research Design

Specific outcomes were established for this project; these are termed a research design. They were as follows:

- Will the depths of excavation required for the traffic signals and trenching impact on archaeological resources?
- Is it possible to determine the chronological span of information preserved within the project area and can this be related to the principal phases of development defined by the historical analysis?
- Is it possible to identify specific processes or features that survive within this profile; for example, road surfaces of a particular period, the 1803 stores building?
- Is it possible to determine the likely impact of twentieth century and later road works, footpath development and the installation of services over the entire project area?
- Is it possible to determine a level of cultural significance for the features and/or profile and its relationship to Thompson Square?

- What are the likely impacts of the specific works proposed for this project area on the archaeological resource and its significance?

2.6

Methodology

The project methodology outlined in the research design provided for a maximum of two trenches that were to be excavated to a maximum length of three metres to provide a reliable sample of the deposit. A shorter length was allowed for if it could be shown that it provided what was likely to be a representative sample of the profile. The trench or trenches were to be excavated to bedrock. The principal trench (trench 10) was to be located at the south-eastern corner of the George Street and Bridge Street intersection within the footpath. The location that was chosen was one that was most likely to intersect any remnant evidence of the 1803 Commissariat building.

The additional trench on the western side of the intersection (trench 11) was to be excavated if the results of the first trench were inconclusive. The proposed location of the trench was not specific to any particular site; it was located in an area that was formerly part of the road and it was anticipated that it could provide a more generic sample of the archaeological profile particularly of the road development.

2.6.1

Locating the Trenches

The methodology for this work was intended to minimise impacts to the profile while still meeting the project objectives. It was determined that no work could be undertaken in the road because of the disruptions that road closures would cause to the community. This left only the pedestrian areas for investigation.

It was known before work commenced that there were services within those footpaths that further narrowed the areas for investigation. The services identified prior to the work commencing are shown on the accompanying diagram. Figure 2 is a plan showing the location of the trenches.

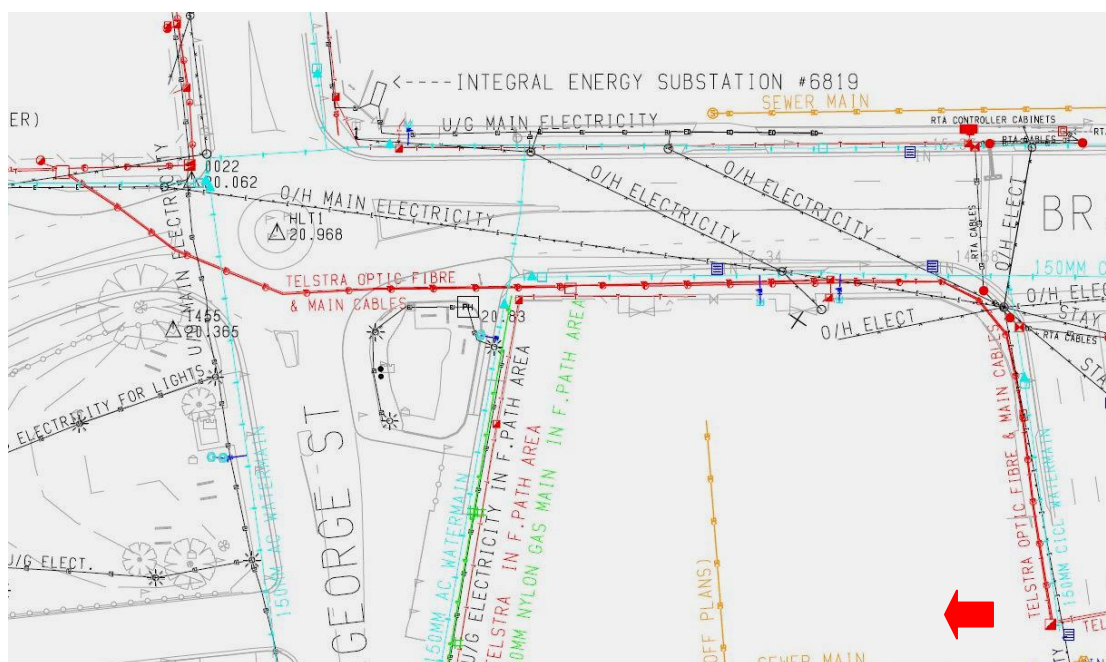


Plate 2: Utilities within the area of investigation (Source: Roads and Traffic 3 December 2005; sheet 2 of 2.)

Trench 10

At the commencement of work a specific services survey was carried out on the eastern side of Bridge Street along the footpath. This work confirmed the presence of services in the grass verges either side of the path and services that cross the path in several places. As well, in the week preceding this investigation an existing service pit within the proposed excavation area had been enlarged further disturbing the ground surface.

The combination of live services and recent disturbance reduced the only safe and practical area of investigation with respect to the site of the Commissariat Store and that of the proposed construction works to a one-metre square in the footpath. It was at the southernmost extent of the trench proposed in the research design; the latter was placed to intersect the possible site of a wall of the 1803 stores building. The disturbance at the northern end of the proposed trench meant that the specific site of the wall, as far as that could be determined by overlaying historic surveys on the present site configuration was likely to have been disturbed by those services and works. The test trench that could be excavated was anticipated to lie within the internal space of the building; evidence for the Commissariat Stores, if present, was likely to take the form of a foundation trench or construction or demolition debris from that building.

While the project methodology provided for a smaller test trench if the results were adequate the small size of this sample area and the probability that it could have been disturbed to some degree by the excavations carried out for the service trenches around it made it necessary to open the second trench on the western side of Bridge Street.

Trench 11

This second trench was to be located in the footpath adjoining George Street. The trench proposed in the research design was not sited for a specific target but to capture evidence of the generic archaeological profile particularly with respect to road development. The large pedestrian area at the south-western corner of the intersection had been until the later part of the twentieth century part of the road. The necessity for establishing temporary kerbs around the work area for the safety of the public and those working on the site narrowed the footpath along George Street to a little over one metre width that was further reduced at the corner in the proposed trench location by the curve of the temporary barrier as it rounded the corner. The proposed trench location lay partly under this barrier.

The narrow section of open space left between the kerb and the garden bed on the southern side of the path meant that at best the excavation was likely to achieve less than a metre square area. This limited sample size combined with the same limited size of the excavation on the eastern side of the street influenced the decision to consider a site as close to the indicative trench as possible to enable the excavation of a larger sample size better suited to meeting the program objectives of establishing the type and integrity of the profile on the ridge top.

A second choice was considered in the paved footpath along Bridge Street close to the eastern end of the indicative trench location. Even with the presence of the jersey kerb for safety reasons this was wider and offered a more practical excavation area with the same archaeological potential. However, the services survey confirmed the presence of a fibre optic cable in the centre of the potential excavation area. The risk of damage to this service as well as the likely damage caused by it to the archaeological profile ruled this out as a viable alternative location.

The third choice was Trench 12, described below; for the reasons outlined there this was abandoned almost immediately.

A site for Trench 11 was selected as close to the original location proposed in the research design but of necessity a little further west than the nominated area to enable the width of the excavator bucket

to be accommodated. This trench was located within the George Street footpath; this site had exactly the same archaeological potential as the proposed site selection and was separated from it by approximately two metres. The trench could not be extended further west to enable a larger sample because this was the only location on which the excavator could be placed and it was further constrained by the presence of car parking spaces at the end of the footpath. The test trench measured approximately 1000 x 1200 mm.

Trench 12

Trench 12 was located within the open ground behind the hedge that defines the edge of the footpath. There were no services and the trench was angled along the north-eastern corner on what was thought to be the indicative line of the proposed conduit shown in plan in Section 2.3. The site was nominated because it was as close to the proposed trench site as possible, allowing space so that no damage was caused to the hedge, in ground that was anticipated to have the same archaeological profile and, thus, more adequately meet the project objectives because of the bigger sample size. A 3 x 1 metre trench was located on this alignment.

400 mm of sterile garden soil was removed to reveal a paved surface. At this point advice was received that although the trench was within the George Street road reserve, this section had been leased by Hawkesbury Council to an adjoining landowner. When this became known the trench was immediately back-filled and the site restored before commencing on the only remaining option; the small sample close to the original Trench 11 location at its western extent. The results of the limited work acquired from the excavation in trench 12 are included in this report.

2.6.2

Excavation

The pavement slab on Test Trench 10 was manually removed and placed to one side to allow it to be restored at the conclusion of the excavation. This one metre test square was entirely excavated by hand.

The pavers in Test Trench 11 were removed by hand. Each of the deposits described in this report were initially cleared to the surface by the mud-bucket of a 5-tonne excavator. Precise cleaning and identification of features within each deposit was carried out by manual excavation.

Test Trench 12 was excavated in a similar way to Test Trench 11, mechanical excavation to the top of each unique deposit and manual cleaning for definition and recording and identification of any feature.

This trench, as well as Trenches 10 and 11, was backfilled with the material removed from it.

When the trenches were backfilled RMS made good each site, replacing the cement paved surface slab, the pavers and compacting the loose soil in Trench 12 and spreading mulch over the open ground to restore its appearance.

2.6.3 Recording

Each unique deposit, structure or feature was assigned a unique inventory or context number and these contexts were described in the site inventory with respect to the nature of the context, integrity, matrix and component elements and relationship to those contexts around it. Every context was photographed with a scale usually in multiple views. The inventory numbers are used in this report; they are written in Bold Italic in parentheses, for example, **[001]**.

2.6.4 Artefacts

There were no artefacts of any kind found in any of the trenches.

2.7 Approvals

This work was carried out under the approval of a S60 application made to the Heritage Council of NSW (No 2013/S60/06) approved on 12 February 2013.

2.8 Authorship and Applicant

The author of this report and the excavation director is Wendy Thorp (Cultural Resources Management) acting on behalf of RMS and in association with Biosis Pty Ltd. The report was reviewed by Pamela Kottaras (Biosis Pty Ltd) and Denis Gojak (RMS).




Legend

- Test Trench 10 - 1m x 1m
- Test Trench 11 - 1m x 1.2m
- Test Trench 12 - 1m x 3m
- Construction Work Zone


Figure 2: Location of test trenches during the current archaeological program

0 15
 Metres
 Scale: 1:400 @ A3
 Coordinate System: GDA 1994 MGA Zone 56



Biosis Research
 Biosis Research Pty. Ltd.
 18-20 Mandible Street
 Alexandria
 NEW SOUTH WALES
 2015

Offices also in: Ballarat, Melbourne, Wollongong, Canberra, Wangaratta



Date: 07 March 2013, File number: 14020
 Checked by: PBK, Drawn by: JMS
 Location: P:\14000s\14020\Mapping\14020_SoHI_AddF2_TestTrench.mxd

Acknowledgements: Aerial - (c) SKM 2011

3.0 TRENCH 10

3.1 Location and Dimensions

This trench was located on the eastern side of Bridge Street, within the footpath; one paving slab was removed for this work. It adjoined the north-western corner of the School of Arts building. The trench measured approximately 1000 x 1000 mm. This was the maximum size that could be achieved between identified services trenches and in a place that had a close relationship to the site of the former Commissariat building (refer Section 2.6.1) as well as being close to the site of the proposed works in the footpath.

Overlays of historic period surveys from the first half of the nineteenth century in relation to the present roads and buildings demonstrate that the site of the former Commissariat building of 1803 is likely to lie under the School of Arts building. The older building appears to have projected beyond the western façade of the School of Arts into the present footpath and Bridge Street.



Plate 3: Overlay of 1831 survey onto contemporary aerial image showing the relationship of the Commissariat Store of 1803 to the present School of Arts building and Bridge Street

The proposed trench in the research design was intended, in a three-metre length to include the site of the northern wall of the 1803 building and a sample of the internal space. The southern wall was in an area of services and the western wall was in the road. The reduction of the trench size due to the need to avoid live services meant that the trench was likely to sample only the internal space of the building or, perhaps, allowing for a degree of variation in the 1831 survey and modern townscape, a foundation trench for that wall as well as evidence of the construction associated with the building or its demolition in the form of debris.



Plate 4: View east showing Bridge Street and the School of Arts building; the position of the test trench is indicated by the arrow



Plate 5: View north showing the slab to be removed (indicated by the arrow) for the test trench with the recent disturbance just to the north of this site caused by enlarging a service pit also visible

3.2 Excavation Evidence

The surface slab from the footpath **[001]** was lifted in one piece. It is made from cement with bluestone inclusions poured into formwork. It is approximately 60 mm thick and was laid directly over the underlying deposit of clay **[002]**.



Plate 6: View north showing the footpath slab [001] removed from the trench revealing the surface of the underlying deposit [002]

The deposit **[002]** below the footpath comprised red clay with minor lenses of sandy soil and some lighter coloured clay distributed unevenly throughout the matrix. The top 100-200 mm was more disturbed and less regular in composition than the lower portion but it was a consistent matrix for the full depth. The mixed red clay **[002]** was excavated to its full depth of 400 mm. This deposit filled the entire trench and extended beyond it.

Immediately below the red clay was the upper surface of naturally occurring sandstone bedrock **[003]**. There were no deposits between the two and no evidence of change to the bedrock.

These were the only deposits in this trench. There were no artefacts.



Plate 7: View south of Trench 10 showing the clay with sand lenses underlying the footpath on the eastern side of Bridge Street; scale 500mm



Plate 8: View north of Trench 10 showing sandstone bedrock at the base of the trench and its immediate relationship to the clay above it. This image also highlights the more disturbed nature of the upper part of the clay visible here in the shadow as a darker and slightly more textured material; scale 500 mm

4.0 TRENCH 11

4.1 Location and Dimensions

The location of this test trench on George Street has been discussed in Section 2.6.1; it was the only viable location free of services, which could accommodate the width of the excavator bucket between the safety barrier and the garden bed, very close to the proposed test trench site and with the same archaeological potential in the project area. The sample provided from this area was expected to provide evidence of road development and possibly accumulated deposits that would characterise the use of this area as a public thoroughfare from early in the nineteenth century. The excavated trench measured 1000 x 1200 mm.



Plate 9: View south at the intersection of George and Bridge Streets showing the investigation area along George Street indicated by the arrow

The evidence from the principal nineteenth century surveys shows that this area, now a pedestrian area, has been within a road or open space until the later part of the twentieth century.



Plate 10: Survey of 1842 showing the position of Trench 11 in open ground, part of the earlier configuration of George Street (detail of Peninsula Farm Auction 5 February 1842, plan prepared by Surveyor Armstrong: source nla map f187 on line)



Plate 11: Survey of 1894 showing the wider area of George Street with the approximate position of the test trench (Source LPI 1009-3000)

4.2 Excavation Evidence

The surface of the test trench was covered with fired brick pavers [004]. These were laid over a bedding deposit of sand [005] to a maximum depth of 100 mm. These deposits were lying over compacted road surface [006]. This road surface of blue metal and bitumen and cement is an extension of the present road surface in George Street covered by the extension of the pedestrian area on this southern side of the road. It is possible that there are two layers of road represented by this surface; if so one is completely bonded to the other and this makes it impossible to determine if this represents two phases of work at different times or two components of one phase of work completed at the same time.

Below this road was a thin deposit, a maximum of 50 mm, of silty soil [007]. This covered an underlying surface or feature [008].



Plate 12: View east of Trench 11 showing the surface pavers and bedding sand and the George Street road surface [006] in section. The base of the trench is covered with a silty soil deposit [007]; scale 500mm

This earlier feature [008] was made using irregularly shaped sandstone rubble and some shaped pieces, packed together without bonding to form a hard and impervious surface. It was approximately 250 mm in depth. It extended beyond the area of the test trench.



Plate 13: View west showing the surface of the sandstone feature exposed; on the left is the band of paving that provides an edge to the garden at the side of the path; scale 500 mm



Plate 14: View west during the removal of the sandstone feature showing the variation in the cobbles; scale 500 mm

The sandstone **[008]** had been laid on a compacted deposit of red clay **[009]**. The clay was between 150 mm and 200 mm deep. It had no inclusions.

Below the clay **[009]** was the surface of the underlying sandstone bedrock **[010]**. The bedrock was very smooth and flat except for a raised section on the northern side of the trench. It had a straight edge and was between 20-30mm higher than the lower smooth surface. The edge was caused by it being shaped and the smooth surface adjoining it of the bedrock might also have been polished or levelled. This action or actions demonstrates that the red clay above it was introduced; it had not been cut through and backfilled to allow for the work to be undertaken on the rock. Further it lies over the top of a service trench visible in the section.

This service trench was at the extreme northern edge of the test trench, at the base of the section or edge of the trench. It had been made by excavating a diagonal cut into the bedrock **[011]**. It is only visible in the base of the trench for a maximum of 70 mm but it certainly extends beyond the limits of this excavation into the road. Within this trench only partly visible was a terracotta or stoneware service pipe **[012]**. At the base of this service trench was a loose deposit of soil **[013]**; it contained some clay but it was impossible to investigate due to the danger of destabilising the section of soil above it.

There were no artefacts found in this trench.

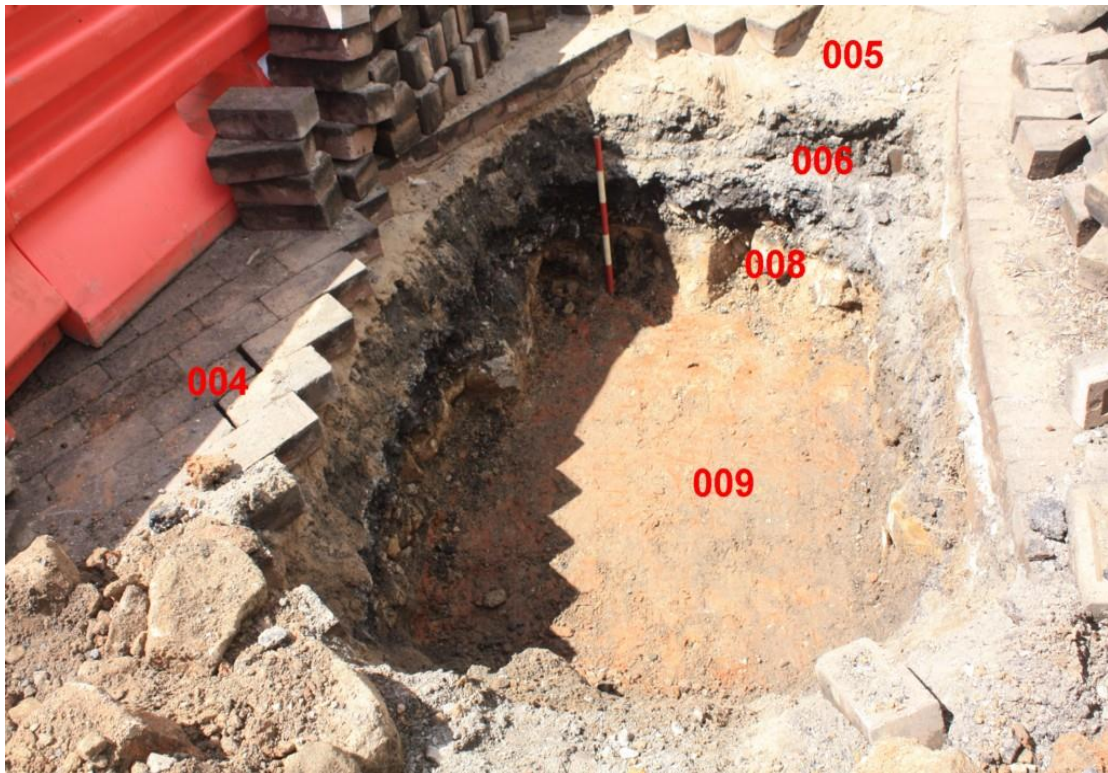


Plate 15: View east showing the surface of the red clay [009] that lies under the sandstone feature; the latter can be seen in the section [008]; scale 500 mm

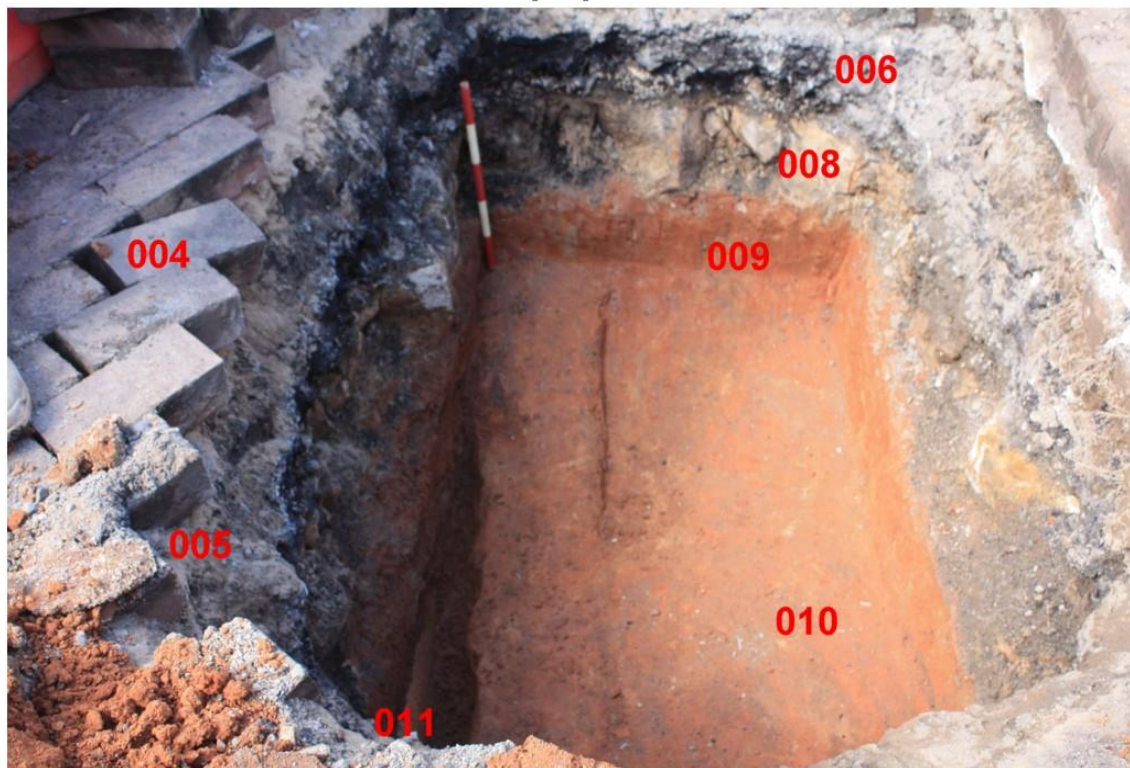


Plate 16: View east showing the sandstone bedrock [010] under the red clay [009]; this image clearly shows the straight edge of the shaped sandstone on the left side of the trench. As well, the trench cut at the base of the section [011] is evident; scale 500 mm

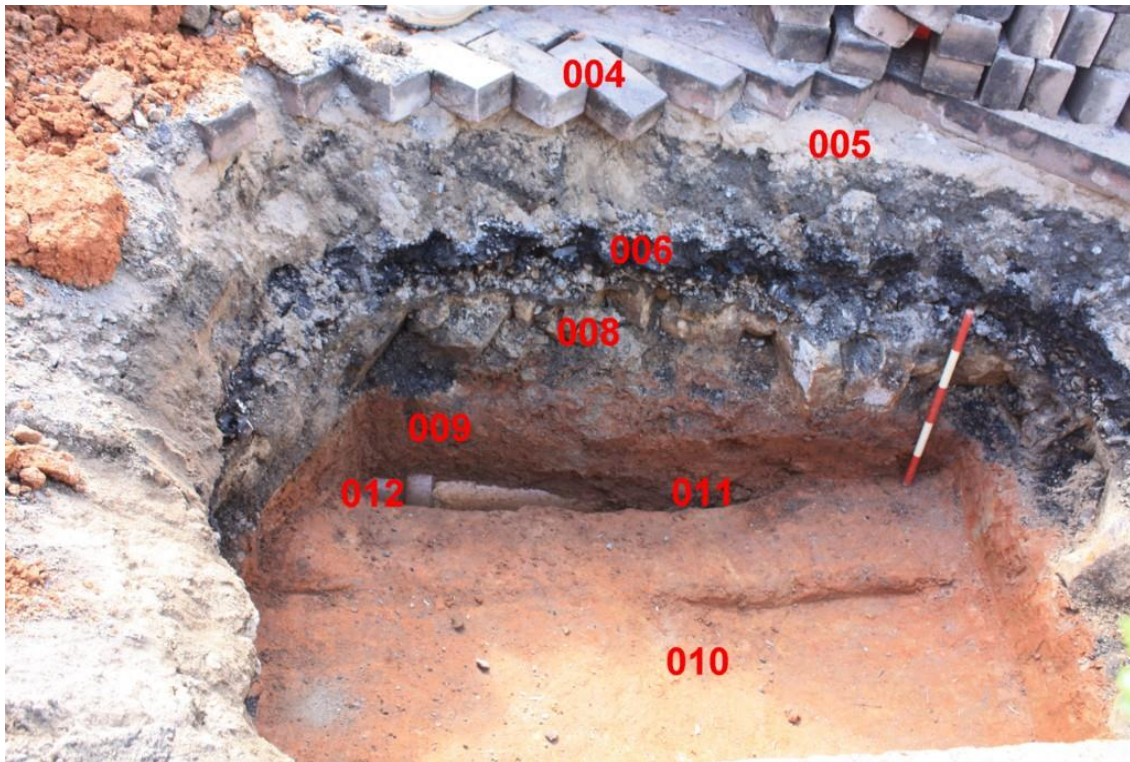


Plate 17: Northern section of Trench 11 highlighting the shaped edge of the sandstone bedrock; the red clay capping the service trench is also visible in this image (scale 500 mm)

5.0

TRENCH 12

5.1

Location and Dimensions

This trench was commenced on the southern side of the hedge abutting the pedestrian footpath; the circumstances of its location are discussed in Section 2.6.1. This area is privately leased and when this was discovered the excavation immediately ceased, the trench back filled and mulch used to make good the appearance of the area.

The trench opened was 3000 x 1000 mm with the long length running from east to west. The site was selected as being close to the proposed test trench site, in an area clear of services and with the potential for a similar generic archaeological profile for the ridge top but with a larger unimpeded sample size possible.



Plate 18: View west of the area on the southern side of the hedge; the trench location is on the right just outside the image field

5.2

Excavation Evidence

The surface of the trench was covered with compacted introduced sterile topsoil [014] to a maximum depth of 100 mm. Below this was 400 mm of sterile introduced topsoil [015]. Immediately below this soil was a hard compacted surface of bitumen and blue metal to a maximum depth of 20 mm [016]. Under this was a bedding deposit for the surface comprised of larger blue metal gravel and clay [017]. This deposit was not removed; the trench was backfilled with the soil removed from it. There were no artefacts recovered from this trench.



Plate 19: View west showing the topsoil [014, 015] above the bitumen surface [016]; scale 500 mm.

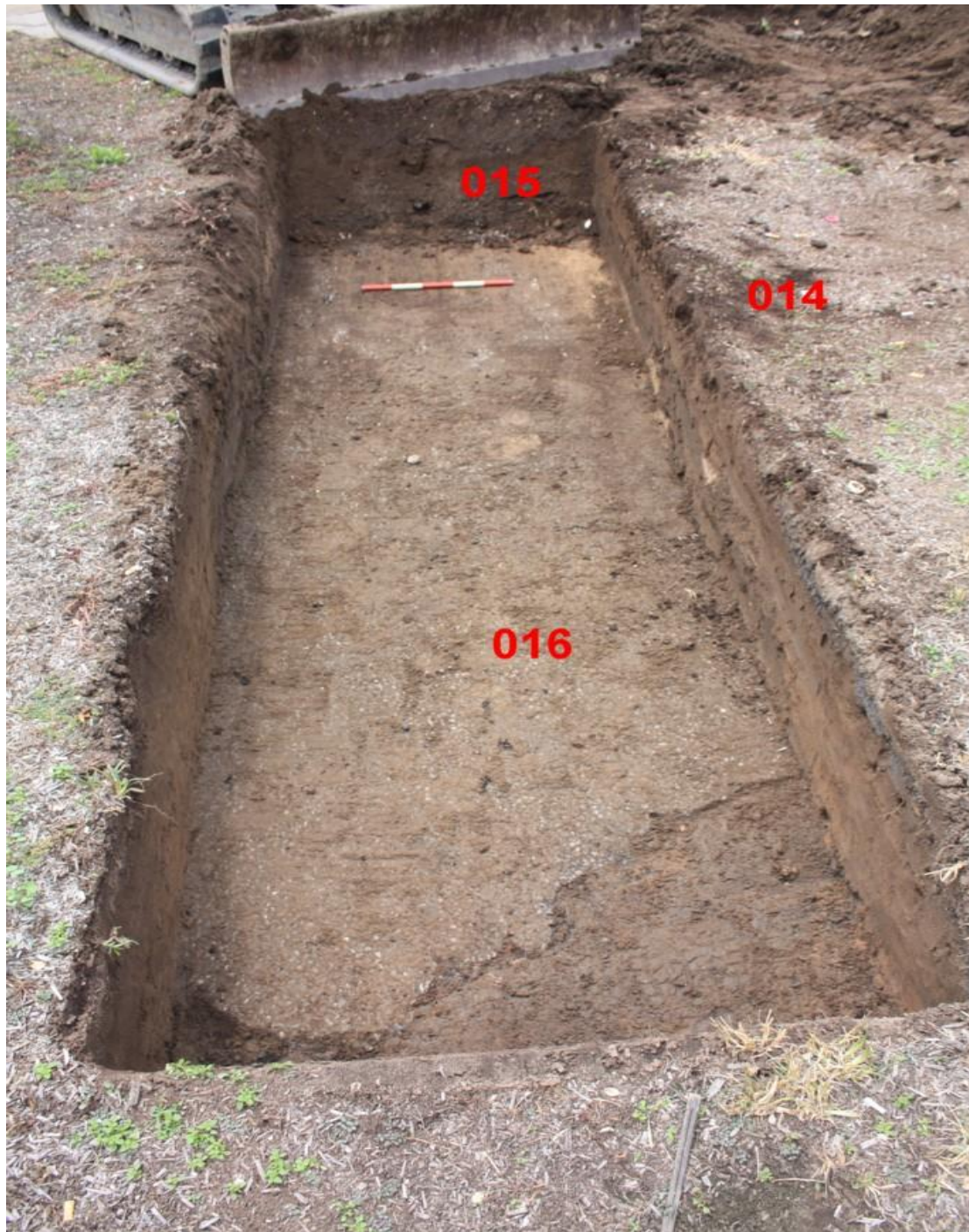


Plate 20: View east showing the bitumen surface [016]; the cut in the surface in the foreground was made in the past prior to the introduction of the garden soil above it; scale 500 mm.



Plate 21: View west showing the bitumen surface [016] removed to reveal the bedding deposit [017] below it.

6.0

THE NORTHERN SIDE OF GEORGE STREET

Test trenches were not excavated on the northern side of George Street for this program due to excavations having already been made there in the earlier program of archaeological investigation. Sufficient evidence had been retrieved from these works to inform the present issues and thus avoid more disturbances to the archaeological resource.

The most relevant pit and closest to the north-western corner of the intersection was a test pit dug to evaluate the profile for indigenous archaeology (ATP A or Indigenous Test Pit 057E 560N). A second test pit further north in Bridge Street was also used to inform the present investigation (ATP B or Indigenous Test Pit 050E 591N). Some evidence has also been used to interpret results from historic period trenches 1 and 2; this evidence is discussed in Section 9.



Plate 22: Location of indigenous test pits; Test Pits A and B are closest to the Bridge Street and George Street intersection.

6.1

ATP A (Indigenous Test Pit 057E 560N)

This test excavation revealed that the top 300 mm of the deposit in the parkland is comprised of dark grey-brown humic loam considerably disturbed by tree roots and including a small sample of European artefacts. The latter have a wide chronological spread including a fragment of a later nineteenth century clay smoking pipe and c. 1950s tiles. Below this material from 300 mm downwards was the upper portion of an ancient sand body including substantial quantities of Aboriginal artefacts. The pit was excavated to a depth of one metre; at this point naturally occurring red clay was exposed.



Plate 23: North section of ATP A showing the small European horizon above the remnant sand dune; the top of the red clay is at the base of the pit (scale one metre)¹.

¹ Image from Kelleher Nightingale Consulting Pty Ltd (2012); Windsor Bridge Replacement Project Cultural Heritage Assessment Report: 23

6.2 ATP B (Indigenous Test Pit 050E 591N)

This pit was located in the traffic island between Old Bridge Street and Bridge Street. The surface was covered with paving bricks to reveal 80mm of bedding sand, above 230mm of blue metal. Below this was 250mm of concrete and at the base of the excavation was sticky red clay.



Plate 24: Section in ATP B; scale 1 metre

7.0 GEO-TECHNICAL CORES

7.1 Core Locations

After the completion of the archaeological test program a number of cores were taken for geo-technical purposes. A total of eleven cores were planned; seven are located at the George and Bridge Street intersection. One core was located in Bridge Street (core PC 01), one at the junction of Bridge Street and George Street (core PC 11), one in the roundabout (core PC 02) and the remainder were in George Street in the middle of the intersection and on either side of it.² Refer to Appendix 1 for the pavement core plan (SKM).

7.2 Profile

The results of the evidence from the cores within this project area may be summarised as follows:³

- Concrete pavers and bedding on the roundabout (core 2)
- Present asphalt concrete road surface along George and Bridge Streets and under the roundabout (cores 1, 2, 3, 4, 5, 11, 12)
- Bedding or base for Bridge Street surface (core 1)
- Older asphalt road surface on George Street (cores 2, 3, 4, 5, 11, 12)
- Road base for second George Street surface (core 3, 5, 12)
- Older aggregate concrete surface? (core 2, 4)
- Third road surface intersection of Bridge Street and George Street (core 11)
- Sandstone block at the intersection of George and Bridge Streets (core 11)
- Dark sandy silt classified as fill (cores 3, 4, 5, 12)
- Silty red clay at varying depths between 600-2000 below surface (cores 1, 2, 3, 4, 5, 11, 12)

Bedrock was not reached in any of the cores in this area.

It is worth comparing the results of these cores with those taken on the northern side of the river as part of the same program (cores 7 – 10). None of these cores revealed the same silty red clay that lies at

² SKM Geotechnics (2013); Windsor Bridge Replacement Detail design Pavement Core Log Report

³ Based on descriptions on the log sheets: Ibid

the base of all the cores taken at the Bridge and George Streets intersection.

7.3

Discussion

7.3.1

Sampling and Interpretation

The first and possibly most important observation to be made from these results, the same as that concluded in relation to the testing program for archaeology, is that the evidence of one or even a small number of samples will not provide a generic profile that can be applied to all of Thompson Square or its environs. There are, for example, great differences between the results of the archaeological test trenches in the pavements and the cores made in George Street. For example in Trench 11 located in the George Street pedestrian area bedrock was reached at approximately 600 mm. In core 3, a few metres to the north-east in George Street bedrock had not been reached at a depth of two metres. In trench 11 evidence of what appears to be a sandstone block road was revealed and this is missing in core 3. Equally the profile recorded in the three archaeological test trenches is completely different in each case.

The archaeological and geo-technical samples acquired in this program of work reinforce the conclusions from the first program of testing on the northern side of George Street. Thompson Square and its environs preserve an extremely complex and diverse cultural profile. It has evolved over a very irregular landform and has been subject to multiple works of varying scales designed to accommodate or change that landform. There are specific improvements in particular places (landscaping, drainage, structures etc) that have been implemented over a very long period of time. The impacts of later works on earlier improvements have removed, reduced or disturbed components of the archaeological profile but in doing so have added to the evidence that explains how, in the historic period, this area of land was used and managed to accommodate many different needs.

This observation has substantial implications for any intervention in Thompson Square or its near environs. Excavation for construction or as a mitigation measure requiring the removal of large portions of the profile in this area will fragment this resource and reduce the ability to interpret individual units and the profile as a whole. There is a high probability that the relationships between individual archaeological components will be obscured or only partly revealed because the excavation areas will have no relationship to any former historical landscape. This would be like cutting a trench through a room that revealed only parts of the furniture and décor and even cut some of the furniture in half; it would be very difficult to determine what the

room had been used for particularly if that room retained furniture and decoration that revealed several changes of use.

This also has the same implications for any part of the present cultural landscape that would be kept or retained as part of the proposed construction with respect to the loss of evidence. Even with comprehensive archaeological documentation of the areas removed the ability of what remained to be interpreted as part of the complex resource that is now preserved in Thompson Square would be adversely impacted by the work.

7.3.2

Land form

It is very clear that the topography recorded in the earliest European images of this place is accurate and that the original landform was sloped steeply from the ridge to the river. This fact alone is a major issue in understanding how the early settlement evolved as it responded to the challenges of that environment. This challenge and response creates the circumstances that lead to the development of an archaeological profile particularly in a place such as Thompson Square where there has been over two centuries of development.

The original landform is now becoming clearer from testing both for archaeological and geo-technical purposes. This evidence suggests that we might perhaps be able to predict or anticipate some aspects of settlement here if we acquire a closer understanding of the pre-settlement environment and topography.

For example, with respect to the present area of investigation, all of the nineteenth century surveys record the very distinctive splayed corner at the southern intersection of George Street and Bridge Street. This corner and its building allotments were certainly placed at least in part to accommodate the scale and angle of the Commissariat building. The information gained from the present work indicates that the position of that building might have been dictated entirely by the presence of bedrock close to the surface along the ridge and the presence of a break in that ridge. The western extent of the building appears to correspond to the westernmost extent of shallow bedrock on this portion of the ridge. Bridge Street may have been placed here to exploit a cleft in the ridge at that point via a gully through it. This early assessment is based on the identification of the presence or absence of bedrock close to the surface in the two test trenches and two cores.

The landform that exists today within Thompson Square and its environs is vastly different to what can be surmised of the original landform based on the small programme of archaeological test trenches, geo-technical cores and early images of the settlement.

This comparison highlights the complexity of the profile that must exist within this area; the extent of alteration or land-forming infers the presence of a deep cultural landscape.

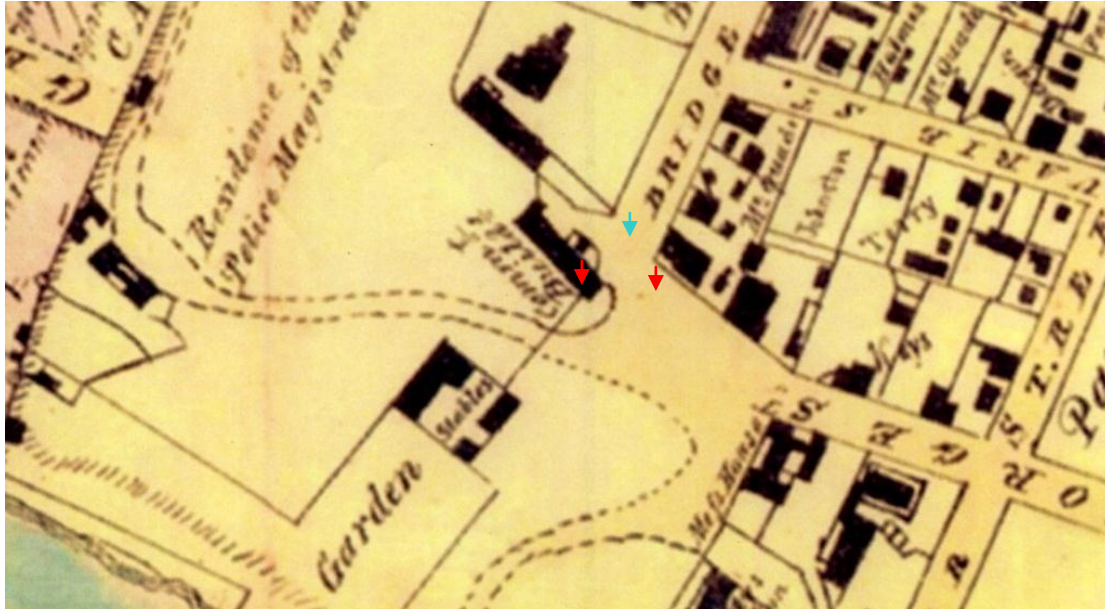


Plate 25: 1842 survey with the red arrows indicating the presence of bedrock close to the surface (archaeological test trenches) and deep deposits of fill and clay shown by the blue arrow recorded in a geo-technical core (detail of Peninsula Farm Auction 5 February 1842, Plan prepared by Surveyor Armstrong: source nla map f187 on line)

7.3.3

Land-forming

The evidence from the geo-technical cores compared with the results of the archaeological test trenches in this location also provides evidence for what appears to be substantial programs of land-forming.

The most obvious example of work of this type is found in cores 3, 4, 5 and 12. The cores are all located in the middle and northern sections of the present alignment of George Street. In each of these cores at the base of all the road surfaces was a consistent deposit of dark brown sandy silt with traces of sand and gravel used as fill. It ranged in depth from approximately 600 mm to well over a metre and lay above red clay. It was not found in cores 1 or 11 within Bridge Street and it does not appear to be consistent with any of the soils exposed in the indigenous archaeology test pits or historic period test trenches excavated on the northern side of George Street.

The evidence suggests that this soil was laid in a band to assist in the formation of George Street, either in the nineteenth or twentieth centuries; there is insufficient evidence to date the work accurately.

Its relevance is that it infers there was a drop down this hill at this point that might represent the edge of the bedrock on the ridge and/or an older cultural profile that needed to be modified for the later works. The soil is being used to modify that topography to facilitate the road.

A particularly important component of the profile in all test trenches and cores is the red clay that is found at the base of all those excavations. The red clay is a natural element in the local geological profile and has been found in situ in indigenous test pit A on the northern side of George Street. Exactly the same clay has been found in Trench 2 where it was used as fill to increase and level the ground surface. This was part of the work that was required to raise the level of the road when the height of the bridge was increased in 1894. There were no obvious differences between the in situ clay and the redeposited clay.

This has particular relevance for the clay exposed in the geo-technical cores and some of the clay exposed in archaeological trenches 10 and 11. This is discussed in the following section. Generally, what is becoming apparent is that the pre-settlement landform has been massively changed in places by land-forming works and much of this work appears to have no archival trace so that its nature and extent cannot be identified or predicted.

8.0 INTERPRETATION OF EVIDENCE

8.1 Topography and Geology

The test trenches and cores excavated on the ridge have provided more evidence for the original landform and how this has influenced European settlement. Test Trenches 10 and 11 are the locations on the southern side of the river in which bedrock has been reached; it is approximately 600 mm from the present surface. Excavations in the indigenous test pits and historic period test trenches on the northern side of George Street have reached depths of between 1 and 1.5 metres and rock has not been encountered in any. None of the geo-technical cores encountered bedrock up to depths of two metres.

The results confirm the accuracy of the earliest European images of this area from c.1810 that shows a high exposed ridgeline that drops steeply down to the river. The results from the excavations in this area suggest that it might have been a narrow ridge line before it commenced that steep drop; there is sandstone bedrock on the southern side of George Street at a depth of 500 mm [003, 010] but it is not encountered in a core just to the north only a few metres away (core 3).



Plate 26: View of the Green Hills settlement in 1809 by William George Evans showing the steep topography from the ridge line (ML PXD 388 V3 Folio 7).

It is possible that the ridge was broken or cut through by deep breaks or clefts; there was no evidence of bedrock in either of the cores in Bridge Street between the two archaeological test trenches where bedrock is revealed at shallow depths.

This evidence could explain the way in which the earliest settlement was built on the southern side of the river. The most substantial buildings used the exposed bedrock as a firm base for building and their position influenced the pattern of streets or paths. As well, if there were natural passages through rather than over the ridge this might have influenced the development of streets such as Bridge Street. Identifying and understanding the pre-settlement topography could add a layer of information about the way in which the settlement evolved and the decision-making behind that the configuration of the earliest settlement.

The excavation has also demonstrated that the ancient sand body revealed in the indigenous test pits and historic period test trenches on the northern side of George Street does not extend further south on or across that road. There was no evidence of any intact sand deposits in the test trenches excavated in this program or in the cores to at least two metres depth. The physical evidence confirms that this deposit has been formed on the steep sandstone bedrock on the northern side of George Street and have been scoured and added to over millennia of flooding.

With respect to occupation and management in the historic period, however, the more relevant fact raised by the current excavations is that there is little evidence to indicate the presence of much or any naturally occurring sand or soil on the ridge top. This evidence suggests that prior to European settlement it was an exposed rocky peak or plateau; at best there may have been a thin layer of sand or soil. The latter may have been deliberately removed to facilitate the first European use (refer Section 8.2).

All of the excavations revealed distinctive deposits of red clay. In the cores this material was encountered at approximately 400 mm below the surface and extended up to two metres depth without change. The same red clay is found in both trenches 10 and 11 lying immediately above bedrock at an approximate depth of 500 mm. It is possible that the clay in Test Trench 10 **[002]** is naturally occurring although the upper portion or has been disturbed or added to for later construction works. However, the same clay in Test Trench 11 must have been laid over the bedrock much later; it covers the excavation of a service trench and had not been cut through to lay that trench.

The implication of this small sample for interpreting evidence from the site is enormous. This clay has no visible difference from the clay

found in Test Trench 11 or from that described in any of the cores. It is also the same as that found in Test Trench 2 where it was used as fill. Clearly the naturally occurring clay is being sourced for use as fill and levelling material but in terms of these small sample areas identifying whether it is in situ above rock or brought in and compacted above a used surface depends at this time entirely on uncovering a feature below that clearly identifies an historic period of use and, thus, an introduced layer of clay.

This raises the question of whether any of the clay in the cores could be interpreted as an introduced material; for example in core 5 at the easternmost end of the samples in George Street two strata of this material are recognized from 300 to 1000 mm and then from 1000 mm onwards. The difference appears to be in relation to plasticity and texture; these are the same differences exhibited between the clay in Test Trenches 10 and 11. Does this mean that introduced clay has been laid over in situ clay to create a different level for some purpose? It would only be possible to address this issue through a larger area of excavation.

8.2

First European Land Use

There is some evidence exposed in the current excavations to suggest that the geology was put to use to assist the earliest settlement. There is the apparent relationship between the western end of the Commissariat building and the extent of shallow bedrock at the same point. Test Trench 11 revealed that the bedrock had been shaped; there is a deliberate straight line formed by apparently slightly cutting and smoothing the sandstone **[010]**. This feature extends both east and west beyond the boundaries of the trench. The feature is also likely to extend north into the road.

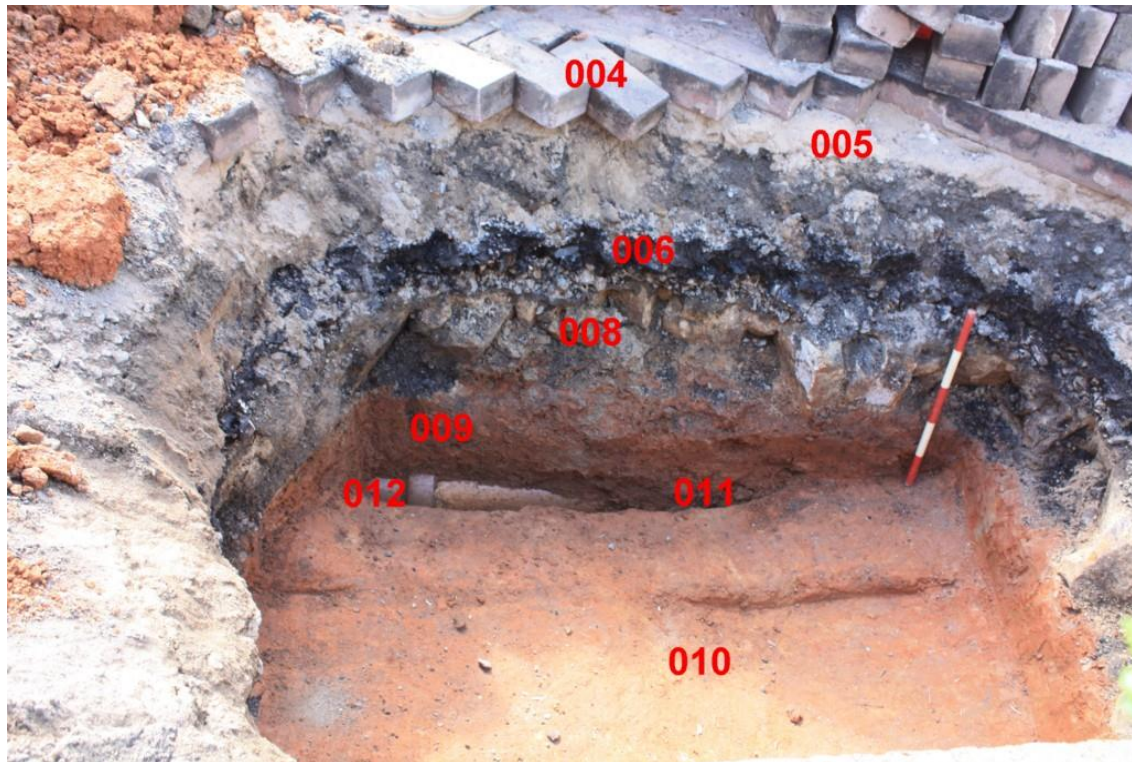


Plate 27: View north showing the shaped sandstone bedrock [010] in Test Trench 11; scale 500 mm.

It is impossible on the basis of the evidence in this small sample to precisely date this work but some general conclusions may be made. It predates the construction of a stone-built feature found in the same trench that is likely to be of later nineteenth century construction (*refer Section 8.4*). This means that the shaped bedrock was worked in the nineteenth century work. It lies within an area that was a road during all of the nineteenth century suggesting that if this rock-shaping was part of a structure or other feature it is likely to date to the very earliest years of the nineteenth century before the width of George Street was formalised. That bedrock was used in this way in the earliest years of settlement to form part of the foundations of buildings or as drains can be demonstrated on several archaeological sites from Sydney.

The sample of evidence is small so the conclusions drawn from it must be treated with caution; more physical evidence is required to make more certain attributions. However, it is possible that this feature represents a European work that utilised exposed bedrock for some form of structural improvement. It could represent a work from the earliest years of settlement, possibly pre-1810 when primary archival evidence demonstrates that there were numerous buildings located in this area for which we have no precise sites. If the bedrock was not exposed then it seems likely deliberate action was taken to remove whatever thin deposits of soil or sand lay here. This is also a

practice than can be demonstrated from nineteenth century archaeological sites in Sydney and Parramatta.

8.3

The Commissariat Stores of 1803

Test Trench 10 provided no positive evidence of the presence or absence of archaeological evidence relevant to the Commissariat stores building of 1803. The section of the footpath where a wall foundation was most likely to lie, if it remains, has been thoroughly disturbed by numerous service trenches and pits. The southern wall lies within an area disturbed by service trenches. The western wall would be within the area of the road and the evidence from cores suggests that all the archaeological profile here might have been removed or disturbed when the road was widened and/or resurfaced (*refer Section 8.6*). There was no evidence of construction or demolition debris in Test Trench 10, which lay close enough to the northern wall alignment to have been impacted by both. There was no evidence of wall trenches in any form.

This trench demonstrated that the impacts from the numerous services, pits, probably the construction of the School of Arts building and the construction of the footpath as well as the changes to Bridge Street have almost certainly removed most, if not all, of the archaeological profile here in the footpath and verges either side. All that was revealed in this trench was a deposit of clay with lenses of sand **[002]**. The clay appears at least in part to have been dug up and redeposited on this site although the sample is very small to make that conclusion in light of the evidence provided by the cores and the comparison with Test Trench 11.

There are several possibilities for explaining its origin. First, the clay could have been brought to the site to form that footpath immediately over bedrock. Secondly it could have been an in situ deposit that was utilised for the footpath but has been disturbed during that construction process. Thirdly, it could encompass elements of both in situ and introduced clay of exactly the same composition. This is a far more likely scenario; it explains the disturbance to the upper part of the matrix and the similarity to the clay found in Test Trench 11. The date and associations of these features are discussed in Section 8.6. Although there is unlikely to be any evidence of additions made to the site for the stores building such as foundation walls, the evidence from Test Trench 11 with respect to what appears to be an early nineteenth century practice of using the underlying bedrock for building works, allows for the possibility that some evidence of this large building could survive as elements of worked sandstone. This is supposition and inference based on a small sample but it is not an unlikely conclusion. The only means of testing this possibility lies

outside the footpath in less disturbed areas, for example the School of Arts site.

8.4 George Street in the Nineteenth Century

8.4.1 Before c.1870

There is very little specific evidence for the development of George or Bridge Streets in the nineteenth century. The archaeological evidence from the current program of investigation suggests that George Street may have been no more than the exposed and possibly shaped ridge-top bedrock in the earliest period of settlement. Certainly the narrow street that existed at the southern end of what is now Thompson Square was widened during Governor Macquarie's regime to match the breadth of his new planned road. There appear to have been further alterations to the configuration in the 1830s or 1840s; the discussion of the archival evidence for these conclusions is contained in the historical analysis made for this project. The configuration of the road is best seen on an 1842 town survey.



Plate 28: Detail of Armstrong's plan of the town in 1842 showing the large open area on the ridge top with the Commissariat building providing a visual curtailment to the end of George Street. The distinct splayed corner at the Bridge Street intersection is also recorded here detail of Peninsula Farm Auction 5 February 1842, plan prepared by Surveyor Armstrong: source nla map f187 on line).

The evidence recovered during the current program suggests that apart from responding to the position of buildings that had existed for many years the roads may have been sited to take advantage of the

original topography and natural contours as well as geology. There was nothing found in any test trench or core that could be certainly attributed to road formation in this period unless the cutting and shaping of bedrock seen in Test Trench 11 was part of a road alignment.

No primary archival evidence has been found to date to describe how the surface of the street was improved over the decades up to the 1870s. If the area of the road commenced as a bare sandstone ridge shaped here and there possibly for buildings no longer present after the square was redeveloped during the Macquarie regime, it had changed by the middle or slightly later years of the nineteenth century. There are two images that provide evidence that at the very least earth had been used to create surfaces. One image shows the land in front of the School of Arts around c. 1870 and a second shows the land around the southern end of Thompson Square into the area of George Street.

Both images show that if this area had been exposed bedrock in the first years of the nineteenth century by the c.1870s the ground had been covered and possibly raised in height. Neither image suggests that there were hard surfaces; both appear to show compressed earth used for both road and pedestrian areas. In fact, there is a slight indication in the Thompson Square view that the road surface of George Street adjoining the Macquarie Arms Hotel was lower and ended in a formed kerb and that the ground beyond it was open and the road was indistinguishable from the area of the square.

None of the trenches excavated for the present program revealed any profile of soil or earth that matches what is shown in these images unless the raised level of the footpath and land around the School of Arts building can be equated with the clay found in trench 10.

The absence of physical evidence infers that major changes were made to these roads later in the nineteenth century or in the twentieth century. The comparison between the archeological and archival evidence suggests that whatever developed profile existed here before that time was removed in this later period.



Plate 29: The School of Arts building in c. 1870; the land behind the picket fence is the area of the present footpath and part of Bridge Street (source ML GPO 1-06260.)



Plate 30: View of the southern end of Thompson Square after 1874 showing the Macquarie Arms Inn and the area of George Street in the foreground (source ML d1-06257)

8.4.2

The 1880s to c. 1900

Archival evidence for roads and infrastructure in this period is limited. Substantial road works appear to have commenced in the 1880s. In 1880 questions were asked in Council concerning funds that had been allocated to repair the roadway in Thompson Square. The Works Committee reported that an additional £5 had been allocated to the project.⁴ In the same month funds were allocated for fencing in Thompson Square and for stone kerbing.⁵ In November 1880 it was reported that an additional £10 be spent on improving the road leading from the Bridge to George Street. A question was asked in Council regarding £8 that had been granted to the repair of the road in the square. The money had been spent “on widening the road in the locality mentioned”.⁶ In 1881 a tender was accepted from W. Wood for gravelling the footpath in Bridge Street.⁷

By 1883 kerb stones were being introduced to the square; questions were asked in Council in August of that year why the stone had been laid down in the square ready to be fixed without Council approval although all noted that Thompson’s Square was a priority for kerbing.⁸ Reaction to the work was mixed particularly as the work took a long time to complete. In 1886 it was reported;

*“the forming of the road on the northern side of Thompson Square is a very good job in its way but there was certainly no necessity for it. On the other side of the Square where all the traffic is and where heavy rates are paid it was not considered good enough to kerb until recently.”*⁹

Earlier, in 1883 a local man complained that it took ten months to get “a bit of tar paving laid in George Street”¹⁰.

The roads in the square were still in a poor state in 1890; more money was voted to attend to “the bad state of road at Thompson Square”.¹¹ Council minutes record the vote of “a sum not exceeding £10” to be used for the repair of the street on the southern side of Thompson Square from George Street to the banks of the river where there was to be clearing.¹² Kerbing and guttering was still being undertaken in the later 1890s in the square.¹³

⁴ AWRH Advertiser 25 September 1880: 2

⁵ AWRH Advertiser 9 October 1880: 2

⁶ *Ibid*

⁷ AHWRH Advertiser 26 March 1881: 3

⁸ Hawkesbury Chronicle 18 August 1883: 2

⁹ Hawkesbury Chronicle 14 August 1886: 2

¹⁰ Hawkesbury Chronicle 4 August 1883: 2

¹¹ Windsor and Richmond Gazette 16 August 1890: 3

¹² Hawkesbury Council Minutes 30 July 1890 Council Records 1889-1902 Hawkesbury Library HAW (28)

¹³ Windsor and Richmond Gazette 14 August 1897: 4

In 1889 it was reported that the water supply for Windsor was proceeding rapidly; In October of that year reticulated pipes had been laid down George Street from Railway Street to the end of Thompson Square.¹⁴ At the same time the footpaths were being asphalted; the path in front of Stearn's premises was being asphalted in January 1889¹⁵ (this building is to the west of the investigation area).

In March 1893 complaints were made concerning the state of the roads and the work of Council to address those issues. It was stated that *"to this day George Street is a disgrace to the town and a reproach to its alderman past and present. George Street should have been paved from Mr Moses' corner to Dight Street at least and the kerbing renewed"*¹⁶. The reference suggests that the street was still unpaved in any way at this time.

The state of the streets provided a means in the early 1890s to combat unemployment caused by the severe recession that gripped the country. It was stated in 1893 that George Street was repaired from Thompson Square to Baker Street; *"the gutter is being taken up and lowered on account of the road not being level. Some fourteen men are at work employment having been found for Windsor's unemployed"*.¹⁷

The reference to reticulated pipes being laid in George Street provides the best evidence for interpreting the physical evidence found in the test trenches. Test Trench 11 revealed the presence of a service pipe **[011]** on the extreme northern side of the trench. The service trench had been cut into the underlying bedrock **[010]** and the pipe **[012]** laid at a shallow depth.

It is possible that this service trench was excavated when some or all of the soil visible in the earlier images was still present. There was a deposit of soil in the base of the trench **[013]** that appeared to be different from the clay above it **[009]** but the area was too small to investigate properly. Even so the shallow depth of the pipe in this trench suggests that the clay above it **[009]** was laid at the same time and was intended to be the capping to these works.

If these associations between archival and archaeological evidence can be accepted this would put a date of approximately 1889 or later (the 1893 road works used for depression era employment) on the introduction of pipes and the new clay deposit recorded in Test Trench 11. This might also date the same or similar clay deposit recorded in Trench 10 **[002]**. The evidence infers that this program of

¹⁴ Windsor Richmond Gazette 5 October 1889; 4

¹⁵ Windsor and Richmond Gazette 26 January 1889; 2

¹⁶ Windsor and Richmond Gazette 11 March 1893

¹⁷ Windsor and Richmond Gazette 4 November 1893; 3

work carried out in the later 1880s and early 1890s was far larger and involved more intervention in the existing fabric of the square than the impression gained from the archival references. Effectively it suggests that apart from the construction of the infrastructure all the older road surfaces or accumulated soil seen in the earlier nineteenth century images were removed at this time.

This raises the question of what was used to surface the roads after that time. There is a stone cobbled feature found above the clay in Test Trench 11 [008]. This was an extremely well constructed feature; there are several similar examples from Sydney and Parramatta that date to the same later nineteenth century period or early years of the twentieth century where this form of construction was used for a road or laneway surface. In this case it is clear that the clay was used as a bedding deposit for this feature and that the two formed one program of improvement at about the same time as the introduction of the service pipes.

The red clay found in Test Trench 2 [**Trench 2: 028**] was used as a means of raising the level of the ground apparently in association with the work required to increase the height of the roads in Thompson Square when the bridge was raised in 1894. It provides a second example of this material used for earth-works. The close period in time between the two programs, c.1889-1893 and 1894 and the similarity of the materials might infer that the use of this naturally occurring local clay was a common and cost effective method employed in the area at that time for large infrastructure works.

The evidence against interpreting this cobbled feature as a road is that other instances of its occurrence, with the single exception of a substantial sandstone block found in core 11 have not been discovered. Core 11 is in the middle of Bridge Street almost in a direct line east from Test Trench 11. It suggests that whatever this feature is it runs in a straight line east-west at this point. It certainly extends north of the location of the test trench and core but appears not to be present in the middle or northern side of George Street.

This absence of evidence allows for several possibilities; that it was never built the full width of the street, that it is not a road surface but a narrow linear feature or that at least half of the surface was removed after it was laid. With respect to the latter this portion of the road also corresponds to the deposits of dark silty fill recorded in the cores and it is possible to interpret the introduction of the fill as a means of building up the road surface where the stone paving had been removed; there is no way to demonstrate or prove this to be the case based on the evidence available.

If it is a linear feature there is no identifiable explanation for it. It is certainly not a building and highly unlikely to have been used as a cap for the services that lie under it. It is also unlikely to have been a gutter. There is a reference in 1877 to a “boulder gutter” being built in Catherine Street¹⁸ however, the location of the feature in Test Trench 11 in relation to the street alignment of the time puts it several metres from the path on George Street. It could have been some form of drainage feature but at this time there is insufficient evidence to make a certain identification of its use.

In conclusion the construction technique suggests that it could have been a road surface. The use of the clay (evidenced in Test Trench 2 as a land-forming medium agent used in the 1890s) and the relationship to the service trench below it in association with primary archival evidence suggests a date of the early 1890s for this work, probably after 1893. The absence of any deposits between the clay and the bedrock, despite nineteenth century images showing built up deposits in this location prior to the 1890s infers that the impact of the work removed any archaeological profile prior to the construction of the road (or gutter or drain). The absence of evidence of this type on the northern side of George Street where there is a different profile of soil could suggest that, if this was a road surface it was largely removed when more substantial program of road works were carried out in George Street.

8.4.3

In the Twentieth Century

It raises the question of how long this possible surface may have remained in use. It certainly does not appear to have been evident in the later 1920s. There is an aerial view of Thompson Square in 1929 and George Street in that image appears to be earth-covered. This could coincide with the deposit of silty soil [007] found in Test Trench 11 lying directly over the stone-built feature.

¹⁸ Sydney Morning Herald 9 June 1877; 3

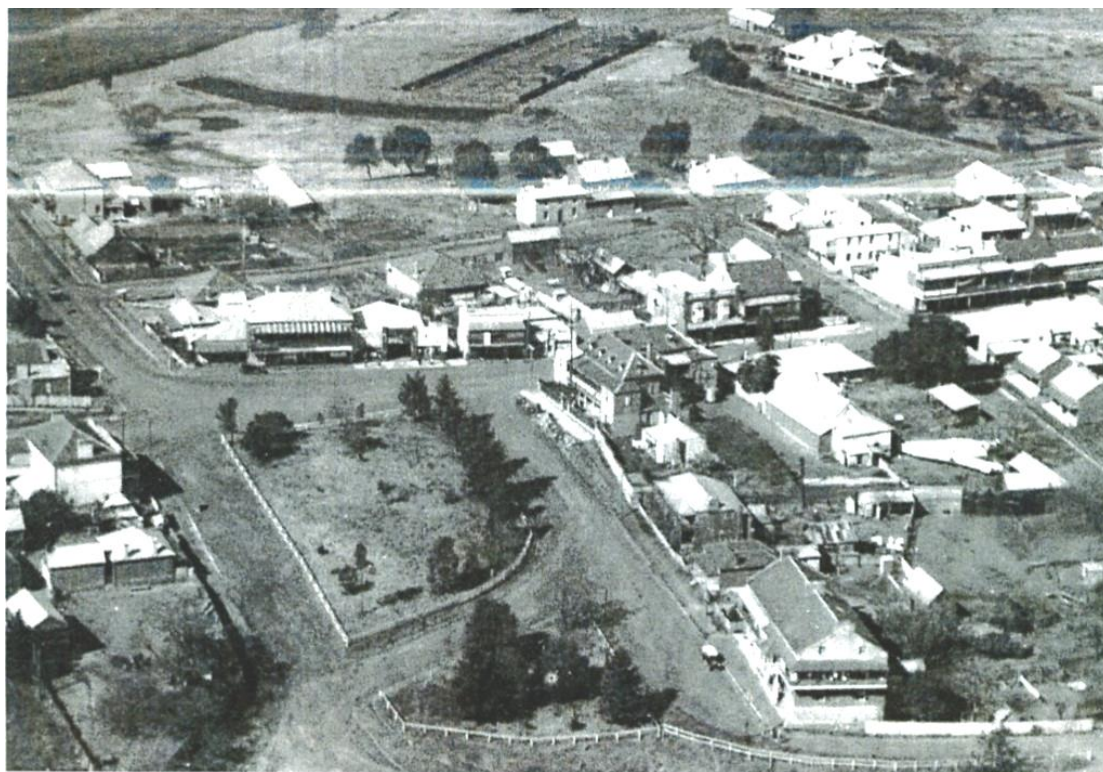


Plate 31: Thompson Square in 1929 showing what appears to be a compacted soil surface along George Street (JHHS 2011 No 2: 21).

Every core reveals at least two or three layers of asphaltic concrete road and up to two were recorded in Test Trench 11 [006]. The earliest of these layers is likely to date from the later 1930s. In 1935 the *Windsor and Richmond Gazette* reported that Windsor Council had decided to approach the Department of Main Roads to commence a program of concreting George Street. The work would involve the removal of water pipes in the centre of the road and relaying them in the sides of the street. It was a decision hailed by the residents; it was noted that the convex surface of the street was at best a handicap and could be a danger to heavily laden vehicles. The request to the Department was to concrete the road from Bridge Street to the picture theatre.¹⁹ The works were carried out in 1938.

The exact scale of that work is unknown but the reference to the convex nature of the centre of the road and the physical evidence of the cores on the northern side of the road might indicate that a substantial part of the work entailed cutting down the road. This could have led to the loss of the stone-built surface or feature here. However, unless more work is undertaken in this area particularly with respect to the northern edge of the stone cobbling it is impossible to be more precise.

¹⁹ *Windsor and Richmond Gazette* 29 November 1935; 10

The cores show that successive layers of asphaltic concrete have been laid, some with bedding and some directly on the surface below to bring the level of George Street to its present height.



Plate 32: View of street works in 1938 looking west down George Street from the Bridge Street intersection (ML GPO 1-32538).

8.5 Footpaths

8.5.1 Bridge Street

There is even less archival evidence for the development of paved footpaths in Windsor. There is an archival reference to the path in front of Stearn's premises (west of the project area) being asphalted in January 1889.²⁰ There are other newspaper references that describe tar paving of footpaths in Windsor.

The land on the eastern side of Bridge Street encompassing Test Trench 10 was originally included within the School of Arts site, demonstrated by the c. 1870 image of the site. The test trench would lie behind the picket fence; Bridge Street has been widened. If the red clay found in Test Trench 10 **[002]** or part of it may be shown to have been used as the clay in Test Trench 11 **[009]** as part of a road works program then it would infer that the formation of this footpath would in its initial stages, have been in the later years of the nineteenth century. If that was the case there is no evidence within

²⁰ Windsor and Richmond Gazette 26 January 1889; 2

the test trench that reveals what surface if any was formed at that time. The upper levels of this deposit have been disturbed, possibly even reduced to accommodate the construction of the present paved path **[001]**.

The 1938 image on the preceding page shows what appears to be a cement paved footpath along the southern side of George Street. It is very similar in appearance to the pavement that presently exists on the eastern side of Bridge Street. This was the slab moved aside at the top of trench 10 **[001]**. The footpath on Bridge Street could date to that time or be a later replacement.



Plate 33: View of the School of Arts in c. 1870 showing the wider property boundary; test trench 10 would lie on the other side of the picket fence within the boundaries of the School (source ML GPO 1-06260.).

8.5.2

George Street

The evidence in Test Trench 12 before it was backfilled and made good does raise some possibilities for a footpath that adjoined George Street on its southern side before the present brick paved pedestrian area and garden was created over part of the former road. The bitumen surface in this trench **[016]** was very thin and unlike any of the deposits recorded in Test Trench 11 or the cores. It is not associated with any of those twentieth century road surfaces. The position of the trench was within the road until the later years of the twentieth century and therefore, the bitumen could represent a tar-paved surface that predated those roads. If so it would have to predate the stone surface (if that is a road) or date from the same period if the stone cobbling **[008]** is a linear feature and not a road. The materials and style and method of construction would suggest

that this is too early a date for the paved surface but it remains a possibility. The relationship to the stone cobbling cannot be determined; there are no common archaeological deposits between this trench and those in Test Trench 11 and the excavation of Test Trench 12 stopped at the paved surface.

The alternative date for this feature in Test Trench 12 is that it is a late twentieth century surface developed after 1978 and before the creation of the pedestrian area as it now exists. The evidence for this is a view along George Street in 1978. This shows at the corner of George and Bridge Streets a grass covered strip that runs from the footpath to George Street encompassing the area of the test trench at its northern end. There was no evidence of this feature in the test trench. That strip of grass was still present in 1981 so if the paved surface revealed in the test strip has replaced this grassed area then it must have done so in the later 1980s. At this time there is insufficient archival and physical evidence to more accurately date this feature.

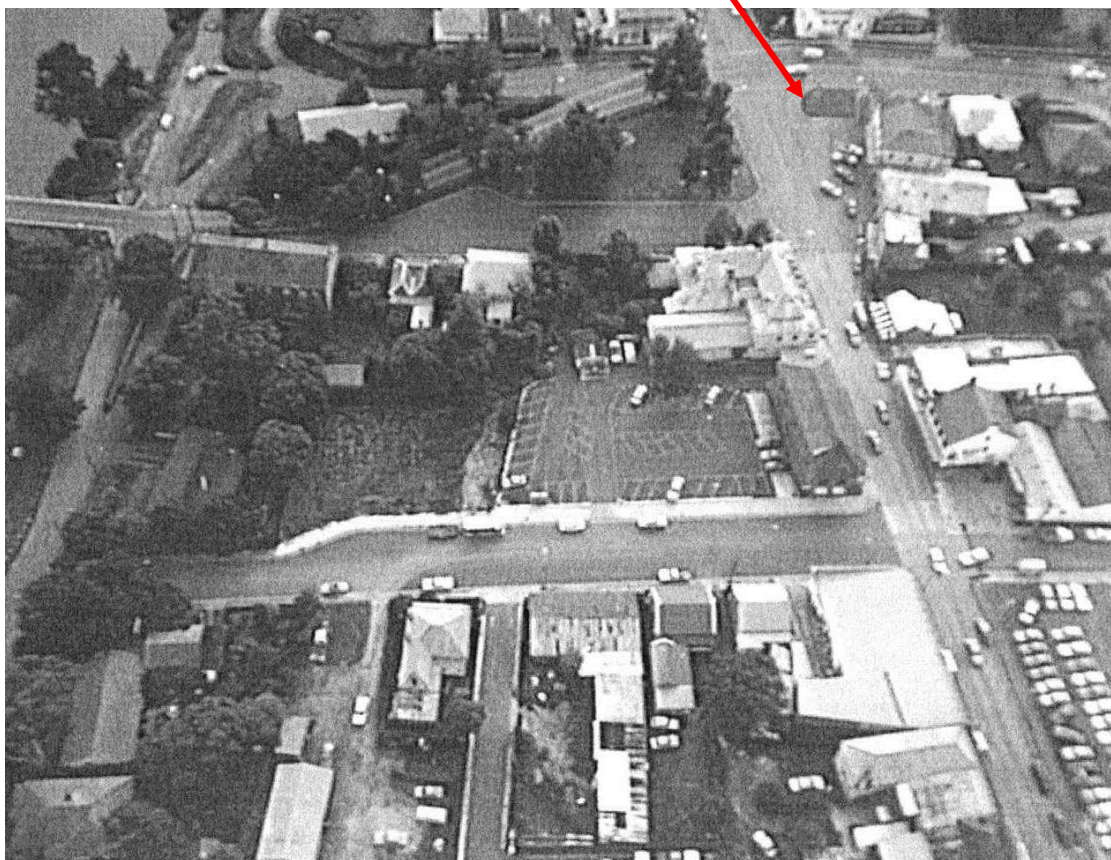


Plate 34: Oblique aerial view of Thompson Square. What appears to be a grassy area in front of the former Hawkesbury Stores in indicated by the red arrow. Source: Hawkesbury Images Local Studies Library Photographic Collection "Aerial view of North Richmond Bridge during floods, March 1978 [sic]. This is clearly an aerial photograph of Windsor with Thompson Square visible at the top of the image.



Plate 35: A view of the former Hawkesbury Stores in 1981; view of the grassy verge in front of the single storey building. Source: Fisher Lucas 1981.

The 400 mm of topsoil at the surface of test trench 12 **[014, 015]** extends beyond the area of the grass strip recorded in the images of 1978 and 1981. It has been introduced as part of the present configuration of this corner created in the last twenty years.

8.6 Bridge Street

The southern portion of Bridge Street has been in existence since the early years of settlement but until 1855 it stopped at the southern side of the George Street intersection. The extension of the road on the northern side of George Street was made in that year to create a direct connection to the wharf. The historical evidence for this event has been presented in the historical analysis prepared for this project.

Evidence of the work that accompanied the creation of this road was revealed during the excavation of Test Trench 2 in Bridge Street in the earlier program of archaeological investigation. It showed that a slicing cut had been made down the hill to form the road and that it has been resurfaced several times although the original macadam surface had been lost through the impact of later improvements.

Archaeological investigation in the road surface of Bridge Street at its southern extension has not been possible but the two cores (cores 1 and 11) provide some information. The southernmost core in the

centre of the road shows the present road surface lying over half a metre of road base and this is laid directly over more than a metre of red clay. There is no evidence at all from this core that any earlier road surfaces have survived the formation of the most recent road surface.

Core 11 is at the junction of Bridge Street and George Street and it reveals the stratigraphy of multiple asphaltic concrete road surfaces (three) lying above the sandstone block that may be evidence of the extension of the stone cobbled feature **[008]** found in Test Trench 11. This lies above red clay.

The difference in survival of older surfaces and features in core 11 and Test Trench 2 to what is revealed in core 11 in Bridge Street strongly suggests that the construction of the present road surface and/or the widening of the street has removed any archaeological evidence that may have been preserved here; this might include evidence of the westernmost extent of the Commissariat building that would lie within the road corridor.

8.7

Conclusions

The conclusions that may be drawn from the evidence recorded in this program of work in conjunction with that from the earlier program of investigation are as follows:

- That the topography recorded in the earliest nineteenth century images of the Green Hills settlement is accurate in its depiction of a high exposed ridge line stepping down steeply to the river; it may have been more extreme than those images suggest with gullies cutting through the ridge line and uneven outcrops of rock;
- That the ancient sand body recorded in test pits on the northern side of the road do not appear to have covered the peak of the ridge or extended further south than the northern side of George Street;
- That this peak or ridge, the later alignment of George Street, may have been exposed bedrock or only thinly covered with sand or soil. It may have been cut through by a gully at the line of present day Bridge Street;
- That this thin soil cover, if it existed, may have been removed in the earliest days of settlement to provide a hard and impervious surface for both pedestrian traffic and construction projects;

- That the exposed bedrock in this location may have been cut and shaped in places to be used in the construction of building foundations, drains or other structural works. If this is the case then evidence of this work could be found in the roads; the work would have been undertaken before the formalisation of those road corridors;
- That there is no clear evidence of the Commissariat building of 1803 and the impact of road works, paving and the introduction of services in the footpath on the eastern side of Bridge Street make it unlikely that much or any remains here. However, if the technique of cutting and shaping bedrock was used in the construction of this building then some evidence of this work could survive at the face or the bedrock. It is unlikely that evidence of the building will be found in the road because of the impact of road widening and the formation of the most recent road surface;
- That by the mid-nineteenth century the alignment of George Street had been altered at least twice and soils had been imported to build up this area possibly higher at the southern end of Thompson Square than the street level immediately adjacent to the Macquarie Arms Hotel; this conclusion is based on archival evidence;
- That these accumulated soils were comprehensively removed in c. 1893 to allow for a major program of infrastructure that entailed laying service pipes in the street and possibly creating a new road surface comprised of a bedding deposit of locally sourced clay topped with a cobbled stone road. If this is not a road then it might be a linear drainage feature. If so a tar paved surface found in Test Trench 12 might be evidence of an associated road surface. The evidence suggests that the latter is more likely to be later twentieth century in origin but there is insufficient physical evidence to make connections between the features in Test Trenches 11 and 12;
- The same locally sourced clay found under the stone cobbling in Test Trench 11 may have been used to create a pedestrian area along Bridge Street adjoining the School of Arts but there is no evidence for how it was finished or paved and the sample is too small to make a positive identification;
- By the 1920s the surface of George Street appears to have comprised silty soil that was laid or accumulated over the stone cobbling;

- Asphaltic concrete footpaths were laid in George Street from 1938 onwards and the physical evidence suggests that the work entailed cutting down the existing road, possibly removing much of the stone cobbling if it was a road surface and any later surfaces and introducing fill along the northern side of the road to help level it for the new concrete surface although this fill could have been introduced for an earlier program of works on the road in the nineteenth century; there is insufficient evidence to date it;
- Three separate resurfacings of this road are shown in the cores along George Street. Test Trench 11 also records layers of asphalt concrete; until the c. 1990s this land was within the street;
- The paved footpath along Bridge Street might date from this same period of the 1930s or it is a later replacement;
- The bitumen paved surface in Test Trench 12 could be a remnant road surface of the later nineteenth century but its form and evidence from archival sources suggests that it could be a very late pavement surface from the 1980s that immediately predated the development of the present alignment and garden at this south-western corner of the George and Bridge Street intersection;
- The 400 mm of topsoil in Test Trench 12 was introduced for the development of this pedestrian area in the c. 1990s;
- The introduction of services in the footpaths has made a substantial impact on the preservation of archaeological evidence.
- The results of this archaeological testing program are consistent with the conclusions of the testing program conducted in April/May 2012. The resource on the ridge has multiple phases of development, and impacts of several programs of work have created a complex profile.

9.0

RESPONSE TO THE RESEARCH DESIGN

The investigation was undertaken with specific objectives to be met; these were the research design questions. The information gained from the present project has been applied to these questions in this section.

Will the depths of excavation required for the traffic signals and trenching impact on archaeological resources?

Yes, the depth of the archaeological profile on the ridge top is shallow, little more than half a metre in places and all the works required for this project extend beyond that depth. This evidence will certainly encompass that of construction programs for earlier road surfaces and pedestrian areas as well as evidence of those finished roads and paths. There is the potential for evidence to be found anywhere within this area of modifications made to the bedrock to facilitate construction in the earliest years of settlement. However, the evidence for this practice is from a very small sample and it needs to be corroborated by more examples of the same practice.

Is it possible to determine the chronological span of information preserved within the project area and can this be related to the principal phases of development defined by the historical analysis?

To a certain degree; if the evidence in Test Trench 11 can be interpreted as a deliberate modification of the bedrock for building purposes it is most likely that this relates to the pre-1810 period of development. The association of archival and archaeological evidence makes a strong case for identifying much of the profile to date from c.1893 and onwards. What occurred in the period between c. 1810 and 1889 can be inferred from archival sources and the absence of physical evidence. It is possible to develop a reasonably consistent and feasible pattern of development for this area from a combination of evidence, lack of evidence and archival sources.

Is it possible to identify specific processes or features that survive within this profile; for example, road surfaces of a particular period, the 1803 stores building?

Yes, for infrastructure however, the excavation did not provide any evidence for the presence of the Commissariat Store of 1803. This absence is likely to be a product of the impact of later nineteenth century and twentieth century works undertaken to develop footpaths and widen Bridge Street but there is still a possibility of intact evidence outside these roads and paths and some changes to the

bedrock that might provide clues to its location but this requires further investigation.

Is it possible to determine the likely impact of twentieth century and later road works, footpath development and the installation of services over the entire project area (of this investigation)?

The largest impact on the nineteenth century profile occurred in the later years of the nineteenth century when roads and services were substantially improved; in doing so it appears that the entire developed profile for the years preceding this work was removed from the ground. Twentieth century works appear also to have had a substantial impact on developed profiles on the northern side of George Street and in Bridge Street. Despite this impact there are features and evidence of land-forming that survive from the later nineteenth century.

It is impossible to determine the impact of construction for the paved area and garden at the south-western corner of the George and Bridge Street intersections in the last approximately twenty years although the evidence from Test Trench 11 suggests that it has not been great.

Is it possible to determine a level of cultural significance for the features and/or profile and its relationship to Thompson Square?

Any features that can be positively attributed to the earliest settlement of Green Hills and of the Macquarie period town would be of state significance. At this time the only possible feature exposed by the present work is the evidence of modifications to the bedrock; this would require additional work to make a positive attribution to this phase of development.

Archaeological evidence of later nineteenth and early twentieth century infrastructure, the creation of roads and footpaths would be of local significance for what it can document about the growth of the town.

The paved area and garden created at the south-western corner of the intersection in approximately the last thirty year period would have at best local significance but it is a tenuous evaluation.

What are the likely impacts of the specific works proposed for this project area on the archaeological resource and its significance?

On the basis of the available evidence the principal impact will be through the fragmentation of large units such as road surfaces and bedding. It is unlikely to completely remove all evidence because these are large areas of work that probably extend beyond the areas of impact.

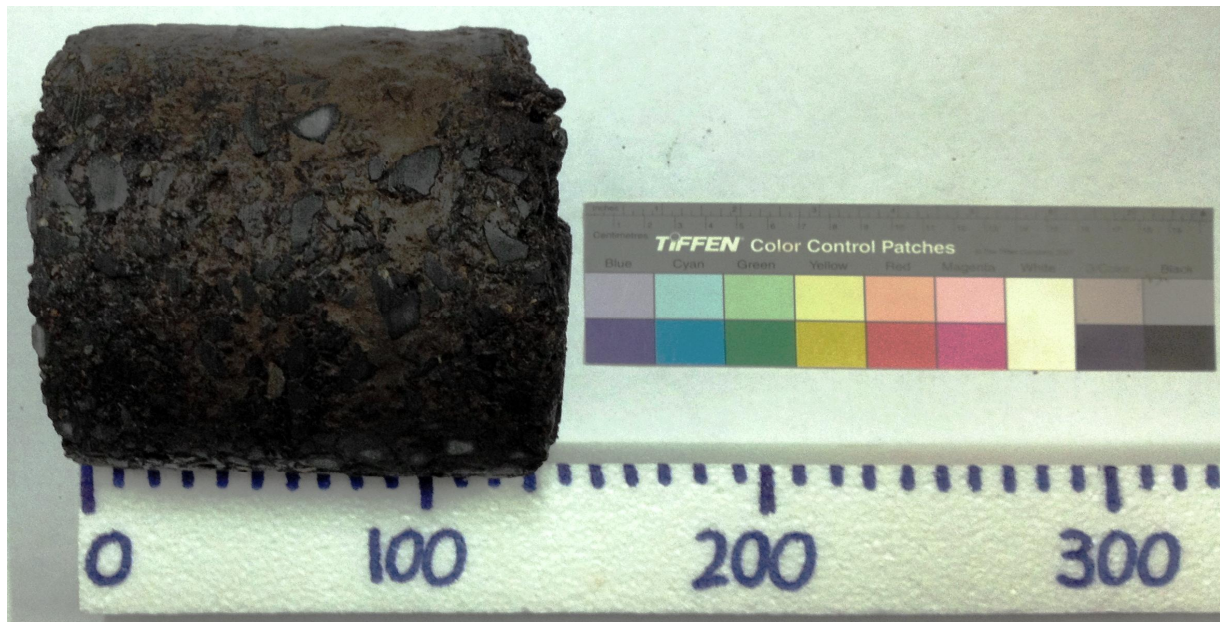
More difficult to assess is the potential for impacting modifications that may have been made to the bedrock to facilitate early buildings works. In the first instance this is a practice that is yet to be positively confirmed in this location; the test result provides an indication but other examples would have to be found to make this a reliable identification. Further, because of the random and largely undocumented location of many of the early structures it is impossible to determine if the proposed works will impact any improvement of this type until it is uncovered.


Appendix 1: Pavement Core Sample Report

| | | |
|--|-----------------------|-----------------------------------|
| Contractor: Terratest Pty. Ltd. (Tim Tucker) | Core Method: Wet | Position: Bridge Street - NB lane |
| Date: 18.02.2013 | Core Diameter: 150 mm | Location: Southern Approach |
| Equipment: Diatube | Logged By: DA | Checked By: SRR |

| Depth (mm) | | Description |
|------------|------|--|
| From | To | |
| 0 | 130 | Asphaltic Concrete: Aggregate up to 20mm, poor condition, occasional small to medium void |
| 130 | | Pavement core terminated at 130mm, continued as borehole |
| 130 | 600 | Road-base: Gravel, grey-brown, fine to coarse sub-angular to sub-rounded, some fine to medium grained sand, trace silt, moist, fill. |
| 600 | 2000 | Sub-grade: Silty Clay, red-brown, medium plasticity, some fine grained sand, moist, very stiff |
| 2000 | | Borehole terminated at 2000mm, target depth |

Photo:

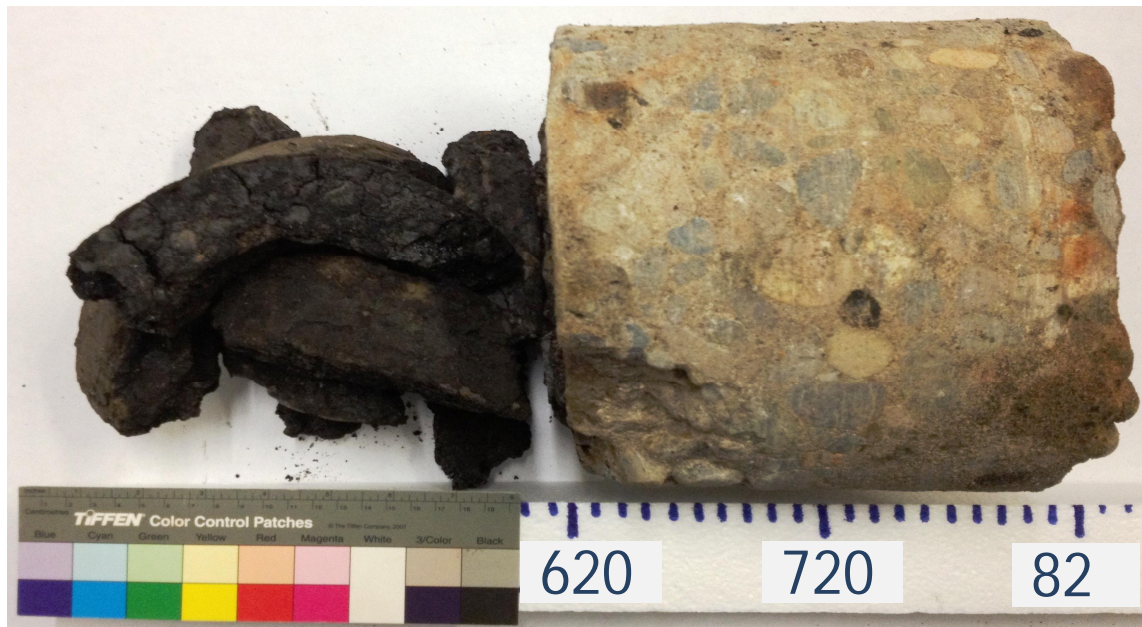



| | | | |
|---|------------|---|--------------|
|  Geotechnics | Client: | Roads and Maritime Services | |
| | Project: | Windsor Bridge Replacement Detail Design | |
| | Title: | Pavement Core Log Report | |
| | Project No | NB98005 | Location ID: |

| | | |
|--|-----------------------|----------------------------------|
| Contractor: Terratest Pty. Ltd. (Tim Tucker) | Core Method: Wet | Position: Bridge St - Roundabout |
| Date: 18.02.2013 | Core Diameter: 225 mm | Location: Southern Approach |
| Equipment: Diatube | Logged By: DA | Checked By: SRR |

| Depth (mm) | | Description |
|------------|------|--|
| From | To | |
| 0 | 80 | Concrete/brick pavers |
| 80 | 200 | Bedding: Gravelly Sand, yellow-brown, fine to medium grained sand, fine to medium sub-angular gravel, dry, fill, loose |
| 200 | 620 | Asphaltic Concrete: Aggregate 5 - 10mm, poor condition, small voids, asphalt deteriorated on coring |
| 620 | 800 | Lean Mix Concrete, aggregate up to 40mm |
| 800 | | Pavement core terminated at 800mm, continued as borehole |
| 800 | 2000 | Sub-grade: Silty Clay, red-brown, medium plasticity, some fine grained sand, moist, very stiff |
| 2000 | | Borehole terminated at 2000mm, target depth |

Photo:

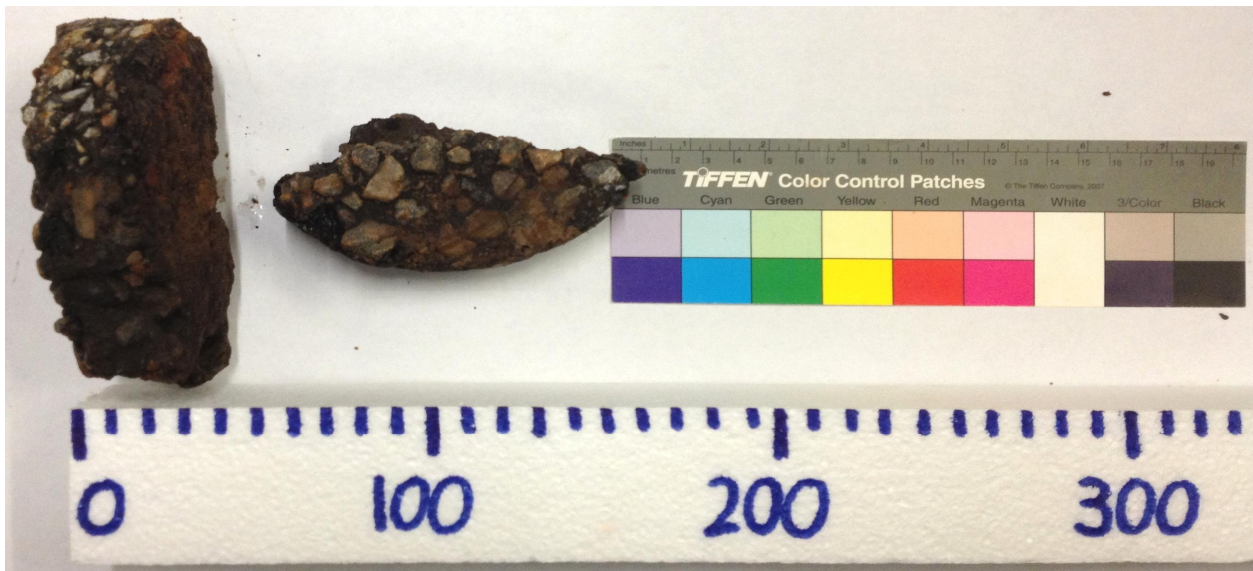



| | | |
|---|------------|---|
|  Geotechnics | Client: | Roads and Maritime Services |
| | Project: | Windsor Bridge Replacement Detail Design |
| | Title: | Pavement Core Log Report |
| | Project No | NB98005 |

| | | |
|--|-----------------------|-----------------------------------|
| Contractor: Terratest Pty. Ltd. (Tim Tucker) | Core Method: Wet | Position: George Street - WB lane |
| Date: 18.02.2013 | Core Diameter: 150 mm | Location: Southern Approach |
| Equipment: Diatube | Logged By: DA | Checked By: SRR |

| Depth (mm) | | Description |
|------------|------|--|
| From | To | |
| 0 | 10 | Asphaltic Concrete: Aggregate 5 - 10mm, fair condition, few small voids |
| 10 | 35 | Asphaltic Concrete: Aggregate 5 - 15mm, poor condition, small to medium voids |
| 35 | | Pavement core terminated at 35mm, continued as borehole |
| 35 | 150 | Road-base: Gravel, grey/brown, fine to coarse sub-angular to sub-rounded, some fine to medium grained sand, dry to moist, fill. |
| 150 | 300 | Sub-grade/fill: Sandy Silt, dark brown, low plasticity, fine grained sand, trace clay, trace fine sub-angular gravel, dry to moist, fill |
| 300 | 1500 | Sub-grade: Silty Clay, red-brown, medium plasticity, some fine grained sand, moist, very stiff. |
| 1500 | | Borehole terminated at 1500mm, target depth |

Photo:

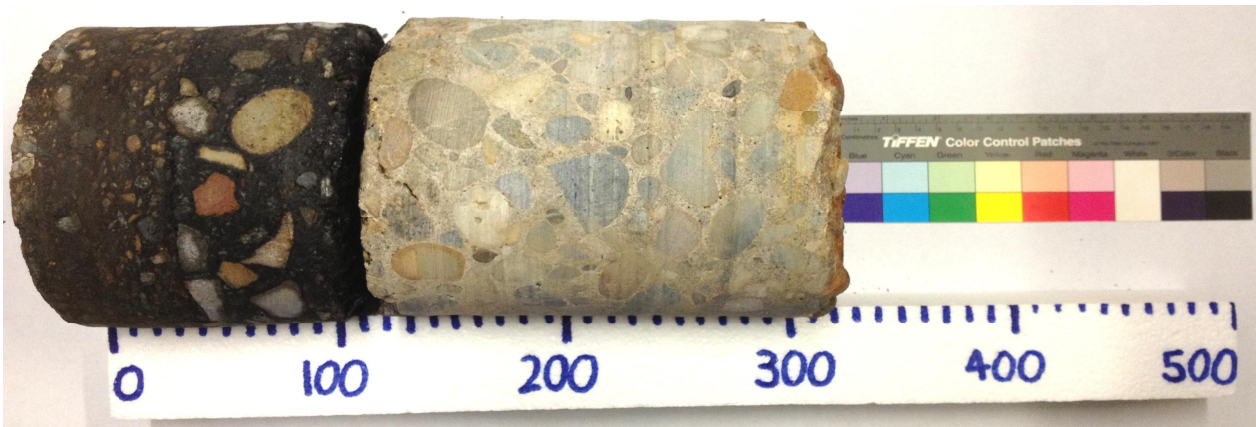



| | | |
|---|------------|---|
|  Geotechnics | Client: | Roads and Maritime Services |
| | Project: | Windsor Bridge Replacement Detail Design |
| | Title: | Pavement Core Log Report |
| | Project No | NB98005 |

| | | |
|--|-----------------------|-----------------------------------|
| Contractor: Terratest Pty. Ltd. (Tim Tucker) | Core Method: Wet | Position: George Street - EB lane |
| Date: 18.02.2013 | Core Diameter: 150 mm | Location: Southern Approach |
| Equipment: Diatube | Logged By: DA | Checked By: SRR |

| Depth (mm) | | Description |
|------------|------|---|
| From | To | |
| 0 | 60 | Asphaltic Concrete: Aggregate 5 - 10mm, fair condition |
| 60 | 120 | Asphaltic Concrete: Aggregate up to 35mm, fair condition, few small voids |
| 120 | 310 | Concrete, aggregate up to 40mm |
| 310 | | Pavement core terminated at 310mm, continued as borehole |
| 310 | 400 | Sub-grade/fill: Sandy Silt, dark brown, low plasticity, fine grained sand, trace clay, dry to moist, fill |
| 400 | 2000 | Sub-grade: Silty Clay, red-brown, medium plasticity, some fine grained sand, moist, very stiff |
| 2000 | | Borehole terminated at 2000mm, target depth |
| | | |

Photo:

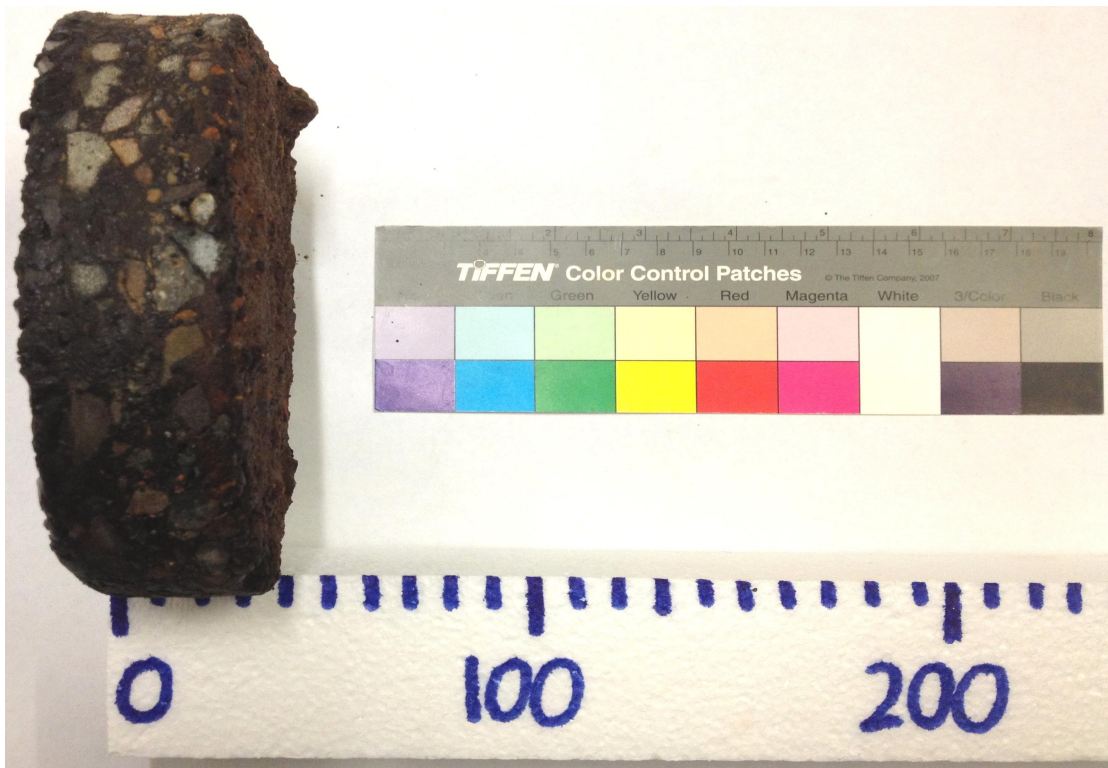



| | | |
|---|--|--------------------------|
|  | Client: Roads and Maritime Services | |
| | Project: Windsor Bridge Replacement Detail Design | |
| | Title: Pavement Core Log Report | |
| | Project No: NB98005 | Location ID: PC04 |

| | | |
|--|-----------------------|------------------------------|
| Contractor: Terratest Pty. Ltd. (Tim Tucker) | Core Method: Wet | Position: George St, EB lane |
| Date: 18.02.2013 | Core Diameter: 150 mm | Location: Southern Approach |
| Equipment: Diatube | Logged By: DA | Checked By: SRR |

| Depth (mm) | | Description |
|------------|------|--|
| From | To | |
| 0 | 10 | Asphaltic Concrete: Aggregate 5 - 10mm, fair condition, few small voids |
| 10 | 35 | Asphaltic Concrete: Aggregate 5 - 15mm, fair condition, few small voids |
| 35 | | Pavement core terminated at 35mm, continued as borehole |
| 35 | 300 | Road-base: Sandy Silt, brown/pale brown, trace clay, fine grained sand, trace fine sub-angular to sub-rounded gravel, dry to moist, fill |
| 300 | 1000 | Sub-grade: Silty Sand, red-brown, trace clay, dry to moist, fine to medium grained sand, dense |
| 1000 | 1500 | Sub-grade: Silty Clay, red-brown, medium plasticity, some fine grained sand, moist, hard |
| 1500 | | Borehole terminated at 2000mm, target depth |

Photo:




| | | |
|---|--|--------------------------|
|  | Client: Roads and Maritime Services | |
| | Project: Windsor Bridge Replacement Detail Design | |
| | Title: Pavement Core Log Report | |
| | Project No NB98005 | Location ID: PC05 |

| | | |
|--|-----------------------|-----------------------------------|
| Contractor: Terratest Pty. Ltd. (Tim Tucker) | Core Method: Wet | Position: Wilberforce Rd, SB lane |
| Date: 19.02.2013 | Core Diameter: 300 mm | Location: Northern Approach |
| Equipment: Diatube | Logged By: DA | Checked By: SRR |

| Depth (mm) | | Description |
|------------|------|---|
| From | To | |
| 0 | 80 | Asphaltic Concrete:: Aggregate 5 - 10mm, some aggregate up to 20mm, fair condition, few small voids |
| 80 | | Pavement core terminated at 80mm, continued as borehole |
| 80 | 500 | Road-base: Gravelly Sand, brown, fine to medium grained, fine to medium sub-angular to sub-rounded gravel, trace silt, dry to moist, fill |
| 500 | 2000 | Sub-grade: Clayey Silt, dark brown, low plasticity, moist, firm, alluvium |
| 2000 | | Borehole terminated at 2000mm, target depth |

Photo:

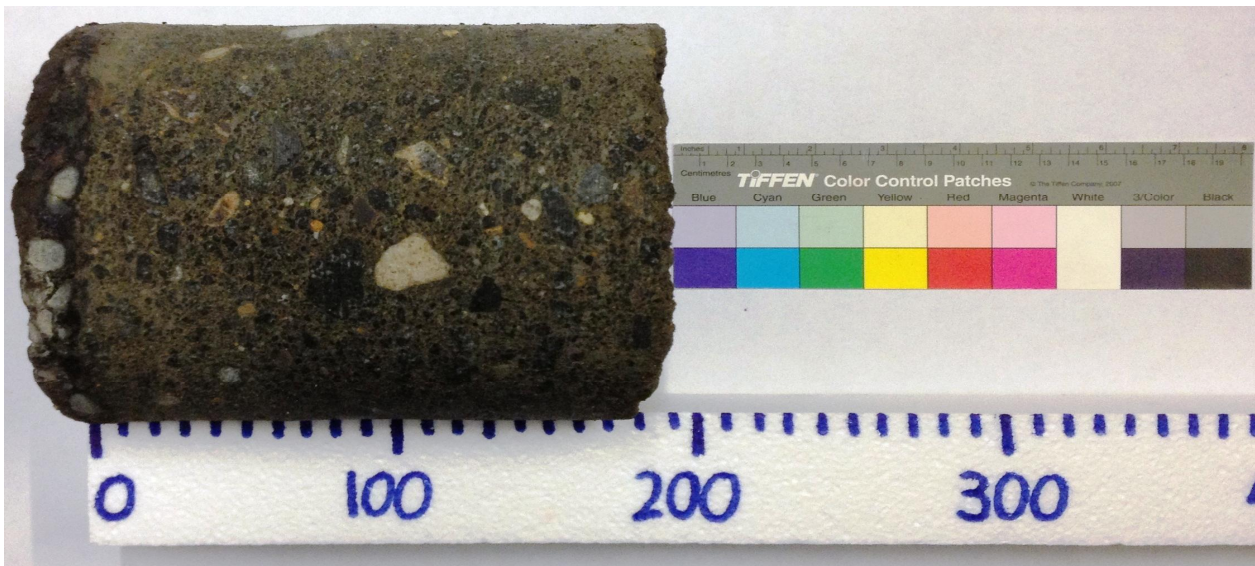



| | | |
|---|------------|---|
|  Geotechnics | Client: | Roads and Maritime Services |
| | Project: | Windsor Bridge Replacement Detail Design |
| | Title: | Pavement Core Log Report |
| | Project No | NB98005 |

| | | |
|--|-----------------------|--------------------------------------|
| Contractor: Terratest Pty. Ltd. (Tim Tucker) | Core Method: Wet | Position: Freemans Reach Rd, SB lane |
| Date: 19.02.2013 | Core Diameter: 150 mm | Location: Northern Approach |
| Equipment: Diatube | Logged By: DA | Checked By: SRR |

| Depth (mm) | | Description |
|------------|------|---|
| From | To | |
| 0 | 15 | Asphaltic Concrete:: Aggregate 5 - 15mm, fair condition, few small voids |
| 15 | 170 | Asphaltic Concrete:: Aggregate up to 25mm, possible Lean Mix Concrete (LMC) |
| 170 | | Pavement core terminated at 170mm, continued as borehole |
| 170 | 500 | Road-base: Gravelly Sand, grey-brown, fine to medium grained sand, fine to medium sub-angular to sub-rounded gravel, trace clay, trace silt, dry to moist, fill |
| 500 | 700 | (Stabilised Layer) Sand, pale grey-pale brown, fine to medium grained, cement stabilised (cement odour), dry to moist, fill |
| 700 | 1500 | Sub-grade: Clayey Silt, dark brown, low plasticity, moist, firm, alluvium |
| 1500 | | Borehole terminated at 2000mm, target depth |

Photo:

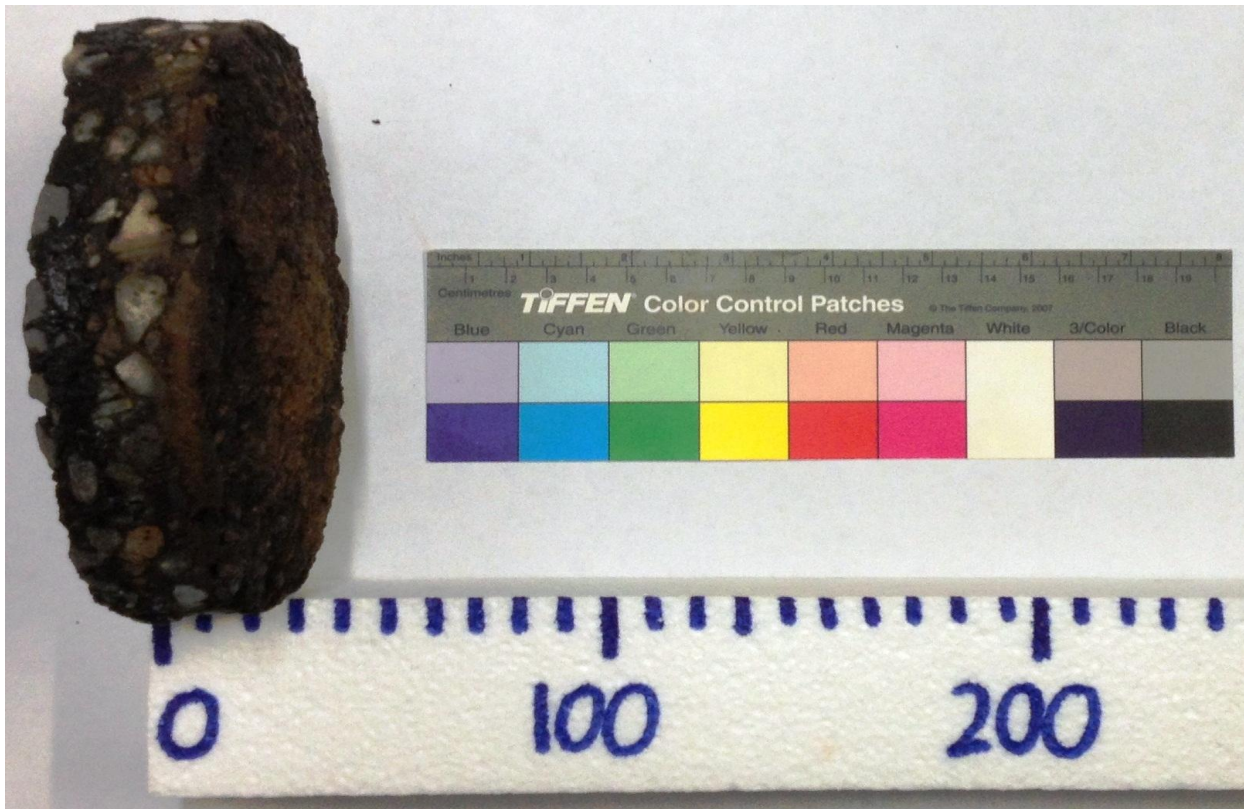



| | | |
|---|--|--------------------------|
|  | Client: Roads and Maritime Services | |
| | Project: Windsor Bridge Replacement Detail Design | |
| | Title: Pavement Core Log Report | |
| | Project No: NB98005 | Location ID: PC08 |

| | | |
|--|-----------------------|-------------------------------------|
| Contractor: Terratest Pty. Ltd. (Tim Tucker) | Core Method: Wet | Position: Wilberforce Road, SB lane |
| Date: 18.02.2013 | Core Diameter: 150 mm | Location: Northern Approach |
| Equipment: Diatube | Logged By: DA | Checked By: SRR |

| Depth (mm) | | Description |
|------------|------|--|
| From | To | |
| 0 | 10 | Asphaltic Concrete: Aggregate 15mm, fair condition, few small voids |
| 10 | 35 | Asphaltic Concrete: Aggregate 5 - 15mm, fair condition, few small voids |
| 35 | | Pavement core terminated at 35mm, continued as borehole |
| 35 | 350 | Road-base: Gravelly Sand, brown, fine to medium grained sand, fine to medium sub-angular to sub-rounded gravel, trace silt, dry to moist, fill |
| 350 | 600 | Sub-base/select: Silty Sand, dark grey-brown, fine to medium grained sand, some fine sub-angular gravel, dry to moist, fill |
| 600 | 1500 | Sub-grade: Clayey Silt, dark brown, low plasticity, moist, firm, alluvium |
| 1500 | | Borehole terminated at 1500mm, target depth |

Photo:




| | | |
|---|------------|---|
|  Geotechnics | Client: | Roads and Maritime Services |
| | Project: | Windsor Bridge Replacement Detail Design |
| | Title: | Pavement Core Log Report |
| | Project No | NB98005 |

| | | |
|--|-----------------------|-------------------------------------|
| Contractor: Terratest Pty. Ltd. (Tim Tucker) | Core Method: Wet | Position: Wilberforce Road, SB lane |
| Date: 18.02.2013 | Core Diameter: 150 mm | Location: Northern Approach |
| Equipment: Diatube | Logged By: DA | Checked By: SRR |

| Depth (mm) | | Description |
|------------|------|--|
| From | To | |
| 0 | 10 | Asphaltic Concrete: Aggregate 5 - 10mm, fair condition, few small voids |
| 10 | 35 | Asphaltic Concrete: Aggregate 5 - 15mm, fair condition, few small voids |
| 35 | | Pavement core terminated at 35mm, continued as borehole |
| 35 | 350 | Road-base: Gravelly Sand, brown, fine to medium grained sand, fine to medium sub-angular to sub-rounded gravel, trace silt, dry to moist, fill |
| 350 | 800 | Sub-base/select: Sand, brown-grey, fine to medium grained, some silt, trace fine sub-angular to sub-rounded gravel, dry to moist, fill |
| 800 | 1500 | Sub-grade: Clayey Silt, dark brown, low plasticity, moist, firm, alluvium |
| 1500 | | Borehole terminated at 1500mm, target depth |

Photo:

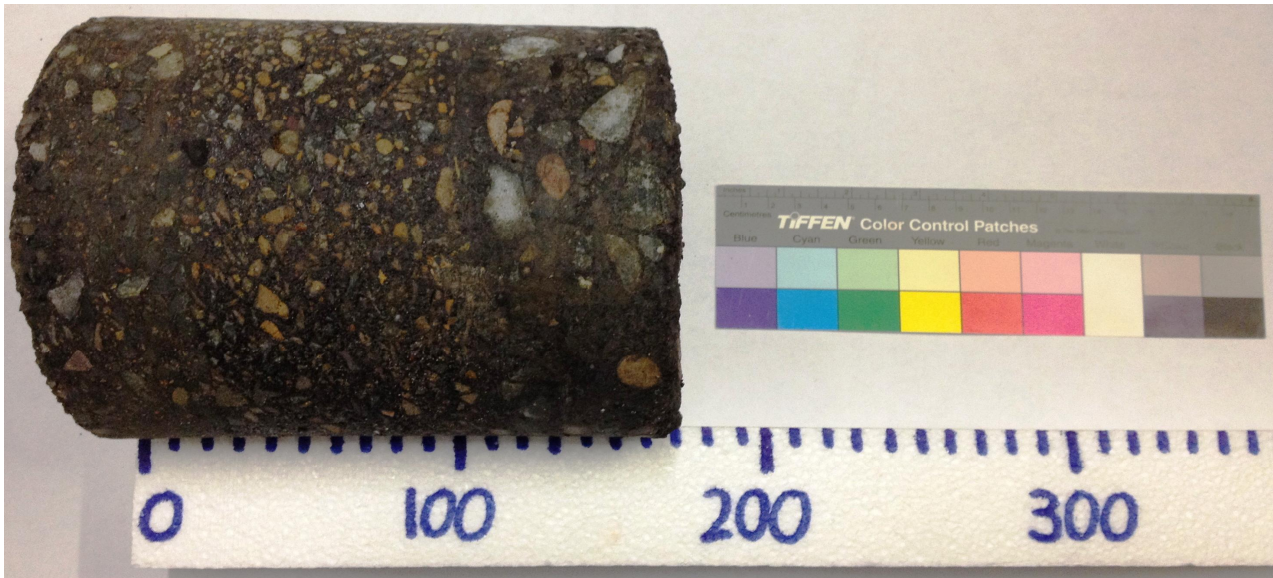



| | | |
|---|--|---------------------------|
|  | Client: Roads and Maritime Services | |
| | Project: Windsor Bridge Replacement Detail Design | |
| | Title: Pavement Core Log Report | |
| | Project No: NB98005 | Location ID: PC010 |

| | | |
|--|-----------------------|-----------------------------------|
| Contractor: Terratest Pty. Ltd. (Tim Tucker) | Core Method: Wet | Position: George Street - WB lane |
| Date: 18.02.2013 | Core Diameter: 150 mm | Location: Southern Approach |
| Equipment: Diatube | Logged By: DA | Checked By: SRR |

| Depth (mm) | | Description |
|------------|------|--|
| From | To | |
| 0 | 45 | Asphaltic Concrete: Aggregate 10mm, fair condition, occasional small void |
| 45 | 120 | Asphaltic Concrete: Aggregate 5 - 10mm, fair condition, occasional small void |
| 120 | 170 | Asphaltic Concrete: Aggregate up to 25mm, fair condition, few small voids |
| 170 | | Pavement core terminated at 170mm, continued as borehole |
| 170 | 400 | Sandstone block: grey-brown, fine to medium grained, ground down to fragments, hard penetration |
| 400 | 2000 | Silty clay, red-brown, medium plasticity, some fine grained sand, moist, hard |
| 2000 | | Borehole terminated at 1500mm, target depth |

Photo:

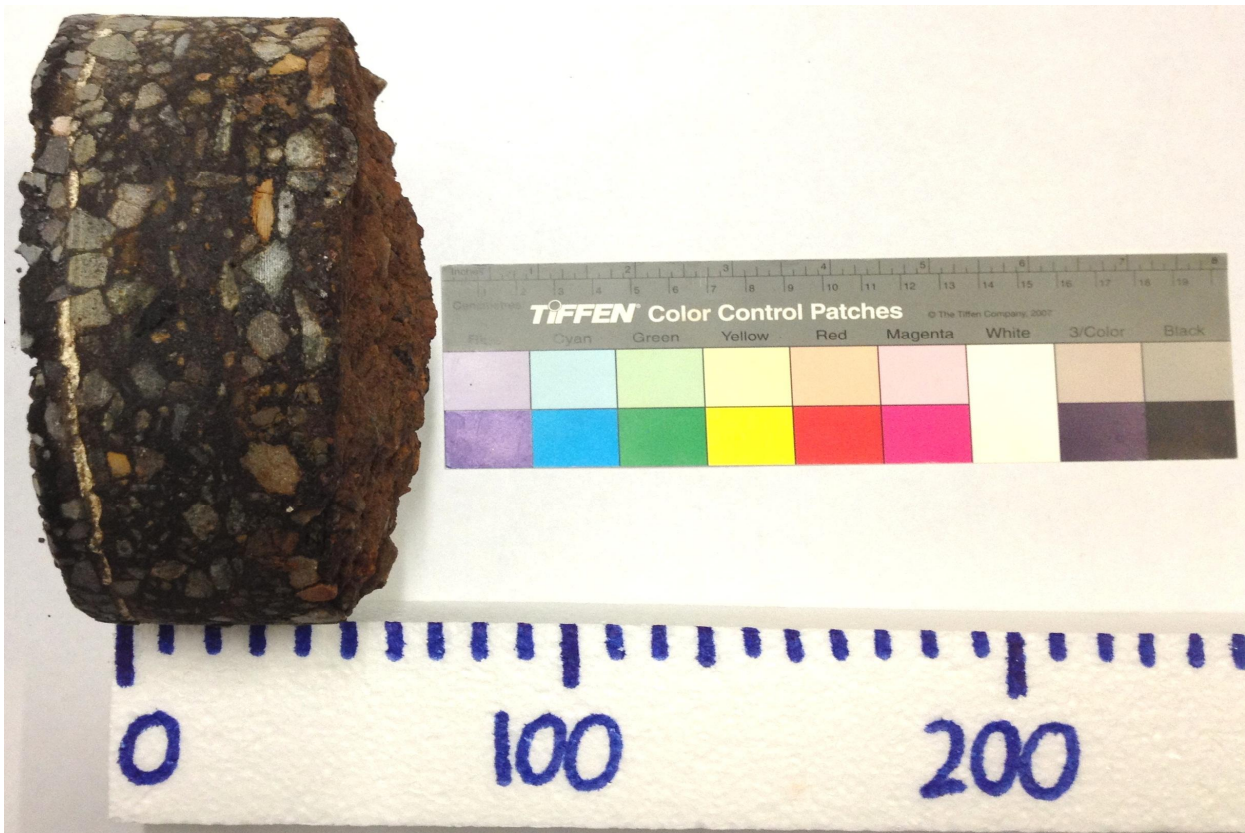



| | | | |
|---|------------|---|--------------|
|  | Client: | Roads and Maritime Services | |
| | Project: | Windsor Bridge Replacement Detail Design | |
| | Title: | Pavement Core Log Report | |
| | Project No | NB98005 | Location ID: |

| | | |
|--|-----------------------|-----------------------------------|
| Contractor: Terratest Pty. Ltd. (Tim Tucker) | Core Method: Wet | Position: George Street - WB lane |
| Date: 18.02.2013 | Core Diameter: 150 mm | Location: Southern Approach |
| Equipment: Diatube | Logged By: DA | Checked By: SRR |

| Depth (mm) | | Description |
|------------|------|--|
| From | To | |
| 0 | 10 | Asphaltic Concrete: Aggregate 5 - 10mm, fair condition, few small voids |
| 10 | 55 | Asphaltic Concrete: Aggregate 5 - 15mm, fair condition, occasional small void |
| 55 | | Pavement core terminated at 55mm, continued as borehole |
| 55 | 300 | Road-base: Sandy Silt, brown/pale brown, fine grained sand, trace fine sub-angular to sub-rounded gravel, dry to moist, fill |
| 300 | 900 | Sub-grade: Silty Sand, red-brown, fine to medium grained, trace clay, dry to moist, dense |
| 900 | 1500 | Sub-grade: Silty Clay, red-brown, medium plasticity, some fine grained sand, moist, hard |
| 1500 | | Borehole terminated at 1500mm, target depth |

Photo:



| | | |
|---|--|--------------------------|
|  | Client: Roads and Maritime Services | |
| | Project: Windsor Bridge Replacement Detail Design | |
| | Title: Pavement Core Log Report | |
| | Project No: NB98005 | Location ID: PC12 |

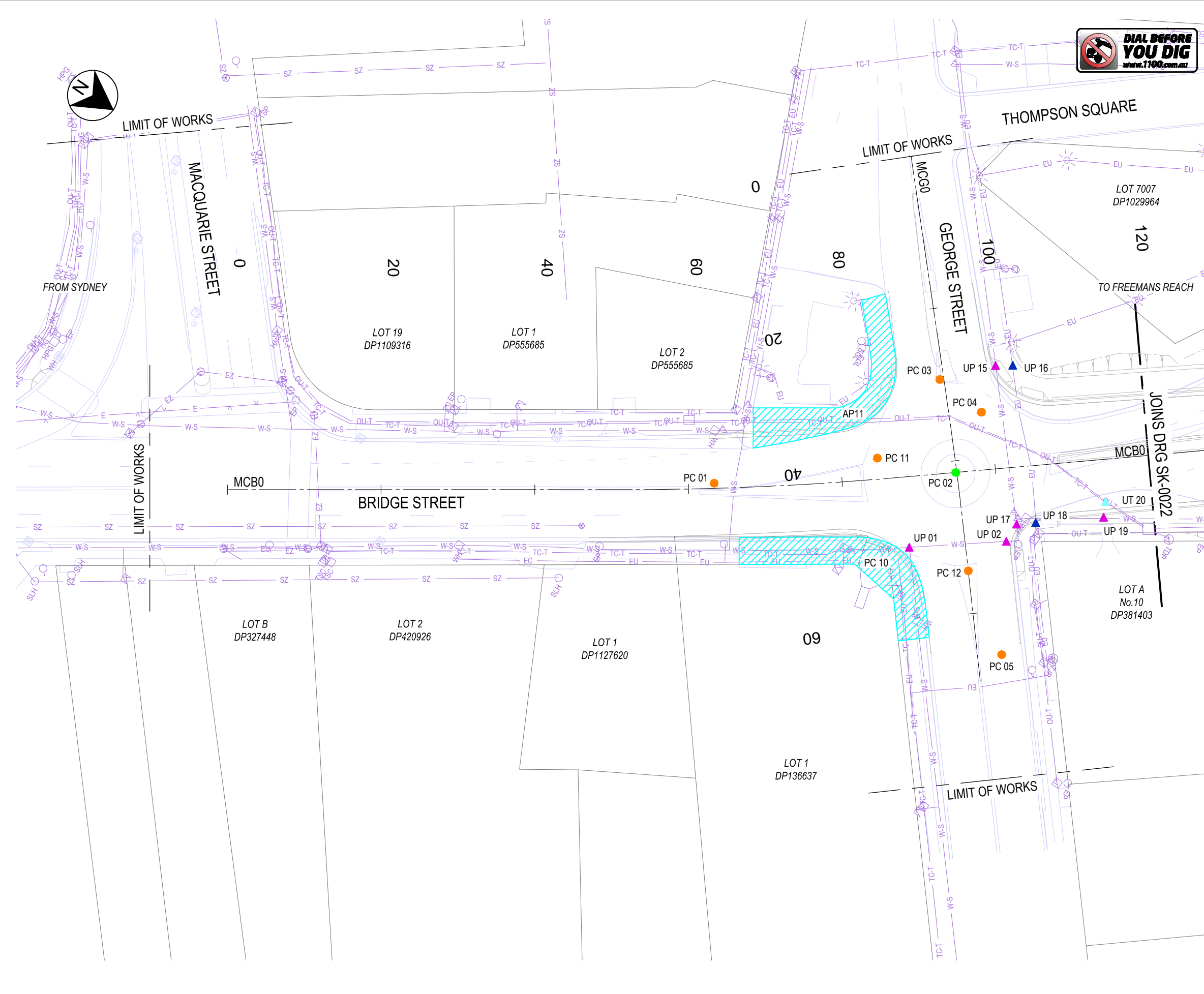


LEGEND

- FOR REFERENCE**
- EXISTING PROPERTY BOUNDARY
 - PROPOSED PROJECT BOUNDARY
 - PROPOSED EASEMENT BOUNDARY
 - RETAINING WALL
- EXISTING UTILITIES TO BE RETAINED**
- EU ELECTRICAL CONDUIT - UNDERGROUND
 - S SEWER MAIN
 - SR SEWER RISING MAIN
 - SZ SEWER MAIN - DIGITISED
 - T TELSTRA TELEPHONE LINE
 - TC-T TELSTRA TELEPHONE CONDUIT
 - OU-T TELSTRA OPTICAL FIBRE - UNDERGROUND
 - W-S WATER MAIN - SYDNEY WATER
 - WH WATER HOUSE CONNECTION
 - Light Pole
 - Electrical Light Pole
 - EP / EGL ELECTRICAL POLE / ELECTRICAL GARDEN LIGHT
 - Electrical Junction Box
 - Single Concrete Pit
 - Twin Concrete Pit
 - TDP TELEPHONE DISTRIBUTION PILLAR
 - Pole
 - Sump
 - Sewer Manhole Cover
 - Hydrant
 - Stop Valve
 - Water Meter
 - Water Air Valve
- UTILITIES INVESTIGATION LOCATION**
- Water Main
 - Sewer Main
 - Telstra Main
 - Electrical Cables
 - Dig Slot for Services
- PAVEMENT TESTING LOCATION**
- Ø100mm PAVEMENT CORE FOR ASPHALT THICKNESS, TYPE & THICKNESS OF BASE, TYPE OF SUBGRADE (8 OF)
 - Ø150mm PAVEMENT CORE AS ABOVE PLUS CBR OF SUBGRADE (2 OF)
- GEOTECHNICAL INVESTIGATION LOCATION**
- OVERWATER SEDIMENT SAMPLING FOR A.S.S TESTING AND WASTE CLASSIFICATION
 - BOREHOLES FOR WATER QUALITY BASIN SUB STRATA & SCOUR PROTECTION DESIGN
- HERITAGE SITES**
- ARCHEOLOGICAL DIGS

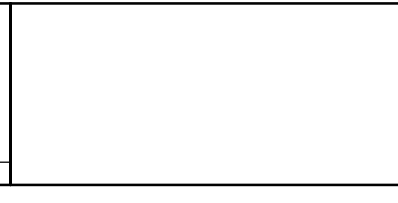
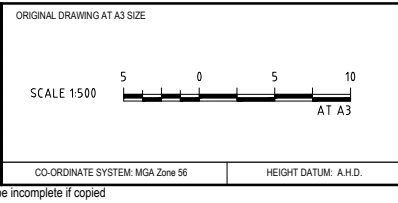
NOTES

- ALL ABOVE GROUND SERVICES HAVE BEEN OMITTED FOR CLARITY
- PRIOR TO COMMENCING ANY POTHOLING WORKS, LOCATION OF IDENTIFIED SERVICES TO BE FURTHER CONFIRMED BY LOCATORS



DATE: 8/02/2013 12:57:39 PM LOGIN NAME: GOMEZ, CLEO (SKM)
 LOCATION: I:\NBIF\Projects\NB98005\Deliverables\Drawings\Civil\Sketches\NB98005-SK-0021-0028.dwg

| REV | DATE | DESCRIPTION | DRAWN | REVIEWED | APPROVAL |
|-----|----------|------------------------|-------|----------|----------|
| D | 08.02.13 | ISSUED FOR INFORMATION | CG | BDP | BDP |
| C | 30.01.13 | ISSUED FOR INFORMATION | CG | BDP | BDP |
| B | 24.01.13 | ISSUED FOR INFORMATION | CG | BDP | BDP |
| A | 16.01.13 | ISSUED FOR INFORMATION | CG | BDP | BDP |



DESIGN PARTNERS

PROJECT

MR182 - BRIDGE STREET WINDSOR
 WINDSOR BRIDGE REPLACEMENT
 UTILITIES, PAVEMENT AND GEOTECHNICAL
 INVESTIGATIONS PLAN
 SHEET 1

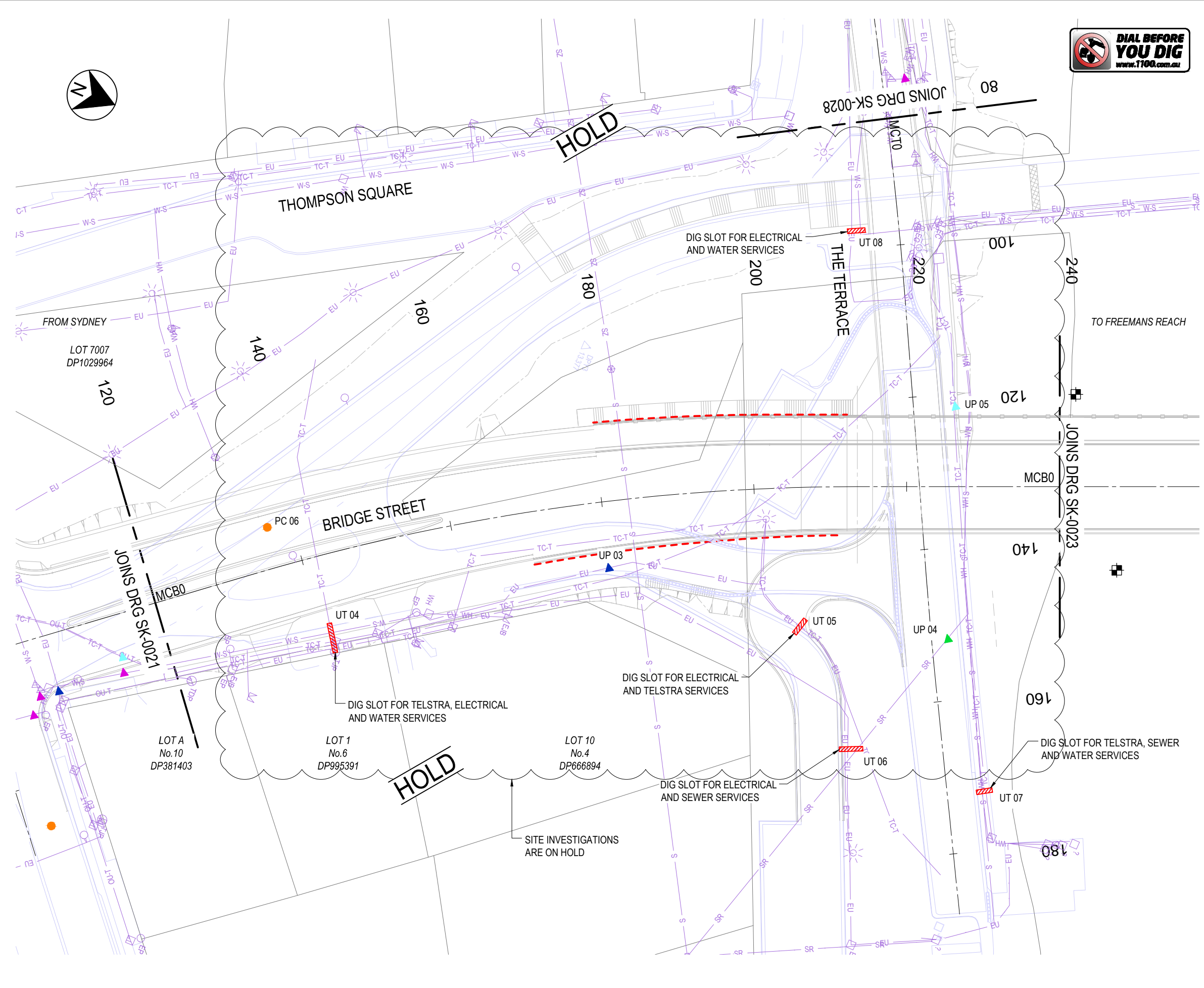
SKETCH

| | | | |
|----------|------------|-----------------|-----|
| DRAWN BY | ISSUE DATE | SKETCH No. | REV |
| CG | 08.02.13 | NB98005-SK-0021 | D |

| | | | |
|----------|------------|-----------------|-----|
| DRAWN BY | ISSUE DATE | SKETCH No. | REV |
| CG | 08.02.13 | NB98005-SK-0021 | D |



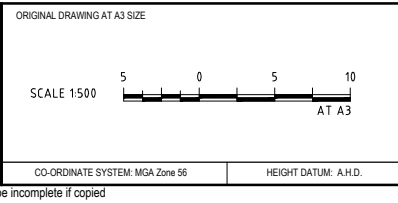
| LEGEND | |
|-------------------------------------|---|
| FOR REFERENCE | |
| | EXISTING PROPERTY BOUNDARY |
| | PROPOSED PROJECT BOUNDARY |
| | PROPOSED EASEMENT BOUNDARY |
| | RETAINING WALL |
| EXISTING UTILITIES TO BE RETAINED | |
| | ELECTRICAL CONDUIT - UNDERGROUND |
| | SEWER MAIN |
| | SEWER RISING MAIN |
| | SEWER MAIN - DIGITISED |
| | TELSTRA TELEPHONE LINE |
| | TELSTRA TELEPHONE CONDUIT |
| | TELSTRA OPTICAL FIBRE - UNDERGROUND |
| | WATER MAIN - SYDNEY WATER |
| | WATER HOUSE CONNECTION |
| | LIGHT POLE |
| | ELECTRICAL LIGHT POLE |
| | ELECTRICAL JUNCTION BOX |
| | SINGLE CONCRETE PIT |
| | TWIN CONCRETE PIT |
| | TELEPHONE DISTRIBUTION PILLAR |
| | POLE |
| | SUMP |
| | SEWER MANHOLE COVER |
| | HYDRANT |
| | STOP VALVE |
| | WATER METER |
| | WATER AIR VALVE |
| UTILITIES INVESTIGATION LOCATION | |
| | WATER MAIN |
| | SEWER MAIN |
| | TELSTRA MAIN |
| | ELECTRICAL CABLES |
| | DIG SLOT FOR SERVICES |
| PAVEMENT TESTING LOCATION | |
| | Ø100mm PAVEMENT CORE FOR ASPHALT THICKNESS, TYPE & THICKNESS OF BASE, TYPE OF SUBGRADE (8 OF) |
| | Ø150mm PAVEMENT CORE AS ABOVE PLUS CBR OF SUBGRADE (2 OF) |
| GEOTECHNICAL INVESTIGATION LOCATION | |
| | OVERWATER SEDIMENT SAMPLING FOR A.S.S TESTING AND WASTE CLASSIFICATION |
| | BOREHOLES FOR WATER QUALITY BASIN SUB STRATA & SCOUR PROTECTION DESIGN |
| HERITAGE SITES | |
| | ARCHEOLOGICAL DIGS |



- NOTES**
- ALL ABOVE GROUND SERVICES HAVE BEEN OMITTED FOR CLARITY
 - PRIOR TO COMMENCING ANY POTHOLING WORKS, LOCATION OF IDENTIFIED SERVICES TO BE FURTHER CONFIRMED BY LOCATORS

DATE: 8/02/2013 12:57:45 PM LOGIN NAME: GOMEZ, CLEO (SKM) LOCATION: I:\NBIF\Projects\NB98005\Deliverables\Drawings\Civil\Sketches\NB98005-SK-0021-0028.dwg

| REV | DATE | DESCRIPTION | DRAWN | REVIEWED | APPROVAL |
|-----|----------|------------------------|-------|----------|----------|
| D | 08.02.13 | ISSUED FOR INFORMATION | CG | BDP | BDP |
| C | 30.01.13 | ISSUED FOR INFORMATION | CG | BDP | BDP |
| B | 24.01.13 | ISSUED FOR INFORMATION | CG | BDP | BDP |
| A | 16.01.13 | ISSUED FOR INFORMATION | CG | BDP | BDP |



SITE INVESTIGATIONS ARE ON HOLD

DESIGN PARTNERS

Sinclair Knight Merz Pty Ltd
A.C.N. 001 024 095
100 Christie Street
St Leonards NSW 2065 Australia
Tel: (02) 9928 2100 Fax: (02) 9928 2500

PROJECT

MR182 - BRIDGE STREET WINDSOR
WINDSOR BRIDGE REPLACEMENT
UTILITIES, PAVEMENT AND GEOTECHNICAL
INVESTIGATIONS PLAN
SHEET2

| | |
|-------------------------------|------------------------|
| SKETCH | |
| DRAWN BY CG | ISSUE DATE 08.02.13 |
| SKETCH No. NB98005-SK-0022 | REV D |

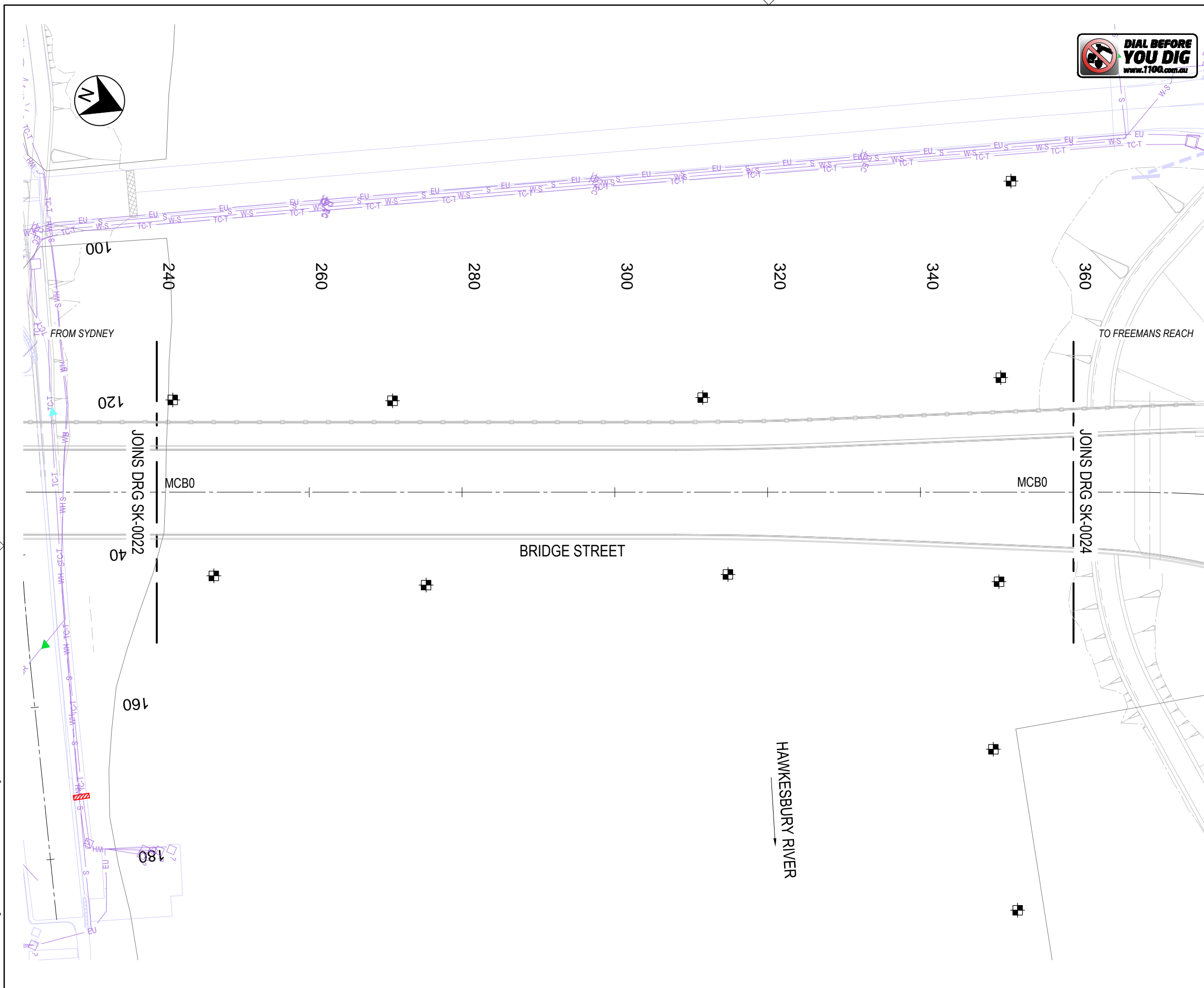


LEGEND

- FOR REFERENCE**
- EXISTING PROPERTY BOUNDARY
 - - - PROPOSED PROJECT BOUNDARY
 - . - . PROPOSED EASEMENT BOUNDARY
 - - - - - RETAINING WALL
- EXISTING UTILITIES TO BE RETAINED**
- EU — ELECTRICAL CONDUIT - UNDERGROUND
 - S — SEWER MAIN
 - SR — SEWER RISING MAIN
 - SZ — SEWER MAIN - DIGITISED
 - T — TELSTRA TELEPHONE LINE
 - TC-T — TELSTRA TELEPHONE CONDUIT
 - OU-T — TELSTRA OPTICAL FIBRE - UNDERGROUND
 - W-S — WATER MAIN - SYDNEY WATER
 - WH — WATER HOUSE CONNECTION
 - ☉ LIGHT POLE
 - EP / EGL ELECTRICAL POLE / ELECTRICAL GARDEN LIGHT
 - ELECTRICAL JUNCTION BOX
 - ▣ SINGLE CONCRETE PIT
 - ▤ TWIN CONCRETE PIT
 - ⊙ TDP TELEPHONE DISTRIBUTION PILLAR
 - POLE
 - SUMP
 - ⊗ SEWER MANHOLE COVER
 - HYDRANT
 - ▲ STOP VALVE
 - ⊕ WATER METER
 - △ WATER AIR VALVE
- UTILITIES INVESTIGATION LOCATION**
- ▲ WATER MAIN
 - ▲ SEWER MAIN
 - ▲ TELSTRA MAIN
 - ▲ ELECTRICAL CABLES
 - ▨ DIG SLOT FOR SERVICES
- PAVEMENT TESTING LOCATION**
- Ø100mm PAVEMENT CORE FOR ASPHALT THICKNESS, TYPE & THICKNESS OF BASE, TYPE OF SUBGRADE (8 OF)
 - Ø150mm PAVEMENT CORE AS ABOVE PLUS CBR OF SUBGRADE (2 OF)
- GEOTECHNICAL INVESTIGATION LOCATION**
- ⊕ OVERWATER SEDIMENT SAMPLING FOR A.S.S TESTING AND WASTE CLASSIFICATION
 - ⊕ BOREHOLES FOR WATER QUALITY BASIN SUB STRATA & SCOUR PROTECTION DESIGN
- HERITAGE SITES**
- ▨ ARCHEOLOGICAL DIGS

NOTES

1. ALL ABOVE GROUND SERVICES HAVE BEEN OMITTED FOR CLARITY
2. PRIOR TO COMMENCING ANY POTHOLING WORKS, LOCATION OF IDENTIFIED SERVICES TO BE FURTHER CONFIRMED BY LOCATORS



DATE: 8/02/2013 12:57:50 PM LOGIN NAME: GOMEZ, CLEO (SKM) LOCATION: I:\NBIF\Projects\NB98005\Deliverables\Drawings\Civil\Sketches\NB98005-SK-0021-0028.dwg

| REV | DATE | DESCRIPTION | DRAWN | REVIEWED | APPROVAL |
|-----|----------|------------------------|-------|----------|----------|
| D | 08.02.13 | ISSUED FOR INFORMATION | CG | BDP | BDP |
| C | 30.01.13 | ISSUED FOR INFORMATION | CG | BDP | BDP |
| B | 24.01.13 | ISSUED FOR INFORMATION | CG | BDP | BDP |
| A | 16.01.13 | ISSUED FOR INFORMATION | CG | BDP | BDP |

ORIGINAL DRAWING AT A3 SIZE

SCALE 1:500

AT A3

CO-ORDINATE SYSTEM: MGA Zone 56 HEIGHT DATUM: A.H.D.

DESIGN PARTNERS

Sinclair Knight Merz Pty Ltd
A.C.N. 001 024 095
100 Christie Street
St Leonards NSW 2065 Australia
Tel: (02) 9528 2100 Fax: (02) 9528 2500

PROJECT

MR182 - BRIDGE STREET WINDSOR
WINDSOR BRIDGE REPLACEMENT
UTILITIES, PAVEMENT AND GEOTECHNICAL
INVESTIGATIONS PLAN
SHEET3

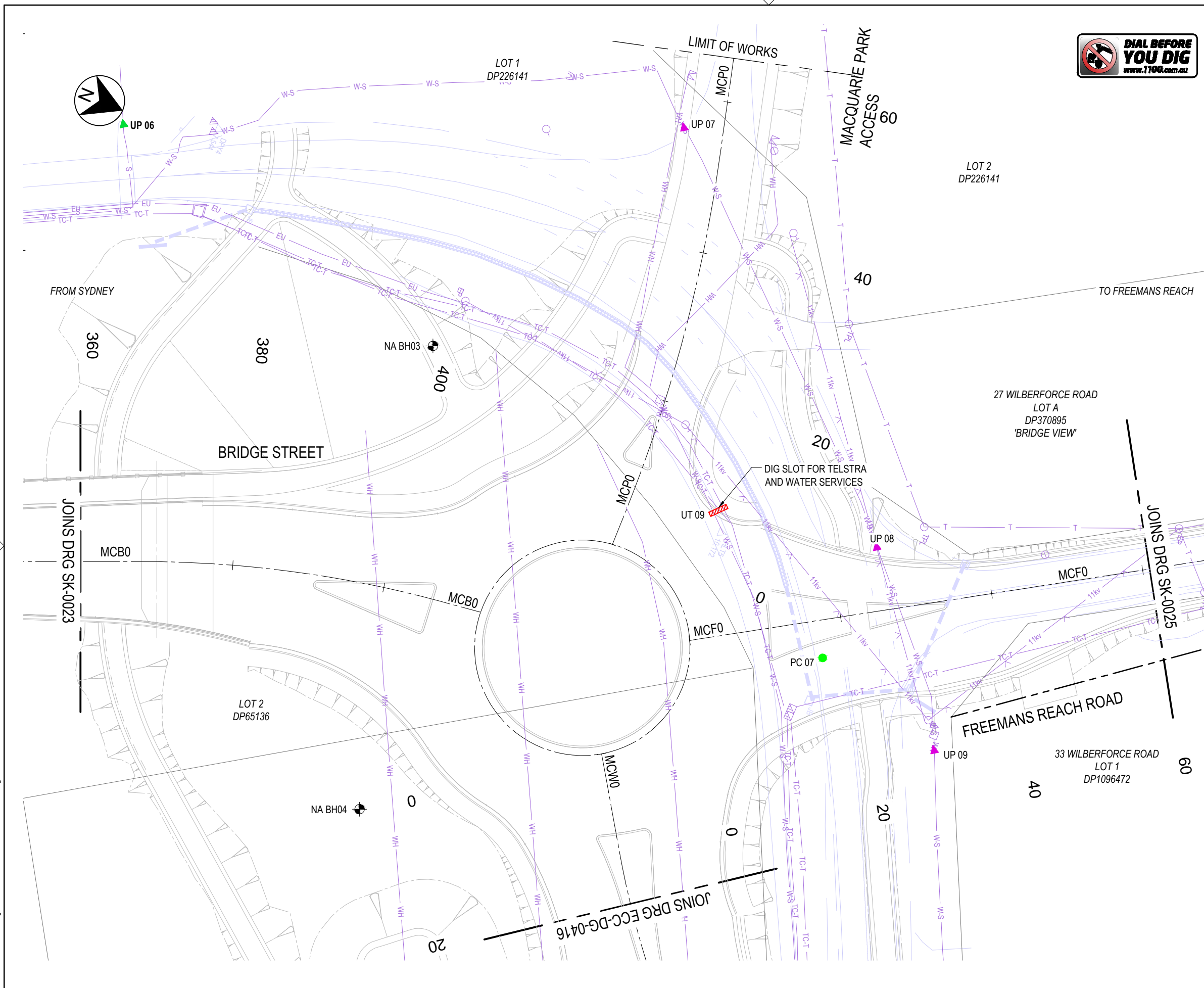
SKETCH

| | | | |
|----------|------------|-----------------|-----|
| DRAWN BY | ISSUE DATE | SKETCH No | REV |
| CG | 08.02.13 | NB98005-SK-0023 | D |



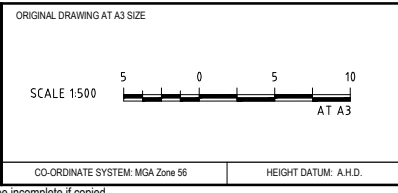
| LEGEND | |
|-------------------------------------|---|
| FOR REFERENCE | |
| | EXISTING PROPERTY BOUNDARY |
| | PROPOSED PROJECT BOUNDARY |
| | PROPOSED EASEMENT BOUNDARY |
| | RETAINING WALL |
| EXISTING UTILITIES TO BE RETAINED | |
| | EU ELECTRICAL CONDUIT - UNDERGROUND |
| | S SEWER MAIN |
| | SR SEWER RISING MAIN |
| | SZ SEWER MAIN - DIGITISED |
| | T TELSTRA TELEPHONE LINE |
| | TC-T TELSTRA TELEPHONE CONDUIT |
| | OU-T TELSTRA OPTICAL FIBRE - UNDERGROUND |
| | W-S WATER MAIN - SYDNEY WATER |
| | WH WATER HOUSE CONNECTION |
| | LIGHT POLE |
| | ELECTRICAL LIGHT POLE |
| | EP / EGL ELECTRICAL POLE / ELECTRICAL GARDEN LIGHT |
| | ELECTRICAL JUNCTION BOX |
| | SINGLE CONCRETE PIT |
| | TWIN CONCRETE PIT |
| | TELEPHONE DISTRIBUTION PILLAR |
| | POLE |
| | SUMP |
| | SEWER MANHOLE COVER |
| | HYDRANT |
| | STOP VALVE |
| | WATER METER |
| | WATER AIR VALVE |
| UTILITIES INVESTIGATION LOCATION | |
| | WATER MAIN |
| | SEWER MAIN |
| | TELSTRA MAIN |
| | ELECTRICAL CABLES |
| | DIG SLOT FOR SERVICES |
| PAVEMENT TESTING LOCATION | |
| | Ø100mm PAVEMENT CORE FOR ASPHALT THICKNESS, TYPE & THICKNESS OF BASE, TYPE OF SUBGRADE (Ø OF) |
| | Ø150mm PAVEMENT CORE AS ABOVE PLUS CBR OF SUBGRADE (2 OF) |
| GEOTECHNICAL INVESTIGATION LOCATION | |
| | OVERWATER SEDIMENT SAMPLING FOR A.S.S TESTING AND WASTE CLASSIFICATION |
| | BOREHOLES FOR WATER QUALITY BASIN SUB STRATA & SCOUR PROTECTION DESIGN |
| HERITAGE SITES | |
| | ARCHEOLOGICAL DIGS |

- NOTES**
- ALL ABOVE GROUND SERVICES HAVE BEEN OMITTED FOR CLARITY
 - PRIOR TO COMMENCING ANY POTHOLING WORKS, LOCATION OF IDENTIFIED SERVICES TO BE FURTHER CONFIRMED BY LOCATORS



DATE: 8/02/2013 12:57:55 PM LOGIN NAME: GOMEZ, CLEO (SKM) LOCATION: I:\NBIF\Projects\NB98005\Deliverables\Drawings\Civil\Sketches\NB98005-SK-0021-0028.dwg

| REV | DATE | DESCRIPTION | DRAWN | REVIEWED | APPROVAL |
|-----|----------|------------------------|-------|----------|----------|
| D | 08.02.13 | ISSUED FOR INFORMATION | CG | BDP | BDP |
| C | 30.01.13 | ISSUED FOR INFORMATION | CG | BDP | BDP |
| B | 24.01.13 | ISSUED FOR INFORMATION | CG | BDP | BDP |
| A | 16.01.13 | ISSUED FOR INFORMATION | CG | BDP | BDP |



DESIGN PARTNERS

Sinclair Knight Merz Pty Ltd
A.C.N. 001 024 095
100 Christie Street
St Leonards NSW 2065 Australia
Tel: (02) 9928 2100 Fax: (02) 9928 2500

PROJECT

MR182 - BRIDGE STREET WINDSOR
WINDSOR BRIDGE REPLACEMENT
UTILITIES, PAVEMENT AND GEOTECHNICAL
INVESTIGATIONS PLAN
SHEET 4

| | |
|------------------------------|------------------------|
| SKETCH | |
| DRAWN BY CG | ISSUE DATE 08.02.13 |
| SKETCH No NB98005-SK-0024 | REV D |

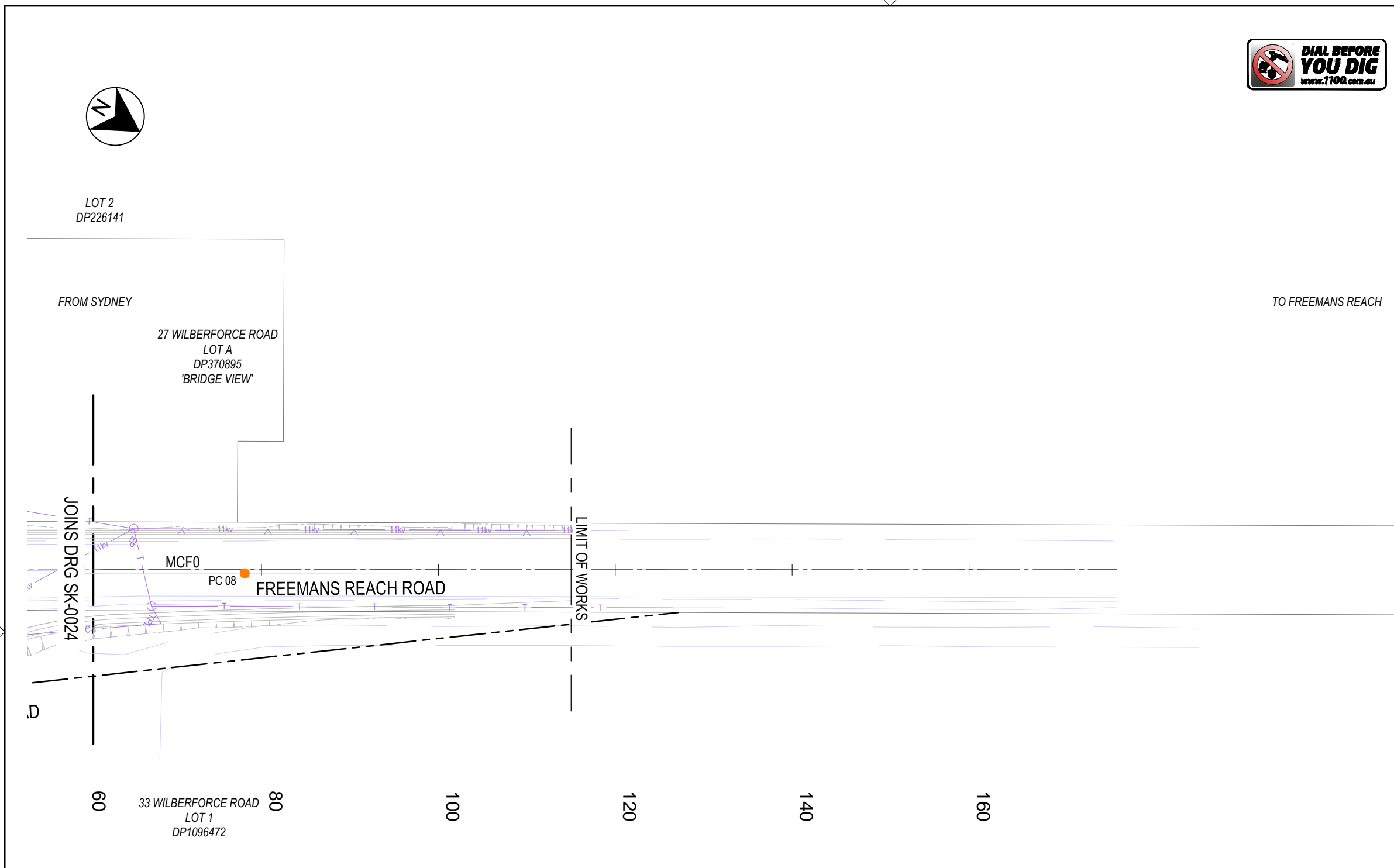


LEGEND

- FOR REFERENCE**
- EXISTING PROPERTY BOUNDARY
 - - - PROPOSED PROJECT BOUNDARY
 - . - . - PROPOSED EASEMENT BOUNDARY
 - - - - - RETAINING WALL
- EXISTING UTILITIES TO BE RETAINED**
- EU — ELECTRICAL CONDUIT - UNDERGROUND
 - S — SEWER MAIN
 - SR — SEWER RISING MAIN
 - SZ — SEWER MAIN - DIGITISED
 - T — TELSTRA TELEPHONE LINE
 - TC-T — TELSTRA TELEPHONE CONDUIT
 - OU-T — TELSTRA OPTICAL FIBRE - UNDERGROUND
 - W-S — WATER MAIN - SYDNEY WATER
 - WH — WATER HOUSE CONNECTION
 - ☀ LIGHT POLE
 - EP / EGL ELECTRICAL POLE / ELECTRICAL GARDEN LIGHT
 - ELECTRICAL JUNCTION BOX
 - ▣ SINGLE CONCRETE PIT
 - ▤ TWIN CONCRETE PIT
 - ⊙ TDP TELEPHONE DISTRIBUTION PILLAR
 - POLE
 - SUMP
 - ⊗ SEWER MANHOLE COVER
 - HYDRANT
 - ▲ STOP VALVE
 - ⊥ WATER METER
 - △ WATER AIR VALVE
- UTILITIES INVESTIGATION LOCATION**
- ▲ WATER MAIN
 - ▲ SEWER MAIN
 - ▲ TELSTRA MAIN
 - ▲ ELECTRICAL CABLES
 - ▨ DIG SLOT FOR SERVICES
- PAVEMENT TESTING LOCATION**
- Ø100mm PAVEMENT CORE FOR ASPHALT THICKNESS, TYPE & THICKNESS OF BASE, TYPE OF SUBGRADE (8 OF)
 - Ø150mm PAVEMENT CORE AS ABOVE PLUS CBR OF SUBGRADE (2 OF)
- GEOTECHNICAL INVESTIGATION LOCATION**
- ⊕ OVERWATER SEDIMENT SAMPLING FOR A.S.S TESTING AND WASTE CLASSIFICATION
 - ⊕ BOREHOLES FOR WATER QUALITY BASIN SUB STRATA & SCOUR PROTECTION DESIGN
- HERITAGE SITES**
- ▨ ARCHEOLOGICAL DIGS

NOTES

1. ALL ABOVE GROUND SERVICES HAVE BEEN OMITTED FOR CLARITY
2. PRIOR TO COMMENCING ANY POTHOLING WORKS, LOCATION OF IDENTIFIED SERVICES TO BE FURTHER CONFIRMED BY LOCATORS



LOT 2
DP226141

FROM SYDNEY

27 WILBERFORCE ROAD
LOT A
DP370895
'BRIDGE VIEW'

TO FREEMANS REACH

LIMIT OF WORKS

FREEMANS REACH ROAD

33 WILBERFORCE ROAD
LOT 1
DP1096472

60 80 100 120 140 160

DATE: 8/02/2013 12:57:59 PM LOGIN NAME: GOMEZ, CLEO (SKM) LOCATION: I:\NBIF\Projects\NB98005\Deliverables\Drawings\Civil\Sketches\NB98005-SK-0021-0028.dwg

| REV | DATE | DESCRIPTION | DRAWN | REVIEWED | APPROVAL |
|-----|----------|------------------------|-------|----------|----------|
| D | 08.02.13 | ISSUED FOR INFORMATION | CG | BDP | BDP |
| C | 30.01.13 | ISSUED FOR INFORMATION | CG | BDP | BDP |
| B | 24.01.13 | ISSUED FOR INFORMATION | CG | BDP | BDP |
| A | 16.01.13 | ISSUED FOR INFORMATION | CG | BDP | BDP |

ORIGINAL DRAWING AT A3 SIZE

SCALE 1:500

AT A3

CO-ORDINATE SYSTEM: MGA Zone 56 HEIGHT DATUM: A.H.D.

DESIGN PARTNERS

Sinclair Knight Merz Pty Ltd
A.C.N. 001 024 095
100 Christie Street
St Leonards NSW 2065 Australia
Tel: (02) 9928 2100 Fax: (02) 9928 2500

PROJECT

MR182 - BRIDGE STREET WINDSOR
WINDSOR BRIDGE REPLACEMENT
UTILITIES, PAVEMENT AND GEOTECHNICAL
INVESTIGATIONS PLAN
SHEET 5

SKETCH

| | | | |
|----------|------------|-----------------|-----|
| DRAWN BY | ISSUE DATE | SKETCH No | REV |
| CG | 08.02.13 | NB98005-SK-0025 | D |

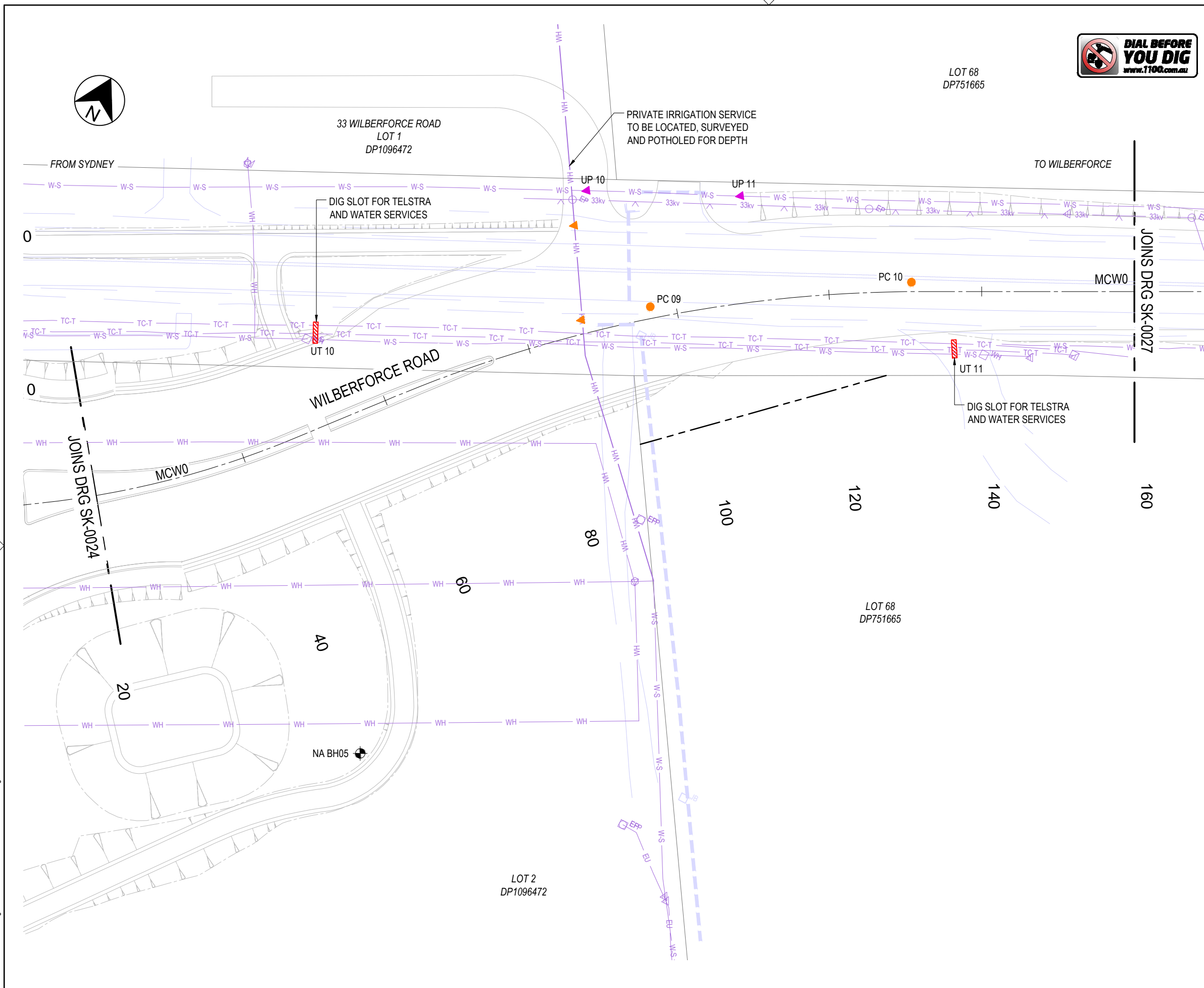


LEGEND

- FOR REFERENCE**
- EXISTING PROPERTY BOUNDARY
 - - - PROPOSED PROJECT BOUNDARY
 - . - . PROPOSED EASEMENT BOUNDARY
 - - - - - RETAINING WALL
- EXISTING UTILITIES TO BE RETAINED**
- EU — ELECTRICAL CONDUIT - UNDERGROUND
 - S — SEWER MAIN
 - SR — SEWER RISING MAIN
 - SZ — SEWER MAIN - DIGITISED
 - T — TELSTRA TELEPHONE LINE
 - TC-T — TELSTRA TELEPHONE CONDUIT
 - OU-T — TELSTRA OPTICAL FIBRE - UNDERGROUND
 - W-S — WATER MAIN - SYDNEY WATER
 - WH — WATER HOUSE CONNECTION
 - LIGHT POLE
 - ELECTRICAL LIGHT POLE
 - EP / EGL ELECTRICAL POLE / ELECTRICAL GARDEN LIGHT
 - SINGLE CONCRETE PIT
 - TWIN CONCRETE PIT
 - TDP TELEPHONE DISTRIBUTION PILLAR
 - POLE
 - SUMP
 - ⊗ SEWER MANHOLE COVER
 - HYDRANT
 - ▲ STOP VALVE
 - ▼ WATER METER
 - ▲ WATER AIR VALVE
- UTILITIES INVESTIGATION LOCATION**
- ▲ WATER MAIN
 - ▲ SEWER MAIN
 - ▲ TELSTRA MAIN
 - ▲ ELECTRICAL CABLES
 - ▨ DIG SLOT FOR SERVICES
- PAVEMENT TESTING LOCATION**
- Ø100mm PAVEMENT CORE FOR ASPHALT THICKNESS, TYPE & THICKNESS OF BASE, TYPE OF SUBGRADE (8 OF)
 - Ø150mm PAVEMENT CORE AS ABOVE PLUS CBR OF SUBGRADE (2 OF)
- GEOTECHNICAL INVESTIGATION LOCATION**
- ⊕ OVERWATER SEDIMENT SAMPLING FOR A.S.S TESTING AND WASTE CLASSIFICATION
 - ⊕ BOREHOLES FOR WATER QUALITY BASIN SUB STRATA & SCOUR PROTECTION DESIGN
- HERITAGE SITES**
- ▨ ARCHEOLOGICAL DIGS

NOTES

1. ALL ABOVE GROUND SERVICES HAVE BEEN OMITTED FOR CLARITY
2. PRIOR TO COMMENCING ANY POTHOLING WORKS, LOCATION OF IDENTIFIED SERVICES TO BE FURTHER CONFIRMED BY LOCATORS



DATE: 8/02/2013 12:58:05 PM LOGIN NAME: GOMEZ, CLEO (SKM) LOCATION: I:\NBIF\Projects\NB98005\Deliverables\Drawings\Civil\Sketches\NB98005-SK-0021-0026.dwg

| REV | DATE | DESCRIPTION | DRAWN | REVIEWED | APPROVAL |
|-----|----------|------------------------|-------|----------|----------|
| D | 08.02.13 | ISSUED FOR INFORMATION | CG | BDP | BDP |
| C | 30.01.13 | ISSUED FOR INFORMATION | CG | BDP | BDP |
| B | 24.01.13 | ISSUED FOR INFORMATION | CG | BDP | BDP |
| A | 16.01.13 | ISSUED FOR INFORMATION | CG | BDP | BDP |

ORIGINAL DRAWING AT A3 SIZE

SCALE 1:500

AT A3

CO-ORDINATE SYSTEM: MGA Zone 56 HEIGHT DATUM: A.H.D.

DESIGN PARTNERS

Sinclair Knight Merz Pty Ltd
A.C.N. 001 024 095
100 Christie Street
St Leonards NSW 2065 Australia
Tel: (02) 9928 2100 Fax: (02) 9928 2500

PROJECT

MR182 - BRIDGE STREET WINDSOR
WINDSOR BRIDGE REPLACEMENT
UTILITIES, PAVEMENT AND GEOTECHNICAL
INVESTIGATIONS PLAN
SHEET6

SKETCH

| | | | |
|----------|------------|-----------------|-----|
| DRAWN BY | ISSUE DATE | SKETCH No | REV |
| CG | 08.02.13 | NB98005-SK-0026 | D |

DATE: 8/02/2013 12:58:05 PM LOGIN NAME: GOMEZ, CLEO (SKM)
LOCATION: I:\NBIF\Projects\NB98005\Deliverables\Drawings\Civil\Sketches\NB98005-SK-0021-0026.dwg



LEGEND

FOR REFERENCE

- EXISTING PROPERTY BOUNDARY
- - - PROPOSED PROJECT BOUNDARY
- . - . PROPOSED EASEMENT BOUNDARY
- - - - - RETAINING WALL

EXISTING UTILITIES TO BE RETAINED

- EU — ELECTRICAL CONDUIT - UNDERGROUND
- S — SEWER MAIN
- SR — SEWER RISING MAIN
- SZ — SEWER MAIN - DIGITISED
- T — TELSTRA TELEPHONE LINE
- TC-T — TELSTRA TELEPHONE CONDUIT
- OU-T — TELSTRA OPTICAL FIBRE - UNDERGROUND
- W-S — WATER MAIN - SYDNEY WATER
- WH — WATER HOUSE CONNECTION
- ☀ LIGHT POLE
- ELECTRICAL LIGHT POLE
- EP / EGL ELECTRICAL POLE / ELECTRICAL GARDEN LIGHT
- ELECTRICAL JUNCTION BOX
- ▣ SINGLE CONCRETE PIT
- ▤ TWIN CONCRETE PIT
- ⊙ TDP TELEPHONE DISTRIBUTION PILLAR
- POLE
- SUMP
- ⊗ SEWER MANHOLE COVER
- HYDRANT
- ▲ STOP VALVE
- ⊥ WATER METER
- △ WATER AIR VALVE

UTILITIES INVESTIGATION LOCATION

- ▲ WATER MAIN
- ▲ SEWER MAIN
- ▲ TELSTRA MAIN
- ▲ ELECTRICAL CABLES
- ▨ DIG SLOT FOR SERVICES

PAVEMENT TESTING LOCATION

- Ø100mm PAVEMENT CORE FOR ASPHALT THICKNESS, TYPE & THICKNESS OF BASE, TYPE OF SUBGRADE (8 OF)
- Ø150mm PAVEMENT CORE AS ABOVE PLUS CBR OF SUBGRADE (2 OF)

GEOTECHNICAL INVESTIGATION LOCATION

- ⊕ OVERWATER SEDIMENT SAMPLING FOR A.S.S TESTING AND WASTE CLASSIFICATION
- ⊕ BOREHOLES FOR WATER QUALITY BASIN SUB STRATA & SCOUR PROTECTION DESIGN

HERITAGE SITES

- ▨ ARCHEOLOGICAL DIGS

NOTES

1. ALL ABOVE GROUND SERVICES HAVE BEEN OMITTED FOR CLARITY
2. PRIOR TO COMMENCING ANY POTHOLING WORKS, LOCATION OF IDENTIFIED SERVICES TO BE FURTHER CONFIRMED BY LOCATORS

LOT 68
DP751665

FROM SYDNEY

TO WILBERFORCE

JOINS DRG SK-0026

WILBERFORCE ROAD

OF WORKS

LIMIT

160 180 200 220

LOT 68
DP751665

DATE: 8/02/2013 12:58:09 PM LOGIN NAME: GOMEZ, CLEO (SKM) LOCATION: I:\NBIF\Projects\NB98005\Deliverables\Drawings\Civil\Sketches\NB98005-SK-0021-0026.dwg

ORIGINAL DRAWING AT A3 SIZE

SCALE 1:500

AT A3

CO-ORDINATE SYSTEM: MGA Zone 56 HEIGHT DATUM: A.H.D.

DESIGN PARTNERS

Sinclair Knight Merz Pty Ltd
A.C.N. 001 024 095
100 Christie Street
St Leonards NSW 2065 Australia
Tel: (02) 9528 2100 Fax: (02) 9528 2500

PROJECT

MR182 - BRIDGE STREET WINDSOR
WINDSOR BRIDGE REPLACEMENT
UTILITIES, PAVEMENT AND GEOTECHNICAL
INVESTIGATIONS PLAN
SHEET7

SKETCH

| | | | |
|-----------------------|-------------------------------|-------------------------------------|-----------------|
| DRAWN BY CG | ISSUE DATE 08.02.13 | SKETCH No NB98005-SK-0027 | REV D |
|-----------------------|-------------------------------|-------------------------------------|-----------------|



HAWKESBURY RIVER



LEGEND

FOR REFERENCE

- EXISTING PROPERTY BOUNDARY
- PROPOSED PROJECT BOUNDARY
- PROPOSED EASEMENT BOUNDARY
- RETAINING WALL

EXISTING UTILITIES TO BE RETAINED

- EU ELECTRICAL CONDUIT - UNDERGROUND
- S SEWER MAIN
- SR SEWER RISING MAIN
- SZ SEWER MAIN - DIGITISED
- T TELSTRA TELEPHONE LINE
- TC-T TELSTRA TELEPHONE CONDUIT
- OU-T TELSTRA OPTICAL FIBRE - UNDERGROUND
- W-S WATER MAIN - SYDNEY WATER
- WH WATER HOUSE CONNECTION
- LIGHT POLE
- ELECTRICAL LIGHT POLE
- EP / EGL ELECTRICAL POLE / ELECTRICAL GARDEN LIGHT
- ELECTRICAL JUNCTION BOX
- SINGLE CONCRETE PIT
- TWIN CONCRETE PIT
- TDP TELEPHONE DISTRIBUTION PILLAR
- POLE
- SUMP
- SEWER MANHOLE COVER
- HYDRANT
- STOP VALVE
- WATER METER
- WATER AIR VALVE

UTILITIES INVESTIGATION LOCATION

- ▲ WATER MAIN
- ▲ SEWER MAIN
- ▲ TELSTRA MAIN
- ▲ ELECTRICAL CABLES
- ▨ DIG SLOT FOR SERVICES

PAVEMENT TESTING LOCATION

- Ø100mm PAVEMENT CORE FOR ASPHALT THICKNESS, TYPE & THICKNESS OF BASE, TYPE OF SUBGRADE (8 OF)
- Ø150mm PAVEMENT CORE AS ABOVE PLUS CBR OF SUBGRADE (2 OF)

GEOTECHNICAL INVESTIGATION LOCATION

- OVERWATER SEDIMENT SAMPLING FOR A.S.S TESTING AND WASTE CLASSIFICATION
- BOREHOLES FOR WATER QUALITY BASIN SUB STRATA & SCOUR PROTECTION DESIGN

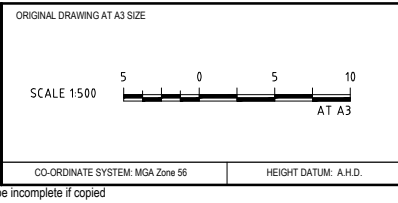
HERITAGE SITES

- ▨ ARCHEOLOGICAL DIGS

- NOTES**
- ALL ABOVE GROUND SERVICES HAVE BEEN OMITTED FOR CLARITY
 - PRIOR TO COMMENCING ANY POTHOLING WORKS, LOCATION OF IDENTIFIED SERVICES TO BE FURTHER CONFIRMED BY LOCATORS

DATE: 8/02/2013 12:58:15 PM LOGIN NAME: GOMEZ, CLEO (SKM) LOCATION: I:\NBIF\Projects\NB98005\Deliverables\Drawings\Civil\Sketches\NB98005-SK-0021-0028.dwg

| REV | DATE | DESCRIPTION | DRAWN | REVIEWED | APPROVAL |
|-----|----------|------------------------|-------|----------|----------|
| D | 08.02.13 | ISSUED FOR INFORMATION | CG | BDP | BDP |
| C | 30.01.13 | ISSUED FOR INFORMATION | CG | BDP | BDP |
| B | 24.01.13 | ISSUED FOR INFORMATION | CG | BDP | BDP |
| A | 16.01.13 | ISSUED FOR INFORMATION | CG | BDP | BDP |



DESIGN PARTNERS

Sinclair Knight Merz Pty Ltd
A.C.N. 001 024 095
100 Christie Street
St Leonards NSW 2065 Australia
Tel: (02) 9528 2100 Fax: (02) 9528 2500

PROJECT

MR182 - BRIDGE STREET WINDSOR
WINDSOR BRIDGE REPLACEMENT
UTILITIES, PAVEMENT AND GEOTECHNICAL
INVESTIGATIONS PLAN
SHEET 8

| | |
|------------------------------|------------------------|
| SKETCH | |
| DRAWN BY CG | ISSUE DATE 08.02.13 |
| SKETCH No NB98005-SK-0028 | REV D |

(blank page)

Appendix C - Technical review of alternative bridge refurbishment methodology

Technical Review of Alternative Refurbishment Methodology of Windsor Bridge



Technical Review of Alternative Refurbishment Methodology of Windsor Bridge

Prepared for

SKM

Prepared by

AECOM Australia Pty Ltd

17 Warabrook Boulevard, Warabrook NSW 2304, PO Box 73, Hunter Region MC NSW 2310, Australia
T +61 2 4911 4900 F +61 2 4911 4999 www.aecom.com

ABN 20 093 846 925

21 March 2013

AECOM in Australia and New Zealand is certified to the latest version of ISO9001 and ISO14001.

© AECOM Australia Pty Ltd (AECOM). All rights reserved.

AECOM has prepared this document for the sole use of the Client and for a specific purpose, each as expressly stated in the document. No other party should rely on this document without the prior written consent of AECOM. AECOM undertakes no duty, nor accepts any responsibility, to any third party who may rely upon or use this document. This document has been prepared based on the Client's description of its requirements and AECOM's experience, having regard to assumptions that AECOM can reasonably be expected to make in accordance with sound professional principles. AECOM may also have relied upon information provided by the Client and other third parties to prepare this document, some of which may not have been verified. Subject to the above conditions, this document may be transmitted, reproduced or disseminated only in its entirety.

Quality Information

Document Technical Review of Alternative Refurbishment Methodology of Windsor Bridge

Ref 60287656

Date 21 March 2013

Prepared by D Meyers

Reviewed by P Blundy

Revision History


| Revision | Revision Date | Details | Authorised | |
|----------|---------------|-------------|--------------------------------------|---|
| | | | Name/Position | Signature |
| 1 | 5 Feb 2013 | For Review | Darrell Meyers Technical Director | |
| 2 | 14-Feb-2013 | For Review | Darrell Meyers Technical Director | |
| 3 | 12 Mar-2013 | Final draft | Darrell Meyers Technical Director | |
| 4 | 21-Mar-2013 | Final | Darrell Meyers Technical Director |  |

Table of Contents

| | | |
|-------|--|----|
| 1.0 | Introduction | 1 |
| 1.1 | Project | 1 |
| 1.2 | Proposal to Rehabilitate | 1 |
| 1.3 | Scope of Technical Review | 1 |
| 2.0 | Available Information | 2 |
| 2.1 | Reports | 2 |
| 2.2 | Drawings | 2 |
| 2.3 | EIS Submission | 2 |
| 3.0 | Existing Bridge | 3 |
| 3.1 | Description and Geometry | 3 |
| 3.2 | Condition | 3 |
| 3.2.1 | Superstructure | 3 |
| 3.2.2 | Substructure | 3 |
| 3.3 | Load Rating | 4 |
| 3.3.1 | Superstructure | 4 |
| 3.3.2 | Substructure | 4 |
| 3.3.3 | Load Rating Factors | 5 |
| 4.0 | Proposed Rehabilitation | 6 |
| 4.1 | Understanding of the Proposed Rehabilitation | 6 |
| 4.1.1 | Substructure | 6 |
| 4.1.2 | Superstructure | 6 |
| 5.0 | Technical Review | 7 |
| 5.1 | Substructure | 7 |
| 5.1.1 | Structural | 7 |
| 5.1.2 | Durability | 7 |
| 5.1.3 | Constructability | 7 |
| 5.2 | Superstructure | 8 |
| 5.2.1 | Structural | 8 |
| 5.2.2 | Durability | 8 |
| 5.2.3 | Constructability | 11 |
| 6.0 | Quantities | 12 |
| 7.0 | Conclusions | 13 |

1.0 Introduction

1.1 Project

Roads and Maritime Services NSW is planning to replace the existing bridge (No 415 on MR182) over the Hawkesbury River at Windsor (known as Windsor Bridge). The 143m long bridge is over 100 years old and is deteriorating with age and is no longer considered cost effective to maintain.

The proposed Windsor bridge replacement project involves

- Construction of a new bridge over the Hawkesbury River at Windsor, around 35 metres downstream of the existing Windsor bridge
- Construction of new approach roads and intersections to connect the new bridge to existing road network.
- Modifications to local roads and access arrangements, including changes to the Macquarie Park access and connection of The Terrace.
- Construction of pedestrian and cycling facilities, including a shared pedestrian/cycle pathway for access to and across the new bridge.
- Removal and backfilling of the existing bridge approach roads.
- Demolition of the existing Windsor Bridge.
- Urban design and landscaping works, including within the parkland area of Thompson Square and adjacent to the northern intersection of Wilberforce Road, Freemans Reach Road and the Macquarie Park access road.
- Ancillary works such as public utility adjustments, water management measures and scour protection works

The Environmental Impact Statement (EIS) for the Windsor Bridge Replacement project has recently been on public display.

1.2 Proposal to Rehabilitate

One of the public submissions received from the EIS display proposes to rehabilitate the existing bridge for light traffic and provide an alternate heavy vehicle high level bridge bypassing the town.

The rehabilitation proposal consists of providing steel jackets to strengthen the aging cast iron piers and extensive patch repairs to the concrete deck units.

1.3 Scope of Technical Review

The scope of this report is to undertake a technical review of the proposed bridge rehabilitation presented by Messrs Wedgwood and Pearson in their submission related to the EIS display. The scope excludes review of the cost estimate. The proposal by Messrs Wedgwood and Pearson also includes an alternate location for a new crossing of the Hawkesbury River, the review of this proposal is beyond the scope of work of this report.

The scope covers a review of the available historical drawings, available condition assessments and load rating reports to understand the form and condition of the existing bridge.

This report reviews the proposed rehabilitation methods and comments on the

- technical merits of the solutions
- constructability of the rehabilitation with respect to impact on traffic, environment and work health and safety (WHS)
- completeness of the proposed rehabilitation with respect to the items and quantities identified in the bill of quantities
- durability of the proposed rehabilitation

2.0 Available Information

2.1 Reports

Inspection & Structural Assessment Report, Report No. C10-69-000-A, Prof. Bijan Samali, Access:UTS, (April 2011).

Graphitisation Investigation Windsor Bridge, Report No. C11231, Rev: Original, CTI Consultants Pty Ltd, (July 2011).

U/W Bridge Inspection Contract 10.2535.0889 B 415 Windsor Bridge 9.5.2011 to 20.5.2011, Commercial Diving Solutions Pty Ltd (June 2011).

U/W Bridge Inspection Contract 10.2535.0889 B 415 Windsor Bridge Follow-Up Inspection 15.6.2011, Commercial Diving Solutions Pty Ltd, (June 2011).

Bridge of Hawkesbury River at Windsor Load Testing — Test Report, Document No. E208R1, Rev 0, Endurance Consulting Pty Ltd, (June 2011).

Performance Load Testing of Bridge over Hawkesbury River at Windsor (BN 415), Regional Operations and Engineering Services Directorate (August 2006).

Rehabilitation of Bridge over Hawkesbury River at Windsor (BN 415 on MR 182), RTA Operations (May 2005).

Underwater Graphitisation Survey Bridge at Windsor (BN 415), Report No. C10174, CTI Consultants Pty Ltd, (April 2005).

Windsor Bridge over Hawkesbury River – Repair Cost Estimate and Life Cycle Cost Analysis, GHD (February 2005).

Inspection and Assessment Report, Bridge over Hawkesbury River on Bridge St/Wilberforce Road (MR182) at Windsor, Windsor Bridge (BN 415), RTA Bridge Section — RTA Operations, (December 2003).

Bridge Over Hawkesbury River at Windsor – Durability Condition Assessment GHD (October 2003).

Developing a Cost Effective Assessment Technique for Bridge Assets Management Phase 2, Field Testing and Assessment of Windsor Bridge, Windsor NSW, Prof B Samali, Dr J Li and A/Prof K Crews UTS, (September 2003).

2.2 Drawings

Existing drawings, 70 scanned images cover original bridge, raising, concrete deck conversion, cantilever walkway, new traffic barrier

2.3 EIS Submission

Document titled "Bridge Over Hawkesbury River at Windsor – Proposal to Repair the Existing Bridge as Part of a Scheme Involving a New Road Linking to Hawkesbury Valley Way, the Flood Evacuation Route, undated, Brian Pearson and Ray Wedgwood

Letter to RMS, Subject: Bridge over the Hawkesbury River at Windsor, 4 May 2012, Brian Pearson and Ray Wedgwood.

Transcript of Presentation to RMS Heritage Committee, 5 Sept 2012 Brian Pearson and Ray Wedgwood.

Untitled document – submission to EIS public display, undated, BJ Pearson, RJL Wedgwood.

CAWB EIS Submission – version 3.1 undated

3.0 Existing Bridge

3.1 Description and Geometry

The Windsor Bridge is a 11 span, 143m long bridge. The bridge carries two traffic lanes with a width between barriers of 6.10m and a 1.2m wide walkway on the downstream side. The original bridge was constructed in 1874 consisted of a timber deck on cast iron piers. The deck was raised by 2.4m in 1897 by bolting extensions to the cast iron piers and reconstructing the timber deck. In 1922 the timber deck was replaced with a precast concrete deck. In 1968 a cantilevered footpath supported off the piers was added to provide separated pedestrian access and accommodate utility services. The traffic barriers were upgraded in 1986.

The piers are made up of 6 foot long internally bolted 1067mm diameter segments the lower segments have been filled with bricks and gravel and upper segments with rubble. The extension to the piers in 1897 consisted of an 8 foot long segment with externally bolted flanges. The two columns of the pier extensions are joined by deep diaphragm consisting of steel I section cross bracing encased in reinforced concrete. The headstock consists of two reinforced concrete beams meeting in the middle of the bridge supported off the pier diaphragm in the centre of the bridge and support off the pier columns at the edges. The headstock was constructed in two parts to satisfy staged reconstruction.

The reinforced concrete beam and slab deck units were precast in two segments per span with a longitudinal central joint. The deck units are supported off the pier headstocks and are doweled at both ends.

3.2 Condition

3.2.1 Superstructure

Inspection reports have identified cracking, spalling and corrosion of the reinforcement on the underside of the deck units. Condition inspections have identified approximately 250m² of the bridge surface area exhibiting spalls, delamination or cracking. Exposed longitudinal reinforcement exhibits significant section loss in the external beams near the scupper locations. Reinforcement in other areas exhibits minor section loss.

The cracking and spalling has also been identified in the pier headstocks and diaphragms beams.

Durability assessment has identified extensive carbonation of the concrete deck units, with the mean measured carbonation depth exceeding the minimum cover the reinforcement at numerous locations. The durability assessment states "*General wide spread carbonation induced deterioration is likely in the near future. The damage, therefore is likely to increase with time as the carbonation front advances*"

Dynamic Frequency Analysis (DFA) undertaken on span 1 in 2003 and spans 1 to 4 in 2010 indicated a 16% reduction in the first mode natural frequency of the span 1 indicating a deterioration of condition of the span 1 over the 7 year period. The 2010 recorded natural frequency of spans 3 and 4 were lower than the results for spans 1 and 2, the lower natural frequency recording was consistent with the visual inspections that show spans 1 and 2 are in better condition than spans 3 and 4

3.2.2 Substructure

Underwater inspection reports have identified significant section loss due to graphitisation, with measured effective wall thickness ranging from 27mm to as low as 2mm. There is evidence of graphitisation along the full length of the submerged sections of the piers down to the river bed level. Circumferential cracking has also been identified in both columns of pier 5 and the downstream column of pier 6.

Significant corrosion of the bottom flange of the horizontal element of the pier bracing has also been identified.

3.3 Load Rating

The structure has been load rated, load tested and instrumented, a summary of the results are presented below.

3.3.1 Superstructure

The results of desk top load rating for “as new” and “as is condition” of the superstructure identified in the RTA Inspection and Assessment Report December 2003 are as follows

- T44 design loading – Load factor 1.48 for as new
- 42.5 Tonne Semi Trailer (ST42.5) – load factor 1.87 for “as new” and 1.45 for “as is condition”
- 62.5 Tonne B-Double Vehicle (BD 62.5) – load factor 1.87 for “as new” and 1.45 for “as is condition”
- Load testing (Aug 2006) concluded – 42.5t GVM Semi trailer be allowed to continue to cross the bridge
- Load testing (Aug 2006) of the deck units measured dynamic load allowances of 17%, this is less than code minimum values of 25% and less than the code value of 40% for short spans used in the desktop load rating of the superstructure.
- Dynamic Frequency Analysis (April 2011) concluded “the bridge in its present condition will be safe for some time” implying it will be safe until the planned replacement of the bridge.

The load ratings undertaken to date have not assessed the capacity of the bridges for High Mass Limit (HML) Vehicles or the current SM1600 design vehicles.

3.3.2 Substructure

Load rating of the piers for “assumed condition” of the substructure identified in the RTA Rehabilitation Report (2005) is as follows

- Current legal loads – Load Factor marginally above 2.0
- T44 design loading – Load Factor was less than 2.0

The load rating of the piers was based on a residual 25mm wall thickness allowing for general graphitisation minus eight, 30mm diameter x 13mm deep per recesses in the cross section to account for localised graphitisation.

Traffic plus braking was found to be the critical loading on the piers. A review of the flooding case found flooding does not govern the pile load rating, and there was no uplift on the upstream pile for the flood case.

CTI undertook additional work in 2011 which indicated the graphitisation was more extensive than had been indicated by the limited assessment prior to the 2005 report. The effective remaining section was found to be as low as 12mm compared to the 25mm used in the 2005 assessment.

Therefore in 2011 RTA undertook load testing with strain gauging of the piers. The instrumentation found good correlation between the stresses in the cast iron under vertical loading with the theoretical values from calculations. Under the braking test the change in strain was a lot less than calculated indicating that the braking forces were being transferred through the deck to the abutments rather than down the piers. The cracking around the dowels into the deck units would support the case that the deck units are restrained at the piers and are prevented from sliding freely under braking and thermal movement. Even allowing for the halving of the section thickness and hence capacity, the load factor of 2 from the 2005 work was still considered to be acceptable for current loading based on the strain gauge results indicating the horizontal braking forces from the deck are being transferred through the deck back to the abutments with the existing articulation of the bridge. However, if the bridge is rehabilitated to its original “as designed” state the articulation could change, resulting in the horizontal braking forces being transferred to the piers and not to abutments. It will then be necessary to determine whether the piers could carry these forces or if another solution to releasing the dowels is required. The flood case was not revisited on the basis the bridge was scheduled for demolition.

RTA also undertook survey of the deck to check for any evidence that the deck was settling due to deterioration of the piers. The survey results indicated that there was no evidence of settlement occurring. Based on these findings and the assessments of the superstructure no load limits were imposed on the bridge.

3.3.3 Load Rating Factors

Based on the analysis results available, the overall rating of the bridge in its current condition is around 1.45 for current loadings.

In accordance with the rating section of the bridge code (AS5100.7), bridge structures are required to have a 2.0 load factor for T44 design loading. As the load factor for this bridge for T44 and current legal loadings (ST42.5 and BD62.5) are less than the required 2.0, RMS have put in place an intensive inspection program (including weekly inspections) to manage the risks associated with a bridge with a load factor less than 2.0.

4.0 Proposed Rehabilitation

4.1 Understanding of the Proposed Rehabilitation

4.1.1 Substructure

Extract from EIS submission by Messrs' Wedgwood and Pearson.

"It is envisaged that the external plates would be in half section semi-circles with flanges for making a bolted connection between the half sections. Neoprene packing would give a uniform tight fit to the cylinders. The strengthening would only need to go for the depth of the cylinder that is severely affected by graphitization. The depth required for strengthening the cylinders would need to be determined (assumed 3.35m).

It is envisaged that 16mm thick plates would be satisfactory for the strengthening covers"

4.1.2 Superstructure

Extract from EIS submission by Messrs' Wedgwood and Pearson.

"It is envisaged that the underside of the reinforced concrete deck could be restored by:

- a) Using high pressure water blasting of the underside surfaces from barges under the deck to ensure traffic using the deck is not disrupted;*
- b) Inspecting the reinforcement for possible loss of cross sectional area and determining if supplementation of the reinforcement is required;*
- c) If supplementation of the reinforcement is required it can be readily achieved by using carbon fibre epoxy bonded to the final concrete surface;*
- d) Replace the blasted concrete using "gunniting" or "shotcreting" process;*
- e) Provide a protective coating to the repaired and/or strengthened concrete"*

5.0 Technical Review

5.1 Substructure

5.1.1 Structural

Jacketing of the piers to reinstate the structural capacity of the piers to their original capacity can be achieved by the proposed bolting of semi-circular steel shells around the existing pier columns. As the original column segments are internally jointed, the proposed sleeve solution would not be fouled by the original column joints.

The steel jackets will provide structural strengthening to compensate for the loss of cast iron due to graphitisation. We are of the opinion that it will be necessary to grout the annulus between the irregular surface of the existing piers and the inside face of steel jacket to achieve effective load transfer into the steel jacket. The steel jacket should be taken, say one times the pile diameter beyond the point of need to achieve load transfer, this would need to be confirmed during detailed design. The provision of a grout annulus also has the added benefits of protecting the inside face of the steel jacket and preventing further graphitisation of the cast iron.

To minimise the visual impact it would be preferable to start the casing at the low water line and extend down to just below (say 0.5m) the river bed level. The jackets may need to extend above the low level line depending on the extent of the graphitisation in this area, measurements taken approximately 0.7m below the water level at the time of the underwater inspection show significant section loss. Extending the jackets one diameter above this level would put the top of the casing around 0.3m above the low water mark. Extending the jackets above the low water level will impact on the pier cross bracing that would need to be modified. There were no thickness measurements recorded in the tidal zone, so additional testing would be required to establish the termination level of the jackets. Inspections of the casting above the high water mark indicate the cast iron is in excellent condition with minimal section loss, so jacking above the high water mark is unlikely to be required. The river bed is around 5m below the low tide level. One set of cast iron wall thickness measurements taken at the river bed level at pier 5 indicate a residual wall thickness of 21mm, this result is significantly thicker than the results higher up the pier. There was evidence that the softer graphitised material has been eroded off the pier at the river bed level. Therefore it is recommended that the jacket is taken a minimum of 0.5m below the river bed level to limit future graphitisation and abrading of the cast iron. Additional investigations would be required to establish the extent of section loss below the river bed to determine the final termination level of the jackets. It is anticipated a jacket length required will be in the range of 5 to 6m, with an average of say 5.5m. A 16mm thick jacket is considered sufficient for structural capacity; an allowance for corrosion needs to be added to this thickness, taking the thickness to 20mm.

5.1.2 Durability

The proposed jacketing solution will provide a long term solution to the repair of the piers. Water sampling results contained in the underwater inspection report indicate the water has a low chloride content and is considered fresh at this location. It is understood in periods of drought, brackish water may be found at the bridge site. An allowance of 0.025mm/year corrosion allowance for the external face of the steel jacket would require a 2.5mm additional wall thickness over a 100 year design life. Grouting of the annulus between the jacket and the cast iron will enhance passivation of the steel and cast iron surfaces and prevent further graphitisation of the cast iron. The outer surface of the jackets should be coated with a protective coating to enhance durability.

Repainting of the cast iron piers above the jacket level and the steel cross bracing will be required to preserve the cast iron and steel work. Repainting would be required approximately every 15 - 20 years.

5.1.3 Constructability

The jacketing of the piers can be undertaken without any impact on the traffic using the bridge.

5.2 Superstructure

5.2.1 Structural

The Wedgewood / Pearson repair methodology for the deck units to maintain “as is” condition providing a load factor of approximately 1.5 on current traffic loadings (42.5 tonne semi trailers and 62.5 tonne b-double vehicles). Repair of the deck to achieve an “as new” condition would increase the load factor on current loading to 1.87. Strengthening of the deck units for flexure would be required to bring the bridge up to a load factor of 2.0 for current loading and T44 design vehicle for code compliance. The refurbishment in combination with the proposed bypass would provide an alternate heavy vehicle route and a load restriction could be placed on the refurbished bridge for light vehicles only. However to reduce current inspection and monitoring requirements, the refurbishment of the bridge would need to achieve a higher load factor for current and T44 design loading. Acceptance of a load factor of less than 2.0 for the refurbished structure would require appropriate risk assessment and risk management procedures.

The load rating of the superstructure undertaken by RMS has indicated strengthening for flexure is required to achieve a load factor of 2.0. The beams have a load factor greater than 2.0 for shear and do not require shear strengthening. Strengthening for flexure could be achieved by bonding high strength carbon fibre laminates to the underside of the beams of the deck. The use of carbon fibre would not distract from the current appearance of the bridge. However there is a risk associated with bonding carbon fibre strips to the beam soffit areas not replaced with concrete patch repairs. The strips would be bonded over the top of areas of potential corrosion activity (un-patched areas) and these areas may over a period of time crack, spall or delaminate losing the effectiveness of carbon fibre. Therefore if carbon fibre strengthening is to be undertaken it is recommended that it be undertaken in conjunction with re-alkalisation and patch repairs.

The connection between the deck units and the pier headstocks consists of a doweled connection. The drawings call up a 48mm diameter anchor at each end of each girder of the deck unit. There is no detail to show how this was achieved with the precast deck units. The girders of the deck units sit directly on the headstock concrete without bearings. It appears the dowels are locked up with diagonal cracking identified at the support locations, these cracks may have been caused by the restraint of thermal expansion and contraction movements. The braking load test undertaken on the bridge supports the theory that the bridge is locked up with negligible bending stresses recorded in the piers under the tests indicating the horizontal forces are being shared by all the piers or being transferred back to the abutments. It would be difficult to remove and replace the dowels, as this would involve coring out the existing dowels and casting new dowels into the headstocks fitted with rubber o-rings and conduits that are grouted into the deck unit to provide rotation and translation capacity to prevent the build up of stresses. The difficulty with replacing the dowels is preventing damage to the existing reinforcement in the deck units and headstocks. A detailed assessment of the bridge articulation would need to be undertaken to determine the most appropriate solution to address the current diagonal cracking. Alternative solutions that provide a stiffer alternative load path for longitudinal and transverse forces to reduce the stresses imposed on the dowels could be developed as part of the detailed design of the strengthening works. The cost estimate for the rehabilitation should provide some allowance for the cost to solve this issue.

Geometrically the width between barriers of 6.1m for the two traffic lanes remains unchanged under the proposed rehabilitation, This width is less than current standards.

5.2.2 Durability

Repairs to the spalled concrete and corroded reinforcement using pressure blasting and scrubbing tools is an established method to remove defective concrete. Wire brushing and grit blasting can be used to remove corrosion product off reinforcement. Cementitious patch repair mortars can be effectively applied by hand for small areas and using methods such as shotcreting for large areas.

It is noted that the condition investigation conducted by GHD was performed in August 2003 and therefore the information and conclusions relate to condition of the structure more than 9 years ago. Considerable continued deterioration would be expected to have occurred since the GHD and RTA reports were written. The extent of additional deterioration that has occurred since 2003 would give a good indication of the rate of deterioration and the expected increase in repair quantities, which in turn could lead to an alternative repair solution being more cost effective than re-alkalisation.

The effectiveness of any repair is influenced by the basic quality of the materials within the structure. The core data indicates the beam and headstock concrete have average compressive strengths of 37 MPa and 50 MPa respectively. These results would suggest that the strength indicates a high quality of concrete considering it was cast in 1922 which is encouraging for the continued performance of the bridge after repair. Under dry conditions, it would be expected such a concrete to have a relatively high resistivity which would also limit the rate of corrosion.

The observation that the majority of the spalling and delamination on the external beams was adjacent to drainage holes demonstrates that the presence of water is a key component in the observed deterioration on this particular structure. The corrosion rate of reinforcing steel within carbonated concrete is often very low and the propagation phase before cracking occurs can be very long. This is usually because of the limited moisture available to promote corrosion. Damp environments lead to saturated concrete which would not be expected to have significant carbonation. The environmental conditions on the Windsor Bridge allow carbonation with intermittent saturation to accelerate corrosion of the depassivated reinforcement due to periodic flooding and surface runoff during rain events.

Installing properly sealed downpipes into the existing drainage holes in the deck to a new longitudinal stormwater drainage pipe suspended on the underside of the slab between the beams draining back to a collection point at each abutment is required. This would prevent drainage water spilling onto the beams and soffit of slab, slowing the rate of corrosion damage adjacent to the existing deck drainage holes. Waterproofing of the wearing surface is also recommended to reduce moisture ingress into the deck units. This would involve removing the existing asphalt surface, applying a sprayed waterproofing membrane and relaying a new asphalt surfacing. As part of the waterproofing of the deck, repairs to the joints between the deck units at the piers will be required. This will involve breaking out defective concrete and repairing. It is also required to create a recess 20mm x 20mm at the top of the deck units to accept a poured joint sealant. A bituminous tape is placed over the joint before reinstating the asphalt surfacing.

Two approaches to the repairing of the concrete elements of the superstructure are discussed in the GHD report. The first option is a conventional patch repair solution; the second option is a patch repair plus re-alkalisation solution.

5.2.2.1 Conventional Patch Repair

For a patch repair and coating option, GHD report states that conventional patch repair “entails removal of all delaminated and loose concrete behind reinforcement and along reinforcement until it is not corroded. This is likely to result in removal of approximately 2-3 times the concrete surface currently identified as cracked/spalled or delaminated. This option is deemed to require cyclic patch repair every 3-5 years” which is based on the assumption that the anti-carbonation coating would not stop the reinforcement corrosion in areas where the carbonation exceeds the cover depth”.

The assumed limited longevity of such repairs is the main reason that the patch repair option is not considered appropriate. If the patch repair option were to include a sacrificial anode to limit the incipient anode effect and a silane treatment prior to application of the anti-carbonation coating, we are of the opinion that a patch repair system could provide an appropriate cost-effective repair option provided the coating system prevents water ingress. Migrating corrosion inhibitors could also be used to further enhance the durability of such an option.

It is unlikely that such an option would not have local defects that may require future repair. A visual survey should be conducted say 10 years after repair to determine any additional areas of cracking/spalling. These should be repaired before reapplication of the anti-carbonation coating.

The patch repair option would not return the reinforcement to a passive state as anticipated in the re-alkalisation option. Nonetheless we are of the opinion that a properly conducted repair and coating system should provide acceptable performance of the structure for an additional service life of 25 years with limited maintenance.

The scope of works for a patch repair solution would include.

- Contain and remove defective concrete in accordance with environmental and WHS requirements
- Breakout of defective concrete to a depth of approximately 80mm to allow for the patch repair to envelope the longitudinal reinforcement. Clean and treat corroded reinforcement including the installation of sacrificial anodes
- Apply repair mortar
- Apply silane coating
- Apply anti-carbonation coating

Periodic maintenance (every 10 to 12 years) would include

- Breakout and repair defective / spalled concrete including treating of reinforcement
- Reapply silane treatment to new repairs
- Reapply anti-carbonation coating to entire surface

5.2.2.2 Re-alkalisation Plus Patch Repair

The second option to repair the deck concrete involves a patch repair plus re-alkalisation. The patch repair area would be similar to the first option however the depth of the concrete to be removed would be less as there is no requirement to envelope the existing reinforcement. The re-alkalisation should restore the reinforcement to a passive state and therefore would be a technically superior option albeit more expensive solution. An important concern for the use of this technique is the possibility of slowly reactive aggregate indicated by the uranyl acetate test. The benign reactivity of the aggregates used in the concrete should be confirmed by petrographic examination. Alternatively more expensive lithium hydroxide or similar may be used as the electrolyte which would not cause any Alkali Silica Reactivity (ASR) problems. A potential side effect of re-alkalisation is that residual electrolyte compounds can crystallise out and cause debonding of the coating. Care needs to be taken to ensure effective surface preparation to ensure the longevity of the coating.

The scope of works for a re-alkalisation plus patch repair solution would include:

- Contain and remove defective concrete in accordance with environmental and WHS requirements
- Breakout of defective concrete to a depth of approximately 50mm depth to expose the corroded longitudinal reinforcement
- Clean and treat corroded reinforcement
- Apply repair mortar
- Apply re-alkalisation
- Apply anti-carbonation coating

Periodic maintenance (every 12 to 15 years) would include:

- Breakout and repair defective / spalled concrete including treating of reinforcement (expected to be minor under this option)
- Reapply anti-carbonation coating to entire surface

Both the patch repair and coating option or patch repair plus re-alkalisation and coating option would provide suitable solutions to extend the life of the Windsor Bridge for 25 or more years. The former would be expected to require future repair of localised areas of cracking/spalling. We would suggest that this should be conducted after 10 years and prior to the reapplication of the anti-carbonation coating. Reapplication of the anti-carbonation coating would be required every 10-12 years.

Re-alkalisation would be expected to provide a long-term solution greater than 50 years that would not require reapplication of the re-alkalisation provided the anti-carbonation coating was properly maintained (i.e. reapplication of the anti-carbonation coating every 10-12 years).

5.2.3 Constructability

The majority of the defects identified in the bridge superstructure have been identified on the underside of the bridge. The majority of the work to clean and repair these defects could be carried out under traffic from the underside of the bridge in accordance with environmental and WHS requirements. To provide access to the underside of the deck and contain the waste a platform could be provided to span between the piers to avoid placing additional loads on the deck units. The platform would need to incorporate an enclosure, drainage system and sump to contain the waste from the high pressure water blasting used to remove the defective concrete for the repairs to the deck soffit.

Depending of the properties of the patch repair material some restriction on traffic movements over the deck may be required while the repair mortars are setting. Traffic restrictions could include reduced speed limits and overnight lane closures.

Repairs to the joints at the ends of the deck units would need to be undertaken during night lane closures. High early strength repair mortars and possibly road plates would be required to enable early trafficking of the repairs to minimise traffic impacts.

Waterproofing of the deck could be undertaken as part of general maintenance during planned resurfacing the asphaltic wearing surface.

6.0 Quantities

Basic quantities for the refurbishment are presented in the table below. Items identified with an asterisk indicate the item was not specifically included in the cost estimate provided in the Messrs Wedgewood and Pearson submission.

| Substructure | Qty | Unit |
|--|------|--------|
| Preparation - Water blast clean existing piers | | |
| Area | 369 | m2 |
| Steel Jackets | | |
| Total Weight | 75 | tonne |
| Protective Treatment Exterior Surface of Steel Jackets | | |
| Area of Protective Coating | 565 | m2 |
| * Protective Treatment Exterior Surface of CI Pier above Jackets | | |
| Area of Protective Coating | 670 | m2 |
| * Replacement of Horizontal Bracing Element | | |
| Total Weight including clamps (galvanised) | 2.4 | tonnes |
| * Grout Annulus in Steel Jackets | | |
| Total Volume Grout | 11.4 | m3 |
| * Pier Diaphragms | | |
| Repair Defective Diaphragm Concrete | 75 | m2 |
| Repair / treat defective reo | 75 | m2 |
| Silane treatment - Deck Units | 277 | m2 |
| Anti carbonation coating - Deck Units | 277 | m2 |
| Articulation | | |
| Rectification of bridge articulation | | Item |
| Superstructure | | |
| Underbridge access and containment platforms | | Item |
| Repair Deck Units - Patch Repair Option | | |
| Repair Defective Deck Concrete (80mm depth) | 750 | m2 |
| Repair / treat defective reo | 750 | m2 |
| * Silane treatment - Deck Units | 2611 | m2 |
| * Anti carbonation coating - Deck Units | 2611 | m2 |
| Repair Deck Units - Re-alkalisation Option | | |
| Repair Defective Deck Concrete (50mm depth) | 750 | m2 |
| Repair / treat defective reo | 750 | m2 |
| * Re-alkalisation - Deck Units | 2611 | m2 |
| * Anti carbonation coating - Deck Units | 2611 | m2 |
| * Repair Deck Joints | | |
| Breakout Defective Deck Concrete | 4 | m3 |
| Repair / treat defective reo | 40 | m2 |
| Joint Sealant | 73.2 | m |
| * Repair Headstocks | | |
| Repair Defective Headstock Concrete | 50 | m2 |
| Repair / treat defective reo | 50 | m2 |
| Silane treatment - Deck Units | 195 | m2 |
| Anti carbonation coating - Deck Units | 195 | m2 |
| * Drainage | | |
| Install scupper downpipes | 44 | each |
| Longitudinal drainage pipe | 280 | m |
| * Deck Waterproofing | | |
| Remove existing surfacing | 897 | m2 |
| Waterproofing layer plus AC | 897 | m2 |

7.0 Conclusions

The proposal to rehabilitate the Windsor Bridge using steel jackets and deck concrete patch repairs is considered technically viable provided future maintenance is undertaken to maintain the integrity of the repairs.

Key points of the review are summarised below.

- To provide an effective load transfer between the steel jackets and the existing cast iron piers it is recommended that a grout annulus be included in the jacket design. This will also provide protection to the remaining cast iron material and protection to the inside surface of the steel jacket.
- The steel jackets should start 0.5m below the river bed and extend to just above the low water level, the estimated average length of the jacket is 5.5m. Additional testing of the remaining cast iron thickness in the tidal zone and just below the river bed will be required to establish the final length of the jacket.
- An allowance for long term corrosion should be incorporated into the design of the wall thickness of the jackets in addition to providing a protective coating to the exterior surface of the jackets.
- The cast iron piers above the jackets and the steel cross bracing will need to be painted on a regular basis approximately every 15 years.
- A patch and repair approach to the concrete defects of the bridge could provide a short to medium solution, (greater than 25 years) if combined with a silane and anti-carbonation coatings, plus deck water proofing. Additional measure such as sacrificial anodes, migrating corrosion inhibitors could be used to improve durability and reduce future maintenance of the concrete elements. Anti-carbonation coatings will need to be re-applied every 10 to 12 years.
- A patch and repair plus re-alkalisation approach to the concrete defects of the bridge if proven to be cost effective would significantly reduce future patch repairs of the structure and would be expected to extend the life of the structure to beyond 50 years. The anti-carbonation coating would need to be reapplied every 10 to 12 year.
- Modification to the current scupper arrangement is required to prevent scupper water splashing on the deck units; this will include the installation of droppers and a longitudinal underdeck piped drainage system.
- Joint repairs, waterproofing and resurfacing of the deck would require night lane closures
- In terms of traffic related impacts, the majority of the repairs to the structure can be undertaken with little impact on traffic using the bridge. Surface repairs to the deck joints will require night lane closures and road plates while the repairs are undertaken. An appropriately designed containment system would be required to prevent the waste products from the repairs entering the river.
- The load factor of the rehabilitated bridge assuming the refurbishment brought the bridge back to a “as new” condition would be 1.87 for current legal loadings (42.5 tonne semi-trailer and 62.5 tonne B-double vehicles). This is less than 2.0 required by current bridge design standards. Acceptance of a load factor of less than 2.0 for the refurbished structure would require appropriate risk assessment and risk management procedures.
- Strengthening of the bridge to achieve load factors of 2.0 for current legal loadings and T44 design vehicles could be achieved through the use of carbon fibre strengthening of the deck beams. Carbon fibre strengthening is only recommended in conjunction with the re-alkalisation repair option.
- The load ratings undertaken to date have not assessed the capacity of the bridges for High Mass Limit (HML) Vehicles.
- A load factor of 2.0 on T44 design vehicle may not be considered necessary if a heavy vehicle bypass bridge was construction and the bridge restricted for use for light traffic only.
- The existing 3.05m traffic lanes are less than current road design standards, the lane width remains unchanged under this refurbishment proposal.

Appendix D - Landscape character and visual impact assessment addendum

MRI 82 - BRIDGE STREET, WINDSOR
REPLACEMENT OF WINDSOR
BRIDGE
LANDSCAPE CHARACTER AND
VISUAL IMPACT ASSESSMENT
ADDENDUM 01

APRIL 2013



CONTENTS

| | |
|------------------------|----|
| Introduction | 3 |
| Description of Changes | 3 |
| Effects of the Changes | 6 |
| Overshadowing | 15 |
| Mitigation | 18 |
| Conclusion | 18 |

Introduction

This addendum to the Urban Design and Landscape Concept Report comments on the effects, in terms of landscape character and visual impact assessment, of the proposed changes to the Concept Design as presented in the Environmental Impact Statement (EIS) for the bridge replacement project at Windsor. The changes to be addressed in this report are described below.

Description of Changes

In response to a number of submissions received during the exhibition of the EIS, Roads and Maritime Services (RMS) propose to amend the design to increase the clearance of the new bridge over The Terrace from a minimum of 3.6 metres to a maximum of 4.6 metres to allow large coaches and garbage trucks to directly access Windsor Wharf. Large coach access to Windsor Wharf is required to allow the patrons of the Hawkesbury Paddlewheeler to have easy access to the wharf. Many of the patrons of the Windsor paddle steamer are elderly, disabled and/or have limited mobility and would find it difficult or impossible to access the wharf if existing arrangements were changed and large coaches were restricted to parking in Thompson Square road or Baker Street.

Bridge Height at The Terrace

To provide the additional clearance over The Terrace the height of the southern end of the proposed bridge would be increased. This would result in a one metre higher bridge and abutment at the southern end - and a marginally higher 45 metre section of the southern approach road through Thompson Square between the driveway of No. 4 Bridge Street to the southern abutment. South of the driveway of No. 4 Bridge Street and in front of the heritage listed properties of No. 6 and No. 10 Bridge Street, the height of the southern approach road would remain the same as that presented in the EIS. The road level grade of the bridge would also increase slightly from 1.6% to 1.9%.

Figure 1.1 and Figure 1.2 presents the difference in heights of the modified project in comparison to the project presented in the EIS.

Pier Spacing

The location of the piers would be slightly changed so that they are evenly spaced across the river, supporting equal spans of 31.32 metres along the length of the bridge. The proposed location of the piers are also shown in Figure 1.1. No changes to the abutments are proposed.

Pier Form

Relatively minor amendments to the bridge piers are also proposed. The ovoid pier shape would be replaced by an oval shape to allow hydraulic jacks to be positioned on top of the pier columns at periodic times for bearing replacement. The width would be reduced from 3 metres to 2.5 metres to suit the solid girder shape and the requirement to include a restraint corbel on the inside of the girder related to a change in bearing type from pot to laminated elastomeric bearings.

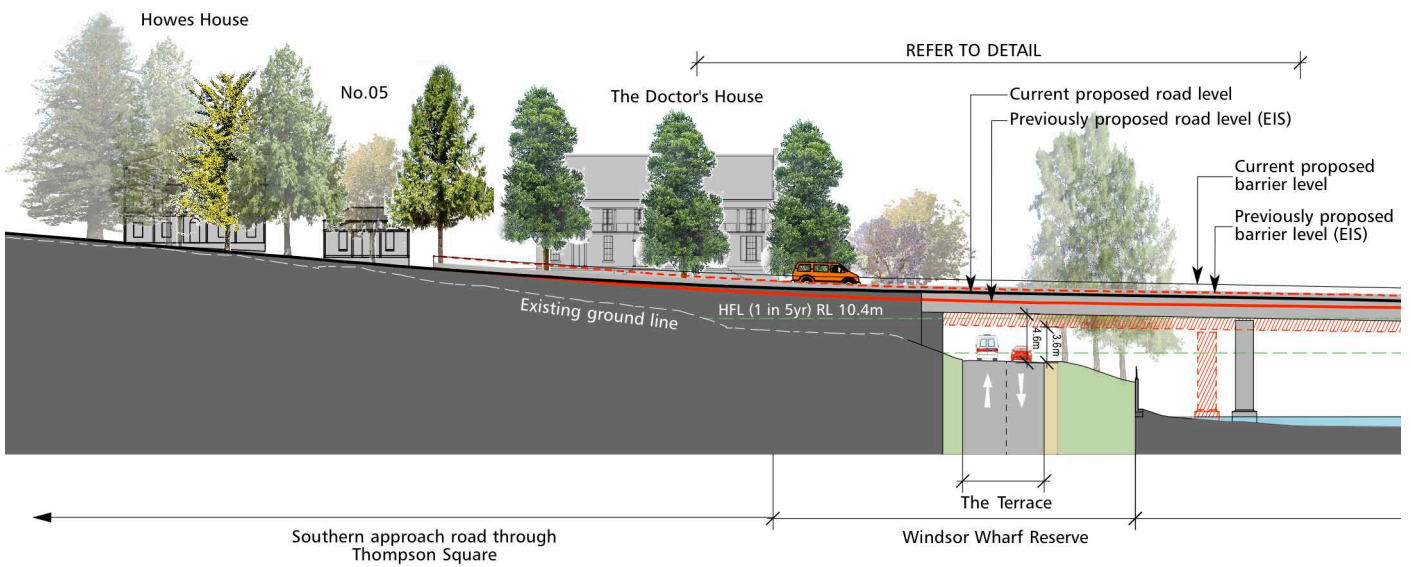


Figure 1.1: Proposed changes to the project. The previous design presented in the EIS is shown in red.

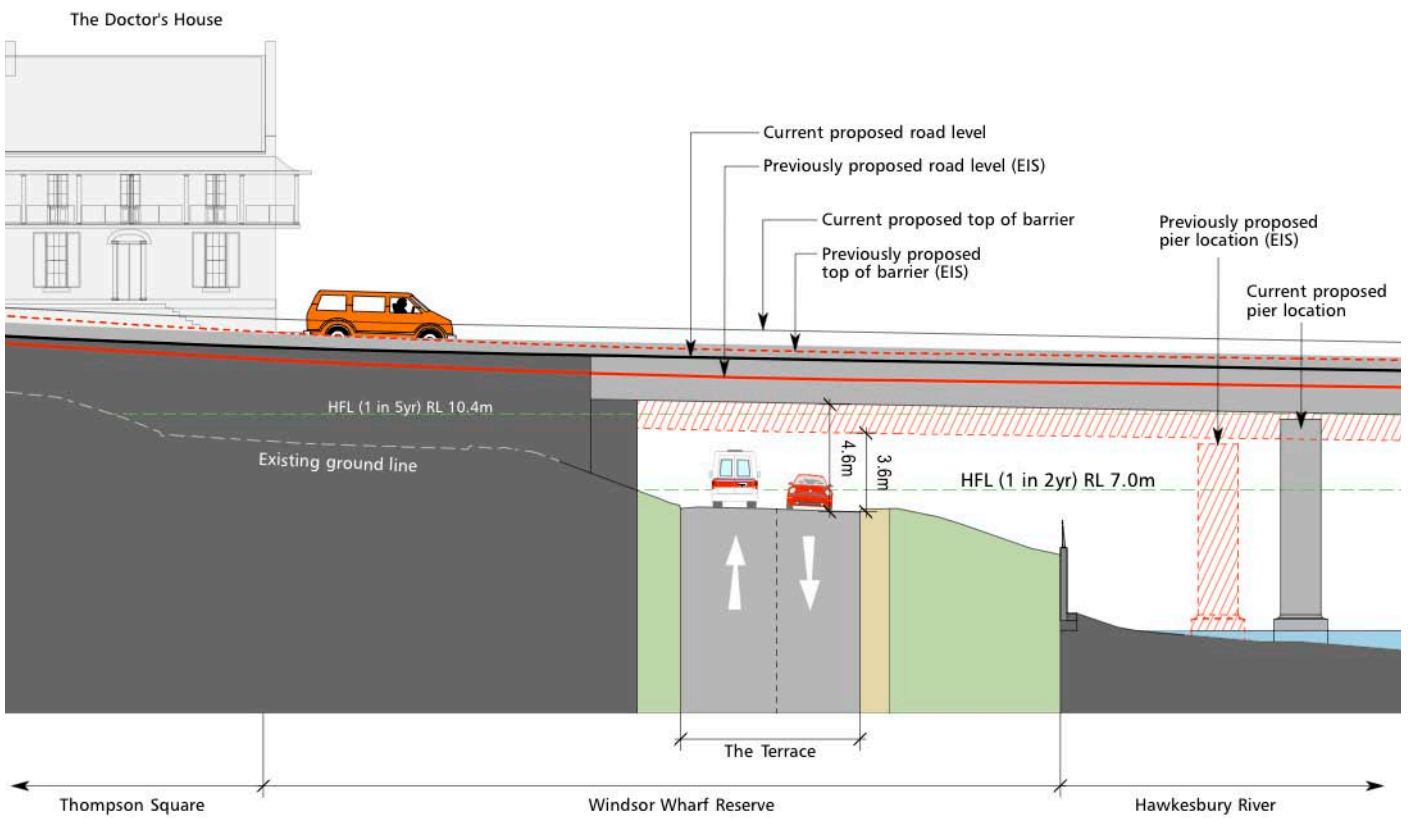
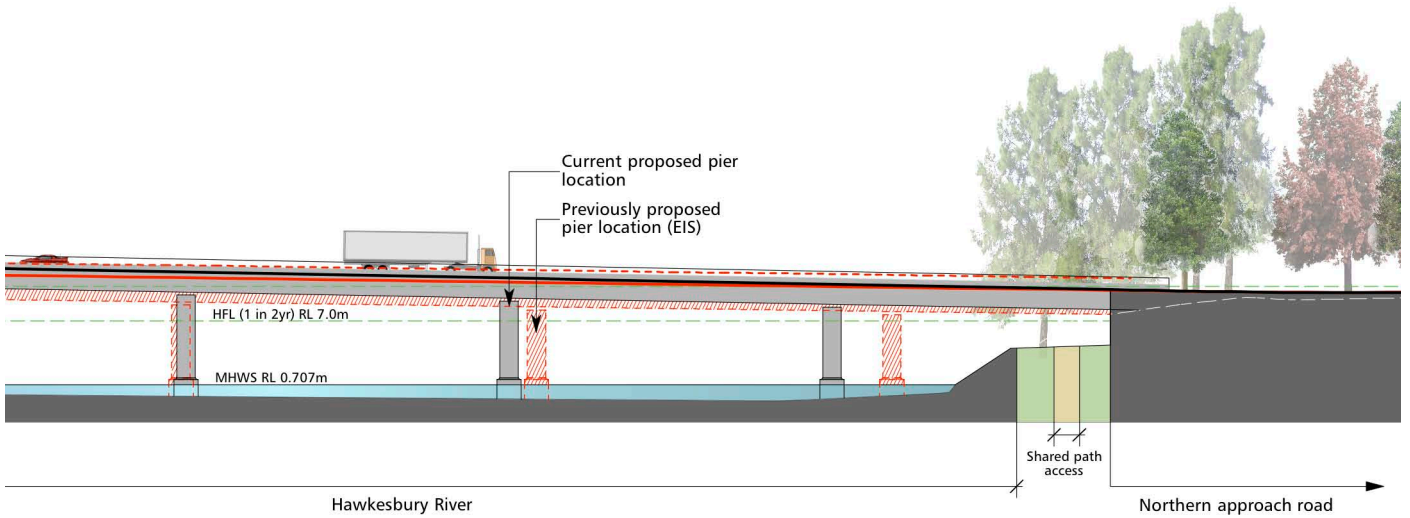


Figure 1.2: Detail section at The Terrace.

NOTE: Tress not shown for clarity

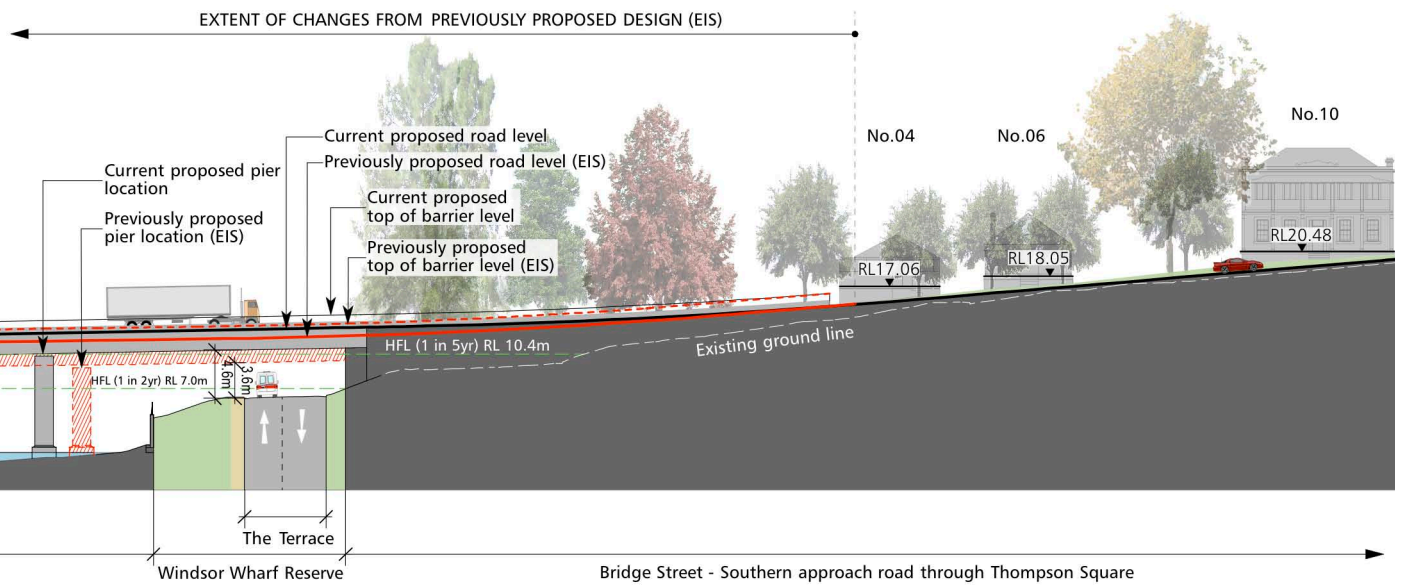




LEGEND

- Previously proposed road level (EIS)
- - - Previously proposed barrier level (EIS)
- ▨ Previously proposed bridge deck and piers (EIS)
- Current proposed road level
- - - Current proposed top of barrier level
- ▨ Current proposed bridge deck and piers

SCALE



LEGEND

- Previously proposed road level (EIS)
- - - Previously proposed barrier level (EIS)
- ▨ Previously proposed bridge deck and piers (EIS)
- Current proposed road level
- - - Current proposed top of barrier level
- ▨ Current proposed bridge deck and piers

SCALE



Figure 1.3: Proposed changes to the project in relation to the buildings on Bridge Street.

Effects of the Changes

The proposed design changes described previously would affect two of the landscape character zones (LCZ) and eight viewpoints previously assessed in the Urban Design and Landscape Concept Report, presented as part of the EIS. The affected LCZ's and viewpoints are highlighted in red on Figure 1.3 and Figure 1.4 and described in more detail below.

LANDSCAPE CHARACTER IMPACT

For the previous assessment, the study area was divided into three LCZ's, corresponding to landscape character types in the area and allowing for a more detailed discussion of the character of each zone. Each zone was then broken down into a number of different character attributes which were described in their existing situation, and as they would be as a result of the project. The magnitude of the proposed works, and the sensitivity of the LCZ to change were then assessed to determine the overall landscape character impact.

The proposed changes to the design would have an affect on LCZ 1:Thompson Square and LCZ 2: Hawkesbury River and River Banks. These changes are described below.

LCZ 1:Thompson Square

The assessment indicates that the proposed design changes would affect the following character attributes within LCZ 1.

Built Form and Heritage

The proposed design changes would add to the vertical scale of the bridge abutments, slightly increasing its physical and visual presence within Thompson Square and when viewed from the buildings along Thompson Square road.

Connectivity and Access

Vehicular connectivity along The Terrace would be enhanced by the allowance of large coaches and garbage trucks to access Windsor Wharf, essentially maintaining the existing access to the wharf. This may result in increased conflict between pedestrians and vehicles on The Terrace.

Public Domain

The physical and visual dominance of the proposal, as reported in the EIS, including the proposed southern approach road to the proposed bridge through Thompson Square and the bridge abutments, would now be marginally higher, slightly increasing their presence on the lower section of Thompson Square. A slightly higher underside to the bridge deck at The Terrace, would slightly improve the spatial experience of the roadway with slightly increased headroom and therefore slightly increased amounts of natural light.

Landscape Character Assessment

The Thompson Square LCZ was previously assessed to have High sensitivity, a High to Moderate magnitude, giving a High landscape character impact. The proposed design changes would not change the sensitivity rating, which would remain High. The slight increase in height of the southern approach road and bridge abutment is offset by minor improvements to public amenity and connectivity along The Terrace, maintaining a High to Moderate magnitude impact. Therefore, the overall landscape character impact would remain High.

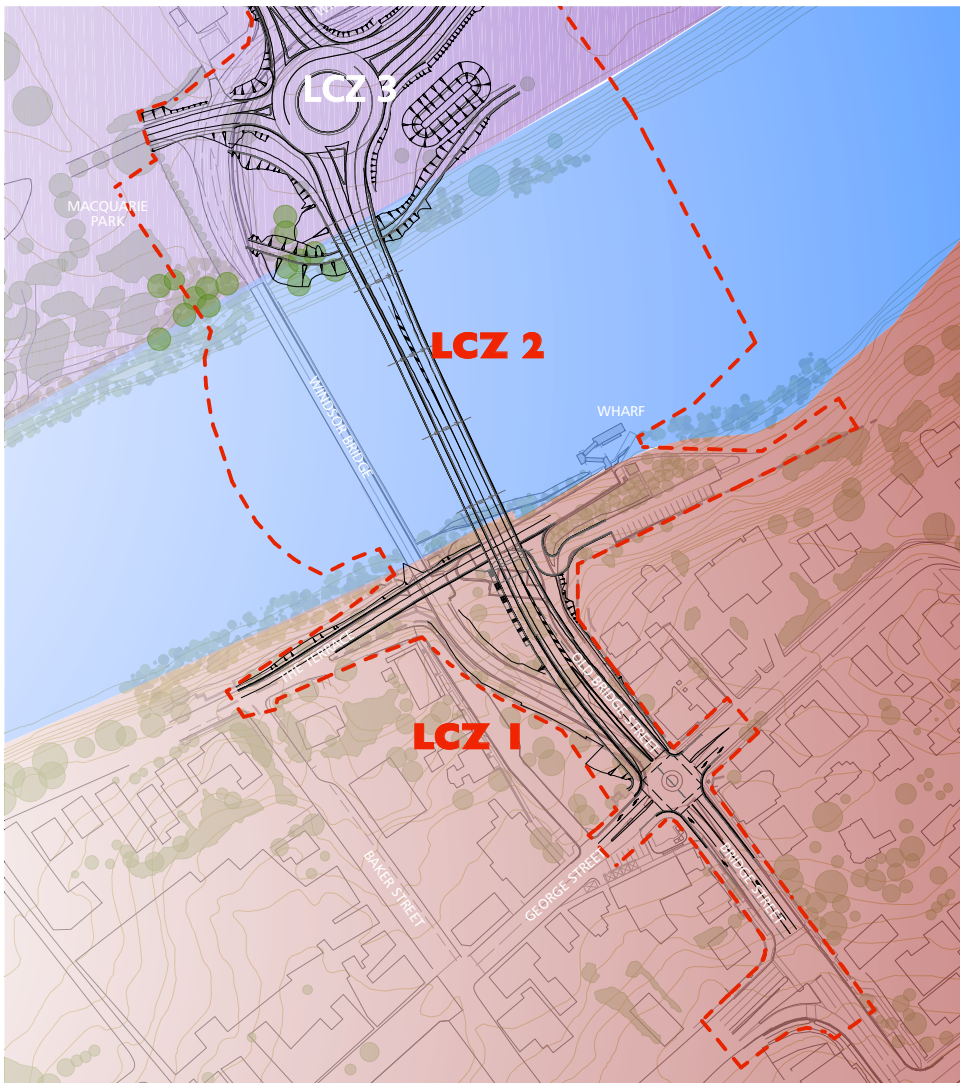
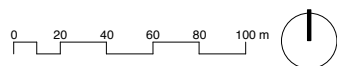


Figure 1.4: Landscape Character Zones, showing those affected in red

LEGEND

- - - CONSTRUCTION WORK ZONE
- LCZ 1 - THOMPSON SQUARE
- LCZ2 - HAWKESBURY RIVER AND RIVER BANK
- LCZ3 - WILBERFORCE ROAD AND FREEMANS REACH ROAD INTERSECTION



LCZ 2: Hawkesbury River & River Banks

The assessment indicates that the proposed design changes would affect the following character attribute within LCZ 2.

The Bridge

The proposed design changes would marginally increase the scale and height of the bridge, making it only slightly more dominant in the landscape than the original EIS proposal. The increase in the grade would further skew the plane of the bridge in relation to the river. The proposed increased height of the bridge and the equal spacing of the piers would increase the perception of space along the foreshore and under the bridge at The Terrace. The proposed location and spacing of the piers away from the river bank would also enhance this perception.

Landscape Character Assessment

The Hawkesbury River & River Banks LCZ was previously assessed to have High sensitivity, a High to Moderate magnitude, giving a High landscape character impact. The proposed design changes would not change the sensitivity rating, which would remain High. The increase in height of the bridge and increase in grade would not be considered sufficient to change magnitude rating, which would remain High to Moderate. Therefore, the overall landscape character impact would remain High.

Summary

The proposal assessed in the Urban Design and Landscape Concept Report as part of the EIS were found to have an adverse impact on landscape character. The landscape character assessment indicated a High sensitivity and a High to Moderate magnitude, resulting in a High landscape character impact for both LCZ's. The qualitative assessment of the proposed works described above, suggest that these ratings would not change.

VISUAL IMPACT

The previous study assessed the potential visual impact of the project in relation to eighteen identified key viewpoints within an estimated visual catchment. A desktop assessment suggests that the proposed changes would affect eight of these viewpoints. These are shown in red in Figure 1.4 and include:

- Viewpoint 5;
- Viewpoint 7;
- Viewpoint 8;
- Viewpoint 9;
- Viewpoint 11;
- Viewpoint 12;
- Viewpoint 17;
- Viewpoint 18.

Viewpoint 5

Location: Foreground view from Bridge Street, looking north west.

Description: The viewpoint overlooks the southern approach road to the bridge, which would be only slightly higher than that previously proposed.



Visual Impact Assessment

Viewpoint 5 was previously assessed to have High sensitivity and a Moderate magnitude, giving a High to Moderate visual impact. The proposed works would not change the sensitivity rating, which would remain High. The changes would not be sufficient to increase the magnitude rating as the changes, viewed from this location and angle, would be minor and the majority of the works would be obscured by the existing buildings and vegetation along the north eastern side of Bridge Street. Therefore the visual impact rating would remain High to Moderate.

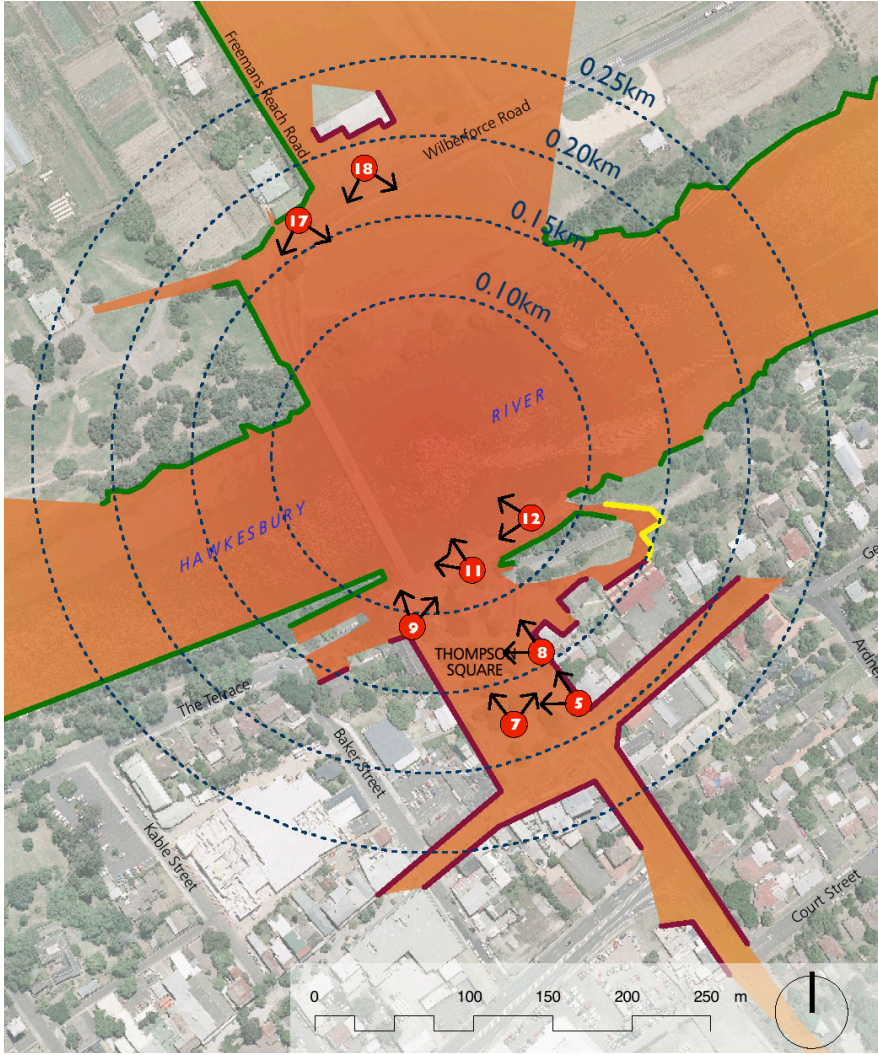


Figure 1.5: The Visual Envelope Map (VEM) and location of affected view points at a local scale (in red).

LEGEND

- PROXIMITY TO PROJECT WORKS
- ← AFFECTED VIEWPOINTS
- CATCHMENT CONSTRAINED BY VEGETATION
- CATCHMENT CONSTRAINED BY TOPOGRAPHY
- CATCHMENT CONSTRAINED BY BUILDINGS
- DISTANCES

Viewpoint 7

Location: Foreground view from Thompson Square, looking north.

Description: The viewpoint overlooks the southern approach road to the bridge and the bridge itself. The marginally increased height of the bridge abutments would be slightly more prominent from this viewpoint, and may obscure mid distance views to the water marginally more than the proposal presented in the EIS.



Visual Impact Assessment

Viewpoint 7 was previously assessed to have High sensitivity and a High to Moderate magnitude, giving a High visual impact. The proposed works would not change the sensitivity rating, which would remain High. The changes would not be sufficient to increase the magnitude rating as the changes in the foreground would be minor and the viewers perception of the changes would be reduced due to the distance and angle of the view to the abutments, and because of the roads downhill grade. Therefore the visual impact rating would remain High.

Viewpoint 8

Location: Foreground and mid distance view from Bridge Street, looking north west.

Description: The slightly raised southern approach road and raised bridge abutments and deck would slightly increase the visual dominance of the structure from this location and may obscure views of the river marginally more than the proposal presented in the EIS.



Visual Impact Assessment

Viewpoint 8 was previously assessed to have High sensitivity and a High magnitude, giving a High visual impact. The proposed works would not change the sensitivity rating, which would remain High. The changes would not be sufficient to increase the magnitude rating as the viewers perception of the changes would be reduced due to the location of the view along the downhill grade of the road. Views to the bridge deck would also be partly obscured by the existing building on Bridge Street. Therefore the visual impact rating would remain High.

Viewpoint 9

Location: This is a foreground and mid distance view from Thompson Square, adjacent to the Doctor's House, looking north.

Description: This viewpoint overlooks the river and the changes to the proposal presented in the EIS would be noticeable from this location.



Visual Impact Assessment

Viewpoint 9 was previously assessed to have High sensitivity and a High magnitude, giving a High visual impact. The proposed works would not change the sensitivity rating, which would remain High. The increase in height would be noticeable from this view due to its direction looking straight across at the works. This is slightly moderated by the distance from the viewpoint to the works and the angle of the view, maintaining a High magnitude rating. Therefore, the visual impact rating would remain High.

Viewpoint 11

Location: Foreground view from the small carpark near The Terrace, looking north west.

Description: This viewpoint is located under the replacement bridge. The increased height of the bridge would reduce the sense of enclosure under the bridge along this section of The Terrace, and would slightly open the view over the river.



Visual Impact Assessment

Viewpoint 11 was previously assessed to have High sensitivity and a High magnitude, giving a High visual impact. The proposed works would not change the sensitivity rating, which would remain High. The outlook from this location would be slightly improved due to the increased height of the underside of the bridge and the location of the southern bridge pier further from the river bank, though this would not be considered sufficient to reduce the magnitude rating which would remain High. Therefore, the visual impact rating would remain High.

Viewpoint 12

Location: Foreground view from Windsor Wharf, looking south west.

Description: This viewpoint provides extensive views along the river towards the existing bridge. The increased height of the bridge and abutments would be noticeable on the already prominent structure.



Visual Impact Assessment

Viewpoint 12 was previously assessed to have High sensitivity and a High magnitude, giving a High visual impact. The proposed works would not change the sensitivity rating, which would remain High. The increased height of the bridge would be noticeable from this viewpoint, which looks directly across to, and is in close proximity to, the proposed works, and may be sufficient to increase the magnitude rating. However, the magnitude rating is already High. Therefore, the visual impact rating would remain High.

Viewpoint 17

Location: Foreground view from Wilberforce Road, west of Freemans Reach Road, looking south.

Description: This viewpoint looks towards Windsor and the bridge replacement works. The increased height of the bridge would be visible from this location, although not substantially different to the previous proposal.



Visual Impact Assessment

Viewpoint 17 was previously assessed to have High to Moderate sensitivity and a High to Moderate magnitude, giving a High to Moderate visual impact. The proposed works would not change the sensitivity rating, which would remain High to Moderate. The changes would not be sufficient to increase the High to Moderate magnitude rating as they would be minor from this view due to the distance from the proposed works and the direction of the view along the roadway reducing the perceptible difference. Therefore, the visual impact rating would remain High to Moderate.

Viewpoint 18

Location: Foreground view from Wilberforce Road, east of Freemans Reach Road, looking south.

Description: This viewpoint looks towards Windsor and the bridge replacement works. The increased height of the bridge would be visible from this location.



Visual Impact Assessment

Viewpoint 18 was previously assessed to have Moderate sensitivity and a High to Moderate magnitude, giving a High to Moderate visual impact. The proposed works would not change the sensitivity rating, which would remain Moderate. The changes would not be sufficient to increase the High to Moderate magnitude rating as they would be minor from this view due to the distance from the proposed works and the direction of the view along the roadway reducing the perceptible difference. Therefore, the visual impact rating would remain High to Moderate.

Summary

The visual impact assessment of the proposal presented in the EIS indicated a mix of ratings from High impact through to Low impact. Of the viewpoints assessed as part of this addendum, five previously had High visual impact and three had High to Moderate visual impact. Overall, the changes to the works would not increase the existing impact ratings. The five viewpoints with a High visual impact would be affected the most, however, the works would not be sufficient to increase ratings due to the direction of views generally reducing the perceptible scale of the works. The three viewpoints with a High to Moderate visual impact would be slightly affected, although not enough to change the overall visual impact rating due to distance and the percentage of the works view.

Overshadowing

Additional shadow diagrams have been prepared by Urban Circus (Figures 1.5 and 1.6), using a computer model of the study area and incorporating the changes to the Concept Design. They show the shadows of the design presented in the EIS in blue, and the shadows of the proposed changes indicated in red. The diagrams depict the shadows cast by the bridge during the winter solstice (21 June) and the summer solstice (21 December) at three times of day; 9am, 12pm and 3pm.

The changes to the design would not greatly add to the existing overshadowing effects of the bridge. Generally, the shadow extent would remain similar; its footprint would move south. The most noticeable change would be in the early morning in winter to the lower section of Thompson Square, where the approach road on the alignment of Old Bridge Street becomes elevated on a fill embankment as it approaches the abutment, the river foreshore and the river itself. The section of The Terrace directly beneath the replacement bridge would receive slightly more sunlight due to the increased height of the bridge and the location of the piers further away from the foreshore.

The additional overshadowing caused by the increase in height of the southern approach road embankment and bridge would only slightly further affect user's experiences within the lower section of Thompson Square, and would continue to be unlikely to impact on activities occurring on the river.

21st JUNE



9am



12pm



3pm

Figure 1.6: Shadow cast by the replacement bridge on 21st June.

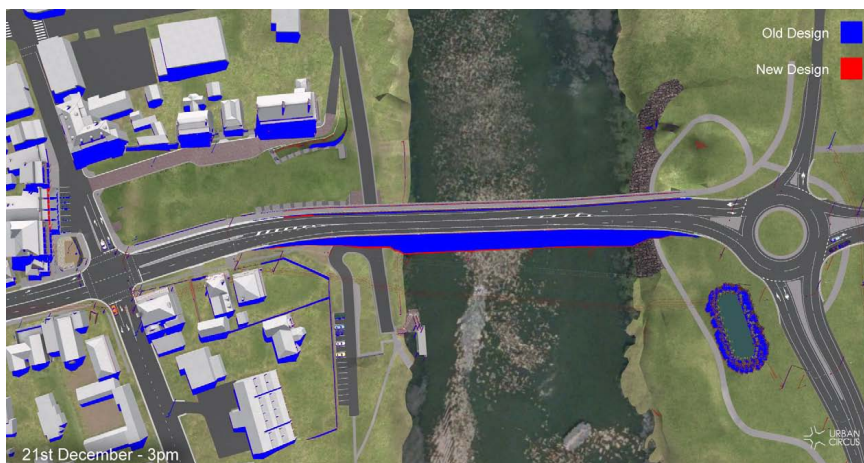
21st December



9am



12pm



3pm

Figure 1.7: Shadow cast by the replacement bridge on 21st December.

Mitigation

During the Concept Design phase of the project, to lessen the visual impact of the proposed works and to help integrate the replacement bridge into the landscape, a number of mitigation measures were incorporated into the design. Further mitigation measures were identified to be considered during the Detailed Design phase and to be implemented during construction.

Mitigation measures implemented during the Concept Design included:

- 50km/hr design speed to keep bridge level as low as possible;
- Incrementally launched bridge type to minimise number of piers and minimise bulk of the bridge;
- Curved formed bridge piers for a finer appearance. The slight change in shape would not affect the streamlined appearance of the piers;
- Placement and design of abutments to improve access along the river foreshore;
- Direct access through and around Thompson Square provided by infilling existing Bridge Street cutting;
- Siting the southern approach road as close as possible to existing levels to maximise the retention of views across the upper area of Thompson Square.

Due to the proposed changes, a number of mitigation measures mentioned in the Urban Design and Landscape Concept Report for consideration during the Detailed Design phase of the project may be considered. These included:

- Further design refinement of The Terrace and foreshore area to achieve a high quality public space and avoid conflict between vehicles and pedestrians;
- Consider locations of new tree plantings to facilitate direct views to the river and screen the replacement bridge and embankment where possible.

Conclusion

The changes to the design of the bridge replacement at Windsor would have minimal impact to the landscape character and visual impact to those already described in the Urban Design and Landscape Concept Report. The raised height of the bridge, southern approach road and abutment slightly increase the scale of the structure and result in a small increase in overshadowing to Thompson Square on winter mornings. These changes would not be considered sufficient to affect the visual impact ratings given in the Urban Design and Landscape Concept Report.

Despite the minimal impact of the proposed changes, consideration should be given to incorporate appropriate mitigation measures during the Detailed Design phase of the project.

Appendix E - Operational noise and architectural treatment addendums



Transport
Roads & Maritime
Services

Windsor Bridge Replacement

Noise and vibration Addendum

Final

(blank page)

Roads and Maritime Services

Windsor Bridge Replacement

Noise and vibration Addendum

Final



Document history and status

| Revision | Type | Prepared by | Reviewed by |
|----------|-------|-------------|-------------|
| 1 | Final | S Hughes | J Ball |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

Contents

| | | |
|----------|-----------------------------------|----------|
| 1 | Introduction | 2 |
| 1.1 | Overview | 2 |
| 1.2 | Project design modification | 2 |
| 1.3 | Revised noise sensitive receivers | 2 |
| 2 | Operational impact | 6 |
| 2.1 | Noise modelling results | 6 |
| 2.1.1 | Additional mitigation measures | 6 |
| 3 | Conclusion | 8 |
| 4 | References | 9 |

1 Introduction

1.1 Overview

The NSW Road and Maritime Service (RMS) are proposing to construct a new bridge across the Hawkesbury River at Windsor to replace the existing bridge that has reached the end of its economic life. To support the design and approval of the Windsor Bridge replacement, the RMS has prepared an Environmental Impact Statement (EIS) under Part 5.1 of the *Environmental Planning and Assessment Act 1979*. The EIS has been displayed for public comment and submissions on the proposed project during November and December 2012.

1.2 Project design modification

Following the display period, a number of submissions regarding access to Windsor Wharf were considered, resulting in a decision by RMS to increase the clearance of the proposed bridge over The Terrace from a minimum of 3.6 metres to a maximum of 4.6 metres. This would allow large coaches and garbage trucks (with a height of 4.3 metres) to directly access the wharf.

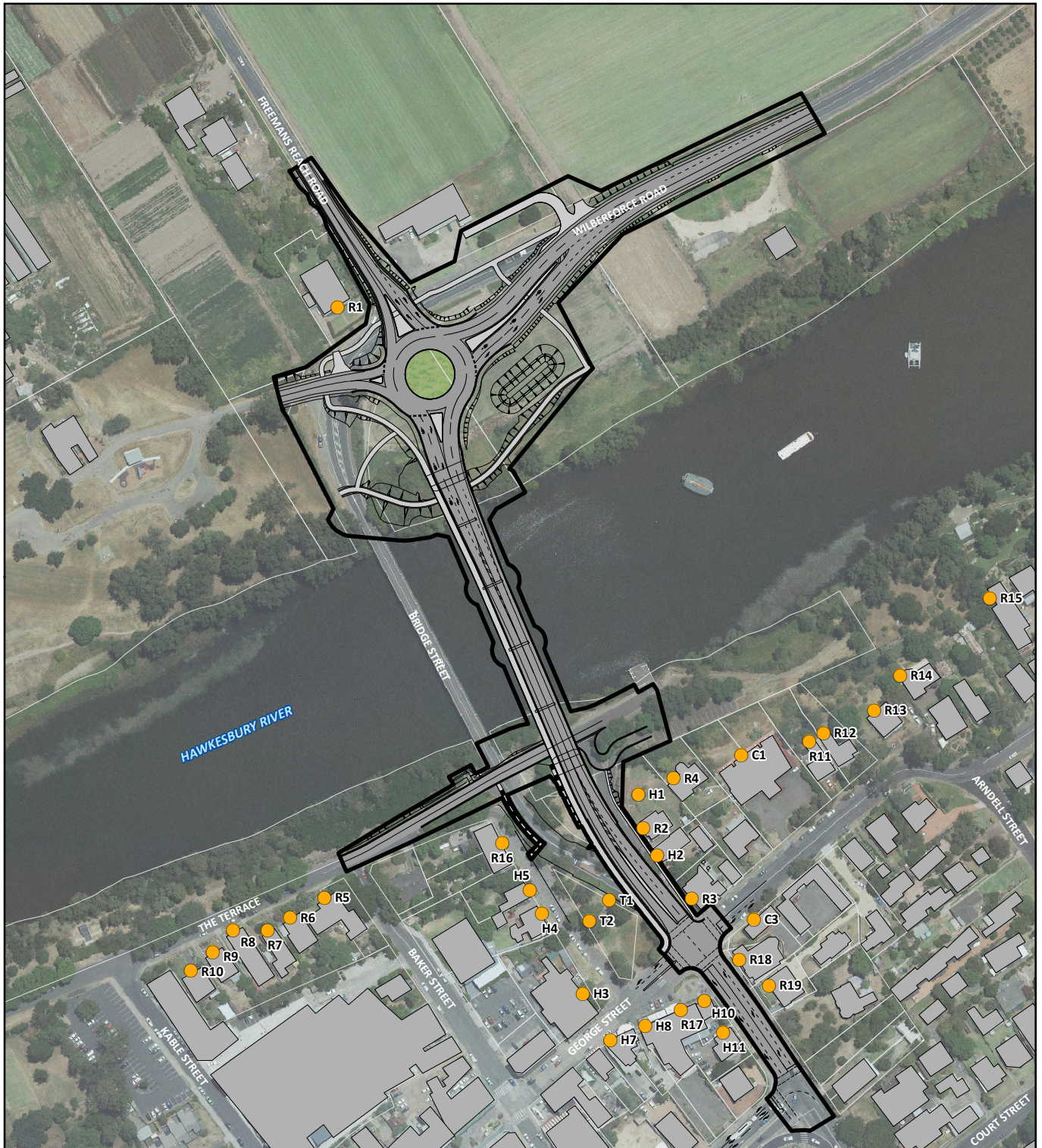
To provide the additional clearance over The Terrace, the height of the southern end of bridge would be increased. This would result in a one metre higher bridge and abutment at the southern end only - and a marginally higher section of the southern approach road through Thompson Square between the driveway of No. 4 Bridge Street to the southern abutment; a length of 45 metres. South of the driveway of No. 4 Bridge Street and in front of the heritage listed properties of No. 6 and No. 10 Bridge Street, the height of the southern approach road would remain the same as that presented in the EIS. The grade of the bridge would also increase slightly from 1.6% to 1.9%. The proposed design modifications are shown in **Section 4, Figure 4-1** of the submission report.

This addendum to the noise and vibration assessment completed for the EIS has been prepared in accordance with the Director General's Requirements for noise and vibration impact assessment and is to be read in conjunction with the Noise and Vibration Working Paper which is an appendix to the EIS.

1.3 Revised noise sensitive receivers

The study area comprises a mixture of residential and commercial receivers, many of which are buildings or items with local and/or State heritage significance. The closest residential receivers identified for the project are shown in **Table 1-1**. Additional properties were identified during the exhibition and submission phase of the EIS and have been included in the assessment of noise sensitive receivers for the revised proposal. These properties were previously identified in the EIS Noise and Vibration Working paper as commercial premises and are listed in **Table 1-1** as R16, R17, R18, and R19. **Table 1-2** presents the detail of the revised list of commercial and non residential receivers for the project. The receiver locations revised are shown in **Figure 1-1**.

Figure 1-1 | Receivers



Indicative only – subject to detailed design

LEGEND

- Receiver
- Concept design
- Concept design footprint
- Building footprint
- Cadastral boundary

Sinclair Knight Merz does not warrant that this document is definitive nor free of error and does not accept liability for any loss caused or arising from reliance upon information provided herein.



GDA 1994 | MGA Zone 56
A4 1:3,000



Table 1-1 Residential sensitive receivers (revised)

| ID | Receiver Location | Details | Distance from existing road |
|-----------|--------------------------|---|------------------------------------|
| R1 | 27 Wilberforce Road | Single storey residential dwelling | 17 metres |
| R2 | 4 Bridge Street | Single storey residential dwelling. Lightweight brick and weatherboard construction. | 27 metres |
| R3 | 10 Bridge Street | Double storey mixed residential upper floor and commercial lower floor, heritage building. Masonry construction | 10 metres |
| R4 | 53 George Street | Double storey residential building. Masonry construction | 40 metres |
| R5 | 12 The Terrace | Single storey residential dwelling. Masonry construction | 145 metres |
| R6 | 14 The Terrace | Single storey residential dwelling. Masonry construction | 160 metres |
| R7 | 16 The Terrace | Single storey residential dwelling. Masonry construction | 172 metres |
| R8 | 18 The Terrace | Single storey residential dwelling. Masonry construction | 190 metres |
| R9 | 20 The Terrace | Single storey residential dwelling. Masonry construction | 205 metres |
| R10 | 22 The Terrace | Single storey residential dwelling. Masonry construction | 223 metres |
| R11 | 45 George Street | Single storey residential dwelling. Masonry construction | 120 metres |
| R12 | 43 George Street | Single storey residential dwelling. Masonry construction | 133 metres |
| R13 | 41 George Street | Single storey residential dwelling. Masonry construction | 150 metres |
| R14 | 39 George Street | Single storey residential dwelling. Masonry construction | 178 metres |
| R15 | 29 George Street | Single storey residential dwelling. Construction unknown | 250 metres |
| R16 | 3 Thompson Square | Double storey residential dwelling. Heritage building. Masonry construction | 10 metres |
| R17 | 64-68 George Street | Double storey commercial. Heritage building. Masonry construction | 18 metres |
| R18 | 14 Bridge Street | Single storey commercial/residential dwelling. Heritage building. Masonry construction | 7 metres |
| R19 | 16 Bridge Street | Single storey residential dwelling. Masonry construction | 8 metres |

Table 1-2 Non residential sensitive receivers (revised)

| ID | Receiver Location | Details | Distance from existing road |
|-----------|---|--|------------------------------------|
| H1 | 4 Bridge Street | Heritage listed brick wall to rear of 4 Bridge Street. Masonry and mortar construction | 30 metres |
| H2 | 6 Bridge Street | Single storey commercial building. Medium-weight brick construction | 15 metres |
| H3 | 99 George Street | Double storey commercial, heritage building. Masonry construction | 45 metres |
| H4 | 7 Thompson Square | Double storey commercial, heritage building. Masonry construction | 30 metres |
| H5 | 5 Thompson Square | Single storey commercial, heritage building. Masonry construction | 25 metres |
| H7 | 70 George Street | Single storey commercial, heritage building, Masonry construction | 45 metres |
| H8 | 74 George Street | Double storey commercial, heritage building. Masonry construction | 40 metres |
| H10 | 62 George Street | Single storey commercial, heritage building. Masonry construction | 6 metres |
| H11 | 17 Bridge Street | Single storey commercial, heritage building. Timber construction | 5 metres |
| C1 | Windsor Terrace Motel 47 George Street | Double storey commercial building. Masonry construction | 80 metres |
| C2 | Road reserve | Underground services channel/pipe running along Bridge Street | 8 metres |
| C3 | Windsor Motel | Double storey commercial building. Masonry construction | 15 metres |
| T1 | Thompson Square 1 | Passive recreational land | 5 metres |
| T2 | Thompson Square 2 | Passive recreational land | 25 metres |

2 Operational impact

2.1 Noise modelling results

The modelling of noise impacts for the revised project design considered the same traffic data used in the earlier assessment of impacts. The results of the revised design noise modelling have been provided as point predictions for each of the identified receiver locations and have also been presented as noise contours overlaid on aerial photography. The noise contours represent the day and night time noise levels for the potential future year of operation in 2026.

Table 2-1 presents the results of the modelling for the unmitigated noise levels for both day and night time for the proposed year of opening and the design year, as well as the predicted change in noise level for the “no-build” and “build” scenarios at these times.

The results for the impact assessment indicate there would be a marginal increase in noise levels as the result of the revised bridge design for the previously assessed receiver locations. Receivers newly identified in this report as residential properties are currently exposed to acute traffic noise levels from the existing alignment and are expected to be impacted by an acute noise levels as the result of the proposal.

2.1.1 Additional mitigation measures

Additional properties that were identified as being residential dwellings during the exhibition of the EIS have been re-assessed against the project criteria in accordance with the Road Noise Policy (RNP) guidelines. The additional residential dwellings that are located around Thompson Square have been identified as having cultural and heritage values consistent with the findings of heritage studies outlined in the EIS.

Noise mitigation considered for the project is likely to be limited to architectural treatments due to the unfeasible implementation of noise barriers and road surface treatments for the proposed alignment. Where project noise criteria are exceeded, the newly identified receivers at R16, R17, and R18 would be the subject of a separate heritage assessment to assist in the consideration of noise mitigation measures for each of the properties.

Table 2-1 Predicted noise levels – without mitigation

| ID | Year opening 'no build' scenario dB(A) | | Year opening 'build' scenario dB(A) | | Design year 'no build' scenario dB(A) | | Design year 'build' scenario dB(A) | | RNP criteria, dB(A) | | Are the RNP Criteria exceeded? | | Change in noise level dB(A) | | | | Acute level of noise | | Consider mitigation? |
|-----|--|-------|-------------------------------------|-------|---------------------------------------|-------|------------------------------------|-------|---------------------|-------|--------------------------------|-------|-----------------------------|-------|-------------|-------|----------------------|-------|----------------------|
| | Day | Night | Day | Night | Day | Night | Day | Night | Day | Night | Day | Night | Opening Year | | Design year | | Day | Night | |
| | | | | | | | | | | | | | Day | Night | Day | Night | | | |
| R1 | 66 | 61 | 63 | 58 | 67 | 62 | 64 | 59 | 60 | 55 | YES | YES | -2.8 | -2.9 | -2.8 | -2.9 | NO | NO | NO |
| R2 | 65 | 61 | 69 | 66 | 65 | 62 | 70 | 67 | 60 | 55 | YES | YES | 4.8 | 4.8 | 4.8 | 4.8 | YES | YES | YES |
| R3 | 71 | 67 | 71 | 68 | 71 | 68 | 72 | 68 | 60 | 55 | YES | YES | 0.5 | 0.2 | 0.5 | 0.2 | YES | YES | YES |
| R4 | 61 | 58 | 63 | 59 | 62 | 58 | 64 | 60 | 60 | 55 | YES | YES | 1.8 | 1.8 | 1.7 | 1.8 | NO | YES | YES |
| R5 | 59 | 54 | 54 | 50 | 60 | 55 | 55 | 51 | 60 | 55 | NO | NO | -4.5 | -4.2 | -4.5 | -4.1 | NO | NO | NO |
| R6 | 58 | 53 | 54 | 49 | 58 | 54 | 54 | 50 | 60 | 55 | NO | NO | -4.0 | -4.0 | -4.0 | -3.9 | NO | NO | NO |
| R7 | 57 | 53 | 53 | 49 | 58 | 53 | 54 | 50 | 60 | 55 | NO | NO | -3.9 | -3.7 | -4.0 | -3.6 | NO | NO | NO |
| R8 | 56 | 52 | 53 | 48 | 57 | 52 | 53 | 49 | 60 | 55 | NO | NO | -3.1 | -3.1 | -3.1 | -3.1 | NO | NO | NO |
| R9 | 55 | 51 | 51 | 47 | 56 | 51 | 52 | 47 | 60 | 55 | NO | NO | -3.9 | -4.0 | -4.0 | -4.0 | NO | NO | NO |
| R10 | 55 | 51 | 51 | 47 | 56 | 51 | 52 | 47 | 60 | 55 | NO | NO | -4.2 | -3.9 | -4.1 | -3.8 | NO | NO | NO |
| R11 | 56 | 52 | 55 | 51 | 57 | 52 | 56 | 52 | 60 | 55 | NO | NO | -0.9 | -0.8 | -1.0 | -0.7 | NO | NO | NO |
| R12 | 57 | 53 | 55 | 51 | 57 | 53 | 56 | 52 | 60 | 55 | NO | NO | -1.3 | -1.2 | -1.4 | -1.2 | NO | NO | NO |
| R13 | 56 | 52 | 55 | 51 | 57 | 53 | 56 | 52 | 60 | 55 | NO | NO | -1.4 | -1.4 | -1.4 | -1.4 | NO | NO | NO |
| R14 | 57 | 52 | 55 | 51 | 57 | 53 | 56 | 52 | 60 | 55 | NO | NO | -1.6 | -1.6 | -1.6 | -1.5 | NO | NO | NO |
| R15 | 55 | 51 | 54 | 50 | 56 | 52 | 54 | 50 | 60 | 55 | NO | NO | -1.7 | -1.7 | -1.7 | -1.6 | NO | NO | NO |
| R16 | 68 | 65 | 63 | 59 | 69 | 65 | 64 | 60 | 60 | 55 | YES | YES | -4.7 | -5.2 | -4.7 | -5.2 | NO | YES | YES |
| R17 | 65 | 62 | 65 | 63 | 65 | 62 | 66 | 63 | 60 | 55 | YES | YES | 0.7 | 0.5 | 0.7 | 0.5 | YES | YES | YES |
| R18 | 72 | 68 | 71 | 67 | 72 | 69 | 72 | 68 | 60 | 55 | YES | YES | -0.6 | -0.9 | -0.6 | -0.9 | YES | YES | YES |
| R19 | 70 | 66 | 70 | 65 | 70 | 66 | 70 | 66 | 60 | 55 | YES | YES | -0.2 | -0.4 | -0.1 | -0.3 | YES | YES | YES |

3 Conclusion

An addendum to the Windsor Bridge Noise and Vibration Working Paper, which includes a revised alignment design and identification of additional residential properties has been undertaken to supplement the conclusions and recommendations in the EIS.

The revised modeling indicates that noise impacts due to the change in vertical alignment are generally consistent with the predictions of the previous modeling. Additional noise sensitive residential receiver locations were also assessed with the results indicating that existing acute noise impacts would be similar under the future 'no build' and 'build' scenarios and therefore would require consideration of mitigation.

Due to the limitations of implementing noise barriers and road surface treatments, the recommended mitigation measures for the proposal are identified in the Noise and Vibration Working Paper as architectural treatments to individual properties. The revised receiver locations R16, R17 and R18 therefore require an individual assessment of options for architectural noise mitigation in keeping with the heritage nature of the dwellings. The receiver at R19 does not require additional consideration of heritage issues.

4 References

- SKM , Noise and Vibration Working Paper – Windsor Bridge EIS, 2012
- Australian Standard AS2187.2-2006 Explosives – Storage, Transport and Use
- ANZEC, 1990 – Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration
- Australian Standard AS2670.2 'Evaluation of human exposure to whole-body vibration'. Identical to International Standard ISO 2631-1:1997
- British Standard BS7385: Part 2 Evaluation and measurement of vibration in buildings, 0 580 22188 1 (British Standards Institution, 1993)
- British Standard BS 6472: - 1992 Evaluation of Human Exposure to Vibration in Buildings
- BS5228:2009 Part 2 Code of Practice for noise and vibration control on construction and open sites-Vibration (British Standards Institution, 2009)
- CityPlan, 2012 Heritage advice on noise reduction mitigation measures associated with Windsor Bridge Replacement Project
- German standard DIN 4150: Part 3 – 1999 Effects of Vibration on Structures
- Office of Environment & Heritage, 2011 Road Noise Policy
- Roads and Traffic Authority, 2011 – Interim approaches to apply the Road Noise Policy
- Roads and Traffic Authority, 2001, Environmental Noise Management Manual, Sydney
- DECCW (2009) Interim Construction Noise Guidelines




Heritage Advice on Noise Reduction Mitigation measures

Windsor Bridge Replacement Project

March 2013

TABLE OF CONTENTS

| | |
|--|----|
| 1.0 INTRODUCTION..... | 2 |
| 1.1 BACKGROUND | 2 |
| 1.2 METHODOLOGY | 3 |
| 1.3 AUTHOR IDENTIFICATION | 3 |
| 2.0 THE SITES SUBJECT TO THIS HERITAGE ADVICE | 4 |
| 2.1 THE DOCTORS HOUSE (1-3 THOMPSON SQUARE)..... | 4 |
| 2.2 FORMER SCHOOL OF ARTS BUILDING (14 BRIDGE STREET) | 5 |
| 2.3 SHOPS - FORMER HAWKESBURY STORES (64-68 GEORGE STREET) | 6 |
| 3.0 EXISTING JOINERY..... | 7 |
| 4.0 GENERAL APPROACH AND POTENTIAL ARCHITECTURAL NOISE MITIGATION MEASURES | 9 |
| 5.0 OPTIONS TABLE FOR NOISE MITIGATION THAT WOULD BE APPLICABLE TO THE WINDOWS & DOORS OF THE HERITAGE ITEMS DISCUSSED IN THIS REPORT..... | 11 |
| 5.1 OPTIONS TABLE FOR NOISE MITIGATION OF WINDOWS | 11 |
| 5.2 OPTIONS TABLE FOR NOISE MITIGATION OF FRENCH DOORS | 12 |
| 5.3 RECOMMENDED SOLUTIONS FOR INTERNAL VENTILATION..... | 13 |
| 6.0 CONCLUSION AND RECOMMENDED MITIGATION MEASURES | 15 |
| 7.0 ATTACHMENT A: SUPPORTING PHOTOGRAPHS | 17 |

| Job No/ Document No | Description of Issue | Prepared By/ Date | Reviewed by Project Manager/Direct or | Approved by Manager/Director |
|--|-------------------------|----------------------|--|---|
| 13-024 | <i>Draft</i> | <i>KD/18.03.13</i> | <i>KD/18.03.13</i> |  Name: Kerime Danis Date: 19.03.13 |
| 12-156 | <i>Final</i> | <i>KD/19.03.13</i> | <i>KD/19.03.13</i> | |
| Note: This document is preliminary unless it is approved by Manager or Director of City Plan Heritage | | | | |

1.0 INTRODUCTION

1.1 BACKGROUND

City Plan Heritage has been engaged by Sinclair Knight Merz on behalf of the Roads and Maritime Services (RMS) to provide consultant heritage advice in relation to the noise mitigation measures associated with the Windsor Bridge Replacement Project.

A letter of heritage advice on the noise mitigation measures for the Heritage Item located at 10 Bridge Street, Windsor has previously been provided on 9 August 2012. That advice was given in response to the Director General's Requirements (DGRs), which were issued on 24 November 2011. The current heritage advice builds upon the previous advice and considers the remainder of the Heritage listed buildings that are used potentially for residential purposes and have potential to be affected by the proposed Windsor Bridge Replacement Project.

The RMS is seeking approval for the replacement of the existing Windsor Bridge crossing of the Hawkesbury River at Windsor and upgrading of adjacent intersection and approach roads. The project has been declared as a State Significant Infrastructure project (number SSI-4951) and the DGRs have been issued. Subsequently, a number of studies have and are being prepared in response to the DGRs including heritage related matters. One of the DGRs heritage related requirements reads as:-

*consider impacts from vibration, demolition, archaeological disturbance, altered historical arrangements and access, landscape and vistas, and **architectural noise treatment, and...***

This heritage advice provides general mitigation measures that can be applied for architectural noise treatment of windows and doors of the heritage items potentially impacted by the project. Although the following recommended architectural noise treatments can be applied to any similar type of windows and doors of residential buildings, this report particularly considers the windows and doors of the heritage buildings detailed below:

- The Doctor's House at 1-3 Thompson Square
- Former School of Arts Building at 14 Bridge Street
- The former Hawkesbury Stores at 64-68 George Street

It should be noted that these properties are potentially eligible for architectural noise treatment based upon the potential for residential use. These properties were not identified in the Environmental Impact Statement (EIS) as residential; however, subsequent information has indicated that they are suitable or currently residential properties.

1.2 METHODOLOGY

This Heritage Advice has been prepared in accordance with the *NSW Heritage Manual* 'Assessing Heritage Significance' guidelines. The philosophy and process adopted is that guided by the Australia ICOMOS *Burra Charter 1999*.

In preparation of this heritage advice City Plan Heritage has consulted the documentation listed below and obtained expert advice of Gary Waller of G & C Waller Builders. Gary is a carpenter with extensive expertise in traditional joinery. The report has been based on the external inspection of the properties from the street with no internal inspections being carried out. Interiors of the heritage item at 10 Bridge Street, which were inspected on 26 July 2012, provide a good understanding of potential intactness and detailing of the windows and doors of the three heritage buildings subject of the current report. The reports and studies that were reviewed include

- RTA, *Windsor Bridge Replacement State Significant Infrastructure application report*, October 2011
- Director General's Requirements (SSI - 4951) dated 24 November 2011
- State Heritage Register Inventory Forms for Thomson Square incorporating 62-64 George Street and 1-3 Thompson Square
- Register of the National Estate listing forms for 14 Bridge Street, 62-74 George Street and 1-3 Thompson Square
- various Windsor Bridge Replacement project reports by the project consultant team in particular *Appendix 4: Site Inspection Recording Forms of the Windsor Bridge Replacement Project Historic Heritage Assessment & Statement of Heritage Impact* by BIOSIS Research dated November 2012.
- W. Murray, A. Croker, *Traditional Joinery - Sydney Houses 1810-1915*, 2005, Watermark Press

Before any architectural noise treatments identified in this report are implemented, a detailed inspection of the properties would be undertaken by Roads and Maritime Services (RMS), a heritage architect and carpenters in conjunction with the respective property owner to identify and agree on appropriate treatments.

1.3 AUTHOR IDENTIFICATION

The following report has been prepared by Kerime Danis (Manager). The author wishes to thank Pamela Kottaras of BIOSIS Research for her help and provision of background information on the subject heritage items.

2.0 THE SITES SUBJECT TO THIS HERITAGE ADVICE

The project is located within the vicinity of a number of heritage items of State and local significance including buildings, town squares and Thompson Square conservation area, which have been identified to be affected by the project. Three of these heritage items are either currently residences or have potential to be residences without substantial modification, and require consideration for the provision of architectural noise treatment to mitigate noise impacts. These items are briefly described in order to understand the construction period, type and intactness of existing joinery to provide a basis for the potential alternative architectural noise treatment options.

2.1 THE DOCTORS HOUSE (1-3 THOMPSON SQUARE)

Built c1844 as a two separate residences, the Doctors House is a twin, two-storey early Victorian style terrace with attics within the simply detailed pitched roof. It consists of two residences and features a face brick construction on an ashlar sandstone base. Located on a prominent position at the western end of Thompson Square, the Doctors House has white painted timber joinery comprising six-pane sash windows to the ground floor level and French doors to the upper floor level. Three solid panelled entry doors with fanlights (two with arched fanlights) provide access from the elevated veranda across the entire facade.

The Doctors House is listed on the State Heritage Register as part of the Thompson Square Precinct (SHR No. 00126) and is also on the Hawkesbury LEP 2012 (No. I00126). The online inventory form for the item does not include a Statement of Significance or description; however, the Register of the National Estate listing provides a very brief Statement of Significance:

Fine substantial early sandstone and brick terrace building.

Statement of Significance in the BIOSIS Research ranks the House as being of *Exceptional* significance and reads as¹:-

The Doctors House is a significant as an individual item for its historic, aesthetic and architectural qualities. It has been a landmark building since it was constructed and played a prominent role in the history of the commercial precinct of Thompson Square.

The Doctors House is also significant for its contribution to the overall significance of Thompson Square by providing a recognisable definition to the western perimeter of the square. As part of a group of buildings surrounding Thompson Square, the Doctors House is one of the buildings, which as a group, demonstrates the different phases of the square's development. It contributes to the sense of age and history that is integral to the identity of Thompson Square and Windsor.

The site of the Doctors House is significant also for the archaeological potential it holds, having previously been the site of an inn.

¹ BIOSIS Research (Nov 2012), Appendix 4, p.40.

2.2 FORMER SCHOOL OF ARTS BUILDING (14 BRIDGE STREET)

The former School of Arts Building was constructed in 1861 as a civic building in a stuccoed Italianate style. It is a single-storey building with a central veranda supported on two posts and accessed by wide stairs between the two later constructed projecting bays. The original simple gabled building is encased by the two symmetrical bays also in stuccoed finish featuring architectural detailing of the classical order with flat parapeted roof.

The original facade behind the veranda features two arched doors with a centrally located arched six-pane sash window. The windows on the later projecting bays also are arched but two-pane sash windows. There are also glass multi-paned doors within the reveals of the veranda, which will require acoustic treatment.

The former School of Arts Building is listed on the State Heritage Register as part of the Thompson Square Precinct (SHR No. 00126) and is also on the Hawkesbury LEP 2012 (Part of No. I00126). The online inventory form for the item does not include a Statement of Significance or description; however, the Register of the National Estate listing provides a very brief Statement of Significance:

Potentially fine architectural element occupying key site in the Thompson Square precinct. Has valuable historical links with early community life of Windsor. Listing excludes skillion additions at front.

Statement of Significance in the BIOSIS Research ranks the House as being of *High* significance and reads as²:-

The former School of Arts building is significant as a mid-Victorian building with civic beginnings. It appears to be largely intact and therefore retains the ability to be restored to its most significant aesthetic form. The former School of Arts building is also significant for its links with early community life in Windsor.

It has historical significance as representing a movement that promoted the benefits of educating the skilled working classes, which was the birth of the municipal library and neighbourhood centre.

The building is part of the group that defines the perimeter of Thompson Square. The combination of all the buildings within the Thompson Square heritage curtilage demonstrates the different phases of Thompson Square's development. It contributes to the sense of age and history that is integral to the identity of Thompson Square and Windsor.

The site is significant also for its archaeological potential. The property encompasses part of the early Government Domain and the former School of Arts is built on some or part of a government storehouse and therefore has a high degree of scientific potential.

² BIOSIS Research (Nov 2012), Appendix 4, p.91.

2.3 SHOPS - FORMER HAWKESBURY STORES (64-68 GEORGE STREET)

Adjacent to a single-storey building at number 62 George Street, the subject building is a two-storey c1880s Victorian terrace style mixed commercial and residential building accommodating three residences on the first floor level.

The upper floor features French doors with fanlights similar to those at number 10 Bridge Street in Thompson Square.

The former Hawkesbury Stores Building is listed on the State Heritage Register as part of the Thompson Square Precinct (SHR No. 00126) and is also on the Hawkesbury LEP 2012 (Part of No. I00126). The online inventory form for the item does not include a Statement of Significance or description; however, the Register of the National Estate listing provides a very brief Statement of Significance for the group consisting of 60, 62-74, 84 George St:

Important sites surrounding Thompson Square precinct that require sympathetic rebuilding in authentic Georgian style to preserve the character of this historic square.

Statement of Significance in the BIOSIS Research ranks the House as being of *High* significance and reads as³:-

The group of buildings at 62 – 68 George Street is significant as part of the Thompson Square precinct as well as in their own group. The buildings have strong associations with the Moses family, an early prominent business family in Windsor and with the important river trade in Windsor. The buildings show three phases of development with the earliest phase represented by the single storey building. No 62 is also significant for its survival as late Georgian to early Victorian building and the rebuilt sections for their direct association with the historical values of the earlier component of the structure.

The buildings are also significant for their location along the ridge of George Street, which provides them a prominent position at the top of the Square and connect Thompson Square with the commercial entrance to Windsor. They are part of a group that defines the south eastern edge of Thompson Square. The combination of all the buildings within the Thompson Square heritage curtilage demonstrates the different phases of Thompson Square's development. It contributes to the sense of age and history that is integral to the identity of Thompson Square and Windsor.

³ BIOSIS Research (Nov 2012), Appendix 4, pp. 105-106.

3.0 EXISTING JOINERY

All of the buildings that are considered in this report feature timber joinery characteristic of their construction periods and architectural styles. While the Victorian terrace style buildings at 1-3 Thompson Square (The Doctors House) and at 64-68 George Street (former Hawkesbury Stores) appear to have intact window and door joinery, the joinery at the original hall section of the former School of Arts Building (14 Bridge Street) may have been replaced with matching joinery with the front projecting bay windows being later additions. Notwithstanding, the joinery of these buildings is considered significant and any architectural noise treatment should maintain their external appearance. Any treatment therefore should be made from the interiors.

As internal inspection of the subject properties could not be carried out, the traditional joinery and the existing joinery of number 10 Bridge Street (River Music), which was inspected in August 2012 was used as the basis for identifying potential treatments. Number 10 Bridge Street features highly intact timber door and window joinery to both ground and first floor main street facades. The windows at both levels are timber framed multi-paned double-hung windows with six-pane to each sash. The main street facade windows have deep splayed reveals. This detailing is similar to the Victorian terrace style of the Doctors House and the former Hawkesbury Stores.

Recommendations for architectural noise treatment that were made for 10 Bridge Street will also be applicable for these buildings. Similar architectural noise treatment should also be applied to the former School of Arts Building at 14 Bridge Street.

The upper residential parts of the two-storey buildings feature French doors opening onto the street facing front balcony from each room. Internal configurations of the residences are unknown and it was assumed that each room rely only on the French doors for ventilation and daylight. Therefore mitigation measures need to consider this constraint and allow for easy operation of the doors. The existing seven French doors at the upper floor of the Doctors House feature three glazed panels with margin glazing to each door leaf. The majority of the existing glazing is anticipated to be original. The ground floor windows and doors of the Doctors House consist of four six-pane sash (12 in total) windows with two of the windows featuring timber louvered shutters. There are three doors on the ground floor and they feature two arched fanlights and one flat fanlight windows. Therefore only the glazed fanlights of these doors will require architectural noise treatment.

The four French doors of the former Hawkesbury Stores, on the other hand, feature single-pane glazing to each door leaf of two French doors with single-pane fanlights, and two-pane glazing to each door leaf of the other two French doors also with single-pane fanlights. The

fifth door on the upper floor balcony is a single door with a single-pane glazing and fanlight above.

Similarly, the upper floor rooms facing George Street feature four (4) windows (2 to each room). All windows are operable and should be retained in operational condition. The profile of the existing glazing bars of the timber joinery (both French doors and windows) is very fine with a deep section that would allow insertion of a second custom made frame.

Supporting photographs have been provided as an attachment at the end of this report.

4.0 GENERAL APPROACH AND POTENTIAL ARCHITECTURAL NOISE MITIGATION MEASURES

Considering the intactness and original fabric of the existing joinery and their operational requirements, the alternatives for mitigation measures are limited. The existing joinery is highly significant and is finely detailed and therefore any mitigation measure should ensure no detrimental impact on both their original fabric and presentation. Presentation of the subject joinery from the interiors may equally be important.

As noted earlier, internal site inspections could not be carried out and the recommendations are based on the external visual inspections from the street and on the joinery of the neighbouring heritage item at 10 Bridge Street. It is therefore recommended that final mitigation options should be decided following internal inspections of the existing joinery detailing.

The following general recommendations for potential noise treatments have been provided so that any windows or doors could be treated with one or more of the available treatments. Again, it is noted that the suitability of any treatment noted here should be considered on case by case for individual properties in association with a heritage architect and property owners.

In general, acoustic treatments for windows may include one or more of:

- installing acoustic seals to existing windows
- increasing the thickness of glazing
- installing double glazed windows
- providing a secondary window.

Acoustic window seals

Acoustic seals around the perimeter of a window will help to reduce noise by providing a tight seal when the window is shut. Rubber seals are best. It is also possible to fit brush seals with a central vinyl fin which provides better noise protection than traditional brush seals. It is important to install and adjust the seals so that the window and frame both contact the seals when closed. The tighter a seal is, the better the noise reduction, provided it is not too thick to prevent the window from being able to be closed properly.

For existing windows that cannot be fitted with acoustic seals, for example single-hung and double-hung windows, secondary glazing may be installed. Secondary glazing products (either permanently fixed or removable) provide an airtight seal without the need to modify the existing window. Any secondary glazing must match the existing windows mullions and pane configuration to ensure no changes occur to the external presentation of the windows.

Thicker glazing

(may not be suitable for many existing windows of the heritage items)

Most standard windows would have 3 mm thick glazing. Thicker glazing (ideally 6 mm or 10 mm) reduces lower frequency road traffic noise due to its density. However, using thicker glass typically requires new window frames, as standard/traditional residential frames may not be able to bear the additional glazing weight. Where the window frames are clearly identified as not being original their replacement with a matching frame but thicker glazing can be considered. Authenticity of the existing frames must be based on documentary and physical evidence and must be confirmed by a Heritage Architect and a suitably qualified carpenter with knowledge of traditional joinery. Where replaced, new frames will be well sealed to the building structure. The frame material does not significantly reduce noise, but it must be strong enough to hold the weight of the glass.

Double glazing

(may not be suitable for many existing windows of the heritage items)

Double glazed windows comprise two panes of glass separated by a gap. The noise reduction through the window is controlled by the thickness of the glass, the width of the air gap, and the gasses, if any, in that gap. The use of thicker glazing and a wider gap, particularly if forming a vacuum, will increase the noise reduction. The thickness of each glass pane should be selected in accordance with manufacturer's recommendations. More noise reduction can be obtained with two panes of different thickness (eg a 6 mm thick pane and a 10 mm thick pane). For better noise reduction, it is noted that the space between the panes of glass should be at least 75 mm. The type of double-glazing optimised for thermal insulation is not as effective at reducing noise. As with single glazed windows, it is critical that window seals are provided around the perimeter.

Providing new secondary windows

(will generally be suitable for many existing windows of the heritage items depending on the depth of the internal window reveals to minimise impact on the appearance)

An alternative to double-glazing is to retrofit a new secondary window with an air gap between the existing window, which will allow for the provision of a double glazed window without modifying the existing window. The secondary window should always be provided with acoustic seals. It is preferable, though not essential, that the existing window is also fitted with acoustic seals along the perimeters. Secondary windows may be glass or acrylic. Some are sealed magnetically, allowing panels to be removed easily for cleaning purposes or whenever required. Others can be designed to be sliding, which allows the window to be opened.

5.0 OPTIONS TABLE FOR NOISE MITIGATION THAT WOULD BE APPLICABLE TO THE WINDOWS & DOORS OF THE HERITAGE ITEMS DISCUSSED IN THIS REPORT

5.1 OPTIONS TABLE FOR NOISE MITIGATION OF WINDOWS

All new glazing to meet required acoustic levels.

| Mitigation Options | Discussion / Comments |
|---|---|
| 1. Insertion of a single pane glazed frame to the reveals (internal) | Although this option will not impact on external appearance, it will seal the whole window and will not allow for its easy operation due to the size of the panel opening inwards. It will change the internal presentation of the windows and therefore it is not an appropriate option. |
| 2. Installation of a second double-hung frame (internal) | This option will mirror/offset the existing window panel configuration and although it will maintain the appearance of the window similar to the existing, it will be visible in street-long views of the building. It will make it difficult to open the windows in a double layered frame. |
| 3. Installation of casement window frames with single glass panel (internal) | The casement windows would be made of single panel glazing to maintain existing presentation of the windows from the exteriors; however, this option will change the appearance of the windows from inside and will be clearly visible from the public domain. This option may allow an easy opening action for the windows but may not provide the required noise mitigation. |
| 4. Installation of custom made individual glazed timber framed panels to each glass pane of the double-hung sashes (internal) | This option will ensure appropriate timber framed glazed panels are individually inserted into each glazed pane of the existing windows with soft elastic sealing without damage to the original timber frame. It requires careful measurements of each pane between the glazing bars in order to make the custom designed frames to fit into the respective pane without nail or screw fixing. The presentation of the windows will remain the same due to the fine detailing of the new custom made frames and minimum intervention to the original joinery. The new acoustic treatment frames can be easily removed if required in the future with no damage to the original fabric. |

| | |
|--|--|
| 5. Installation of a magnetite retrofit double glazing system (internal) | This is a relatively new system that has similar individual glazed panels inserted into the existing frame as a one frame or inside each panels. It has not been tested by traditional joiners yet; however, it appears to be used for acoustic treatments of residential joinery. Retrofit double glazing is the addition of a secondary glazing layer to an existing window. Based upon information on a specific system that <i>installation of a discreet subframe allows a clear optical grade acrylic panel to attach inside the existing window. Using continuous magnetic channels ensures a secure and airtight seal around the window.</i> However, the standard frame for this system would make some difference to the appearance of the existing joinery and may not be the best option. This system, however, may be a more economical option than Option 4 above. One case study is the David Jones Sydney CBD building on Elizabeth Street. The heritage building maintains its external and internal presentation while the noise reduction is provided for the offices |
|--|--|

5.2 OPTIONS TABLE FOR NOISE MITIGATION OF FRENCH DOORS

All new glazing to meet required acoustic levels.

| Mitigation Options | Discussion / Comments |
|--|---|
| 1. Installation of second set outward opening French doors to the exterior | This option will allow for a double frame joinery inserted into the existing external reveals of the French doors. The new French doors will have to be made exactly the same as the existing French doors. This option will maintain the existing appearance of the joinery but will create difficulty in the operation of the doors due to the existing inwards opening French doors. It is not a practical option for the users and its acoustic performance may not be sufficient. The fanlights will also be difficult to keep operable. |
| 2. Installation of shutter system in traditional manner to the exterior | This option involves the traditional shutter system but will not allow for appropriate daylight into the rooms as to provide noise mitigation the |

| | |
|---|--|
| | shutters would need to be kept shut at all times. The shutters will also not allow air ventilation to the rooms and will necessitate mechanical ventilation system. It is not recommended. |
| 3. Installation of custom made individual glazed timber framed panels to each glass panel (including margin glazing) of the French doors (internal) | As for the windows this option is considered to be the most suitable option for the appropriate acoustic treatment without making changes to the appearance of the French doors. Each glazing panel will be fitted with a new custom made timber frame with acoustic glazing similar to those windows described above. |
| 4. Installation of Magnetite Retrofit double glazing system (internal) | This new system is described in the above table and based on each magnetite frame being inserted into the glazed panels of the French doors. It is similar to the custom made option. |

5.3 RECOMMENDED SOLUTIONS FOR INTERNAL VENTILATION

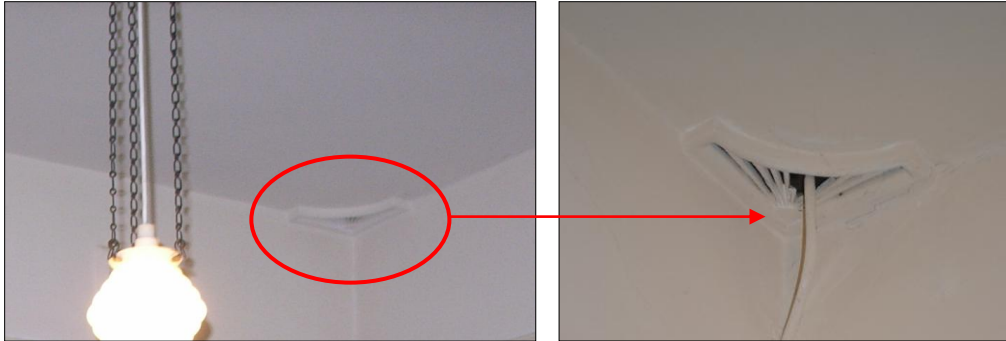
Once the treatment for the noise mitigation is undertaken for them to be effective the doors and windows will be required to be kept closed. In this case some type of ventilation system will be necessary to allow fresh air into the subject rooms of the respective residential spaces of the buildings.

It is obviously preferable not to modify any ceilings and utilise the existing fanlights of the French doors or keep the windows half open for a couple of hours during the day. However, since the aim of the noise treatment to ensure the maximum mitigation measures for the residential amenity, the following alternative solutions, which were explored and noted for the heritage item at 10 Bridge Street can be considered. As the internal configuration and ceiling detailing is unknown at this stage, it has been assumed that the buildings will have similar type of ceilings and the following solutions would be suitable.

In general, the existing ceilings are considered to be original and intact, therefore any future air-conditioning (ventilation) system should be carefully installed in a manner that minimises number of the air outlets (vents) on the ceilings. One of the traditional ways for such ceiling vents is placing them at the corners of the ceiling (preferably maximum 2 vents, if technically possible) rather than randomly in the centre or other panels of the ceilings.

The ventilation system ducts / cabling can be placed within the roof cavity with only minimum required opening for the ducting registers in the ceilings. Consultation should be undertaken

with an appropriately qualified Heritage Architect in order to establish the locations for ducting registers. Images of an example of traditional corner ceiling vent from a house in Alexandria have been provided below for reference. New detailing should not imitate this example but be a simple version of the traditional ceiling vent.



6.0 CONCLUSION AND RECOMMENDED MITIGATION MEASURES

As detailed in the general methods and the tables above there are a number of ways that existing windows and French doors can be treated for acoustic mitigation. The main consideration is the heritage buildings' significance and the existing fabric's condition, intactness and integrity. In the case of the three heritage buildings considered in this report it is clearly evident that they are rare and ranked as being of excellent or high level significance buildings. They maintain their Victorian style architecture with intact timber joinery and most likely the majority of the glazing. The exception to this are the later additions to the former School of Arts Building at 14 Bridge Street. Notwithstanding, existing joinery should be retained in any future mitigation.

Given consideration to the streetscape, internal presentation and importance of the existing joinery, it is thought that custom made individual glazed timber framed panels (Option 4 for windows and Option 3 for French doors) will be the most appropriate treatment. The custom made frames will create double glazing with an air cavity sealed and fitted without any damage to the existing original glazing panels. The appearance of the joinery will be the same from both inside and outside thus the aesthetic significance of the heritage item will not be affected. Both single-hung or double-hung system windows will be operable. Furthermore the new frames can be removed without damage to the existing fabric if required in the future.

Magnetic double glazing systems should also be assessed for suitability by obtaining testimonials from carpenters who have used them before. Performance of magnetic double glazing systems are not known at this stage; however, one of the case studies provided on one of the manufacturer's website show application of the system on the windows of the David Jones Elizabeth Street building. It appears to be a successful application with no or negligible impact on presentation of the building's both exterior and interior. This could be a possible option for the subject heritage buildings; however, a careful consideration should be given to the existing internal configurations of the windows before making the decision on its use. It may be the more economical option than the custom made option.

As noted earlier, further close-up inspection of the subject windows and doors should be undertaken prior to commencing any works to ensure the most suitable type of architectural noise treatment is implemented without making any detrimental impact to the existing joinery. Replacement of timber frames and any extant joinery is not acceptable and should be the last option. Based on the above discussion and the configuration of the windows and French doors at the nearby heritage item at 10 Bridge Street, the custom made individual glazed panels option is the preferred option. It is recommended that an experienced carpenter with traditional joinery expertise be engaged to undertake a detailed inspection and measurement of the windows and French doors joinery for the design of the most appropriate timber frame profile and sealant requirements to fit without any need for screw/nail fixing.

Should the magnetic double glazing system be considered then advice of an experienced carpenter must be sought and examples of such installations (eg. David Jones offices) be inspected before making a decision on their installation. Inspections should involve a heritage consultant in order to make sure no detrimental impact occur to the existing original joinery and to the presentation of the heritage item.

For ventilation systems, recommendations made in the previous section should be taken into consideration when making decisions on the appropriate treatment and mitigation measures.

Regardless of the option implemented all work should be designed in consultation with and carried out under the supervision of a suitably qualified heritage consultant.

CITY PLAN HERITAGE

MARCH 2013

7.0 ATTACHMENT A: SUPPORTING PHOTOGRAPHS

Views of the Doctors House at 1-3 Thompson Square, Windsor



Views of the former School of Arts at 14 Bridge Street, Windsor



Views of the former Hawkesbury Stores at 64-68 George Street, Windsor



Appendix F - Options for archaeological investigation of Thompson Square



Windsor Bridge Replacement Project: Archaeological Options Paper

Prepared for Roads and Maritime Services

20 March 2013

Biosis offices

AUSTRALIAN CAPITAL TERRITORY

Canberra

Unit 16 / 2 Yallourn Street
Fyshwick ACT 2609

Phone: (02) 6228 1599
Fax: (02) 6280 8752
Email: canberra@biosis.com.au

NEW SOUTH WALES

Sydney

18–20 Mandible Street
Alexandria NSW 2015

Phone: (02) 9690 2777
Fax: (02) 9690 2577
Email: sydney@biosis.com.au

Wollongong

8 Tate Street
Wollongong NSW 2500

Phone: (02) 4229 5222
Fax: (02) 4229 5500
Email: wollongong@biosis.com.au

QUEENSLAND

Brisbane

Suite 4 First Floor, 72 Wickham Street
Fortitude Valley QLD 4006

Phone: (07) 3831 7400
Fax: (07) 3831 7411
Email: brisbane@biosis.com.au

VICTORIA

Ballarat

506 Macarthur Street
Ballarat VIC 3350

Phone: (03) 5331 7000
Fax: (03) 5331 7033
Email: ballarat@biosis.com.au

Melbourne (Head Office)

38 Bertie Street
Port Melbourne VIC 3207

Phone: (03) 9646 9499
Fax: (03) 9646 9242
Email: melbourne@biosis.com.au

Wangaratta

16a Templeton Street (PO Box 943)
Wangaratta VIC 3677

Phone: (03) 5721 9453
Fax: (03) 5721 9454
Email: wangaratta@biosis.com.au



Document information

| | |
|--------------------|--|
| Report to: | Roads and Maritime Services |
| Prepared by: | Wendy Thorp (CRM) Pamela Kottaras (Team Leader Cultural Heritage) |
| Biosis matter no.: | 14020 |

Document Control

| | |
|---------------------|---|
| Reviewer: | Pamela Kottaras |
| Mapping: | James Shepherd |
| Project: | Windsor Bridge Replacement Project |
| Biosis Project No.: | 14020 |
| Report Title: | Windsor Bridge Replacement Project: Archaeological Options Paper |
| LGA: | Hawkesbury City |

| Revision | Prepared | Internal Review | External Review | Amended |
|----------|----------|-----------------|-----------------|---------|
| 1 | CRM | Biosis | RMS | CRM |
| 2 | CRM | Biosis | RMS | Biosis |
| 3 | Biosis | -- | RMS | -- |

| Revision | Issued | Name | Signed |
|----------|------------|-----------------|---|
| 1 | 10/03/2013 | Pamela Kottaras |  |
| 2 | 13/03/2013 | Pamela Kottaras |  |
| 3 | 20/03/2013 | Pamela Kottaras |  |
| 3 | 19/03/2013 | Pamela Kottaras |  |

© Biosis Pty Ltd

This document is and shall remain the property of Biosis Pty Ltd. The document may only be used for the purposes for which it was commissioned and in accordance with the Terms of the Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

Disclaimer:

Biosis Pty Ltd has completed this assessment in accordance with the relevant federal, state and local legislation and current industry best practice. The company accepts no liability for any damages or loss incurred as a result of reliance placed upon the report content or for any purpose other than that for which it was intended.

Acknowledgements

Biosis Research gratefully acknowledges the contributions of the following people and organisations (listed alphabetically) in preparing this report:

Dalene Amm Roads and Maritime Services
Jonas Ball SKM
Matt Faust SKM
Braith Gilchrist SMEC
Denis Gojak Roads and Maritime Services
John Steele SKM
Roy Surace Roads and Maritime Services
Wendy Thorp Cultural Resources Management
Windsor Bridge Alliance Project Team

Government Departments

Client

- Roads and Maritime Services

Approval Authority

- Department of Planning

Consultation

- Heritage Branch, Office of Environment and Heritage

Abbreviations

c. Circa
CHL Commonwealth Heritage List
CMA Catchment Management Authority
DECCW Department of Environment, Climate Change and Water
DGRs Director General's Requirements
DP&I Department of Planning and Infrastructure
EA Environmental Assessment
EIS Environmental Impact Statement
EPA Environment Planning and Assessment

| | |
|------|---|
| REF | Review of Environmental Factors |
| LEP | Local Environmental Plan |
| m | Metre |
| mm | Millimetre |
| REP | Regional Environmental Plan |
| RMS | Roads and Maritime Services |
| SoHI | Statement of Heritage Impact |
| OEH | Office of Environment and Heritage, Department of Premier and Cabinet |
| SHI | State Heritage Inventory |
| SHR | State Heritage Register |

Contents

| | |
|---|------------|
| Acknowledgements | ii |
| Abbreviations..... | ii |
| Executive Summary | vii |
| 1 Introduction | 1 |
| 1.1 Project Background..... | 1 |
| 1.2 Project Area..... | 2 |
| 1.3 Purpose of this Document..... | 3 |
| 2 Review of Archaeological Resources..... | 5 |
| 2.1 Historical Framework..... | 5 |
| 2.2 Archaeological Assessments | 5 |
| 2.2.1 Aboriginal Archaeological Resources..... | 6 |
| 2.2.2 Maritime Archaeological Resources..... | 6 |
| 2.2.3 Historic Period Terrestrial Archaeological Resources | 6 |
| 3 Testing the Assessments..... | 9 |
| 3.1 Background..... | 9 |
| 3.2 Aboriginal Archaeology | 9 |
| 3.3 Maritime Archaeology | 9 |
| 3.4 Terrestrial Historic Period Archaeology..... | 10 |
| 3.5 Implications..... | 13 |
| 3.5.1 Variation within small areas..... | 13 |
| 3.5.2 Linking the different profiles..... | 13 |
| 4 Cultural Significance | 15 |
| 4.1 Terrestrial Historic Period Archaeology..... | 15 |
| 4.2 Maritime Archaeology | 16 |
| 4.3 Aboriginal Archaeology | 17 |
| 4.4 Implications of Fragmenting the Resource on Cultural Values | 17 |
| 5 Bridge Options and Impacts..... | 18 |
| 5.1 Introduction | 18 |
| 5.2 Land Bridge..... | 18 |
| 5.2.1 Design..... | 18 |
| 5.2.2 Impacts | 18 |
| 5.3 "L-Shaped" Retaining Walls..... | 19 |
| 5.3.1 Design..... | 19 |
| 5.3.2 Impacts..... | 19 |
| 5.4 Summary of Bridge Abutment Options..... | 21 |

| | | |
|----------|--|-----------|
| 5.5 | Landscaping in the Parklands and Service Roads | 21 |
| 6 | Archaeological Options | 22 |
| 6.1 | Introduction | 22 |
| 6.2 | Option 1: Construction Footprint | 27 |
| 6.3 | Option 2: Consolidated Construction Footprint | 30 |
| 6.4 | Option 3: Salvage excavation of the entirety of Thompson Square parkland and roads | 34 |
| 6.5 | Freemans Reach - The Northern River Bank | 37 |
| 6.6 | Depths of Excavation | 37 |
| | 6.6.1 Introduction..... | 37 |
| | 6.6.2 Salvage only of Impacted Depths | 37 |
| | 6.6.3 Comprehensive Salvage In all Impacted Areas..... | 38 |
| 7 | The Research Design | 39 |
| 7.1 | Introduction | 39 |
| 7.2 | Integrated Archaeology..... | 39 |
| | 7.2.1 Identifying the Research Objectives..... | 39 |
| | 7.2.2 Direct Community Involvement..... | 40 |
| | 7.2.3 Information Exchange..... | 40 |
| 7.3 | Long Term Outcomes..... | 40 |
| 7.4 | Project Integration..... | 40 |
| 7.5 | Conservation..... | 40 |
| 8 | References | 41 |

List of Tables

| | |
|---|----|
| Table 1: Option 1 - Construction Footprint - Archaeological advantages and disadvantages | 27 |
| Table 2: Option 1 - Construction Footprint- Engineering and environmental advantages and disadvantages..... | 28 |
| Table 3: Option 2 - Consolidated Construction Footprint - Archaeological advantages and disadvantages..... | 31 |
| Table 4: Option 2 - Consolidated Construction Footprint - Engineering and environmental advantages and disadvantages | 32 |
| Table 5: Option 3 - Salvage excavation of the entirety of Thompson Square parkland and roads – archaeological advantages and disadvantages | 34 |
| Table 6: Option 3 - Salvage excavation of the entirety of Thompson Square parkland and roads – Engineering and environmental advantages and disadvantages | 35 |
| Table 7: Savage of impacted depth only – advantage and disadvantages..... | 38 |
| Table 8: Comprehensive salvage in all impacted areas – advantages and disadvantages..... | 38 |

List of Figures

| | |
|--|----|
| Figure 1: The project area in a regional context..... | 4 |
| Figure 2: Option 1 - Construction Footprint | 29 |
| Figure 3: Option 2 - Consolidated construction footprint for archaeological excavation | 33 |
| Figure 4: Option 3 - Salvage excavation of the entirety of Thompson Square parkland and roads..... | 36 |

List of Plates

| | |
|--|----|
| Plate 1: The SHR plan of the "Thompson Square Precinct". Source SHR listing 00126. | 2 |
| Plate 2: Cross section of the replacement bridge in Thompson Square with the Land Bridge Option showing the piles across the structure. An additional 6 piles on each long side also formed part of this particular design. Source: SKM Plan DS2012/000155 Sheet 3. | 19 |
| Plate 3: Diagram of one side of the L-shaped retaining walls proposed for the bridge abutment in Thompson Square. Source: SKM Plan DS2012/000155 Sheet 3. | 20 |
| Plate 4: Diagram showing the depth of excavation in Thompson Square associated with the construction program. (Source SKM) | 23 |
| Plate 5: Diagram showing the depth of fill in Thompson Square associated with the construction program. (Source SKM) | 24 |
| Plate 6: Diagram showing the depths of cut and fill on the north bank in Freemans Reach..... | 25 |
| Plate 7: 12D model showing construction impacts | 26 |

Executive Summary

This document has been prepared to address specific requirements of the Department of Planning and Infrastructure (DP&I) and the Heritage Branch NSW (Office of Environment and Heritage: OEH) with respect to the Windsor Bridge Replacement Project.

Archaeological resources have been identified as one of the major components of environmental heritage that would be affected by the proposed bridge construction project. The EIS prepared for the project concludes that the optimal outcome for the archaeological profile within the project area is for conservation, intact and in its entirety, as it now exists. Conservation will maintain the heritage precinct's cultural value, and preserve the complex physical relationships that constitute the research value of this resource.

Approval of the RMS preferred option would cause substantial damage to the archaeological resource and its cultural significance. Recommendations were made in the EIS (in the event that the project is approved) for an integrated program of archaeological investigation, documentation, and outreach, as a means of salvaging information before it is lost or damaged. However it should be noted that the resulting archive of information would not have the same cultural value as the physical evidence that is now preserved within the project area.

The purpose of this paper is to present options for how an archaeological program could be integrated into the development with respect to the extent of the investigation, collaboration between three disciplines of archaeology, outcomes that would be achieved by the work and its relationship to the construction program.

This paper reviews the scope of analysis and investigation undertaken for the EIS with respect to Aboriginal archaeology and maritime and terrestrial archaeology of the historic period. It has found that there is likely to be a large, complex and very significant archaeological profile within the project area for all three strands of archaeology. It also found that this profile is likely to be so complex that any excavation, either for construction or archaeology, would fragment it and the means of interpreting any sample retrieved would be compromised. Conversely, whatever would be preserved in the ground would also be impacted in its integrity, due to loss of evidence explaining its relationship to the landscape, the processes that have shaped that landscape, and its position in the chronological development of this place.

The options discussed in this paper will not redress or mitigate the impacts of any construction project. They are designed to salvage information that will be lost through the construction works. Three options for the extent of excavation have been considered:

- Option 1 - Excavation strictly within the construction footprint, construction impacted land, and proposed landscaping and ancillary works
- Option 2 - Excavation within the consolidated construction footprint - construction impacted land, and proposed landscaping and ancillary works, plus additional salvage of all areas within the construction footprint
- Option 3 - Excavation of the entirety of the Thompson Square parklands and roads

The selection of these three options or strategies is based on the objective of retrieving the most coherent suite of data from any future investigative program.

These options are not discussed solely in relation to the benefits or otherwise of archaeological salvage. The advantages and disadvantages of each option are considered, from an archaeological perspective and from the perspective of other factors such as constructability, cost, effect on program and other environmental and amenity impacts.

This paper is not a “research design”, as that term is used in archaeological works and conditions in New South Wales. This is a paper concerned with defining which option will deliver the greatest benefit for short and long term objectives. After a preferred archaeological strategy has been identified, the methodologies and staging of the program will then need to be addressed in a specific research design. Several issues that will need to be discussed in that research design are highlighted in this paper.

1 Introduction

1.1 Project Background

The Roads and Maritime Service (RMS) is seeking approval under Part 5.1 of the *Environmental Protection and Assessment Act 1979* to replace the bridge that crosses the Hawkesbury River at Windsor. The project would entail the construction of a new bridge thirty-five metres downstream (east) of the present bridge, realignment of the roads to meet the position of the new bridge, and infilling the current approaches to the existing bridge. The present bridge would be demolished when the new bridge reaches completion. Landscaping works would be undertaken in the parklands.

Heritage resource values, both material and intangible, were identified as key issues to be considered prior to the commencement of the project, and have remained significant factors in the evaluation of this project and its potential impacts. Aboriginal heritage has been addressed in a separate report by Kelleher Nightingale Consultants.¹ Historic period resources have been addressed in two separate strands; those that may be found within or functionally connected to the river, and those that may be found on the land. Cosmos Archaeology Pty Ltd has addressed maritime archaeological evidence within the river in a separate paper.²

Terrestrial heritage resources of the historic period have been addressed in several papers prepared by Biosis Pty Ltd in collaboration with Cultural Resources Management (CRM).³ These investigations have encompassed the following:

- The development of a primary archival analysis intended to provide a framework for understanding the development of the project area and for identifying specific sites, places, associations and events that have contributed to the heritage resources of this place and their significance;
- Specific primary research to document the development and context of the present bridge;
- Identification and evaluation of historic period resources above ground including buildings and other structures, landscapes and views and vistas;
- An archaeological assessment;
- Two targeted programs of excavation for historic period archaeology as a means of testing the conclusions of the archaeological assessment and providing evidence for the potential impact of the proposed work on the archaeological resource;
- Assessments and evaluations of significance for the project areas and individual components;

These studies and others related to different issues including noise, traffic and landscape informed an Environmental Impact Statement (EIS) prepared by RMS. The EIS and the technical studies were publicly exhibited in December 2012. A submissions report is currently being prepared to address the issues raised in the exhibition period. Determination on the project application is anticipated in mid- 2013.

1 Kelleher Nightingale Consulting Pty Ltd (2012); Windsor Bridge Replacement Project Cultural Heritage Assessment Report

2 Cosmos Archaeology Pty Ltd, Maritime Archaeological Statement of Heritage Impact: Final Working Paper Report, October 2012.

3 Biosis Pty Ltd and CRM, Windsor Bridge Replacement Project: Historic Heritage Assessment & Statement of Heritage Impact, November 2012

1.2 Project Area

The project area encompasses land on both the northern and southern banks of the Hawkesbury River adjacent to the present bridge (Figure 1). On the southern bank the project area encompasses the state significant and listed conservation area of Thompson Square.

The definition of Thompson Square in this document, as in the Historic Period Heritage Working Paper, includes the SHR bound entity as well as the majority of the historical entity. The two are not consistent as the SHR boundary follows modern property boundaries, excludes Bridge Street and does not extend to the river bank, which has remnants from the early town. For the purposes of this document, "the excavation of Thompson Square" refers to the upper and lower parkland, Bridge Street and The Terrace to include the river bank and sites within the river. The area of land that is specific to the discussion of archaeological options is essentially the area of the historical Thompson Square but does not include the surrounding buildings and the eastern and western extents of George Street (refer to Plate 1 for the SHR legal plan; refer to Figures 2, 3 and 4 for the areas of excavation described in the archaeological options in this document).

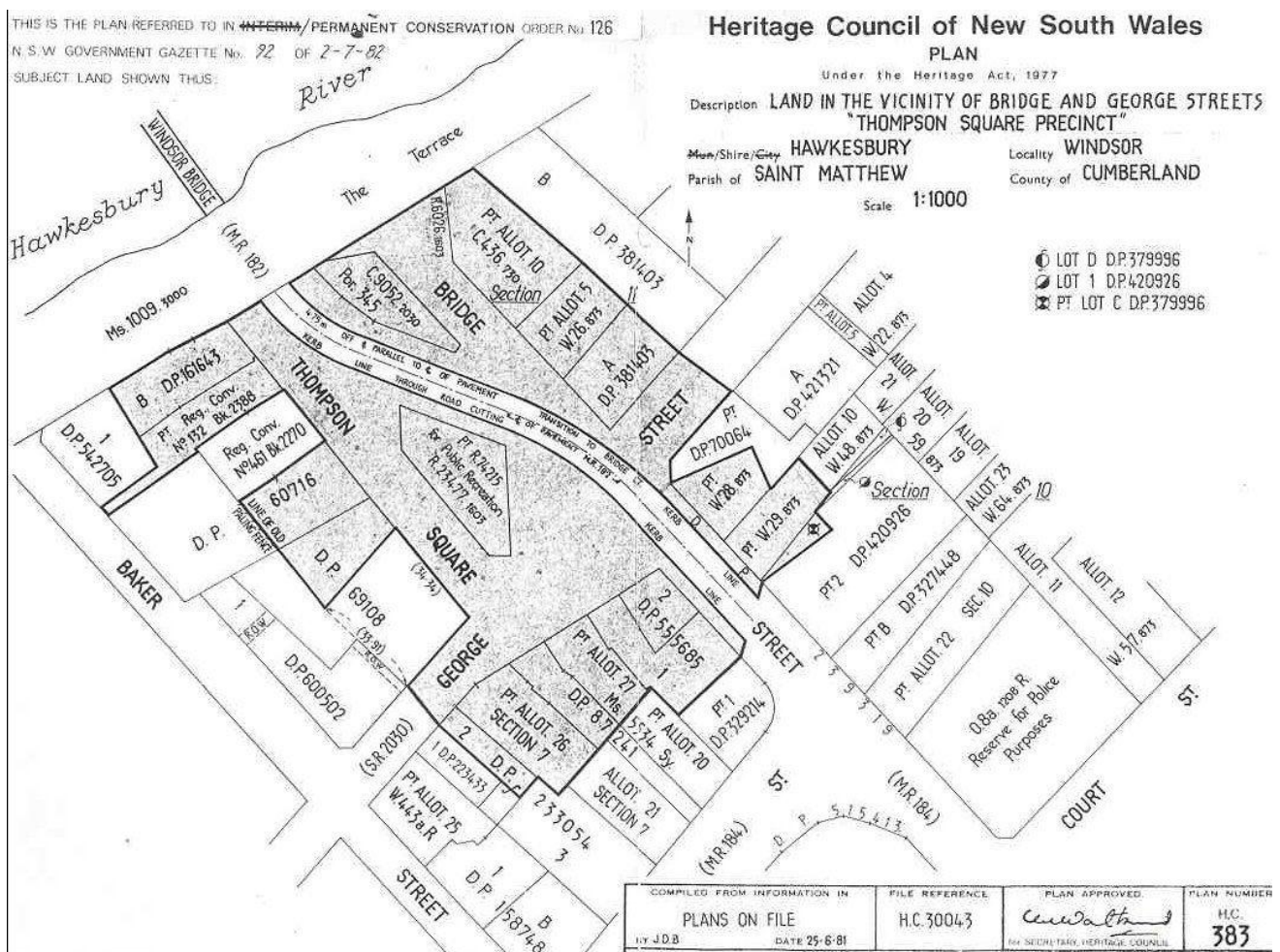


Plate 1: The SHR plan of the "Thompson Square Precinct".

Source SHR listing 00126.

1.3 Purpose of this Document

Heritage resources have been the subject of consultation between RMS and the Department of Planning and Infrastructure (DP&I) and the NSW Heritage Branch (of OEH) and the Culture and Heritage Division of the Office of Environment and Heritage (OEH) for Aboriginal cultural heritage issues throughout the project duration. The DP&I has advised RMS that an additional paper is required for the submissions report that expands on the heritage management commitments made in the EIS. This is a management document that examines the way in which archaeological procedures could be integrated into the project if approval for it is forthcoming. Consultation with the Heritage Branch and the DP&I was undertaken and it is understood that this document is to address options for management rather than a single strategy.

The purpose of this document is to address the requests from the Heritage Branch and DP&I. This is an options paper that considers several strategies for how an archaeological program could be integrated into the development project and what outcomes could be expected from those options. Further this paper looks at the implications for each strategy.

This document does not establish the “how” of any future archaeology. That is the purpose of a research design and a document of that type will be necessary when an appropriate strategy for any future work is determined; it is the purpose of this report to determine options for the “what”. What is the best program that can be undertaken to address the impacts of the project if it is approved and implemented? To this end the report addresses the following issues:

- Options for archaeological programs that are based on establishing the most comprehensive recovery of information and research objectives within the context of excavation programs of different scales;
- The advantages and disadvantages of each option;
- Issues that need to be addressed in the selection of any option.

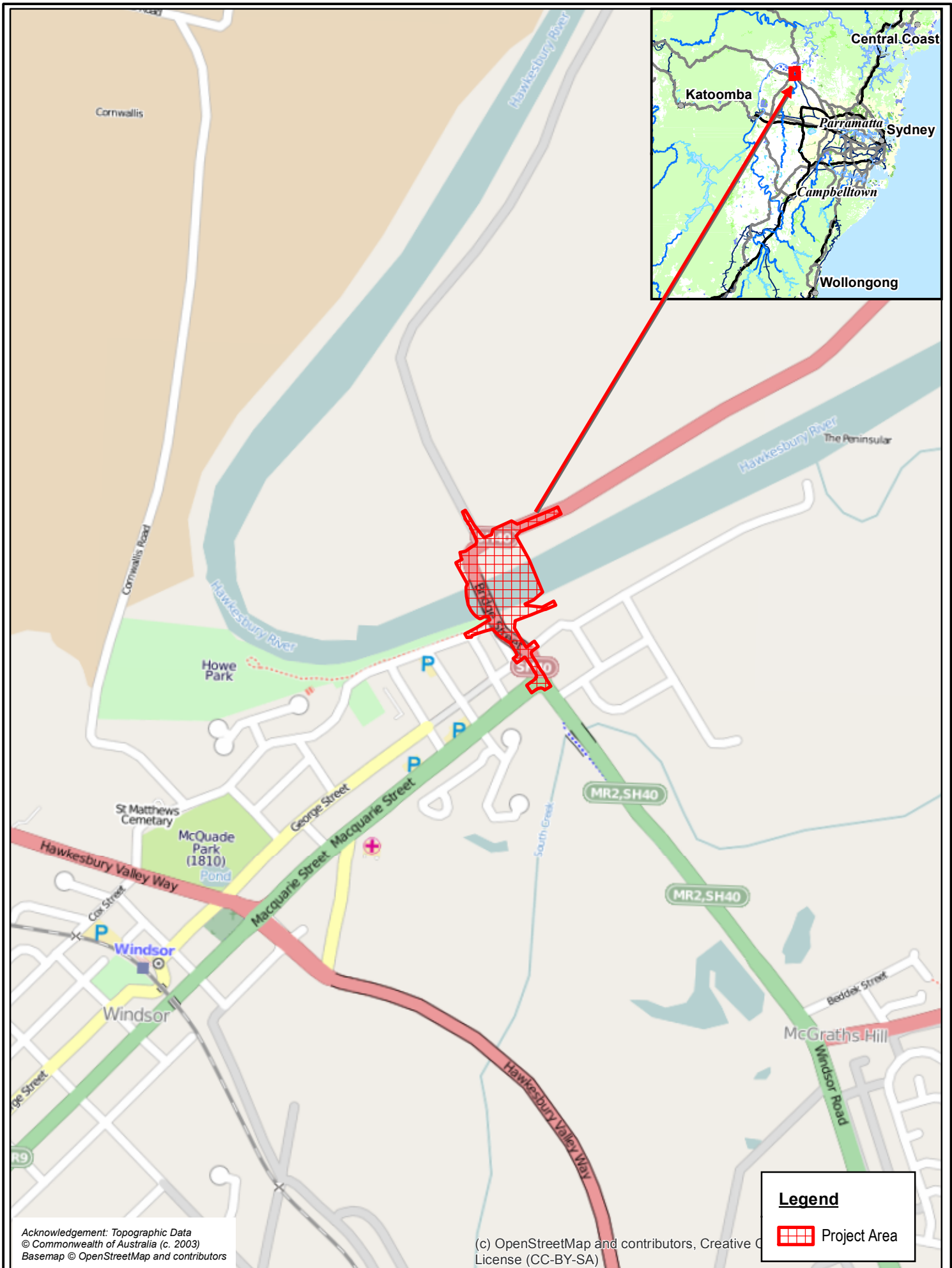
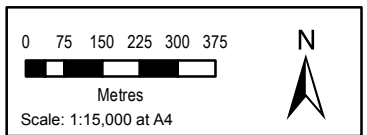


Figure 1: Location of the Study Area in a Regional Context

Date: 31 August 2012 Matter: 14020
 Checked By: PBK Drawn By: JMS
 Location: P:\14000s\14020\Mapping\14020_SoHIF1_Locality.mxd



2 Review of Archaeological Resources

2.1 Historical Framework

The historical analysis undertaken for the project produced a detailed developmental history that described the evolution of the project area from the first European settlement to the present-day. It also discussed influential factors such as environmental change, and the impact of different forms of transport on the material world of Thompson Square and the farming land on the northern side of the river. Specific associations were highlighted including those of Governor Macquarie and Andrew Thompson, which were not only important to the development of the town but continue to resonate with respect to the identity of this place.

A framework was established to place physical evidence within a timeline of development. This timeline and the enables the physical evidence (above or below the ground or within the water) to be valued for its capacity to illustrate that development, and for the substance they provide for this history and town identity. This is especially important when that history or association is not always articulated in the buildings, landscape and other works that can be seen today. This is the basis for evaluating cultural significance.

Archaeological resources, in particular, can be shown to be the primary source of contact between the history contained in archival sources and that which we can now touch and see, particularly for the first twenty years of settlement at Windsor but also for much of the first half of the nineteenth century. The archaeological testing programs undertaken for this project have also demonstrated that evidence in the ground can reveal work that has had substantial influences on the landscape as it now exists but has left no record in primary documentation. Archaeology can help to anchor the past landscape to the present by identifying sites for places only known through images or surveys. Archaeology adds texture and dimension to the history of place and identity acquired from documents. The narrative of archival sources, however, provides a structure. Archives can provide a picture and archaeology can add detail and colour to that picture. It can also change the picture or even draw a new one.

The following broad thematic and chronological sequence was established for the project area:

- The Importance of Topography and Environment
- An Aboriginal Place before and after the historic period settlement
- Mulgrave Place in 1794
- Green Hills settlement from 1795-1800
- The consolidation of a government and regional precinct from 1800-1810
- The incorporation of the precinct within the newly founded Macquarie town of Windsor 1810 - 1820
- The importance of the place as a regional centre from the 1820s to the 1850s
- The changing status of the place in the second half of the nineteenth century
- The emerging status of the place as an “historic” town in the twentieth century

2.2 Archaeological Assessments

Assessments were produced for all three strands of archaeology (historic period terrestrial and maritime and indigenous). These documents describe the physical evidence likely to be left in the ground (or in the water), demonstrating the evolution of the place and the lives of the people there. With respect to Aboriginal life, this encompasses several thousands of years, and over two centuries for historic period settlement. The assessments

are based on many strands of information: archives, physical evidence, identifying environmental models, and similarities to comparable sites amongst other sources. The overall conclusions of the separate fields of archaeological investigation are described in the following sections.

2.2.1 Aboriginal Archaeological Resources

The Aboriginal Cultural Heritage Assessment posed the question regarding the existence of intact sand deposits on Tertiary substrate or non-gravel alluvial sand.

Research was undertaken using geomorphological and archaeological information to inform the predictive model, which was tested with the subsurface test excavation. The indicators to significant archaeological resources (of Aboriginal origin) are reproduced below:

- Intact biomantles, especially sand bodies, on Tertiary substrate have the potential to contain archaeological objects;
- Biomantles containing sand (Aeolian or alluvial) and low level bioturbation may also allow chronologic, stratified cultural deposition;
- Archaeological excavation of Aeolian sands within 100 m of the study area has identified stratigraphic cultural deposit representing possible Pleistocene occupation;
- Significant artefact densities exist above 1:100 flood level along the Windsor – Pitt Town river terraces.⁴

2.2.2 Maritime Archaeological Resources

An assessment undertaken for the maritime resources within the project area identified the following potential sites or features:

- The first settlement wharf built in 1795;
- A second wharf built in c. 1814 and repaired in 1820 and still present up to as late as the 1940s;
- A private punt service commenced in c. 1815, taken over by the Government in 1832, using the wharf as a southern landing place;
- The replacement of the original punt service with one located upstream in c.1835 using a cable system laid across the water;
- The first bridge constructed in 1874;
- A temporary bridge constructed in 1896 as part of the programme of raising the height of the bridge; possibly located upstream from the present bridge site;

2.2.3 Historic Period Terrestrial Archaeological Resources

The assessment prepared for the terrestrial resources of the project area recognised the potential for a large, varied and complex profile that encompassed the full scope of historic period settlement from 1794 to the present day and including sites of seminal importance for the town and the state.

To summarise this potential profile with respect to the project area on the southern bank there may be evidence of the following:

- The pre-settlement environment;

⁴ Kelleher Nightingale Consulting Pty Ltd September 2012: 13

- Evidence of environmental manipulation and change from first settlement onwards;
- Evidence of clearing and the first buildings (store, guardhouse and wharf) from 1794-1795;
- Evidence of the shaping of the landscape by removal of deposits along the George Street ridgeline;
- Evidence of tracks and paths, a boat slip, barracks, granaries, government buildings including domestic residences, a lock-up and Thompson's first house and garden that date between 1795-1800;
- Evidence of more government buildings including a prison and a possible government wharf and tracks and paths dated between 1800-1810; more sites of substantial buildings and works are recognised to lie close to but outside the project area;
- Evidence of a wharf, roads, cuttings, a large brick barrel drain and possible secondary drains and large quantities of levelling fill in the square from the period 1810-c.1820; the potential for significant archaeological evidence in building allotments on the eastern, western and southern sides of the square outside the project area is also recognised;
- Evidence of new road surfaces, punt landings, a watchhouse/punt house on the terrace from the period of c. 1820-1840; evidence of new government buildings on the eastern side of the square is also recognised but this is outside the project area;
- Evidence of extensions to Bridge Street on the eastern side of the square in 1855 and 1874, of other road surfaces on the western side of the square and resurfacing of roads in the centre of the square, evidence of drains and other services, evidence of filling in the approach to the raised bridge level of 1896, cutting down of some levels in the square and its roads from the later years of the nineteenth century; evidence of a summerhouse and pavilion in the reserves and fences along the roads and reserves;
- Evidence of cutting along the western side of the square for the construction of a new approach to the bridge in 1934;
- There is the potential for artefact assemblages from all periods and services from the later part of the nineteenth century onwards.

Many of the buildings and sites recognised by the assessment cannot be specifically identified with a particular location within Thompson Square, meaning that the entire precinct must be treated as one of archaeological sensitivity.

With respect to the northern riverbank within the project area there may be evidence of the following sites and or features:

- Evidence of the pre-settlement environment;
- Evidence of the impact of first settlement on that environment and evidence of the nature of that settlement with respect to clearance and agricultural development;
- The potential for farm buildings, house and fencing from the first grant of 1794; no specific sites can be determined for this period of occupation;
- Evidence of a hotel that was in operation from at least 1839 and may have been continuously occupied to the 1880s. The site could encompass structural evidence, fences, drains and other landscape improvements as well as artefact assemblages. No specific site has been identified but anecdotal evidence suggests that it might be close to the intersection of Freeman's Reach Road and Wilberforce Road;
- Evidence of market gardening and turf farming from the twentieth century.

Although the different types of evidence are analysed and discussed separately it is important to remember that they represent different viewpoints of the same landscape. Aboriginal people had a history of association with this

place for thousands of years before Europeans arrived and they still were a presence in the historic period town. Remnants of an early nineteenth century wharf in the river helps to make sense of the location of roads and buildings on the land that took advantage of this wharf or helped to service it. The landscape above and below the ground and in the water is a complex and connected artefact.

3 Testing the Assessments

3.1 Background

Physical investigation was undertaken to test the validity of the assessments for each strand of archaeology. The fields of historic period terrestrial and maritime archaeology and Aboriginal archaeological investigations were all investigated and analysed via physical evidence acquired from survey and small programs of archaeological excavation. This evidence confirmed the ability of the project area to preserve information about this complex cultural landscape and the activities of the people who have lived in it. A brief summary is presented in the following sections of the results of each investigation.

3.2 Aboriginal Archaeology

Test pits for Aboriginal archaeology were placed on both the northern and southern sides of the river. Five 1x1 metres test squares were hand excavated on the south bank and nine 1x1 metre squares were hand excavated on the north bank. In addition to the nine test squares, the Aboriginal archaeological assessment incorporated the results of geoarchaeological boreholes and geotechnical boreholes. The results of the testing program were reported as follows:

Geotechnical and Aboriginal archaeological investigation was undertaken as part of the EIS for the Windsor Bridge Replacement Project. No significant Aboriginal archaeology was identified on the north bank due to the impact of successive flood events. Significant archaeological information was identified in elevated portions of the south bank. Two test squares on the south bank found moderate to high levels of Aboriginal objects. The most elevated test square in the south-east corner of Thompson Square revealed high numbers of stone artefacts within a thin layer of fine-grained Aeolian-like sands, which offers the possibility of obtaining important cultural dates. A second test square in a lower elevation revealed a disturbed Aboriginal shell midden possibly (re)deposited during historic times.⁵

3.3 Maritime Archaeology

Two maritime archaeological surveys have been undertaken in the river within the footprint of the new bridge from the southern bank to the northern bank. The impact of the new bridge in the river would be through the construction of piles to support the deck of the bridge. The results of these programs of work may be summarised as follows:

- There is intact structural evidence above and below the water level of the c. 1815 wharf; there is rock ballast, and within it, and for at least a five-metre area around this ballast, there is substantial potential for structural components of the wharf;
- There is likely to be structural evidence and artefact deposits associated with this wharf within the southern river bank;
- There is moderate potential for archaeological evidence associated with the c. 1835 punt landing on the northern side of the river upstream from the current bridge site but low archaeological potential for evidence of this crossing within the river;

⁵ Kelleher Nightingale Consulting Pty Ltd (2012); [Windsor Bridge Replacement Project Cultural Heritage Assessment Report](#): 05

- There are timber structural elements on the northern side of the river close to the bank on the eastern side of the current bridge, possibly derived from mooring posts of the c.1950s or a retaining wall: these elements are not considered to have significant research potential;
- Remote sensing identified objects in the river thought to be artefacts; further investigation found this to be not the case.⁶

3.4 Terrestrial Historic Period Archaeology

Two small programs of testing were undertaken; the first on the northern side of George Street within Thompson Square and on the northern river bank and the second on the southern side of George Street. The results of the first program with respect to the northern side of the river may be summarised as follows:

- The majority of the evidence found in these excavations demonstrated the processes of siltation from floods and soil added for specific activities such as the turf farm and road surfaces. Almost all of these events can be identified as twentieth century activities. The soil associated with these processes can be up to two metres in depth;
- There was little specific evidence of historic period occupation or works other than the purposely added soil levels. There were no clear surfaces with one possible exception, no evidence of agricultural works, the impacts of pastoralism and little structural evidence. Specific sites such as the Squatters Arms Hotel could not be identified from this work;
- Only one site provided substantial evidence of historic period activity; this was related to works associated with the development of new approaches to accommodate the increased height of the bridge in 1896. Similar evidence was found on the southern side of the river;
- The almost complete absence of artefacts suggests that the land here was sparsely occupied apart from farming.

The results of the first program of testing on the southern side of the river, north of George Street may be summarised as follows:

- Evidence of the pre-settlement environment was preserved with respect to land-form although it had been modified in the historic period;
- Archaeological evidence dating to the 1830s and possibly earlier is preserved at the north-eastern side of Thompson Square. It encompasses evidence of gardens and what is likely to have been domestic occupation;
- There is the potential for structural evidence that dates back to at least 1800 associated with significant and identifiable occupants including Andrew Thompson or part of the government reserve;
- There was evidence of major land-forming and infrastructure works associated with the extension of Bridge Street in 1855 and improvements made to this road in several later phases of work in both the nineteenth and twentieth centuries. Evidence from an Aboriginal archaeological test pit indicated more extensive cutting further south along George Street probably undertaken late in the twentieth century;
- There was evidence of another major program of land-forming and road construction associated with the changes made to the bridge in 1896; this evidence was similar to that found on the northern side of the

⁶ Cosmos Archaeology Pty Ltd (2012); Proposed Windsor Bridge Replacement, Windsor NSW. Maritime Archaeological Statement of Heritage Impact Final Working Paper Report: i-iii

river including structural components designed to stabilise the steep ground close to the river and support the construction of a new road at a higher level;

- There was evidence to indicate that the archaeological profile at the northern end of Thompson Square close to the terrace and river would be of considerable depth with the potential to preserve important sites and works associated with the earliest settlement;
- Evidence from test pits for Aboriginal archaeology also provided information concerning the development of Thompson Square in the historic period. The upper parkland appears to have been truncated close to George Street in the mid-twentieth century with fill used to level the new surface. The lower parkland contained evidence of nineteenth century fill containing Aboriginal midden material possibly brought from another site and used to shape and resurface the site; this work also appears to have occurred in the mid-twentieth century.

The evidence from the second program of testing on the southern side of George Street in conjunction with evidence taken from several geo-technical cores may be summarised as follows:

- That the topography recorded in the earliest nineteenth century images of the Green Hills settlement is accurate in its depiction of a high exposed ridge line stepping down steeply to the river; it may have been more extreme than those images suggest with gullies cutting through the ridge line and uneven outcrops of rock;
- That the ancient sand bodies recorded in test pits on the northern side of the road do not appear to have covered the peak of the ridge or extended further south than the northern side of George Street;
- That this peak or ridge, the later alignment of George Street, may have been exposed bedrock or only thinly covered with sand or soil. It may have been cut through by a gully at the line of present day Bridge Street;
- That this thin soil cover, if it existed, may have been removed in the earliest days of settlement to provide a hard and impervious surface for both pedestrian traffic and construction projects;
- That the exposed bedrock in this location may have been cut and shaped in places to be used in the construction of building foundations, drains or other structural works. If this is the case then evidence of this work could be found in the roads; the work would have been undertaken before the formalisation of those road corridors;
- That there is no clear evidence of the Commissariat building of 1803 and the impact of road works, paving and the introduction of services in the footpath on the eastern side of Bridge Street make it unlikely that much or any remains here. However, of the technique of cutting and shaping bedrock was used in the construction of this building then some evidence of this work could survive at the face of the bedrock. It is unlikely that evidence of the building will be found in the road because of the impact of road widening and the formation of the most recent road surface;
- That by the mid-nineteenth century the alignment of George Street had been altered at least twice and soils had been imported to build up this area possibly higher at the southern end of Thompson Square than the street level immediately adjacent to the Macquarie Arms Hotel; this conclusion is based on archival evidence;
- That these accumulated soils were comprehensively removed in c. 1893 to allow for a major program of infrastructure that entailed laying service pipes in the street and possibly creating a new road surface comprised of a bedding deposit of locally sourced clay topped with a cobbled stone road. If this is not a road then it might be a linear drainage feature. If so a tar-paved surface found close by and to the south might be evidence of an associated road surface. The evidence suggests that the latter is more likely to be

later twentieth century in origin but there is insufficient physical evidence to make connections between the features in these separate locations;

- The same locally sourced clay found under the stone cobbling may have been used to create a pedestrian area along Bridge Street adjoining the School of Arts but there is no evidence for how it was finished or paved and the sample was too small to make a positive identification;
- By the 1920s the surface of George Street appears to have comprised silty soil that was laid or accumulated over the stone cobbling;
- Asphaltic concrete footpaths were laid in George Street from 1938 onwards and the physical evidence suggests that the work entailed cutting down the existing road, possibly removing much of the stone cobbling if it was a road surface and any later surfaces and introducing fill along the northern side of the road to help level it for the new concrete surface although this fill could have been introduced for an earlier program of works on the road in the nineteenth century; there is insufficient evidence from the sample to date it;
- Three separate resurfacings of this road are shown in geo-technical cores taken along George Street and test trenching also records layers of asphaltic concrete;
- The paved footpath along Bridge Street dates from the middle or later part of the twentieth century;
- By 1978 there was a grass covered strip that projected from the footpath into George Street at the south-western intersection with Bridge Street. This grass strip survived into the 1980s but may have been replaced with a bitumen surface. The present paved footpaths and raised garden behind the hedge on the footpath at this intersection are a product of the c. 1990s. The raised garden is made on 400 mm of introduced sterile topsoil;
- The introduction of services in the footpaths has made a substantial impact on the preservation of archaeological evidence.

Taken together the evidence from these test excavations demonstrates that the project area retains archaeological evidence of the following:

- The original and modified land-form and environmental conditions;
- Evidence of environmental change and the impacts of change on human settlement;
- Aboriginal occupation in the form of objects preserved in the sand body north of George Street;
- Programs of work that have very substantially modified the place from the early years of the nineteenth century, the mid-nineteenth century but particularly from the later years of the nineteenth century onwards. These land-forming works are related to specific projects and while they encompass large portions of Thompson Square evidence of them will not be found across the entire project area;
- Physical evidence that could date back to at least 1800 and may be associated with significant owners or sites both within the river and on the land ;
- The creation of infrastructure in both the nineteenth and twentieth centuries; the testing programs have also revealed the impacts of these works on earlier phases of development.

The southern bank has the largest, most diverse and culturally significant archaeological profile, including deposits in the river. The northern bank and river's edge is less culturally rich.

3.5 Implications

3.5.1 Variation within small areas

Much of the evidence revealed in the testing programs is unknown from archival sources or substantially expands the archival framework for specific events or conditions. It should be understood, though, that this does not represent the full suite of evidence that is likely to be preserved within the project area. Every test trench has produced a completely different result to the others with very few or no common deposits shared between them. It demonstrates the complexity of this profile and the great change that may be found within very short distances.

The testing programs have also demonstrated that there is a very large variation in the depth of intact archaeological deposits. The archaeological profile is approximately 500-600 mm in depth at George Street at the southern end of Thompson Square. Whereas the northern end of Thompson Square is likely to be several metres in depth. The same is true on the northern side of the river where introduced soils extend to a depth of up to two metres.

This issue is made more complex by the evidence that illustrates the extremities of the original topography and the unpredictability of that land-form. The evidence suggests that there was a narrow and probably broken ridge line, with a deep cleft and a steep and irregular slope to the river possibly with outcropping rock and deep sand deposits and terraces between. The response of the early settlers to this irregular landscape is likely to produce considerable variation in small areas that cannot be predicted.

3.5.2 Linking the different profiles

The first very substantial programs of land-forming do not appear to have been undertaken until the later years of the nineteenth century, with the exception of the formation of Bridge Street (northern end) in 1855, and the large drainage and levelling works of the Macquarie era. This has significant implications for interpreting archaeological evidence. It reduces our ability to make a reliable prediction, other than in very general terms for settlement of the pre-1850 period. It will also make it difficult to interpret isolated areas of archaeological evidence in relation to each other without the benefits of either common soil deposits within or between them or the ability to comprehensively excavate and thus record the processes, such as cutting and filling that would make sense of the varied profiles in those areas.

The testing program has demonstrated the potential for a chronologically long and diverse archaeological resource within the project area. This program also produced evidence that demonstrates the issues that would arise in further sampling programs whatever the scale. It highlights the pitfalls of excavating a large part of the profile when that portion of excavation has no relationship to the historical landscapes of Thompson Square as far as they are known. These factors may be summarised as follows:

- The original landform appears to have been more extreme and varied than is evident from the limited archival sources and this topography appears to have been very influential in the formation and development of the first settlement. The presence of a small beach at the northern end may have been the factor in selecting this site for a government precinct and the landform influenced the placement of buildings and roads;
- The response of early settlers to the variability of topography and other environmental conditions is likely to have been individual and localised; this means that the archaeological profile is likely to exhibit great variation in its earliest levels and is inherently unpredictable with very few exceptions;
- There is evidence for major programs of land-forming, mostly from the later years of the nineteenth century although with at least two exceptions from 1855 and c.1815 and these could create large horizons that provide common reference points for separate, small or isolated excavation areas as well as chronological markers for the entire profile. However, even these large programs do not appear to have

been consistent across Thompson Square; for example, they appear to have been related to the construction of specific roads or forming the parklands and this will also impact on the ability to reliably interpret any excavated sample;

- The best means of providing a reliable interpretation of the archaeology of this complex and significant period of settlement would be to comprehensively excavate it; this would enable the documentation not only of specific sites but the processes that create the landscape around them and, thus the links, between those sites. Excavating isolated pockets or even large areas of land, essentially a large sample, is unlikely to reveal those links and will make future interpretation of the evidence recorded difficult at best. Conversely, it will create a break in the links and even individual sites that would be preserved and this has long term implications for the viability or integrity of the preserved resource.

4 Cultural Significance

4.1 Terrestrial Historic Period Archaeology

A detailed evaluation of cultural significance for the project area and its individual elements was an important component of the heritage evaluations made for the project. The statement of significance with respect to the archaeology of the project area is as follows:

The historical analysis, archaeological assessment and evidence from preliminary testing and past works demonstrate that there is likely to be a complex and chronologically deep archaeological profile within Thompson's Square and to a lesser degree on the northern river bank. It is impossible to isolate the resource that could exist within the project area and assess its significance. It must be assumed that the evidence contained within the project area will have the same values and significance as the rest of the square even if specific elements within both may vary from each other. The significance of the archaeological resource within the project area is the same as that for the resource across the entire square and this cultural significance must be assessed on several levels.

Windsor is the third settlement in Australia after Sydney and Parramatta. These are the places that made long-term European settlement possible and their histories inform us of the circumstances, the pressures and visions that would shape our history and the way we live. Apart from its importance as one of our first permanent settlements Windsor also has added status as a Macquarie town, one of very few places that were specifically selected and influenced by arguably our most important Governor. A number of the improvements and designs for the square are a direct result of his involvement. Thompson Square also has direct associations with outstanding people in the development of the town and region particularly Andrew Thompson, who lived and worked here. The archaeological resource could provide tangible links or associations with significant historical figures by revealing works or improvements that have been created for, on behalf of or by these figures.

Thompson Square is the single place that links the earliest settlement on the Hawkesbury, Mulgrave Place, with the Macquarie-era town. This site was used as a civic precinct to service Mulgrave Place from 1794. It evolved into a small village in its own right that also provided the services and administration for the region. It is the seminal place of the town's evolution. It was this village that was incorporated into the Macquarie planned town of Windsor; it was the only town to incorporate this earlier layer of settlement. It is unique.

If Windsor and Thompson Square are important then archaeological evidence that can better document or reveal the history of use and development that is unique to this place and provide evidence of its associations is also significant. The below ground resources are likely to provide evidence of the earliest years of settlement, pre-dating the fabric that survives above ground. Archaeological evidence is also likely to provide evidence of events and processes that were specific to the square but are representative of the development of this town.

The principal value of the potential archaeological profile in Thompson's Square is its cumulative value. It has the potential to document events, processes, improvements and places that span the full history of European development in this place from 1794 to the present day. It is likely to be the only place in Windsor or its environs that can do so. The archaeological profile of the project area on the south bank is completely unique to it. Because of the potential chronological depth of the profile it may include sites that are rare beyond the specific history of this place.

Apart from the potential to document and demonstrate the changing town and the place of the square in it over a long period of time the archaeological profile in the square can be evaluated for different levels of significance that are largely relevant to their rarity either through age or singular uses. In particular, evidence that relates to the founding settlement of 1794 up to and inclusive of Macquarie-era works is assessed to be of exceptional

significance for its importance within the town, its rarity and its contribution to documenting the growth of the colony in its formative years. For the earliest years of settlement this resource would be the only fabric that survives in the town; there is no evidence above ground that predates 1811. It is comparable to only a very small number of other places that have the same depth of development such as Sydney or Parramatta.

As well as works from the first decades of the town's growth the project area is also likely to encompass important improvements from the middle and later years of the nineteenth century that reflect the changing status and role of the town and this particular square. These include the development of the bridge across the river to link the two communities. Many of these processes are not evident in above ground resources. These are resources that can make a substantial addition to the evidence that survives above ground; they have value for the town.

Evidence that derives from the early – middle years of the twentieth century is less significant. These processes are still evident in other forms and they have impacted on earlier and more rare resources. Evidence from the later years of the twentieth century onwards which is still largely intact above ground and has acted to remove or disturb older or more rare elements is considered to have little individual significance but is recognized as an integral component in the complex profile.

The northern area of the project area across the river also has a history of settlement that dates back to 1794 with a farm established here by an ex-convict, Edward Whitton, in that year. Apart from his pioneer status Whitton's contribution is representative of the thousands of people who worked to develop the region.

Archaeology in this part of the project area is unlikely to have the same complexity of resources because of the nature of settlement here; largely pastoralism and agriculture. It has value as a comparison to the complex history of Thompson Square but its individual components are likely to be less significant; the exception would be the site of a long-standing landmark inn although its precise location cannot be determined. The resource in the northern part of the project area, with few exceptions, is likely to be more representative of the agricultural/pastoral development that characterized this side of the river.

The archaeological resource is likely to provide a depth of historical layering and sense of place to the acknowledged visual qualities of the square. These are qualities and resources that can be valued by the community. It has the ability to provide unique, rare and representative components for this place and for New South Wales. The cumulative profile records evidence of works and change over two centuries is unique. Within that overall profile evidence of the Mulgrave Place period of development and Macquarie-era works would be of state significance. The remainder of the archaeological profile has local significance.⁷

4.2 Maritime Archaeology

The assessment and testing program for maritime archaeological resources concluded that archaeological evidence associated with the c.1815 wharf would be of state significance. Archaeological evidence of the c.1835 punt would be of local significance.⁸

⁷ Biosis Research & CRM 2012: 229-230.

⁸ Cosmos Archaeology Pty Ltd (2012): i-iii

4.3 Aboriginal Archaeology

It was concluded with respect to Aboriginal archaeological resources that *"the potentially impacted Aboriginal objects offer scientifically valuable information but are not contextually suitable for outright conservation because of the overall high level of disturbance within the project area."*⁹

4.4 Implications of Fragmenting the Resource on Cultural Values

The statements of significance with respect to cultural values identify why these resources have value or potential value as they are now preserved within the ground. This is like a library of books that has not been opened. As long as the library and books are kept intact the information may not be readily accessible but it will always be available.

The impact on cultural values with respect to the excavation required for the bridge replacement project has largely been thought of in terms of the removal of a portion of the profile. To extend the analogy this would be the equivalent of demolishing part of the library, removing the books and in some cases taking off the covers so that the contents of the books are no longer comprehensible. Developing programs to record the information that is removed is intended to document the part of the room lost and catalogue the books. However well this work is carried out it will not redress the damage inflicted by for removing parts of collected volumes of works, rare and unique books or cutting some of the books in half.

What has been given less consideration is the impact of fragmenting the resource on what remains or is preserved in the ground. Obviously the positive outcome is that part of the library and its collection is preserved but it is still damaged by the fractures that will be caused by cutting a hole through the room and its collections. The documentation of the portion removed is intended to redress this trauma but there is a large difference between a complete set of volumes on a shelf and half the volumes on the shelf and the rest in an electronic file stored away from site. The differences affect the relationship of the information and its internal structure, the use of that information by the reader and the environment in which the information is used.

⁹ Kelleher Nightingale Consulting Pty Ltd 2012: 05

5 Bridge Options and Impacts

5.1 Introduction

Construction of the replacement bridge has been assessed to have major impacts to heritage resources within the Project Area. Impacts would be most noticeable in Thompson Square in Windsor and would include the removal of significant archaeological evidence, disruption to significant views and vistas, and the current setting of Thompson Square, as well as a cultural landscape that has evolved gradually since Green Hills was established.

The design process has considered the issues surrounding construction of the southern bridge abutment in Thompson Square.

The design team prepared two construction methods:

1. A land bridge comprising seventeen piles at 8 metre centres inserted into the ground around the perimeter to support the side walls and abutment; then from that, building a bridge structure over the void;
2. A concrete abutment comprising of two "L-shaped" walls and abutment wall facing inwards founded on rock, then infilling with material upon which the road is built.

The finished appearance of the two options would be similar.

5.2 Land Bridge

5.2.1 Design

The land bridge design would have five 900 mm piles across the abutment and six 900 mm piles on each side for a total of 17 piles on the southern approach (refer to Plate 2). The land bridge was initially proposed as it has what appears to be a lesser impact on the site. Construction of a land bridge on the southern approach would avoid disturbing or excavation for construction purposes, the area between the walls and would only require drilling 900 mm diameter holes at 8 metre centres along the sides and five closely spaced piles in the front of the abutment structure. The design would however, impact relics within the footprint of the 17 piles without giving the opportunity to extract the archaeological data in the southern abutment further fragmenting and isolating the resource. Moreover, for health and safety reasons it is not feasible to undertake local archaeological excavation at each of the pile locations. Excavation at this depth would require substantial stepped benching around each pier location, resulting in a larger excavation footprint that would negate any advantage that this approach had to localising impact.

5.2.2 Impacts

This proposal reduces the extent of excavation although seventeen approximately one metre-wide holes along the eastern side of Thomson Square in an area demonstrated to have an intact and significant archaeological profile would completely fragment the integrity of this resource. Only a portion of intact profile would be retained between the piles.

The impact of this option is compounded by the inability to acquire any meaningful data from the drilling areas either through inspection of the cores or creating wider but still small excavations in each location. This issue of interpreting isolated fragments of information, particularly small samples, has been discussed in the preceding section. For these reasons this approach results in a major impact, with little or no opportunity to mitigate or redress those impacts.

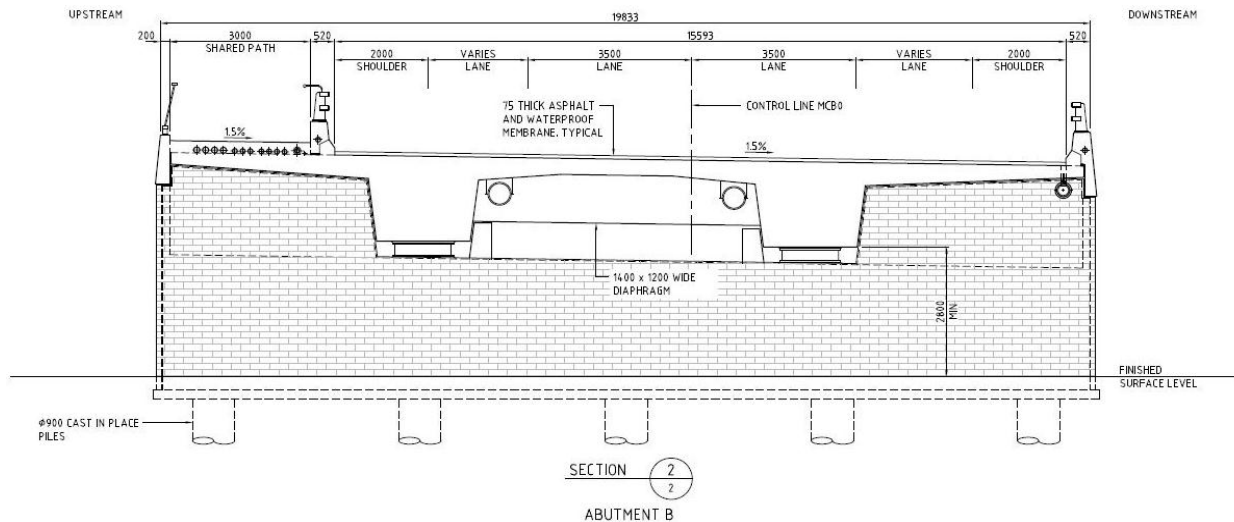


Plate 2: Cross section of the replacement bridge in Thompson Square with the Land Bridge Option showing the piles across the structure. An additional 6 piles on each long side also formed part of this particular design. Source: SKM Plan DS2012/000155 Sheet 3.

5.3 "L-Shaped" Retaining Walls

5.3.1 Design

The L-Shaped Retaining wall design option includes two L-shaped walls facing each other, with a spread footing at the abutment all founded on bedrock with the space between filled-in. The retaining wall option for the southern abutment would need to be built to support the approach road onto the bridge deck.

The L shaped wall would be constructed in the following sequence:

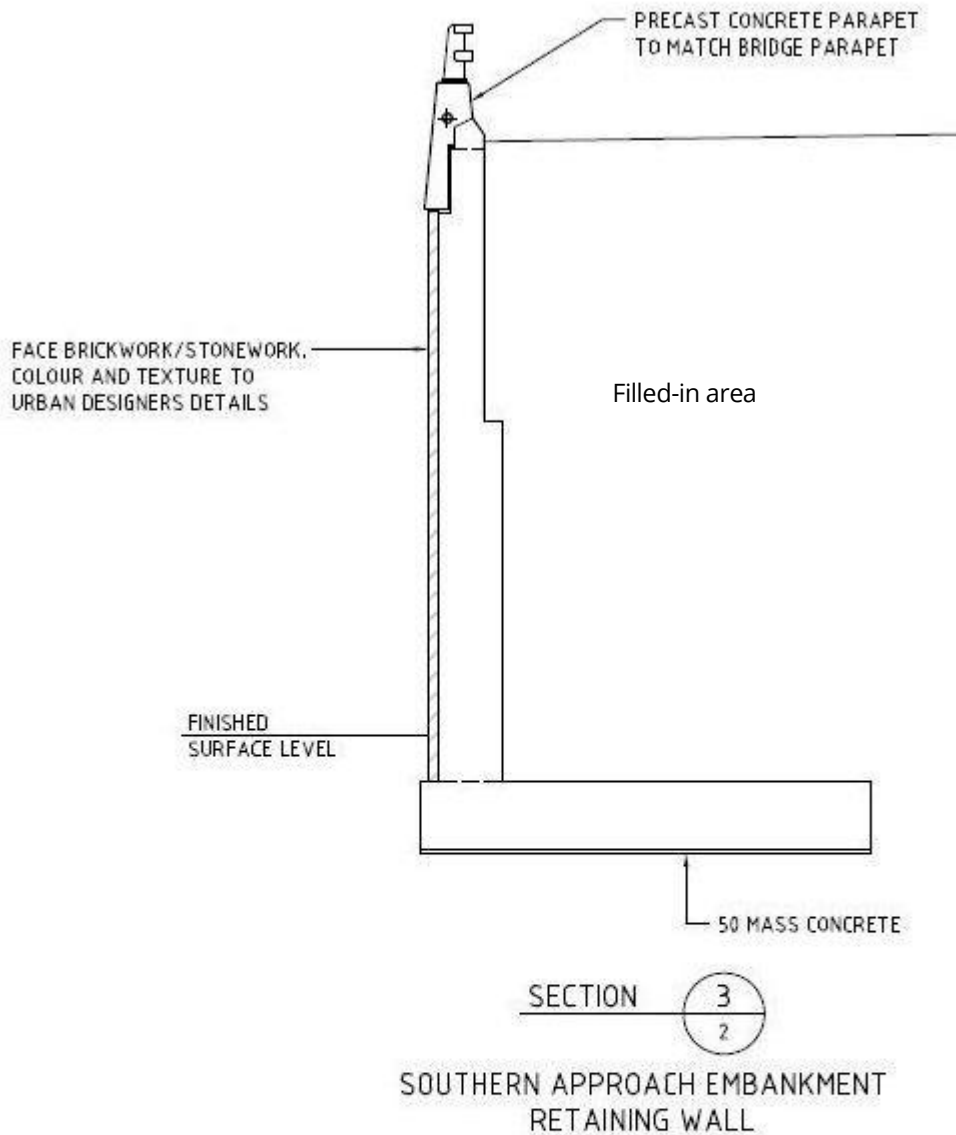
1. Open area archaeological excavation down to base of cultural material
2. Protection and stabilisation of any archaeological material to remain in situ (either for permanent conservation or for later recovery),
3. Further mechanical excavation to bedrock,
4. Stabilising the deep excavated batters to prevent slippage due to surcharge loads,
5. Levelling with approximately 50 mm of concrete base.

The L-shaped wall footings would be cast, followed by the walls themselves. The area between the walls would then be backfilled in layers and compacted and the pavement built. Both options would result in the removal of archaeological resources in the immediate area; these options and their implications are discussed in more detail in the Archaeological Options Report (Biosis and Cultural Resources Management).

5.3.2 Impacts

Construction of this option will remove the entire archaeological profile to bedrock (within the footprints of the abutments) and damage archaeological resources close to the surface. Excavation in this area is required from between two to six metres depth in an area equivalent in size to two Olympic-sized pools (approximately 3600 cubic metres).

Additional impacts are possible due to compression produced by machinery and stockpiling during the construction works. The scale of the work enables a large sample of archaeological evidence to be recorded during the construction program.



GENERAL NOTES


SCALE  OR AS SHOWN
 FOR GENERAL NOTES REFER TO SHEET No 2

Plate 3: Diagram of one side of the L-shaped retaining walls proposed for the bridge abutment in Thompson Square. Source: SKM Plan DS2012/000155 Sheet 3.

5.4 Summary of Bridge Abutment Options

The land bridge was initially preferred to the L-shape wall option due to the potential to minimise the excavation and archaeological impact in Thompson Square. The extent of this advantage is dependent on the extent of archaeological excavation required to clear the site for the piling. The land bridge also has some construction program advantages and avoids the need for the engineered backfill material to be brought to site and be compacted between the walls thus reducing the vibratory impacts to the existing heritage structures.

The implication of possible impact to archaeological resources since they cannot be investigated prior to commencing drilling influenced the decision to choose the "L-shaped" wall design.

5.5 Landscaping in the Parklands and Service Roads

The impacts of construction are not limited to excavation works required for the bridge. There are additional works that require excavation of varying depths for access to the car park at the north-eastern end of Thompson Square, along The Terrace, for the realignment of Bridge Street, which will have particular impacts on the lower parklands, at the south-eastern corner of the upper parklands and for the installation of traffic lights and cabling at the intersection of George and Bridge Streets (refer to SKM plans after Figure 4). Other than changes to the south-eastern corner, works associated with the project are not proposed for the upper parkland.

Many of these works encompass excavation to a depth of one metre or less although there are areas of up to two metres depth and very small areas that require excavation to three metres. As the testing programs have demonstrated there is archaeology of differing levels of significance (as close as 500 mm from the surface) in most areas of Thompson Square. Although these works have less impact than the major excavations required for the abutments all would have an impact on the archaeological profile within Thompson Square.

Works also require the movement of heavy machinery and creation of stockpiles. These have potential to create compressive loads, the impact of which on archaeological resources requires consideration.

6 Archaeological Options

6.1 Introduction

The archaeological resource that is preserved within Thompson Square is of state significance. It has the potential to illustrate and inform the present and future people of the state about the origins of settlement in the country; it tells us about frontiers in our past and their change through time.

It is the conclusion of the investigation that the optimal outcome for the archaeological profile within the project area, with respect to conserving its cultural values and the complex physical relationships and evidence preserved in the ground is to conserve it intact and in its entirety as it now exists. This would preclude the construction of the proposed replacement bridge,

RMS undertook an option selection process to determine the site of the proposed new bridge. Option 1 of that study was preferred and approval is being sought for this design, 35 metres downstream of the existing bridge. If approval is given then the optimal outcome for the archaeological resource of preservation in its entirety (as discussed above) is not possible. For this reason options for addressing the loss of evidence through salvage archaeology have been presented in this paper. It is clearly understood, though, that these options do not redress the impact of any approved work, they can only partially mitigate against the total loss of information by preserving it in a different form. The following archaeological options are designed to provide salvage programs to retrieve information before it is lost. The result of that work will not have the same cultural value as the physical evidence that is preserved in the ground.

The options discussed in this section seek to identify a strategy that will retrieve the most coherent suite of data from any future investigative program, taking into account the factors of the complex profile, and interpreting the data from a sample of any scale. The three options selected to achieve this objective are:

- Option 1: Construction Footprint, construction impacted land, and proposed landscaping and ancillary works only
- Option 2 - Excavation within the consolidated construction footprint - construction impacted land, and proposed landscaping and ancillary works, plus additional salvage of all areas within the construction footprint
- Option 3: Salvage excavation of the entirety of the Thompson Square parkland and roads

The advantages and disadvantages of each option are considered, from both an archaeological perspective and from the perspective of other factors such as constructability, cost, affect on program and other environmental and amenity impacts. These considerations are presented in the tables below in terms of archaeological advantages and disadvantages prepared by Wendy Thorp and reviewed by Pamela Kottaras (Table 1, Table 3, Table 5, Table 7 and Table 8). The engineering and environmental advantages are the point of view of RMS and were prepared by RMS and Baulderstone (Table 2, Table 4 and Table 6).

Refer to the sections and 12D model (Plate 7) and cut and fill diagrams (Plate 4, Plate 5 and Plate 6).

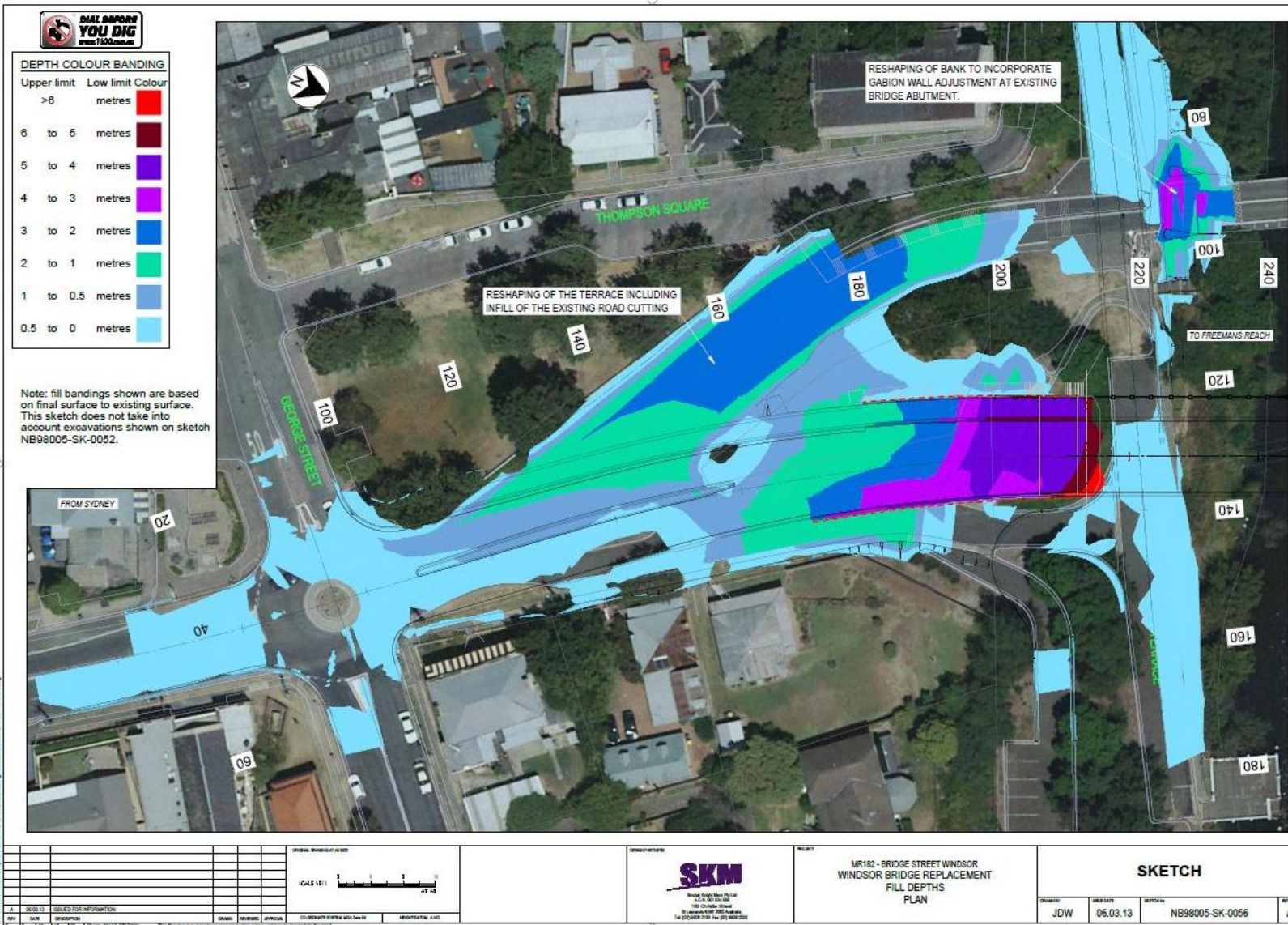
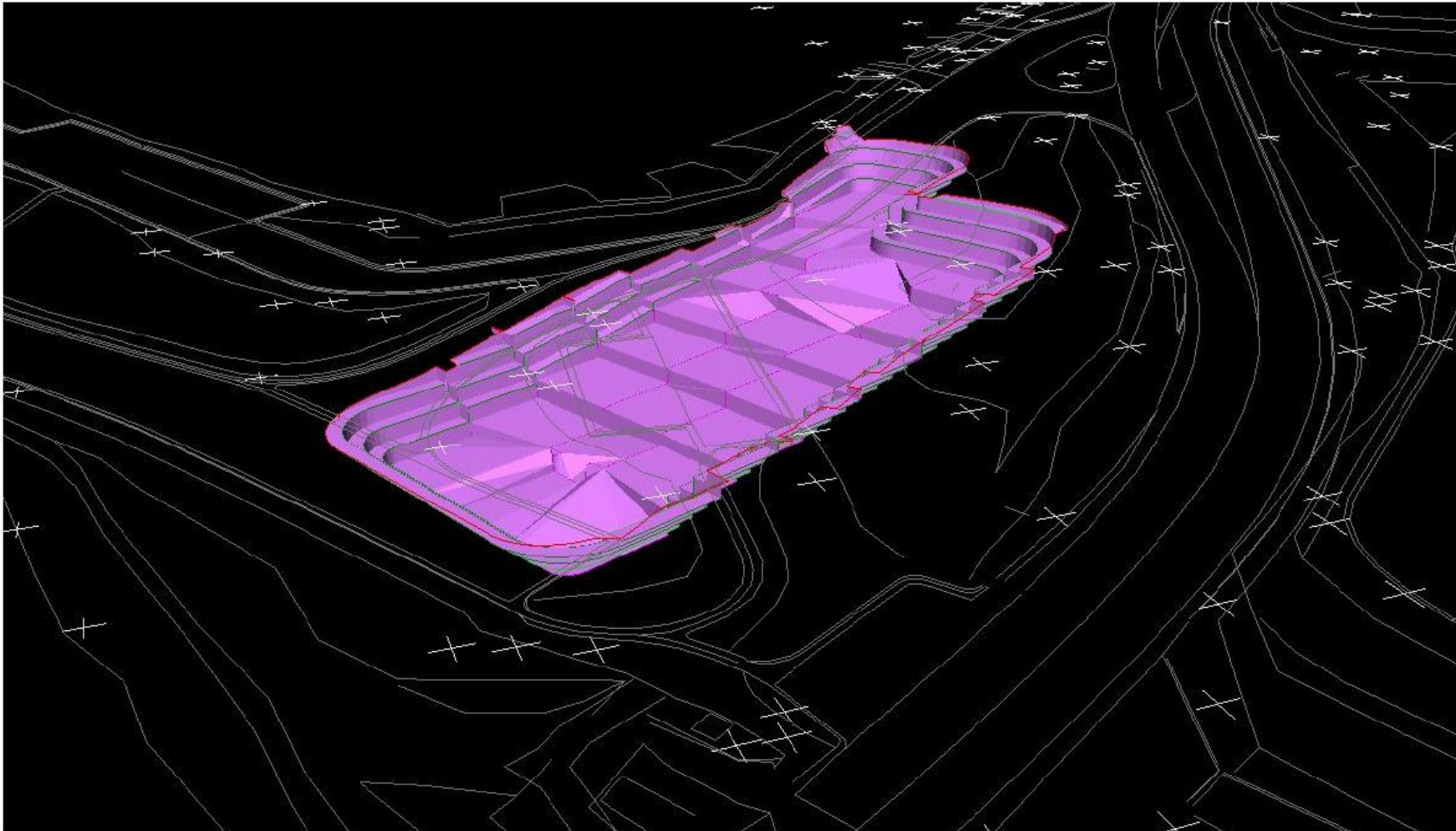


Plate 5: Diagram showing the depth of fill in Thompson Square associated with the construction program. (Source SKM)



Volume of main excavation = 3645m³

Plate 7: 12D model showing construction impacts

The view is to the south east; each contour within the area of impact is equal to 1 metre. (Source SKM).

6.2 Option 1: Construction Footprint

This option is for archaeological excavation of the construction footprint, construction impacted land and proposed landscaping and ancillary works only. Option 1 would entail archaeological salvage of those areas directly impacted by construction works, including excavation, and (if it can be shown to have a detrimental impact) areas where compression will impact on the underlying profile. The outline of these works is shown in the accompanying diagram.

Apart from the excavation required for the road and the bridge abutments, there are many small strips and irregularly shaped excavation areas. The excavation also leaves several isolated and narrow strips of ground as small islands within the excavated areas.

The depths of excavation required by construction within this footprint vary from 0.5 metres to 6.0 metres. Test excavations have demonstrated that excavations to these depths and less will impact historic period archaeology (and Aboriginal archaeological deposits north of George Street).

Table 1: Option 1 - Construction Footprint - Archaeological advantages and disadvantages

| Advantages | Disadvantages |
|--|--|
| Minimises the impact to archaeology to areas to be disturbed only; | The excavation will irreversibly remove a large portion of the archaeological profile within Thompson Square both horizontally and vertically within the landscape; |
| Retains the majority of the upper parkland as a "bank" of the archaeological profile; | The irregular shape of the construction footprint leaves small, intact fragments of the existing profile completely isolated particularly along the eastern edge of the footprint and at the northern end of the lower parkland, while creating irregular excavation areas that would be arbitrarily retained. |
| Retains the majority of the upper parkland, which has heritage values in its own right as a landscape and visual component of Thompson Square. | Remaining intact fragments would be further splintered by the introduction of service trenches in The Terrace and George and Bridge Streets. |
| | The significance of the remnant archaeological profile in the upper parkland will be compromised because of the removal of the majority of the landscape and the relationships preserved in the ground that give meaning and context to the archaeology contained within it. |

Table 2: Option 1 - Construction Footprint- Engineering and environmental advantages and disadvantages

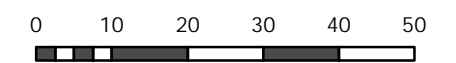
| Advantages | Disadvantages |
|--|--|
| <p>Minimises the impact to archaeology to only those areas that are strictly required for construction excavation;</p> | <p>'Islands' of retained deposit need to be protected and managed during completion of archaeological works and construction stage.</p> |
| <p>Retains the great majority of the upper parkland as a "bank" of the archaeological profile;</p> | <p>Size and shape of areas to be excavated archaeologically is not optimal, eg awkward for mechanical removal of fill.</p> |
| <p>Retains the majority of the upper parkland, which has heritage values in its own right as a landscape and visual component of Thompson Square.</p> | <p>Minor design changes may require impact on retained areas close to bridge.</p> |
| <p>Minimises amount of spoil to be taken offsite which is a positive environmental outcome.</p> | <p>Leaving 'islands' within the excavation area and having to provide batter slopes will complicate the vertical profile of the excavation unnecessarily, making movement of workers and spoil more complex and hazardous.</p> |
| <p>Reduces the number of trucks for haulages thus reducing noise and traffic impacts.</p> | |
| <p>Overall minimal environmental impact in terms of noise and vibration, air quality, erosion and sedimentation issues, visual amenity, and flood risks</p> | |
| <p>Archaeological excavation would be in detail and progress at a very slow rate thus any reduction amount of work will reduce the inconvenience caused to all affected.</p> | |
| <p>Excavation of the footprint only will reduce the number of trees that would have had to be cut or displaced.</p> | |
| <p>Overall minimising the amount of excavation will reduce the construction time thus reducing impacts and inconvenience for the community.</p> | |



Legend

- Area of archaeological excavation
- Subject to further discussion to include in archaeological excavation

Figure 2: Option 1 - Boundary of the construction footprint



Metres
 Scale: 1:1,000 @ A3
 Coordinate System: GDA 1994 MGA Zone 56



Ballarat, Brisbane, Canberra, Melbourne, Sydney, Wangaratta & Wollongong

Matter: 14020
 Date: 18 March 2013
 Checked by: PBK, Drawn by: IMS, Last edited by: jshepherd
 Location: P:\14000s\14020\Mapping\14020_ArcOps_F2_Option1

6.3 Option 2: Consolidated Construction Footprint

This option includes an archaeological salvage program in the same construction footprint as Option 1 but this footprint has been enlarged to incorporate the small, isolated strips of retained profile so that these become part of the salvage excavation program. This option would also include the excavation of the remaining portion of retained lower parkland between the bridge abutment and realigned road. There are also substantial landscape works that will effectively damage a large portion of the profile.

The outline of Option 2 enlarged in at least two areas.

1. On the western side of the realigned road is a roughly L-shaped excavation. Making this a complete square of excavation would engage the trench at the western end into a single unit or zone of excavation.
2. The junction between the lower parkland and the section of Bridge Street that would be retained. The construction footprint requires two narrow and irregularly shaped strips of excavation and Option 2 has these two strips being replaced by a solid zone of excavation. This excavation zone would link the bridge and road. Effectively all the land between the southern portion of Bridge Street (between the bridge and road excavations) would be included to create one large unit of investigation at the northern end of Thompson Square.

The rationale of Option 2 is that by including the small fragments that would be isolated, and slightly enlarging irregularly shaped areas of excavation to make more manageable zones (particularly where they can link the two principal areas of disturbance – such as the bridge and road excavations), provides a better opportunity to salvage and record evidence that has potential for meaningful interpretation.

This option raises the question of how the impacts at the George and Bridge Street intersection should be managed within any archaeological program. In Option 1 the trenches that cross the roads would be the only subjects of excavation. As the program of test trenching has demonstrated there is a very large variation between profiles in this part of the project area, excavating only the trenches required for the project is likely to expand the information retrieved from test pits, and is unlikely to address the questions raised by that work.

Ideally the Bridge and George Street intersection would be investigated, particularly as the profile here is so shallow, approximately 500 mm. It would be a desirable outcome, in terms of recording a cohesive archaeological sample, but it would have very substantial implications for traffic management unless the excavation could be undertaken in stages or portions.

This issue is linked to the retention of the southern portion of the existing Bridge Street, the bridge, and the temporary pavement at the south-eastern corner of the upper parkland. It is planned that this portion of the road will be disturbed only by the excavation of three small strip trenches. However, if it were included in a salvage program it would result in the comprehensive excavation of all of the eastern side of Thompson Square. It is a huge impact on the archeological profile within Thompson Square but, ironically, it is far more likely to result in a meaningful and cohesive picture of the full scope of development. The management of the retained section of Bridge Street, and the George and Bridge Street intersections, can be viewed from two completely different view points (unlike the small fragments proposed for inclusion on the eastern boundary and at the northern end of Bridge Street).

From the perspective of a research objective focused on the investigation of settlement in Windsor, and the influence of the landscape in that settlement, then the inclusion of both the southern portion of Bridge Street and the George and Bridge Street intersection is a logical and necessary inclusion. It provides not only a large sample but one that has some relation to the older landscapes that underlie it. It would add a vast resource of information that describes how settlement commenced and evolved in this town and how that settlement was influenced by the extreme terrain. Balancing this outcome is the loss of some profile that could be preserved although fragmented by the service and other trenches in each place.

From the perspective of the construction program it would involve a large additional cost, substantial disruption to traffic and the community and possibly would require some changes to the construction details.

Table 3: Option 2 - Consolidated Construction Footprint - Archaeological advantages and disadvantages

| Advantages | Disadvantages |
|---|---|
| <p>Creates a sample or area of excavation that has greater potential for meaningful interpretation than the fragmented landscape of Option 1. This enlarged option creates an area of excavation that has meaning to the development of Thompson Square. The records of settlement that emerge from the excavation would provide a fuller picture of human and environmental change that can be related to the archival framework that currently informs our knowledge of this place. The degree of how successful that interpretation would be depends on the inclusion or exclusion of the section of Bridge Street currently proposed for retention and the George and Bridge Street intersection;</p> | <p>The excavation will irreversibly remove an even larger portion of the archaeological profile within Thompson Square both horizontally and vertically within the landscape than Option 1;</p> |
| <p>Retains the upper parkland area as a "bank" of the archaeological profile;</p> | <p>Small fragments of land that are proposed for retention in Option 1 would be removed; the value of these splinters of land is compromised, though with respect to their research values because of the scale of excavation that surrounds them;</p> |
| <p>Retains almost all the upper parkland which has heritage values in its own right as a landscape and visual component of Thompson Square.</p> | <p>The significance of the remnant archaeological profile in the upper parkland will be compromised because of the removal of the majority of the landscape and the relationships preserved in the ground that give meaning and context to the archaeology contained within it.</p> |

Table 4: Option 2 - Consolidated Construction Footprint - Engineering and environmental advantages and disadvantages

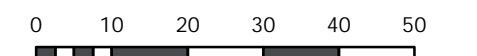
| Advantages | Disadvantages |
|--|---|
| <p>Work planning would be simplified without the need to conserve islands of deposit with stratigraphic integrity within the open area excavation.</p> | <p>Will result in removal or displacement of more trees, spoil creating dust and noise which overall is a negative environmental outcome;</p> |
| | <p>Increased excavation footprint will increase the number of trees that would have had to be cut or displaced;</p> |
| | <p>Increases the number of trucks for haulages thus increasing noise and traffic impacts;</p> |
| | <p>Increases the amount of spoil to be taken offsite relative to Option 1, which is a negative environmental outcome;</p> |
| | <p>Increased excavation footprint may increase the construction time thus compounding impacts and inconvenience for the community;</p> |
| | <p>Increased overall environmental impacts in terms of noise and vibration, air quality, erosion and sedimentation issues, visual amenity, and flood risks;</p> |
| | <p>Additional excavation will add a considerable cost to the project;</p> |
| | <p>Archaeological work around the Bridge and George Street intersection will affect traffic.</p> |



Legend

- Area of archaeological excavation
- Subject to further discussion to include in archaeological excavation

Figure 3: Option 2 - Boundary of the regularised construction footprint



Metres
 Scale: 1:1,000 @ A3
 Coordinate System: GDA 1994 MGA Zone 56



Ballarat, Brisbane, Canberra, Melbourne, Sydney, Wangaratta & Wollongong

Matter: 14020
 Date: 19 March 2013
 Checked by: PBK, Drawn by: IMS, Last edited by: jshepherd
 Location: P:\14000s\14020\Mapping\14020_ArcOps_E3_Option2

6.4 Option 3: Salvage excavation of the entirety of Thompson Square parkland and roads

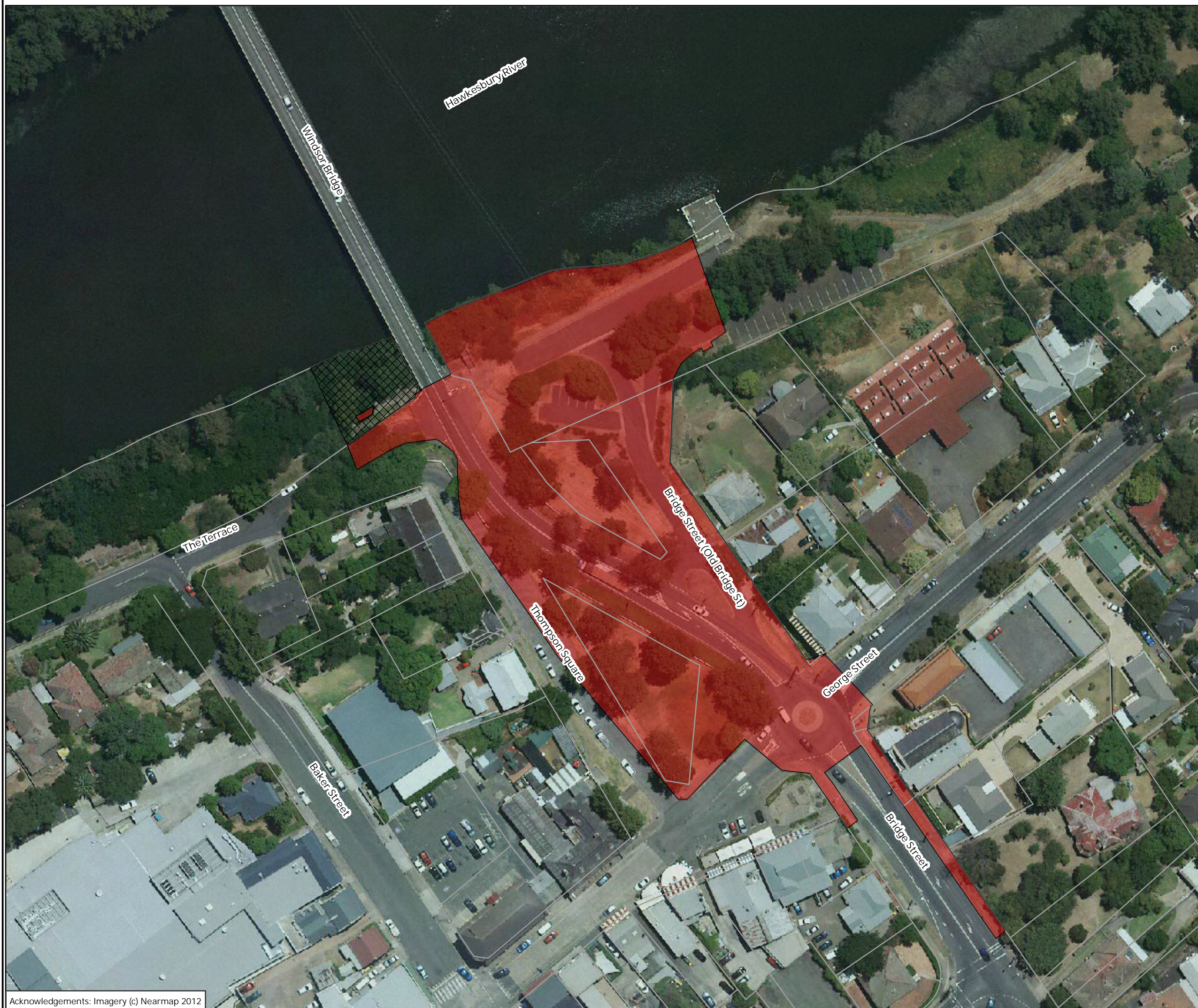
Option 3 is concerned with ensuring the comprehensive documentation of the complex profile that exists within Thompson Square. This option would ensure that the complex processes of land-forming, the relationships between all phases of settlement and all evidence of those phases would be revealed, documented and meaningfully interpreted at any place within this landscape. This option would require complete salvage of all the construction zones and the upper parkland, an area currently intended for preservation.

Table 5: Option 3 - Salvage excavation of the entirety of Thompson Square parkland and roads – archaeological advantages and disadvantages

| Advantages | Disadvantages |
|---|--|
| <p>Retrieving the research potential of the historical entity of Thompson Square, providing the ability to interpret and document the entire history of settlement and association;</p> | <p>The excavation irreversibly removes the entire archaeological profile – very little would be retained or banked including the majority of evidence of potential state and local significance;</p> |
| <p>Creates a sample or area of excavation that has greater potential for meaningful interpretation compared to both fragmented landscapes of Option 1 and Option 2;</p> | <p>Complete impacts on areas that would not otherwise be impacted by the bridge replacement project</p> |
| | <p>The excavation would remove the upper parkland</p> |
| | <p>The loss of the upper parkland would have other heritage implications; it will be the only remnant element of the landscape of Thompson Square that would remain relatively unchanged by the bridge construction and it has heritage values in its own right as a landscape component and in its relationship to the buildings in its immediate environs.</p> |
| | <p>The excavation of the upper parkland would be a great loss to the community – it is a valued open space;</p> |

Table 6: Option 3 - Salvage excavation of the entirety of Thompson Square parkland and roads – Engineering and environmental advantages and disadvantages

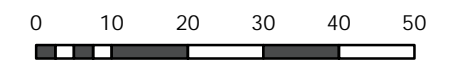
| Advantages | Disadvantages |
|--|--|
| <p>Following removal of all surface deposit within Thompson Square any new landscaping will have less archaeological impact.</p> | <p>Excavation of the Upper Thomson Square will have considerable other environmental impacts that have not been assessed. If we had to do option 3 then it would take considerable time to assess all impacts thus resulting in delay;</p> |
| | <p>Will result in the removal of all existing trees in the park Will result in the removal and relocation of all plaques and memorials in the parkland;</p> |
| | <p>Requires the greatest amount of spoil to be taken offsite, which is a negative environmental outcome;</p> |
| | <p>Requires the greatest number of trucks for haulages, thus having the worst noise and traffic impacts;</p> |
| | <p>Has the largest excavation footprint , extending construction time significantly, and thus having the worst impacts and inconvenience for the community;</p> |
| | <p>Has the worst overall environmental impacts in terms of noise and vibration, air quality, erosion and sedimentation issues, visual amenity, and flood risks;</p> |
| | <p>Archaeological work around the Bridge and George Street intersection will affect through traffic.</p> |



Legend

- Area of archaeological excavation
- Subject to further discussion to include in archaeological excavation

Figure 4: Option 3 - Boundary of the comprehensive salvage excavation



Metres
 Scale: 1:1,000 @ A3
 Coordinate System: GDA 1994 MGA Zone 56



Ballarat, Brisbane, Canberra, Melbourne, Sydney, Wangaratta & Wollongong

Matter: 14020
 Date: 18 March 2013
 Checked by: PBK, Drawn by: IMS, Last edited by: jshepherd
 Location: P:\14000s\14020\Mapping\14020_ArcOps_F4_Option3

6.5 Freemans Reach - The Northern River Bank

Options 1-3 address the archaeological requirements of the project area within Thompson Square. There will be substantial physical impacts on the northern river bank caused by the construction of the roundabout, road and other works. This area is less archaeologically sensitive than the project area of the southern bank of the river, however, at least one archaeological site associated with the redevelopment of the approaches to the bridge in 1896 has been identified by test excavation. As well, the potential sites identified for this area (Section 2.2.3) could be revealed by those works; it is impossible to more precisely target their locations.

For this reason a combination of salvage excavation and monitoring is proposed for managing the impacts of the construction program on the archaeological profile. A salvage excavation program will be required where the construction program impacts on the site of the nineteenth century bridge approaches. For the rest of the construction zones it is intended to monitor the works. Monitoring will enable two outcomes;

- Profiles of site formation can be recorded from sections revealed in trenches;
- If an intact archaeological site is uncovered by the work, the site can be isolated and excavated in full.

6.6 Depths of Excavation

6.6.1 Introduction

The three options discussed in the preceding sections were focused on the horizontal scope of an excavation; how much of Thompson Square will be included in any salvage program. The depths of excavation required in a salvage program also need to be considered.

The archaeological testing programs for this project have shown that, with respect to historic period archaeological resources, any excavation that has a depth of approximately one metre from the middle of Bridge Street south to and including George Street will effectively remove the archaeological profile. In those areas comprehensive salvage excavation is the only viable option as the excavations planned here will almost universally remove the complete archaeological resource.

Within the area of the bridge abutment depths of excavation will reach between three and six metres. It is almost certain, though not guaranteed, that this excavation will also comprehensively remove whatever archaeology is preserved here. Thus, an archaeological program that encompassed complete salvage excavation is also appropriate.

The situation is less clear in those areas (the road alignment, landscaping in the parkland, service trenches etc) where excavation for the construction program will not or might not completely remove the archaeological profile.

There is a case to be put forward for both the retention of the archaeological profile below the necessary construction impacts as well as for the comprehensive salvage of all areas of impact irrespective of the depths of those impacts.

6.6.2 Salvage only of Impacted Depths

It can be argued that retaining whatever remains of the profile beneath the depths of excavation required for construction adds to the "bank" that would be preserved in the upper parkland if Option 3 is not selected. However, the implementation of this strategy would add even more fragmentation to the profile and multiply the impacts of dislocation and isolation already discussed for the upper parkland spreading this impact over a much wider area. The off-set benefits of preservation in this case are probably reduced by the loss of meaningful interpretation of the evidence recovered and inconsistent preservation.

Secondly, the outcome of adopting this strategy with respect to the objectives of salvage excavation are likely to be a substantial compromise in the ability of the evidence retrieved to address any research objectives.

Table 7: Savage of impacted depth only – advantage and disadvantages

| Advantages | Disadvantages |
|--|--|
| Preserves more of the archaeological profile than just that in the upper parkland. | Imposes even more fragmentation and isolation on what will remain of the archaeological profile; |
| | Impacts on the successful interrelation of archaeology in those areas and their connection to the rest of the Thompson Square profile; |
| | Impacts on the successful outcomes of large research objectives for any program of salvage excavation; |
| | Compaction impacts are likely for any retained archeological deposits below the maximum depth of excavation. |

6.6.3 Comprehensive Salvage In all Impacted Areas

The most successful strategy with respect to achieving a useful outcome from what would be a massive program of archaeological intervention would be retrieve all the information from any zone irrespective of whether it would be removed or not as part of the construction program. It is a strategy that greatly increases the ability to interpret individual areas and works and processes as well as achieve a successful outcome for larger research objectives.

However, adoption of this strategy will have implications for the cost of the project and possibly for the design but it will have the biggest implications for the landscape of the lower parkland. If, for example, this strategy were adopted for the lower parkland as part of Option 2 it would effectively mean that all of the lower parkland would be removed; this would substantially alter any proposed landscape options for it.

Table 8: Comprehensive salvage in all impacted areas – advantages and disadvantages

| Advantages | Disadvantages |
|--|---|
| Likely to provide for more successful interpretation of individual archaeological units within those areas and the relationship of those units to the larger profile within the square | Reduces the potential for preservation or banking of archaeological resources |
| Likely to create a more comprehensive suite of information that can address large research objectives | Possible design changes |
| | Large impact on the landscape of the lower parkland |
| | Greater costs for the project |

7 The Research Design

7.1 Introduction

This paper outlines three possible options for managing archaeology in the event of project approval. When one of the options is identified as the preferred strategy a specific research design must be prepared that addresses the specific scope of the work. The review and discussion presented in this paper has highlighted a number of issues that will need to be addressed in this research design. These are not the only issues but are important factors that must be addressed by it.

7.2 Integrated Archaeology

The archeological investigations undertaken for the EIS highlighted the complexity of the project area as an environmental and cultural landscape. With respect to archaeology this complexity is effectively managed by three types of archaeological investigation and analysis; indigenous archaeology and terrestrial and maritime archaeology of the historic period.

There must be three programs of archaeological work that manage the different types of physical evidence that inform these strands. It will be important to map out a strategy that not only examines how and when each of those programs of work will be carried out, particularly the relationship of terrestrial historic archaeology and aboriginal archaeology, but how the results of those three programs will be knitted together to produce a single narrative of the evolution of this precinct.

7.2.1 Identifying the Research Objectives

In the first instance all the work that is undertaken within the project area will be salvage and it must be a priority to ensure that the maximum scope of information is retrieved. Ideally under any circumstances it would be possible to derive the answer to the research questions from the data accumulated during the salvage and documentation program.

However, for a program of this scope and in a landscape of this complexity establishing priorities for important outcomes should be considered within the research design. In the simplest terms they could be assigned as evidence that relates to state significance or questions that address local significance. While it is a workable approach, and needs to be a consideration, it may reduce the interpretation of the salvaged evidence to not much more than a catalogue of chronologically related elements.

The excavation and documentation will need to incorporate a more holistic objective. An obvious example is the identification of the pre-settlement environment and an exploration of how this shaped the earliest settlement. This would be followed by an examination of how the modified environment influenced more developed occupation and the appreciation and value placed on that cultural landscape.

Effectively this might not have any direct influence on the excavation strategy but understanding the excavation as a means of recording more than a series of sites of particular periods would be fundamental to this program. This also has important implications as well, for how the three strands of archaeology will be integrated. This aspect of the program should also involve the community. Archaeologists and historians approaching a program of this type will have very specific issues that are related to their fields of research. The community in which this program will be undertaken may have a very different set of questions or issues and the development of the research design should allow for community participation to enable the outcomes of the program to have both scientific and “popular” components. The community must have some ownership of this work.

7.2.2 Direct Community Involvement

Community participation in development of the program is important and there should be opportunities for the community to have an involvement in the work as it is carried out. Excavation is not an option; issues of professional outcomes and safety would be compromised. However, there are other aspects of the work that could benefit from direct involvement. Artefact programs have been used successfully in the past to this end. There are other options that might be considered; carefully trained and informed community guides or “explainers” might be one option. Possibly instead of one or two open days during the course of the program an hour or two each week could be set aside for public viewing.

A number of options should be canvassed in the research design; they will need to be discussed with RMS with regard to safety and other issues before a final program is settled.

7.2.3 Information Exchange

An archaeological program of this type would attract a lot of attention, not just from the local community. Strategies should be put in place to allow information to be regularly accessible for any interested party. Options could include daily update boards on the fences around the site, a dedicated web-page or one associated with the RMS web-site, a small column for the local newspaper and hand-out leaflets amongst others.

7.3 Long Term Outcomes

The first outcome of any program will be the retrieval of information. The second outcome will be reports that document that information and interpret it in terms of the research objectives and historical framework. Longer term objectives need to be considered; some options could include publications, displays in the museum and an outdoor museum component of the parkland.

7.4 Project Integration

A fundamental component of the research design must be to discuss with the Alliance the practical issues of how the archaeological program will work within and next to the construction program. This is a discussion that needs to canvas issues including the size of archaeological zones to be excavated within the overall option areas, the timeline of these excavations and issues of spoil removal or relocation amongst others. This issue also needs to address the timeline and integration of the three strands of archeology with each other as well as the construction program.

7.5 Conservation

At the finest level on site conservation, processing and storage of artefacts that come from any excavation will need to be addressed; consideration might be given to developing a program with the museum that enables this work to be undertaken as a public “display” during the course of the work.

More complex issues of conservation need to be addressed in the event that a substantial and significant structural component is revealed by the work, for example, the 1815 drain. There must be a clear policy in place for this situation but flexibility needs to be allowed in case some components can be maintained in situ.

Consideration also needs to be given to removal of components for relocation or use in future displays and their interim conservation needs.

8 References

Biosis Pty Ltd and CRM, *Windsor Bridge Replacement Project: Historic Heritage Assessment & Statement of Heritage Impact*, November 2012

Cosmos Archaeology Pty Ltd, *Maritime Archaeological Statement of Heritage Impact: Final Working Paper Report*, October 2012.

Kelleher Nightingale Consulting Pty Ltd, *Windsor Bridge Replacement Project Cultural Heritage Assessment Report*. September 2012.

Appendix G - Technical investigations of the structural condition of Windsor Bridge

Windsor Bridge structural condition

The following is a detailed chronology of the key technical investigations related to structural condition that were undertaken for Windsor Bridge between 2003 and 2013.

The information provides a description of the investigations undertaken, the findings of the investigations, and the decisions made on the basis of these findings. These numerous reports and studies on the existing bridge include investigations to determine:

- The realistic load capacity of the bridge.
- The condition state of the bridge superstructure, in particular, the extent of carbonation of concrete and corrosion of steel along with short term and long term repair options.
- The condition of the cast iron piers and extent of their graphitisation.
- The rehabilitation options to restore the substructure capacity.
- Repair cost estimate and Life Cycle Cost Analysis (LCCA) of various rehabilitation options for the bridge to carry current legal loads.

Each report is discussed in order below. For completeness, the date during which wider community consultation was undertaken on alternative options is also included in the chronology.

The findings of these investigations led to conclusions about the deteriorating condition of Windsor Bridge.

Durability Condition Assessment – October 2003 by GHD

The purpose of the durability condition assessment was to map the defects of the bridge and recommend repair methodologies.

The assessment included a visual inspection of the above water elements of the bridge and using a boat for the underbridge elements. A delamination survey of approximately 30 per cent of the bridge beams and headstock was undertaken using a cherry picker mounted on a barge. Diagnostic testing was undertaken at three detailed areas and included a cover meter survey, depth of carbonation measurements, chloride content analysis, alkali silica reactivity (ASR) testing, reinforcement thickness measurements and concrete compressive strength testing.

Three options to remediate the identified defects were assessed.

- Conventional patch repair
- Realkalisation
- Cathodic protection

The condition assessment identified significant visible spalling on the soffits of the external beams concentrated around drainage hole locations. It also identified regular vertical cracking at stirrup locations on the majority of the beams, significant quantity of horizontal cracking at the level of the longitudinal reinforcement and diagonal cracking at the end of beams radiating from dowel supports.

Approximately 250m² of the bridge surface area was spalled, delaminated or cracked. The investigation also showed that exposed primary longitudinal reinforcement exhibits significant section loss for the external beams near the drainage holes.

Carbonation (concrete cancer) was identified as the deterioration mechanism with the average carbonation depth exceeding the minimum concrete cover. The report found that damage is likely to increase with time as the carbonation front advances.

The assessment recommended re-alkalisation as the most technically appropriate repair method for the bridge. This was considered to be the most cost effective repair option over a future service life of 25 years.

The report further recommended that, prior to final selection of the repair option, a life cycle cost analysis for the repairs should be undertaken so that the most appropriate repair option may be chosen on both a technical and economic basis.

The preferred remedial option should be implemented as soon as practical.

Inspection & Assessment Report – December 2003 by RMS Bridge Assessment and Evaluation Section (BAE)

This inspection and assessment report detailed the findings of a detailed “Level 3” visual inspection of the above water components of the bridge to assess the condition of the bridge.

It assessed the load carrying capacity of the bridge elements using analytical methods based on original bridge drawings (“as new” rating) and the impacts on the load carrying capacity due to deterioration of the elements (“as is” rating)

A visual inspection of the above water elements of the bridges was undertaken to record, cracks, settlements, movements, deformation, defects and corrosion, which could impact on the load carrying capacity of the bridge. Observation of the bridge under normal traffic loading was also undertaken, as well as analytical assessment of the bridges for “as new” and “as is” condition of the materials.

The report also drew on the specialist materials engineering consultant findings (GHD, 2003 above) for the durability condition assessment.

The structure was assessed to be in poor condition in view of the extensive spalling due to carbonation of the concrete in the longitudinal beams and headstocks. The report advised that the structure requires extensive repairs, as also identified in the inspection and durability reports.

The report also considered live load factors. The “as new” rating live load factor (LLF) for current semi trailer and B-doubles vehicles was 1.87 which is less than a value of 2.0 required by current design standard AS5100.7. Furthermore, the “as is” rating was found to be around 1.5 which is significantly less than the 2.0 required by the standards.

Options considered to address the poor condition of the bridge included:

- Replacement of the existing bridge with a new bridge
- Provision of new bridge deck on existing piers pending inspection and assessment of the bridge piers
- Re-alkalisation and other repair works of bridge superstructure as recommended by GHD in their durability report

The recommendation of the report was to replace the bridge within five years. It also recommended that remedial works be carried out to prevent further deterioration, as

identified in the inspection, and underwater inspection of the piles and piers be undertaken to determine the nature of damage if any.

Repair Cost Estimate and Life Cycle Cost Analysis – February 2005 by GHD

This analysis was undertaken to provide cost estimates for two scenarios including ongoing maintenance commitments:

- A short term solution that comprises repairs needed to operate the bridge for five years
- A long term solution to operate the bridge for more than 25 years

The analysis involved the preparation of cost estimates, including life cycle cost analyses, for repairing the bridge in its entirety. Two repair options were identified for consideration to address the two scenarios above:

- Patch repair and coat the identified defects
- Application of re-alkalisation repair techniques to beams and headstocks, and patch repair and coat to other defects

As discussed above, service lives of five years and 25 years were considered. The five year option assumed the bridge would be replaced. The cost estimate assumed the cast iron piers are in good condition from above water inspections and only required repainting.

The life cycle cost estimates for the two repair options for a 25 year service life *in 2005 dollars* were found to be

- Option 1 - conventional patch repair around \$4.1 to \$5.3m
- Option 2 - re-alkalisation around \$2.9m.

The report noted that these repair works would only restore the bridge to its original “as new” rating that is less than current design standards. Strengthening would be required to meet current design standards.

The report recommended further underwater inspections to assess the condition of the cast iron piers below water.

Underwater Graphitisation Survey – April 2005 by CTI Consultants Pty Ltd

As recommended by the GHD (2005) study above, this survey involved an investigation of four bridge piers with an emphasis to determine the condition of the immersed section and on determining the extent of graphitisation. Graphitisation is a deterioration mechanism of cast iron that has similarities to rusting in steel.

Above water inspections involved cleaning of the cast iron surface, ultra sonic wall thickness measurements and the taking of small 10mm diameter core samples of the cast iron.

The underwater work involved a visual inspection, sampling of marine growth layers and cast iron nodules for laboratory inspections. The surface was then cleaned and re-inspected and localised “plug defects” depths were measured using a pin profile gauge. Small diameter core samples were taken at selected locations to establish residual wall thickness.

Five of the core samples were analysed to determine the metallurgical properties of the cast iron.

The investigation identified significant uniform (layer) graphitisation up to 13mm and localised plug graphitisation up to 28mm depth during the inspections. The original wall thickness of the immersed cast iron piers was 40mm. The above water sections of the cast iron was reported to be in good condition, with minor localised defects. Bracing between the piers at the water line was shown to be undergoing significant corrosion

Due to the significant section loss of the cast iron casing a structural assessment of the piers was recommended to determine current capacity.

If the piers were found to be structurally adequate, installation of cathodic protection to prevent further graphitisation was identified as necessary to be considered. If strengthening was required, strengthening of the piers using concrete sleeves or other methods to restore capacity will be required.

The report further recommended that a structural assessment of the piers be undertaken to determine current capacity, taking into account the significant section loss due to graphitisation in the below water sections of the cast iron piers.

Report on Rehabilitation of Windsor Bridge – May 2005 RTA Bridge Rehabilitation Projects Section

The purpose of this report was to develop concepts and costing for a long term solution to rehabilitate the bridge, including strengthening of the bridge to meet a minimum T44 design standard capacity.

The report involved modelling of the bridge structure using analysis software. Three strengthening options were developed for the deck as follows:

- Installing steel girders
- External post tensioning
- Carbon Fibre Strengthening

An assessment of structural capacity (rating) of the substructure was based on the condition of the cast iron piers from the findings of the CTI underwater inspection (April 2005), discussed above. Strengthening options were identified for the cast iron piers along with cost estimates.

The cost estimates for the three deck strengthening options (in 2005 dollars) were estimated to be around \$7.67m to install steel girders and \$7.26m for external post tensioning. The carbon fibre strengthening approach was not considered viable at that time due to the extent of carbonation identified in the cover concrete. An allowance of \$3.6m was made for strengthening the cast iron piers based on similar types of work.

The report concluded that the cost of rehabilitating and strengthening the existing substandard bridge to meet T44 minimum design standard was extremely high and not cost effective and safe. This was due primarily to the very poor condition of the bridge, narrow width and poor alignment. Therefore, it was recommended that the bridge be replaced with a new bridge within five years.

In the interim it was necessary to closely monitor the bridge for propagation of cracks, further concrete deterioration, adverse movement or excessive deflection until the bridge is replaced. Quarterly monitoring of the bridge deck levels was also identified to detect any movements.

The report also identified the need to record actual stresses in the bridge beam using strain gauges to establish actual live load factors under current traffic

Performance Load Testing of Windsor Bridge – August 2006 RTA Bridge Assessments and Evaluation Section

The performance load testing of Windsor Bridge was undertaken to determine the live load factor for the deck using performance load testing for comparison against earlier calculated values. It also determined the dynamic load allowance for a fully laden semi trailer.

The investigation involved recording the strains in the reinforced concrete bridge beams under different loading configurations of the test truck by fixing strain gauges at the middle of each deck beam in spans 4 and 5 of the bridge. The bridge was closed to traffic and the test truck was taken across the spans at crawl speed in both directions. Strain gauge readings were recorded for three configurations of the test truck:

- Level 3 – 43.14 tonne gross vehicle mass (GVM) semi trailer (ST).
- Level 4 – 46.34 tonne GVM.
- Level 5 – 49.54 tonne GVM.

The recorded strain was compared against the calculated values for each.

The dynamic load testing consisted of travelling the Level 3, 43.14 tonne configuration of the test truck over the bridge at speeds up to 60km/h in 10km/h increments and recording the results. The results were compared against the calculated values. The strains were also recorded in the gauges over a one week period with the bridge open to normal traffic.

The findings from load testing were:

- The strains on the concrete beams were less than calculated for the three test truck configurations at crawl speed.
- The recorded dynamic load allowance (DLA) was 17% for the test truck travelling in southbound at a speed of 40km/h. This is less than value of 40% from the design standards.

The report concluded that the bridge in 'as is condition' is capable of carrying General Access Vehicle (semi-trailer) ST42.5 and Restricted Access Vehicle (B-doubles) BD62.5 in the short-term until the planned replacement of the bridge provided that a risk management strategy to monitor the performance and condition of the bridge is in place.

Internal RMS Memo: Review of all past reports to extend the life of structure – April 2008 RTA Bridge Assessment and Evaluation

A high level review was undertaken of previous studies to assess the safe capacity and remaining life of the structure. All previous studies and condition reports were reviewed.

The review delivered the following conclusions:

- General Access Vehicle (semi trailer) ST42.5 and Restricted Access Vehicle (B-Double) BD62.5 would be allowed to continue travelling across the bridge in the short-term until the planned bridge replacement.
- The bridge must be closely monitored for propagation of cracks, further concrete deterioration and any adverse movement of piers.

As a result, the decision was made to allow General Access Vehicle (semi-trailers) ST42.5 and Restricted Access Vehicle (B-Doubles) BD62.5 to continue to cross the bridge subject to the following:

- The bridge must be closely monitored for propagation of cracks, further concrete deterioration and any adverse movement of piers until bridge replacement in 2010.
- Measures should be taken to ensure that over mass and oversized vehicles do not cross the bridge.

Community consultation report and options assessment RMS 2008 to November 2011

In 2008 the project received broader consideration within RMS. At around the same time, the NSW Government announced that it would provide funding to rehabilitate or replace the bridge, identifying four alternatives for the river crossing at Windsor including:

- Do nothing and continue to maintain the existing bridge – This option would involve doing nothing except continuing the ongoing regular maintenance of the existing Windsor Bridge.
- Refurbishment of the existing bridge – this alternative would involve temporarily closing the existing bridge and refurbishing elements of the bridge and approach roads to meet current design standards where possible.
- Bypass of Windsor – this alternative would involve constructing one or more bridges and associated roads to bypass the town centre of Windsor.
- Replacement bridge – this alternative would involve constructing a replacement bridge either up or downstream of the existing bridge, with traffic still being able to access the town centre directly.

RMS subsequently began investigating potential route options and, in July 2009, ten potential options were identified: two for refurbishment of the existing bridge, two for a bypass of Windsor and six for a replacement bridge. While two bypass options were identified, it was recognised that a bypass would substantially exceed the project budget. However bypass options were further developed to provide a comparison to other alternatives.

A detailed options assessment report was prepared by RMS (available on the RMS website), which presented information on the location, performance, potential environmental impacts and costs/benefits of each option. Project objectives and criteria were also developed to allow an assessment of each of the options.

In 2011 the options assessment report was presented to the community, stakeholder groups and government agencies and their feedback on the options was obtained. The issues raised during the consultation process were documented in Chapter 6, the “Windsor Bridge over the Hawkesbury River Options Report” (RTA, 2011) and the “Windsor Bridge over the Hawkesbury River Report on Community Consultation” (RTA, 2009), which are available on the RMS website (www.rms.nsw.gov.au/roadprojects).

The Heritage Council of NSW was consulted in 2009 and identified refurbishment of the existing bridge as its preferred option. Their second preferences were the bypass options of Windsor. They also recommended that detailed heritage investigations and a Statement of Heritage Impact would be required especially for those options that impacted Thompson Square.

Based upon feedback from the consultation process on the options, RMS short-listed and further developed three options, namely:

- Option 1 - Replacement high-level bridge via Old Bridge Street, Windsor.
- Option 2 - Replacement low-level bridge via Old Bridge Street, Windsor.
- Option 6 - Bypass of Windsor via a new bridge parallel to Palmer Street, Windsor and a new bridge over South Creek.

Additional preliminary investigations were undertaken to assess the relative advantages and disadvantages of each short-listed option, how each option performed against the project objectives and to identify opportunities to improve project outcomes. The results of preliminary investigations were used in the development and refinement of short-listed project options and ultimately in the selection of the preferred option for the project.

The preliminary investigations considered potential adverse impacts and benefits in relation to historic heritage, Aboriginal heritage, traffic and transport, landscape and town character, and socio-economic outcomes. Construction impacts and costs were also considered.

Rehabilitation Estimate – December 2009 by GHD

The purpose of this engagement was to prepare an updated cost estimate for the rehabilitation of the bridge. The cost estimate is to include the ongoing maintenance commitments for a 25 year period.

The work follows on from earlier work undertaken by GHD in 2005.

It involved the preparation of cost estimates including life cycle cost analyses for repairing the bridge in its entirety. The following three repair options were considered:

- Option 1 - Patch repair and coat the identified defects
- Option 2 - Application of re-alkalisation repair techniques to beams and headstocks, and patch repair and coat to other defects
- Option 3 - Cathodic protection and patch repairs.

It is noted that these repair options would only restore the bridge to its original “as new” rating that is less than current design standards. Strengthening to meet current T44 design standards was not included in the scope for this report and would cost significantly more.

The life cycle cost estimates for the three repair options for a 25 year service life in 2009 dollars were found to be around \$5.45 to \$6.43m for Option 1, \$4.36m for Option 2 and \$5.1m for Option 3.

The cost to repair the bridge in its current working condition for a five year life prior to replacement was estimated to be \$0.3m. It was noted that the cost estimate assumed the cast iron piers would not require strengthening and only allowed for repainting costs.

Review of Rehabilitation Estimate – January 2010 by RMS Bridge Technology and Practice

This involved a review of the GHD 2009 cost estimate for the rehabilitation of the bridge, including a review and update of the previous rehabilitation 25 year life cycle cost estimate for the three methods of repairs considered in the 2009 GHD report, namely:

- Option 1 - Patch repair and coat the identified defects
- Option 2 - Application of re-alkalisation repair techniques to beams and headstocks, and patch repair and coat to other defects
- Option 3 - Cathodic protection and patch repairs.

The review utilised cost rates obtained from recent similar rehabilitation projects undertaken by RMS.

The revised cost life cycle cost estimate over a 25 year period from this review in (2009 dollars) for the rehabilitation of the bridge deck to maintain current “as is” load rating were identified as \$2.89m to \$3.77m for the conventional patch repair and \$2.71m for re-alkalisation. Cathodic protection was not considered as previous cost estimates showed cathodic protection is more expensive than re-alkalisation.

Despite the higher costs, the review recommended conventional patch repair as a lower risk option due to the limited local experience with re-alkalisation within both the contracting and consulting sector in Australia.

The review recommended that in order to maintain the bridge deck in a serviceable condition for the next 25 years, the concrete elements that are suffering from corrosion induced deterioration should be rehabilitated by convention patch repair and coating application. The patch repairs should incorporate the installation of sacrificial zinc anodes.

Internal RMS Memo: Estimate for Windsor Bridge for Pedestrian Usage – February 2010 RTA Bridge Rehabilitation Projects Section

This involved preparation of a cost estimate for the rehabilitation of the bridge for pedestrian usage only.

The rehabilitation was aimed at reducing long term maintenance requirements given the current “as is” condition of the bridge is adequate for pedestrian loading. Under this approach the existing low level railing would need to be replaced with a pedestrian railing.

The cost of rehabilitating the bridge superstructure was estimated (2010 dollars) to be \$7m. The indicative cost to rehabilitating the substructure was estimated (2010 dollars) to be \$5m based on similar previous projects

The investigation concluded that further detailed investigation of the cast iron piers is required to understand the extent of deterioration due to graphitisation to confirm the scope of work required to rehabilitate the cast iron piers.

Dynamic Load Testing of Spans 1 to 4 – November 2010 UTS

In this investigation UTS undertook a dynamic frequency analysis (DFA) on span 1 to 4 of the existing bridge to assess the natural frequency and stiffness of the representative spans.

This involved attaching sensors to the bridge and striking the bridge with a modally tuned hammer. The signals picked up by the sensors are then processed to establish the modal analysis. This information is then used to establish the natural frequency, damping ratio and mode shapes. These results can then be compared against theoretical results from finite analysis modelling. The difference in the results can then be used to assess the impacts of deterioration of the bridge and its impact on the load carrying capacity of the bridge.

The test results indicated there has been a reduction in the stiffness of the span 1 of the deck by 16 per cent over the past seven years indicating a continuing deterioration of the deck. The natural frequency recorded for span 2 was similar to span 1. The results for span 3 and 4 were approximately 10 per cent less than the recorded results for span 1 and 2. These results are consistent with the visual inspections that show span 1 and 2 are in better condition than spans 3 and 4.

The investigation concluded that if RMS intends to decommission the bridge in the near future, the bridge in its present condition and loading would be safe for some time. However, if the RTA intends to maintain the bridge, further testing and employing parallel finite element analysis is recommended to translate this deterioration into a quantifiable load limit.

Graphitisation Investigation – July 2011 CTI Consultants Pty Ltd

In this investigation CTI Consultants undertook a detailed underwater graphitisation study for all piers to gain a thorough understanding of the extent of graphitisation of the cast iron piers. Commercial Diving Solutions undertook the underwater inspection and sampling under the supervision of CTI and RMS.

The underwater inspection involved cleaning, visual inspection and measurement of the extent of damage due to graphitisation to establish remaining structural cast iron thickness. The surface was cleaned using scraping and high pressure water. The cleaned areas were explored to identify the extent of graphitisation and measured using a pin profile gauge and photographed.

Small diameter (20mm) core samples were taken at selected locations to allow the residual wall thickness to be measured directly. One core sample taken from near the river bed at pier 5 was examined metallurgically for comparison with the samples analysed in the 2005 survey. Three water samples at different depths were also taken for chloride analysis.

The inspection identified that there is significant graphitisation evident in all piers. There are a significant number of locations with more than 20mm of graphitised material present resulting in an average residual structural thickness of 15mm (over 50 per cent loss of section).

The inspection also identified a full circumferential crack in the upstream and downstream columns at pier 5. A three quarter circumferential crack was identified in the downstream column of pier 6. A 100mm long vertical crack was also identified in the upstream column of pier 5.

The water samples indicated a low chloride content indicating the water is essentially fresh water with a low hardness (soft). While Commercial Diving Solutions provided a separate inspection report the key elements and photographs of the inspection report were included in the CTI report.

Horizontal cracking was identified in three of the cast iron columns and the cracks appear to be quite old. Nevertheless, the investigation concluded that such cracks would be expected to have a serious impact on the overall serviceability of the bridge, and a detailed structural analysis should be carried out to determine the probable impact on the bridge's capacity

Underwater Bridge Inspection, Follow up inspection June 2011, Commercial Diving Solutions

This assessment formed part of the assessment of Higher Mass Limit vehicles discussed below. It involved inspection of piers 5 and 6 of the existing bridge following the performance load tests undertaken in June 2011.

Twelve glass plate slides were installed across the circumferential cracks at pier 5 and 6 to identify if there is any movement of the cracks under existing traffic. Underwater inspection of the previously identified circumferential and vertical cracks at pier 5 and 6 was also undertaken. The installation of glass plate slides involved the cleaning of the cast iron surface adjacent to the crack to remove any soft graphitised material and gluing the 75x20x1mm glass plates to either side of the crack using a two part epoxy adhesive.

The inspection of the cracks following the load testing found no evidence that the existing circumferential cracks in the cast iron columns at pier 5 and pier 6 have changed, widened or shifted.

There was no evidence that the small vertical crack in pier 5 upstream had changed. The 12 glass slides were installed and the position of the slide recorded and photographed.

The glass slides on Piers 5 and 6 were inspected in June 2012 and found to be cracked at Pier 5 Upstream and Pier 6 Downstream.

Bridge over Hawkesbury River Load Testing Test Report – October 2012 Endurance Consulting

This inspection was also considered as part of the Higher Mass Limit assessment discussed below. It involved performance load testing of the cast iron piers for static loading (test truck), and measurement of ambient traffic (dynamic testing) for a minimum period of six months. A longitudinal braking test was also conducted to assess how the horizontal forces due to heavy vehicle braking abruptly on the bridge are transferred in to the cast iron piers.

Strain gauges were fixed to the both cast irons columns of piers for piers 4 to 7 just above the water level. Gauges were also fixed to pier 4 and 6 just above the riverbed level. The gauges were fixed to both sides of the columns to be able to measure bending strain (due to braking) as well compressive strains due to vertical loads.

A “dynamic displacement transducer” was installed across the joint at pier 4 to record relative movement of adjacent spans under the braking test loads. For the static load test, three configurations of the test truck were used:

- 42.4 tonne gross vehicle mass (GVM) semi trailer (ST).
- 47.4 tonne GVM.
- 52.4 tonne GVM.

The test report made the following findings:

- All strain gauges experienced compression under loading in all tests.
- Flexural strain was not the dominant strain in the braking load test indicating the horizontal forces are being shared amongst all piers and therefore to the abutments.
- There was no evidence of opening of the expansion joints under the braking load test indicating the deck is “locked up” via the dowel connection between the deck units and the headstock of the foundation. This behaviour is not consistent with the expected behaviour and may explain the cause of the diagonal cracks in the beams near each support location.
- Strain gauge recording from the ambient traffic monitoring recorded strains in the piers higher than the results from the ST42.4 tonne test vehicle (semi trailer) configuration.

RMS Bridge Evaluation and Assessment assessed the results as part of the assessment of Higher Mass Limit vehicles discussed below.

RMS Report – Assessment of Higher Mass Limit Vehicles Performance Load Testing & Investigation of Deck & Pier (2011 & 2012) Report – February 2013 RMS Bridge Assessment and Evaluation

This report drew on earlier findings to undertaken an assessment to determine:

- The load capacity of the bridge.
- Extent of graphitisation of cast iron piers.
- Performance of the bridge to RMS test truck and ambient traffic.

It also involved undertaking the graphitisation study by CTI Consultants, load testing and load rating by RMS.

The review recommended allowing Higher Mass Limit (HML) ST45.5t and BD68t in the short-term until the planned replacement of the bridge subject to the following stringent management practices:

- Monitoring the graphitisation of pier columns.
- Monitoring the bridge deck where spans are in poor condition
- Remove any spalled concrete which could be a danger to public.
- Speed limit for heavy vehicles of 40 kilometres per hour