Appendix H

OPTIONS ANALYSIS (EJE HERITAGE)

Our ref: 11009
Date: 08/04/2022

Planning & Assessment
Department of Planning, Industry & Environment
4 Parramatta Square, 12 Darcy Street,
Parramatta NSW 2150

Heritage NSW
Department of Premier & Cabinet
Level 6, 10 Valentine Ave,
Parramatta NSW 2150

ATTENTION: **To Whom it May Concern**

Dear Sir/Madam,

RE: **SHR:01987 Carrington Hydraulic Engine House – Engine Room Sub-Floor Asbestos Remediation Strategy - Options Analysis**

Following two previous stages of conservation works to the exterior of the building between 2018-2021, EJE Heritage has been working with the Port of Newcastle, owners of the Carrington Hydraulic Engine House, to develop a strategy to remediate an asbestos hazard currently present within the main Engine Room of the building. Please see attached letter from the project's Hygienist giving technical details of the asbestos hazard and asbestos removal processes within the building to date.

In summary, the nature of the hazard involves friable asbestos fibres stuck to/embedded within the original cast-iron floor grates of the engine room (Figure 1-2), and embedded asbestos material in the ground surface of the sub-floor cavity (Figure 3-5). The remaining surfaces of the Engine Room (and of the entire building) have been cleaned of asbestos by hazardous material specialists, and given clearance for occupation by the project's hygienist.

The asbestos hazard present in the floor grates and sub-floor is currently preventing human access to the main engine room (without PPE and decontamination procedures in place), and hence holding up conservation works that would lead towards the future goal of adaptive re-use of the building.

An additional hazard with the project is the poor structural integrity of the original steel floor framing in this room, with almost all columns supporting the cast-iron grates being corroded through more than 90% of their sectional area at their base (Figure 5). The main engine room floor section is as such non-trafficable in its current condition, and at extreme risk of collapse with any movement or interventions in the space.

EJE Heritage and the Port of Newcastle have been in discussion with NSW Heritage regarding the potential options to remediate this hazard (in tandem with update of the site's Conservation Management Plan), including a presentation of concept options for remediation at an online video conference 18 May 2021. Following this meeting, Senior Heritage Officer Isaac Clayton advised via email 10/06/21:

> *From previous consultation and from the information you have presented to us, the structural integrity and sub floor asbestos contamination are clearly hazards that need to be addressed to assisting in attracting and securing an end user for the adaptive re-use of the engine house.*
>
> *We agree that remediation works proposed for the sub floor are required and advise that a S60 application for these works is submitted. An options analysis of potential stabilisation and remediation works should also be submitted with your application. This analysis should demonstrate what options have been considered and discounted and why the actions/works proposed are most appropriate. Where specialist advice (industrial hygienist, structural engineer, etc) has been sought it should be submitted as part of your application…*

Concurrently, attached following is an options matrix describing the various methodologies investigated for remediation of the asbestos hazard, and the factors that have led to the selection of the methodology proposed in this Section 60 Application.

If you have any questions, please do not hesitate to get in touch.

Yours faithfully,

EJE HERITAGE

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Figure 1. The floor of the Carrington Hydraulic Engine House main Engine Room is partially covered in original cast-iron floor grates suspended above a deep cavity on a steel column/beam structure. The grates are exceptionally heavy (not able to be lifted safety without hoisting equipment).

Figure 2. The cast iron floor grates present an asbestos hazard, with their porous surface containing remnant fibres despite previous cleaning in the room. Note also the large cavities present across parts of the floor. The hygienist has described that it would be implausible to fully clean the grates of asbestos in-situ, given the myriad openings and porous surface.

Figure 3. A very deep sub-floor cavity is present below the grates, which has been cleaned of asbestos as best as possible.

Figure 4. The solidified base surface however presents an asbestos hazard, with detectable asbestos physically embedded within the surface material.

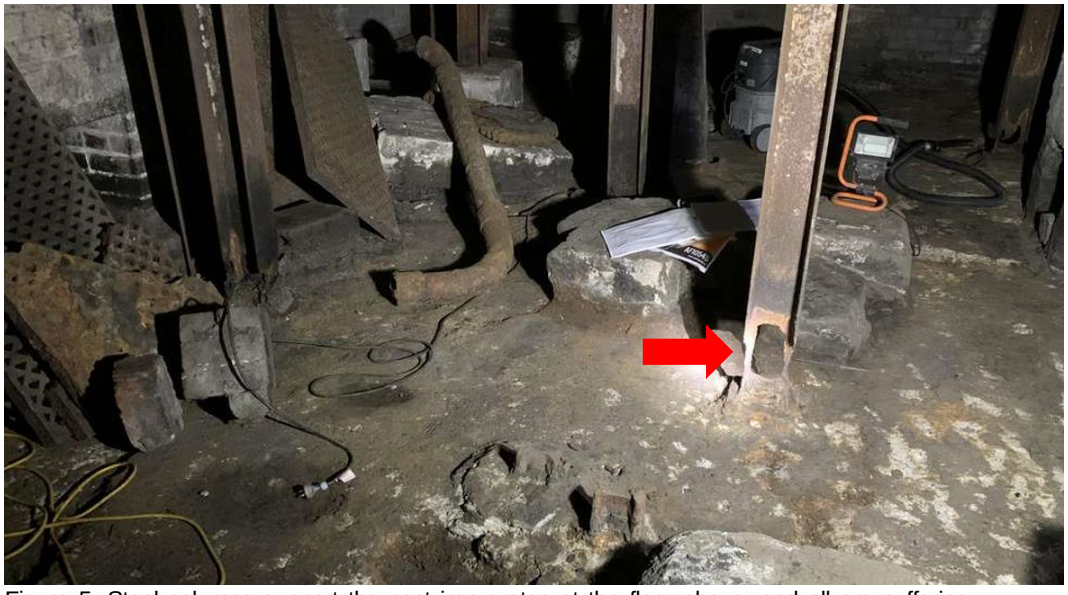

Figure 5. Steel columns support the cast iron grates at the floor above, and all are suffering extreme corrosion particularly at their base, meaning that the grates are non-trafficable and at risk of collapse.

CARRINGTON HYDRAULIC ENGINE HOUSE – STAGE 3 – ENGINE ROOM ASBESTOS REMEDIATION

REMEDIATION OPTIONS ANALYSIS MATRIX

Proposal Definitions

Methodology	Design proposal to remediate (remove or encapsulate) the asbestos hazard within the Engine Room, developed by the Architect, Owner, Engineer & Hygienist.
Interpretation	Heritage Interpretation devices included within the proposal, able to be experienced by a user within the remediated Engine Room.
Risks	Significant risks of the proposed methodology, generally across all categories.
Benefits	Significant benefits of the proposed methodology, generally across all categories.
Owner Comment	Comments on the proposed methodology by the asset owner, the Port of Newcastle, *Representative: Peter Ostrowski.*
Architect Comment	Comments on the proposed methodology by the project Architect/Heritage Consultant, EJE Heritage, *Representative: Dominic Warland.*
Engineer Comment	Comments on the proposed methodology by the project's Structural & Services Engineer, Northrop, *Representative: Karlie Collis.*
Hygenist Comment	Comments on the proposed methodology by the project's Hygeinist, Verico, *Representative: Ken Maher.*

Analysis Definitions

Efficacy	Will the proposal adequetely remediate the asbestos hazard to allow human occupation of the space for the long term?
Affordability	Is the proposal affordable / within the financial capacity of the asset owners?
Construction Safety	Is the proposal safe to construct?
Construction Practicality	Is the proposal practical to construct?
Heritage Value	What is the value of the proposal, in terms of its impact on the building's Heritage? (i.e, Does it support the building's heritage significance or not?)
End User Practicality	What is the practicality of the proposal for a future user/tenant of the building?

Analysis Values

Very Low	An outcome so poor that would be almost implausible to enact.
Low	A poor outcome, however possible if necessary.
High	A good outcome.
Very High	The most favourable outcome.

Option 1	Decontaminate In-Situ	Efficacy	Affordability	Construction Safety	Construction Practicality	Heritage Value	End User Practicality
Methodology:	Install temporary decontamination unit through sealed personelle entrance to Engine Room. Repair/replace/strengthen steel floor structure in-situ with like-for like steel members to make floor structure trafficable. Bring mobile decontamination equipment into engine room, and blast clean all floor grates in-situ. Decontaminate all other surfaces of the room following blasting. Flood grout base of floor cavity with concrete (say 100mm) to encapsulate ground surface.	VERY LOW	VERY LOW	VERY LOW	VERY LOW	VERY HIGH	VERY LOW
Interpretation:	All existing fabric remains within the space for visual interpretation.						
Risks:	Extreme safety and logistical risks during construction due to poor condition of floor structure, high potential of collapse/accident during the works. Very likely risk that the on-site blasting will not be effective in cleaning the grates (poor efficacy), and asbestos clearance will not be achieved. Potential issues with moisture in the cavity due to sealing of the lower floor surface.						
Benefits:	No removal of heritage fabric.						
Owner Comment:	Budgetary constraints would likely prevent this, as building is not receiving revenue. Time frame could be an issue. This does not address useability issues with the holes in the floor surface.						
Architect Comment:	While potentially favrouable in terms of heritage impact, this option is not practical for an end user as the floor structure of the building as existing has many large openings and cavities across its surface. Any future fitout would require these to be covered with a new floor surface regardless.						
Engineer Comment:	Existing structural steel would require surface clean and new corrosion protection for long term future use. Potential damage to existing steel structure in blast clean. Potential damage to existing brickwork at steel/brickwork junction during cleaning.						
Hygienist Comment:	The use of high-pressure water sprays, compressed air tools and equipment that generate dust, such as high-speed abrasive power and pneumatic tools, on asbestos containing material is not permitted. Therefore, cleaning of the grates in situ would be very difficult (and possibly ineffective) and may lead to re-contamination of areas already cleaned. Encapsulation of ground surface would achieve a safe condition.	**Selection Ranking:**			**8th of 10**		

Option 2	Decontaminate Off-Site and Reconstruct as Original	Efficacy	Affordability	Construction Safety	Construction Practicality	Heritage Value	End User Practicality
Methodology:	Install temporary decontamination unit through sealed personelle entrance to Engine Room. Systematically deconstruct all steel structure of the engine room floor, seal material in packaging, remove through decontamination unit via small mobile crane, and re-locate off site for decontamination blasting. Decontaminate all other surfaces of the room following deconstruction. Flood grout base of floor cavity with concrete (say 100mm) to encapsulate ground surface. Re-construct steel floor strutcure as original, repaing or replacing corroded structure as necessary.	HIGH	VERY LOW	VERY LOW	VERY LOW	HIGH	VERY LOW
Interpretation:	All existing fabric remains within the space for visual interpretation, although partly rebuilt with new material.						
Risks:	Extreme safety and logistical risks during construction due to poor condition of floor structure, high potential of collapse/accident during the works. Extreme logistical risks with removal of the floor grates from the room (as they weigh several hundred kilograms each). Risk that corroded steel structures may not be able to be deconstrtucted at all. High potential that the re-construction exactly "as original" will not be possible given the intricate and chaotic nature of the steel structure as existing. Potential issues with moisture in the cavity due to sealing of the lower floor surface.						
Benefits:	Better likelihood of achieving asbestos clearance for floor grates via treatment off site.						
Owner Comment:	Budgetary constraints would likely prevent this, as building is not receiving revenue. OH&S risks with handling large heavy fabric. Time frame could be an issue. This does not address useability issues with the holes in the floor surface.						
Architect Comment:	As with Option 1, this option does not provide a useable floor surface for a future tennant. Reconstructed floor surface will by its nature lose some heritage value, if it is possible to do at all without destroyong the material.						
Engineer Comment:	Existing structural steel would require surface clean and new corrosion protection for long term future use. Potential damage to existing steel structure in blast clean. Potential damage to existing brickwork at steel/brickwork junction during removal/reinstatement.						
Hygienist Comment:	This option would result in floor grates achieving clearance if the safe removal from site can be achieved. Encapsulation of ground surface would achieve a safe condition.	**Selection Ranking:**			**7th of 10**		

Option 3	Mass Concrete Encapsulation	Efficacy	Affordability	Construction Safety	Construction Practicality	Heritage Value	End User Practicality
Methodology:	Install temporary decontamination unit through sealed personelle entrance to Engine Room. Install protective plastic barrier to base walls of engine room throughout. Install styrofoam filler blocks thoughout sub-floor cavity. Flood entire sub-floor space with mass concrete to encapsulate up to and above existing cast iron floor grates.	VERY HIGH	HIGH	VERY HIGH	HIGH	VERY LOW	LOW
Interpretation:	Artistic interpretation of the engine room floor structure could be included within the topping of the mass concrete slab.						
Risks:	Loss of Heritage Significance due to removal of fabric sealed within concrete. Community dissaproval at loss of heritage fabric. Problems with moisture, settlement, lack of access for maintance to sub-floor structure. Potential effects on building structure surrounding the engine room. Loss of options for future introduction of services or changes to the use of the space.						
Benefits:	A simple, permanent and economical solution to resolve the asbestos risk within the space.						
Owner Comment:	Likely the most economical solution, time efficient, easy and safe.						
Architect Comment:	This option provides little scope for changing uses within the space. Loss of heritage fabric may make the space less appealing for future tennants. Heritage fabric is lost for any future study/use/interpretation.						
Engineer Comment:	Potential to exacerbate rising damp issues with mass concrete fill						
Hygienist Comment:	This would encapsulate all asbestos. Asbestos would contaminate the concrete slab. If the slab was ever to be removed or penetrated then the concrete would have to be treated as containing asbestos, work carried out under controlled conditions and waste disposed of as asbestos waste.	**Selection Ranking:**			**6th of 10**		

Option 4	Bulk Fill & Capping Slab Encapsulation	Efficacy	Affordability	Construction Safety	Construction Practicality	Heritage Value	End User Practicality
Methodology:	Install temporary decontamination unit through sealed personelle entrance to Engine Room. Install protective plastic barrier to base walls of engine room throughout. Fill entire sub-floor space with a loose bulk fill (sand, gravel etc) up to the level of the grates. Install plastic vapour barrier liner over the grates. Pour new concrete raft slab across entire surface of engine room.	VERY HIGH	HIGH	VERY HIGH	HIGH	LOW	LOW
Interpretation:	Artistic interpretation of the engine room floor structure could be included within the topping of the concrete slab.						
Risks:	Loss of Heritage Significance due to removal of fabric sealed within concrete. Problems with moisture, settlement, lack of access for maintance to sub-floor structure. Potential effects on building structure surrounding the engine room.						
Benefits:	An economical and safe solution that could be easily constructed and later removed if necessary.						
Owner Comment:	Similar to Option 3, economical solution, time efficient and relatively easy.						
Architect Comment:	This option has the benefit over Option 3 that it could be reversed at a later date. The introduction of changes/new services at a later date is difficult, but not impossible.						
Engineer Comment:	Likely to exacerbate rising damp issues with bulk fill.						
Hygienist Comment:	This would encapsulate all asbestos. Asbestos would contaminate the loose bulk fill. If the loose bulk fill was ever to be removed or penetrated then the loose bulk fill would have to be treated as containing asbestos, work carried out under controlled conditions and waste disposed of as asbestos waste.	**Selection Ranking:**			**5th of 10**		

Option 5	Glass Floor Encapsulation, Unsealed Cavity Floor	Efficacy	Affordability	Construction Safety	Construction Practicality	Heritage Value	End User Practicality
Methodology:	Install temporary decontamination unit through sealed personelle entrance to Engine Room. Patch repair or permanently prop steel floor structure in-situ to maintain long term integrity (but not trafficability). PVA seal all floor grates in-situ. Install feature lighting and HEPA filtered external air ventilation system to sub-floor cavity. Install new contemporary steel floor structure with glass surface across entire floor plate of room, spanning between walls and concrete engine buttresses (not on the floor grates themselves). Install new sealable personelle access door into sub-floor cavity (to be used for periodic maintenance with PPE and decontamination unit in place).	VERY HIGH	VERY LOW	HIGH	HIGH	VERY HIGH	LOW
Interpretation:	All heritage fabric is attractively presented as an archaeological relic, illuminated below the glass floor surface.						
Risks:	Issues with maintenance of the glass surface within the cavity (cleaning, condensation etc).						
Benefits:	An aesthetic proposal which showcases the building's heritage.						
Owner Comment:	Does not support long term user options, economically unfeasable (construction and limiting options for re-use / rental income).						
Architect Comment:	This proposal lacks flexibility for a future tennant, as the glass floor structure would have limits on weight and could not be adapted to suit changing fitouts of the room.						
Engineer Comment:	Structural support for glass structure would be significant and likely detract from structure below. More impact on existing structure to create isolated support points (removal of brickwork in zones).						
Hygienist Comment:	This option will enclose the asbestos. Material in the grates should be sealed with a PVA sealant as enclosure is not recommended for friable asbestos. Seals between the walls and the glass floor would require regular inspection. Air ventilation system will require regular maintenance and HEPA filters changed regularly. Air extraction may achieve a negative air pressure within the sub-floor area which will prevent any contamination from escaping through incomplete seals. Control measures will be required for accessing the sub-floor area.	**Selection Ranking:**			**3rd of 10**		

Option 6	Glass Floor Encapsulation, Sealed Cavity Floor	Efficacy	Affordability	Construction Safety	Construction Practicality	Heritage Value	End User Practicality
Methodology:	As for Option 5, but also flood grout base of floor cavity with concrete (say 100mm) to encapsulate ground surface.	VERY HIGH	VERY LOW	HIGH	HIGH	VERY HIGH	LOW
Interpretation:	As for Option 5.						
Risks:	Potentially increased issues with moisture in the cavity due to sealing of the lower floor surface.						
Benefits:	As for Option 5, and with better encapsulation of the floor surface within the cavity which further minimises risk to maintenance personelle accessing the cavity.						
Owner Comment:	As for Option 5.						
Architect Comment:	As for Option 5.						
Engineer Comment:	As for Option 5.						
Hygienist Comment:	As for Option 5.	**Selection Ranking:**			**4th of 10**		

Option 7	Concrete Floor Encapsulation, Unsealed Cavity Floor	Efficacy	Affordability	Construction Safety	Construction Practicality	Heritage Value	End User Practicality
Methodology:	Install temporary decontamination unit through sealed personelle entrance to Engine Room. Patch repair or permanently prop steel floor structure in-situ to maintain long term integrity (but not trafficability). PVA seal all floor grates in-situ. Install feature lighting and HEPA filtered external air ventilation system to sub-floor cavity. Install new suspended concrete floor slab with several inset glass viewing windows across entire floor plate of room, spanning between external walls and concrete engine buttresses (not on the floor grates themselves). Install new sealable personelle access door into sub-floor cavity (to be used for periodic maintenance with PPE and decontamination unit in place).	VERY HIGH	HIGH	HIGH	HIGH	HIGH	VERY HIGH
Interpretation:	Artistic interpretation of the engine room floor structure to be included within the topping of the concrete slab. Viewing windows with feature lighting allow tailored views to items of interest below.						
Risks:	Issues with maintenance of the glass windows within the cavity (cleaning, condensation etc).						
Benefits:	An effective proposal which showcases the building's heritage as well as providing flexibility for a variety of uses.						
Owner Comment:	Falls within budget constraints and provides suitable end result with options for future re-use. Does not eliminate asbestos hazard, requires ongoing management to control the risk.						
Architect Comment:	This option allows the highest flexibility for use of the space by a tennant in an adaptive re-use scenario.						
Engineer Comment:	Floor slab able to readily be designed for 5kPa live load (and 2.5kPa SDL), which gives many options for future use.						
Hygienist Comment:	This option will enclose the asbestos. Material in the grates should be sealed with a PVA sealant as enclosure is not recommended for friable asbestos. Seals between the suspended concrete floor slab and the inset glass viewing windows would require regular inspection. Air ventilation system will require regular maintenance and HEPA filters changed regularly. Air extraction may achieve a negative air pressure within the sub-floor area which will prevent any contamination from escaping through incomplete seals. Control measures will be required for accessing the sub-floor area.	**Selection Ranking:**			**1st of 10**		

Option 8	Concrete Floor Encapsulation, Sealed Cavity Floor	Efficacy	Affordability	Construction Safety	Construction Practicality	Heritage Value	End User Practicality
Methodology:	As for Option 7, but also flood grout base of floor cavity with concrete (say 100mm) to encapsulate ground surface.	VERY HIGH	HIGH	HIGH	HIGH	HIGH	VERY HIGH
Interpretation:	As for Option 7.						
Risks:	Potentially increased issues with moisture in the cavity due to sealing of the lower floor surface.						
Benefits:	As for Option 5, and with better encapsulation of the floor surface within the cavity which further minimises risk to maintenance personelle accessing the cavity.						
Owner Comment:	As for Option 7.						
Architect Comment:	As for Option 7.						
Engineer Comment:	As for Option 7.						
Hygienist Comment:	As for Option 7.	**Selection Ranking:**			**2nd of 10**		

Option 9	Complete Removal of Fabric	Efficacy	Affordability	Construction Safety	Construction Practicality	Heritage Value	End User Practicality
Methodology:	Install temporary decontamination unit through sealed personelle entrance to Engine Room. Demolish all internal steel floor structure including floor grates, columns, beams etc, and dispose of as contaminated waste off-site. Excavate contaminated sub-floor surface and dispose of material as contaminated waste off site. Demolish mass-concrete engine blocks and dispose of, or decontaminate in-situ, along with decontamination of all other surfaces of the space following (dusty) demolition works. Leave Engine Room as empty shell with floor surface as bare-ground at sub-floor level.	VERY HIGH	HIGH	LOW	LOW	VERY LOW	VERY HIGH
Interpretation:	Wall surfaces of engine room and possibly mass concrete engine footings left extant, no other interpretation remaining.						
Risks:	Loss of Heritage Significance due to removal of fabric. Community dissaproval at removal of heritage fabric. Difficult construction logistics of using demolition machinery in contaminated confined space.						
Benefits:	Asbestos hazard is permanently removed. Clean slate for future tenant fitout, services and structure.						
Owner Comment:	Solves asbestos issue permanently, de-risks the owner (removes issue from site HAZMAT register).						
Architect Comment:	Complete loss of heritage fabric unnaceptably impacts the building's significance, and makes the space less appealing for a future tenant.						
Engineer Comment:	Likely damage to existing masonry/concrete where items are embeded.						
Hygienist Comment:	Demolition would have to be done under controlled conditions to ensure re-contamination of cleaned areas does not occur. Would achieve full clearance of building.	**Selection Ranking:**			**9th of 10**		

Option 10	Continued/Permanent Closure of Engine Room	Efficacy	Affordability	Construction Safety	Construction Practicality	Heritage Value	End User Practicality
Methodology:	Maintain/ permanently fix existing temporary seals to all Engine Room openings, and prevent human access to the space for the long term.	VERY LOW	VERY HIGH	VERY HIGH	VERY HIGH	LOW	VERY LOW
Interpretation:	All extant heritage fabric is maintained as existing, on-site interpretation however is prevented and available only through photographs, drawings and 3D model viewing software.						
Risks:	Unremediated asbestos hazard within the building is an ongoing risk for the owner. Lack of access / effort to remediate the building risks community dissaproval. Condition of Engine Room will deteriorate over time with lack of maintenance. Closure of Engine Room prevents adaptive re-use of the building, preventing income from a tennant.						
Benefits:	An easy and economical solution for the short term.						
Owner Comment:	Least impact on budget as no internal works required (short term), no option however for future re-use and revenue from building (long term budget drain).						
Architect Comment:	While the heritage value of the building fabric of the Engine Room is not physically compromised in this option, it is detrimental to the building's significance to prevent access in the long term. Remediation and adaptive re-use should be the goal.						
Engineer Comment:	Continued further deterioration expected and likely collapse of floor long term.						
Hygienist Comment:	Asbestos hazard will remain. Control measures will be required for accessing the contaminated area of the building.	**Selection Ranking:**			**10th of 10**		