

Appendix E - Operational noise and architectural treatment addendums



Transport
Roads & Maritime
Services

Windsor Bridge Replacement

Noise and vibration Addendum

Final

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Roads and Maritime Services

Windsor Bridge Replacement

Noise and vibration Addendum

Final



Document history and status

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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.

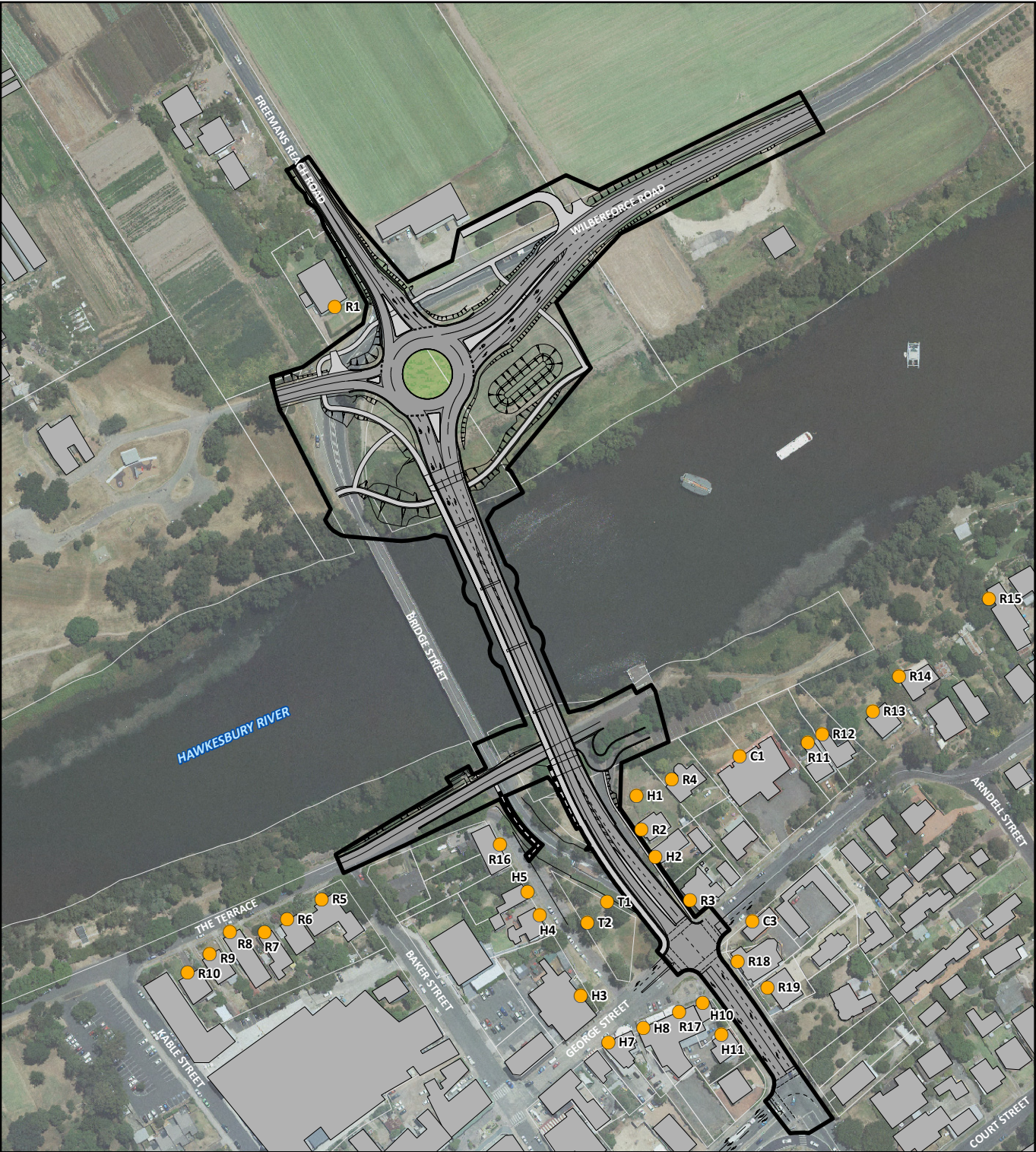
To provide the additional clearance over The Terrace, the height of the southern end of bridge would be increased. This would result in a one metre higher bridge and abutment at the southern end only - and a marginally higher section of the southern approach road through Thompson Square between the driveway 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

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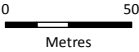


Table 1-1 Residential sensitive receivers (revised)

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 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?
													Opening Year		Design year				
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	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 Porject
- 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

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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
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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

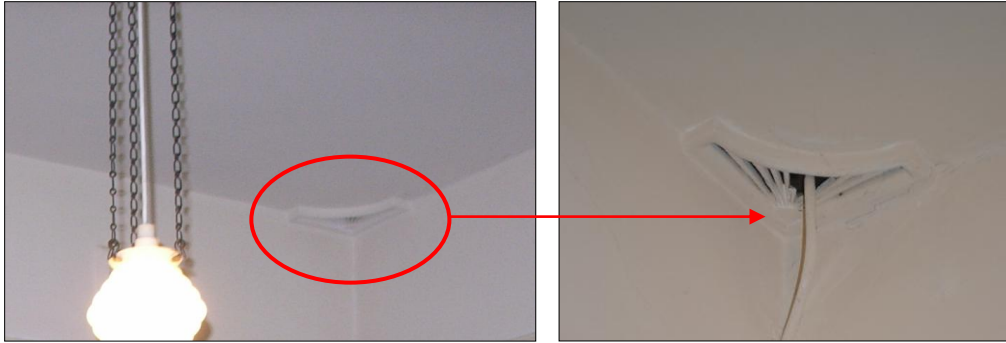
Once the treatment for the noise mitigation is undertaken for them to be effective the doors and windows will be required to be kept closed. In this case some type of ventilation system will be necessary to allow fresh air into the subject rooms of the respective residential spaces of the buildings.

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***