

Appendix D Vibration testing results and instrumentation

Table 9-1 Directed Vibration Monitoring Results (1400mm drop height, 24kg weight)

Receiver	Separation distance Pulse Tri-axial Minimate ↔ Drop / m	Separatio n distance: Building (referenc e) ↔ Drop /m	Minimate						Pulse										
			PPV / mms ⁻¹			PPV Frequency / Hz			PPV / mms ⁻¹			PPV Frequency / Hz			Max RMS Acceleration / mms ⁻²			Reference PPV (z) / mms ⁻¹	Max Reference RMS Acceleration / mms ⁻²
			x	y	z	x	y	z	z	z	z	x	y	z	x	y	z		
4 Bridge Street	1m	5.4m	11	21	12	41	37	60	12	22	11	35	36	38	0.1	0.2	0.15	2.2	<0.01
	1.5m	5.4m	13	25	19	41	33	57	12	22	16	34	41	38	0.05	0.12	0.13	2.1	<0.01
	2.5m	5.4m	7	14	12	49	39	64	7	13	10	36	40	35	0.02	0.1	0.05	1.8	<0.01
	4.0m	5.4m	4	10	4	51	51	41	5	11	5	33	40	36	0.01	0.05	0.02	1.8	<0.01
	5.4m	5.4m	2	3	2	31	39	35	2	2	2	37	38	35	0.01	0.02	0.01	2	<0.01
10 Bridge Street (Music Shop)	1m	8m	12	20	11	30	36	40	13	21	12	38	40	41	0.2	0.18	0.21	0.5	<0.01
	3m	8m	10	11	10	32	38	52	8	12	11	36	39	36	0.01	0.13	0.11	0.4	<0.01
	4m	8m	4	9	3	35	38	42	5	8	4	38	35	39	0.02	0.02	0.05	0.6	<0.01
	6m	8m	1	2	1	32	38	45	2	2	2	35	36	39	0.01	0.01	0.02	0.2	<0.01

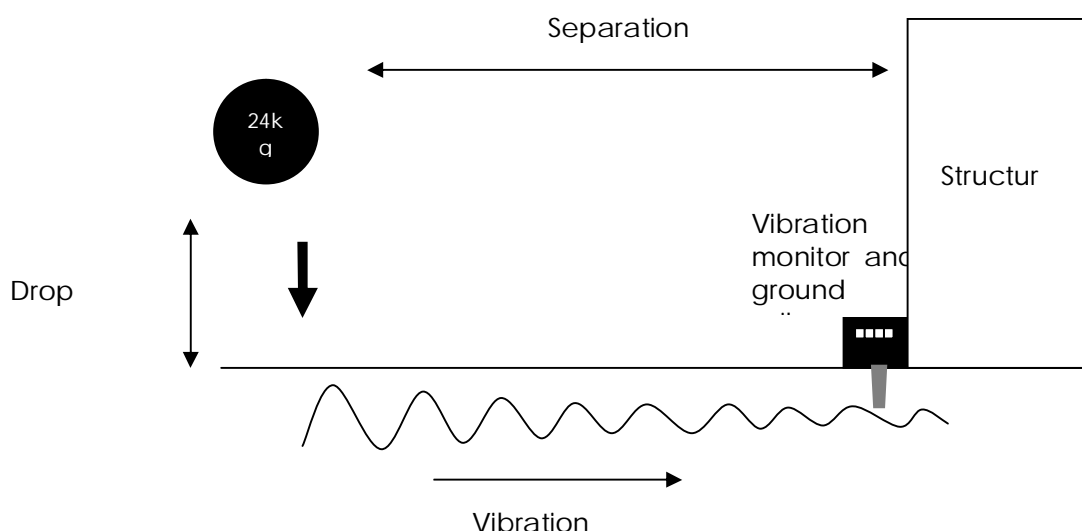
Vibration monitoring and testing equipment

Data Instrumentation: The recording equipment used for both the testing and traffic monitoring comprised of a Bruel & Kjaer Pulse Analyser Platform with associated accelerometers (tri-axial block and single axial reference) and data collection software. In combination with this, an Instanetl Minimate Digital Seismograph (and tri-axial geophone) was also used to collect ground borne vibration velocity data (PPV and frequency). Details of the instrumentation used are below.

Fixing Methods: The fixing methods used to couple the accelerometers and geophone to the ground and sensitive structures was in line with those advised within the OEH Assessing Vibration; a technical guideline document and BS 5228. A single axis reference accelerometer was attached to the sensitive structure (in the vertical (z) axis) throughout the testing phase, using a magnet and glued metal bracket. The tri-axial block and geophone were coupled to the ground using ground spikes which were hammered into the ground.

The equipment used in the testing phase as a source of energy producing ground borne vibration was a 24kg 'kettlebell weight'. The known weight was dropped from a set height onto a wooden block located on the ground to be tested; therefore the same impact energy was received at the impact point on the ground during each drop. The testing set up and location remained constant throughout the testing phase, with the only variable being the separation distance of the energy source and the tri-axial block & Minimate geophone, see below for graphical representation.

Instrument	Serial Number	Data Output	Frequency Range	Sensitivity
Bruel & Kjaer Type 3560 C Pulse Analyzer Platform	2392422	rms acceleration acceleration	-	-
PCB single axis accelerometer 353B	77463	-	1-4000Hz ($\pm 5\%$) 0.7-6500Hz ($\pm 10\%$)	100mV/g
PCB single axis accelerometer 353B	77464	-	1-4000Hz ($\pm 5\%$) 0.7-6500Hz ($\pm 10\%$)	100mV/g
PCB single axis accelerometer 353B	77465	-	1-4000Hz ($\pm 5\%$) 0.7-6500Hz ($\pm 10\%$)	100mV/g
PCB single axis accelerometer 353B	77461	-	1-4000Hz ($\pm 5\%$) 0.7-6500Hz ($\pm 10\%$)	100mV/g
Instanetl Minimate Plus (Triaxial)	65184	PPV	2-250Hz	0.125-254mms ⁻¹



Appendix E Architectural heritage report

09 August 2012

Mr Jonas Ball
Senior Environmental Scientist
PO Box 164
St Leonards 1590

Dear Jonas,

RE: HERITAGE ADVICE ON NOISE REDUCTION MITIGATION MEASURES
ASSOCIATED WITH WINDSOR BRIDGE REPLACEMENT PROJECT

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.

It is understood that 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 proposed bridge has been declared a State Significant Infrastructure project (number SSI-4951) and the Director General's Requirements (DGRs) have been issued on 24 November 2011. A number of studies 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 letter of heritage advice provides response to the **architectural noise treatment** requirement of the above quoted DGR and provides appropriate mitigation measures for the treatment of windows and doors of a heritage item affected directly from the proposed bridge replacement.

In preparation of this heritage advice the undersigned has consulted the following documentation and obtained expert advice of Gary Waller of G & C Waller Builders.

Gary is a carpenter with extensive expertise in traditional joinery. A site inspection was undertaken by the undersigned and Roy Surace of RMS on 26 July 2012.

- 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 Form for Thomson Square incorporating 10 Bridge Street
- Register of the National Estate listing form for 10 Bridge Street
- various Windsor Bridge Replacement project reports by the project consultant team
- W. Murray, A. Croker, *Traditional Joinery - Sydney Houses 1810-1915*, 2005, Watermark Press

The author wishes to thank the owners of the heritage item, Gail and Peter Reynolds at 10 Bridge Street for their help during the site visit and background information on the subject item.

THE SITE

The subject project is located within the vicinity of a number of heritage items of State and local significance including buildings, town squares and conservation area, which have been identified to be affected directly from the proposed works. One of these heritage items is a c1856 Regency style 'House and Outbuildings' located at 10 Bridge Street at the corner of George Street. The premises currently operates as a music shop (River Music) on the ground floor while the upper floor is used for residential accommodation.

The House and Outbuildings are listed on the State Heritage Register as part of the Thompson Square Precinct (SHR No. 00126) and is also on the Hawkesbury LEP (No. 273). 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 brief Statement of Significance and describes the house as -

Two storey brick Regency style building with a particularly fine cast iron verandah to both floors fronting Bridge Street; stuccoed parapet and slate

roof. Building has potentially an elegant facade but is marred by verandah being enclosed and extended. Two good slab outbuildings at rear.

Statement of Significance

Potentially fine Regency town house when restored. Of sympathetic scale and form with other elements in precinct. See also main listing for precinct, RR 001366.

Since the preparation of the National Estate database form in May 1980 the house has been restored and the ground floor veranda has been reinstated to its original form (see supporting photographs at the end of this letter).

EXISTING JOINERY

The subject house features highly intact timber door and window joinery to both ground and first floor main street facades. The windows to 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.

The upper residential part of the premises features five (5) French doors opening onto the front timber balcony from each room facing Bridge Street. Each room on the upper level is rented to individual tenants and with the exception of the corner room the remainder of the rooms on bridge Street facade 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 French doors feature four glazed panels with margin glazing to each door leaf and a fanlight above also with margin glazing. The majority of the existing glazing is original.

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 at the end of this letter.

POTENTIAL MITIGATION MEASURES

Given consideration to the intactness and original fabric of the existing joinery and their operational requirements the alternatives for mitigation measures are limited. The existing joinery subject for mitigation measures are exceptionally significant and are finely detailed as such any mitigation measure should ensure no detrimental impact occur to both their original fabric and presentation. Presentation of the subject joinery from the interiors is equally important to their external presentation due to the fine detailing of the joinery and overall internal integrity of the residence.

Options table for noise mitigation for windows (all new glazing to meet required acoustic levels) with appropriateness discussion:

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 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 actions for the windows but may not provide the required
4. Installation of custom made individual glazed timber framed panels to	This option will ensure the most appropriate timber framed glazed panels individually inserted into each glazed pane of the existing windows with soft elastic

each glass pane of the double-hung sashes (internal)	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 necessity for 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 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 similar acoustic treatments of residential joinery. Retrofit double glazing is the addition of a secondary glazing layer to an existing window. It is noted in the online data for the 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, its standard frame considered to 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.

Options table for noise mitigation for French doors (all new glazing to meet required acoustic levels) with appropriateness discussion:

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 of exactly the same as the existing French doors. This option will maintain the existing appearance of the joinery but will create a 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 be kept operable.
2. Installation of shutter system in traditional manner to the exterior	This option follows the traditional shutter system but will not allow for the required daylight into the rooms as the acoustic needs will require them to be kept shut all the time. The shutters will also not allow air ventilation to the rooms and will necessitate mechanical ventilation system. It has a number of suitability issues in this regard.
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 frames 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.

RECOMENDED SOLUTIONS FOR INTERNAL VENTILATION

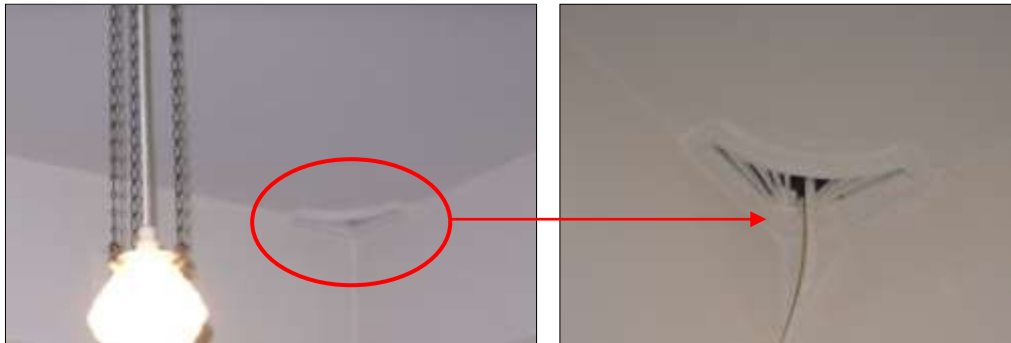
It is apparent that once the treatment for the noise mitigation is undertaken for them to be effective the doors and windows will be required to be kept closed. In this case some type of ventilation system will be necessary to allow fresh air into the subject rooms of the House on the upper level.

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 within the day. However, since the aim of the noise treatment to ensure the maximum mitigation measures for the residential amenity the following alternative solutions have been explored and noted.

The existing ceilings of the upper level rooms of the House are original lath and plaster ceilings strengthened with square pattern battens. Evidence of water damage and small localised chips / cracks observed during the site inspection. However, in general the ceilings are in good condition given consideration to the age of the House. The existing light fittings and other hooks etc are suspended from the battens rather than from the main lath and plaster panels. This places the ceilings in an intact condition as such any future air-condition (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 (maximum 2 only preferable if technically possible) rather than randomly in the centre or other panels of the ceiling.

The ventilation system ducts / cabling can be placed within the roof cavity with only minimum required opening for the ducting registers at the agreed points of the ceilings. Consultation should be undertaken with an appropriately qualified heritage

consultant in order to establish the locations for ducting registers. Images of an example of traditional corner ceiling vent, taken by the author 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.



CONCLUSION AND RECOMMENDED MITIGATION MEASURES

As detailed in the above tables there are a number of ways that existing windows and French doors can be treated for acoustic needs. The main consideration should be given to the heritage item's significance and the existing fabric's condition, intactness and integrity. In the case of the subject House at 10 bridge Street, Windsor it is clearly evident that this heritage item is a rare and excellent example of Victorian Regency style architecture with remarkably intact timber joinery including the majority of the glazing.

Given consideration to the streetscape and 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 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 aesthetic significance of the heritage item will not be affected. Furthermore the new frames can be removed without damage to the existing fabric if require in the feature.

Magnetite Retrofit double glazing system should also be checked for suitability by obtaining testimonials from known carpenters who had used them before. Performance of magnetite Retrofit double glazing system is not evident at this stage

to us. It appears to be a possible option for the subject House; however, it has a high potential to impact on the presentation due to the standard profile of its subframes. It may however be the more economical option than the custom made option.

Based on the above discussion the custom made individual glazed panels option will be our preferred option. It is recommended that an experienced carpenter with traditional joinery expertise be engaged to undertake a detailed inspection and measurement of the subject window 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 Magnetite Retrofit double glazing system be considered then advice of an experienced carpenter must be sought and examples of such installations be inspected before making 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.

As for required ventilation system recommendations made in the previous section (recommended solutions for internal ventilation) should be taken into consideration when making decision on the appropriate treatment and mitigation measures. Opportunity should also be taken to halt any water leakage problem and repaint the ceilings affected by the implemented system.

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.

I trust the above heritage advice is satisfactory for your assessment of the appropriate acoustic treatment and allow for making a decision. Should you require further information or clarification of the above please do not hesitate to contact me on 8270-3508.

Yours sincerely,



Kerime Danis
Manager

SUPPORTING PHOTOGRAPHS

Views of the existing French doors and windows on the upper level of 10 Bridge Street, Windsor including external street views



