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14 December 2018

By email: bill.woodruff@infrastructure.gov.au

Dear Bill,

Review of KAVHA Safety Hazard Investigation

This desktop review is provided to the KAVHA Advisory Committee of the Department of Infrastructure, Regional Development and Cities (the Department) in response to their Approach to Market (Ref: TERR18/0310-01, dated 7 November 2018). It is intended as a peer review of the proposed rectification works on Norfolk Island prior to the project proceeding to a detailed design stage. This peer review considers the *KAVHA Safety Hazard Investigations Report* prepared by AECOM in October 2018 against the recommendations made in the *KAVHA Safety Hazard Scoping Study* prepared by GML Heritage in June 2018.

The review is limited to the following heritage assets:

- Civil Hospital
- Arthur's Vale Retaining Wall
- Bounty Street Bridge
- Longridge Arches
- Royal Engineer's Office (REO) Entry Portico

As per the project scope, our review seeks to:

- Identify any inconsistencies between the recommendations of the two reports and the proposed AECOM solution
- Comment on whether any inconsistencies are likely to be material to site safety
- Comment on the consistency with best practice heritage practices of the prescriptions contained in the AECOM report.
- Comment on the likely feasibility that the proposed staging of works will be able to occur as planned and deliver a successful outcome.

A detailed comparison of the two reports in relation to the five heritage assets listed above has been prepared in tabular format and is appended to this document.

Limitations

Please note that our review contains the following limitations:

- this is a desktop review only
- it does not provide architectural or engineering advice
- does not involve any site inspections or attendance at any meetings, nor is it informed by a site inspection specifically considering the two subject documents

Purcell Asia Pacific Limited is a limited company registered in Hong Kong, registration number 1422134. Purcell Miller Tritton LLP is the holding entity, a limited liability partnership registered in the UK, registration number 0C315259.

By way of general advice going forward, we are happy to reiterate the planning approvals advice contained within the AECOM report which forms part of this assessment, an excerpt of which appears below:

The following is recommended to progress the Proposal:

- *Initiate consultation with Norfolk Island authorities early to confirm the environmental approval pathway and refine the scale and scope of the heritage and environmental assessment as required. This should be carried out early in project design.*
- *Design should take into account the requirements of:*
 - *The Burra Charter (2013)*
 - *Eric Martin & Associates (2005) Norfolk Island: Longridge Arches Heritage Management Plan*
 - *GML (2016) Kingston and Arthur's Vale Historic Area Heritage Management Plan*
 - *GML (2018) KAVHA Cultural Landscape Management Plan Preliminary Draft Report.*
- *Where practicable, select design options that:*
 - *Have minimal impact on original fabric*
 - *Are visually recessive*
 - *Minimise ground disturbing works.*
- *Conduct a HIS for each Proposal options for each heritage item by a competent Senior Heritage Specialist to support the building Approval submission.*

The proposed solutions that have been put forward can range from a 'do nothing' approach (or at least the minimum required for safety) through to full reconstruction.

In this assessment, Purcell have not commented on the costings which have been put forward in the AECOM report.

I. Civil Hospital

Description (from AECOM Report)

The Civil/Convict Hospital is located in the Kingston and Arthur's Vale Historic Area (KAVHA) of Norfolk Island, one of the 11 properties forming part of the Australian Convict Sites World Heritage Listing. The convict hospital was first built in 1829, with extensions added to the building in 1833. The building is made from calcarenite stone and originally had a thatched roof, which was later shingled as part of the 1833 extensions.

Currently the Civil Hospital is in a state of ruins, with the roof and large portions of the walls missing but it remains a strong visual component of the KAVHA precinct and is integral to the historical interpretation of the site.



Figure 1 (left) – Northern gable of the Civil Hospital showing structural crack [Source: GML] and Figure 2 (right) – Civil Hospital ruins [Source: AECOM]

Condition Summary and Structural Assessment (based on both reports)

The Civil Hospital is a ruined structure of locally sourced calcarenite limestone. This stone is comprised of fossils, shells and general calcareous (limestone-based) detritus, 'cemented' together within a calcite and/or clay matrix. The reports note that the mechanical properties of the stone have not been tested. Three features of the Civil Hospital have been identified in the reports as areas of concern:

- Northern gable
- Retaining wall
- Timber lintel

The primary concern is the unrestrained northern gable wall which has no lateral restraint and exhibits a large crack at its eastern corner. The gable is at risk of collapse, particularly during a high wind event or seismic activity. The walls of the building have been extensively pointed and skim coated with cement-based render and large voids extending 600mm into the wall have been identified. Erosion and cattle grazing have left the stone base of the wall exposed.

A retaining wall in the complex has previously exhibited signs of rotation at its base but is no longer thought to be subject to movement. A drain located in the centre of the wall may not be functioning properly and may lead to build-up of water behind wall if not cleared.

A timber lintel to a doorway has completely disintegrated, leaving calcarenite stone blocks unsupported.

Inconsistencies and Matters Affecting Site Safety

There are a number of inconsistencies between the two reports in their assessment of the structural condition of the identified elements and the site safety measures that have been recommended.

Northern Gable

Both reports agree that the gable represents a significant risk and access to this area should be limited to minimise public risk in the short term. Both reports consider that the likelihood of visitors being present in the site during a high wind event is low, however Purcell would contend that given the unpredictable nature of extreme weather events on the island this is not a reasonable assumption upon which to base visitor safety. Both reports suggest a longer-term strategy of incorporating some

form of restraint or bracing into the wall to prevent overturning. The GML report proposes a form of "partial reconstruction" involving the installation of a new roof structure to emulate the original roof form to brace the walls, and the possible use of stainless steel tie rods between walls to improve the bond. The AECOM report suggests the building of a stand-alone structure behind the gable to tie the wall back.

Retaining Wall

The GML report contends that the retaining wall has rotated significantly and that structural failure of the wall leading to collapse is likely to occur. It recommends the prevention of pedestrian and vehicular access to the site, and that investigations be undertaken to investigate cause of failure. The AECOM report suggests that although the wall may have rotated in the past, it has had an upper section added (which remains vertical) and since this addition the evidence suggests there has been no further rotation. Annual monitoring and observation is recommended.

Timber Lintel

Both reports agree that while the decayed lintel does not contribute significantly to the overall stability of the wall, it does leave some stones unsupported with falling stones a foreseeable risk.

AECOM Report Recommendations and Proposed Solution

The recommended strategy for the gable wall in the short term is an exclusion zone be established around the area and a temporary support be provided. In the long-term, a permanent additional support structure should be constructed. The report proposes that a heritage impact statement be developed to assess the proposed changes and their impact on the significance of the structure.

The retaining wall is considered safe, with annual monitoring and observation recommended to ensure any deterioration is noted should it occur. The drain within the wall is to be maintained to ensure that it remains functioning.

Both reports recommend replacement of the timber lintel. The lintel(s) should be replaced with a new section of timber which is in keeping with the species, size, form, shape and appearance of the original fabric. It is unclear what this original species was, and investigation is required.

Review against best heritage practice

The act of restraining the gable wall to minimise the risk of its collapse is supported in heritage terms. Purcell agree with the recommendations of the AECOM report that a partial reconstruction (installation of some form of new roof structure as proposed in the GML report) would be visually intrusive, however in some instances such a proposal may be warranted as a long-term solution for the site. Purcell note that there are no practical methods to remove contemporary coatings without significant impact to the extant original fabric. As such these areas should be left to take their course of deterioration. Future works should be undertaken in lime-based materials. Voids in the wall should be filled to minimise the risk of further cracks developing. Such measures will help ensure the long-term preservation of the walls and will help reduce further deterioration.

We note project precedents such as the Port Arthur Penitentiary Precinct Conservation Project and the structural stabilisation the gable wall to the Bakehouse and being potential case studies for best practice conservation.

Comment on project staging and feasibility

The AECOM report recommends detailed design and construction documentation to undertake the following works:

- Excavate the base of the gable wall, inspect by structural engineer to confirm proposed repair works, point stonework and reinstate ground level
- Timber bracing structure to stabilise gable walls
- Timber lintels to doorway
- Detailed design, drawings, specifications
- Heritage review & approvals
- Contract documentation

In principle Purcell support the above project staging and feasibility. We would recommend that the inspection of the drain within the retaining wall also be undertaken by a structural engineer to ensure its condition and effectiveness and any necessary repair works be carried out as part of the above works.

2. Arthur's Vale Retaining Wall

Description (from AECOM Report)

The Arthur's Vale retaining wall is a calcarenite stone wall that is located within the KAVHA precinct on Norfolk Island, one of the 11 properties forming part of the Australian Convict Sites World Heritage Listing. The retaining wall is located just north of the Civil Hospital. The retaining wall was a part of the original convict settlement site that was built in 1833. The retaining wall is approximately 60 m long, 2.8 m at the tallest point, and extends east to west from the southern end of Pier Street, Kingston.

The Arthur's Vale retaining wall is a significant part of the KAVHA site and was constructed as part of an access road that continued along Arthur's Vale. The site is open to both pedestrian and vehicular access and "bulging" of the wall has created a safety concern regarding its adequacy. The site needs to be maintained and preserved for both the heritage and historical value but also as a structurally capable retaining wall to restrain the land behind.



Figure 3 (left) – Bulging retaining wall below Civil Hospital [Source: GML] and Figure 4 (right) – Drain locations in the retaining wall [Source: AECOM]

Condition Summary and Structural Assessment (based on both reports)

The Arthur's Vale retaining wall is constructed of calcarenite stone and is of undetermined thickness. The wall was identified in both reports as being at risk of structural failure from the loads imposed by vehicular traffic on the upper level, particularly following a period of prolonged rainfall. Both reports recommend permanent exclusion of vehicles from a zone 2m to the rear of the wall. Drains within the wall appeared to be non-functional and the current landscape behind the wall is directing rainwater towards the centre of the wall rather than dispelling it away from the wall.

Inconsistencies and Matters Affecting Site Safety

The central portion of the wall constitutes the most damaged portion. It appears to be a dry stone facing laid over an earth surface, with some sections having had mortar repair pointing in 1996. A distinct "bulging" could indicate both inadequate wall thickness and excessive water pressure behind the wall. The GML report recommends that the wall should be rebuilt using original materials following careful documentation prior to disassembly. This solution is at odds with the current heritage management policies for the place, and is not supported by the AECOM report which recommends that the damaged section of wall can be left as is (once stabilised with the recommended drainage works) and re-pointed with lime mortar if necessary.

AECOM Report Recommendations and Proposed Solution

The report recommends directing water away from the wall through the construction of an earth bund and the addition of an agricultural drain behind the wall, along with ensuring the existing drainage system within the wall is operational. If such works are observed to stabilise the wall, then the wall can be left as is. If strengthening is required, the application of appropriate lime mortar is recommended.

Review against best heritage practice

Purcell agree with the AECOM report that the dismantling and rebuilding of the wall would be expensive, time consuming, and not in keeping with conservation policy for the place. The potential impact of drainage works upon the ground conditions and the archaeological remains around the wall will require a heritage impact statement be prepared.

Comment on project staging and feasibility

The AECOM report recommends detailed design and construction documentation to undertake the following works:

- Archaeological and heritage assessment
- Detailed design, drawings, specifications
- Heritage review & approvals
- Creation of bund to direct waterflows from the ridge to Watermill Creek via an alternative route
- Agricultural drain to intercept surface and subsurface flows from behind the wall and direct them to Watermill Creek via the three existing drains in the retaining wall
- Provision of a means for excluding vehicular traffic from the zone of influence at the rear of the wall
- Contract documentation

In principle Purcell support the above project staging and feasibility. We would not support the dismantling of the wall prior to the landscaping/drainage works listed above which are aimed at halting the displacement of the wall. Once the proposed drainage works are undertaken, the wall should be inspected by a structural engineer to monitor its condition and the effectiveness of the works. Actual replacement of stones or mortar should only come about following the above works.

3. Bounty Street Bridge

Description (from AECOM Report)

The Bounty Street Bridge is a convict-built bridge, constructed circa 1832 (O'Connor, undated) and located within the KAVHA precinct on Norfolk Island, one of the 11 properties forming part of the Australian Convict Sites World Heritage Listing. It has significant cracking and has suffered from non-uniform subsidence leading to concerns regarding the structural integrity of the bridge. The GML Report references a number of previous studies including Hughes Trueman (Apr 2010), Higginbotham & Associates (Apr 2010) and Northrop Report (Dec 2014). However, a number of earlier reports dating back to Wilson (2002) all report similar findings relating to the bridge condition and associated issues with high water levels, weeds and structural defects. The watercourse is a constructed straight channel and is recorded in various documents as both Watermill Creek and Swamp Creek. This report will refer to Watermill Creek.



Figure 5 (left) – Bounty Street Bridge and Figure 6 (right) – crack in the western portal [Source: AECOM]

Condition Summary and Structural Assessment (based on both reports)

The bridge is suffering from well documented structural issues, including extensive cracking and settlement. The western portal of the bridge has a particularly large crack, indicating settlement of the northern abutment, likely to be caused by inadequate bearing material as the bridge foundations settle into the mud. The fact that the bridge is submerged will lead to continued erosion of the stonework.

Inconsistencies and Matters Affecting Site Safety

Both reports recommend the closure of the bridge to vehicular traffic, followed by significant measures to achieve de-watering of the site to allow an appropriate investigation of the bridge and its foundations. The Watermill Creek Dam has been identified in the GML report as a potential safety (drowning) risk and that warning signage or other appropriate protective measures be implemented.

AECOM Report Recommendations and Proposed Solution

The AECOM report recommends the bridge be immediately closed to all but pedestrian traffic. A geotechnical investigation is required to assess the foundation conditions. Before any works to the actual bridge can be undertaken, a number of other works will be required to address site issues. Works to address the issue of sewage contamination are required before any other works commence, as these represent not only human health risks but also a risk to the ecology of Emily Bay. Later works include the lowering of the water level of Watermill Creek to historical levels by removal of water and weeds, the construction of a coffer dam and diversion channel, emptying and repairing the existing dam, removing the concrete blockwork weir immediately downstream of the tunnel,

Review against best heritage practice

Purcell agrees with the recommendation of the AECOM report that “with works to remove modern alluvium, there is the potential for impact to archaeological remains within that alluvium, or to archaeological deposits in sediments adjacent to the waterways. There is also the potential for damage to surrounding heritage fabric during desilting, including the bridge, dam and tunnel.” A heritage impact statement (HIS) should be prepared to assess the potential impacts of the works and recommend appropriate mitigations.

Comment on project staging and feasibility

The AECOM report recommends the following works be undertaken as the initial step in any proposed works in order to allow appropriate site investigation:

- Install signage and traffic control measures to limit traffic on bridge to pedestrian only.
- Identify and rectify septic systems that are contaminating Watermill Creek.
- Undertake environmental testing to confirm water quality in the creek and confirm methodology for desilting Watermill Creek.

The AECOM report recommends detailed design and construction documentation to undertake the following works

- Archaeological and heritage assessment
- Heritage review & approvals
- Empty, desilt and repair dam wall and spillway
- Lower Watermill Creek level at the tunnel

Only by first undertaking extensive works to address sewer contamination and then remove the significant build-up of alluvium will it be possible to undertake a meaningful structural and condition assessment of the bridge. There is little doubt that the submersion of the structure will in the long-term lead to significant degradation of the stonework. Purcell agree with the AECOM report that excavation works for desilting or other purposes may undermine bridge structure and/or result in damage to original material and archaeological deposits. A suitably qualified engineer should direct the excavation works, with appropriate archaeological monitoring.

4. Longridge Barracks Arches

Description (from AECOM Report)

The Longridge Barracks Arches are part of the convict heritage found on Norfolk Island. The arches are not located within the Kingston precinct but on a ridge to the west of the KAVHA precinct. The arches are part of the military barracks which was constructed during the late 1800s and are listed on the CHL. The arches are approximately 2.5 m tall with the above wall reaching up to approximately 5 m above the ground.

The Longridge Barracks Arches are currently in a state of ruin with the face of the arches leaning to the south by up to 200mm. The barracks structure has significantly decayed and has left the arches wall unrestrained.



Figure 7 (left) – Longridge Barracks Arches showing thickness of wall [Source: GML] and Figure 8 (right) – Colonnade wall of Longridge Barracks Arches [Source: AECOM]

Condition Summary and Structural Assessment (based on both reports)

The Longridge Barracks Arches are part of the remnants of a two-storey barracks building and are located west of the KAVHA precinct. There are ten arches within what was the southern wall of the barracks with a section of solid wall at each end. Behind the arches are two rows of lower walls that formed the interior and rear wall of the barracks. All timber and other elements of the buildings are absent and only the stone walls and arches remain. Although the stone of the arches appears to be in relatively good condition, it was determined that the arches have insufficient capacity to withstand wind loads that can be expected to occur at the site, with well documented structural issues including tilting, cracking, and foundation overstress.

The centre portion of the wall has a significant lean, and this is likely to result from undersized footings. The lean in the wall is exacerbating this effect, meaning the lean is likely to increase over time leading to the potential loss of this exceptionally significant structure and possible injury or death from structural collapse.

Inconsistencies and Matters Affecting Site Safety

Both reports identify the significant lean of the structure and the potential for collapse. The reports are unanimous in their short-term recommendation that the area immediately to the south of the arches be closed off to both pedestrian and vehicular traffic to mitigate the risk to public safety from potential wall collapse. The GML report suggests that following a geotechnical investigation the structural design of a new “heritage interpretation” of the roof/floor structure could brace the walls, while the first part of a two-stage solution proposed by the AECOM report focusses on underpinning the arches to prevent further rotation.

AECOM Report Recommendations and Proposed Solution

A “do nothing” approach is not considered a viable option in this case. The AECOM report proposes a two-stage solution. Firstly, works would be undertaken to underpin the footings to the arches to prevent further rotation. The wall will need to be temporarily braced on both sides to prevent collapse

of the wall during the works and vertical propping installed to transfer load from the footings to allow underpinning to proceed.

The second phase would involve the top of the wall above the arches being braced to resist wind and seismic forces. This may be achieved in a fashion similar to that proposed for the retaining of the Civil Hospital Gable.

Review against best heritage practice

Purcell agree from our desktop review that the initial focus of any proposed works should be to reduce the pressure on the foundations from the eccentricity of the wall by way of underpinning the footings. The introduction of extensive bracing structures alone would ultimately not address the issue. We agree with AECOM that the "less intrusive option for the stabilisation of the Arches will be most in keeping with the conservation aims of the EPBC Act and the Burra Charter." The exact method of inserting underpinning needs to be investigated further, and Purcell question whether the proposed temporary propping of the wall (below) during this process is anticipated to actually remove the lean in the wall at the same time. The exact form, material and detail of the necessary propping should be predicated on minimising the visual intrusion of any new structure on the existing wall while at the same time offering the best long-term structural stability. We do not consider the rebuilding of roof or floor elements in some form of "interpretation" to be best heritage practice in this instance.

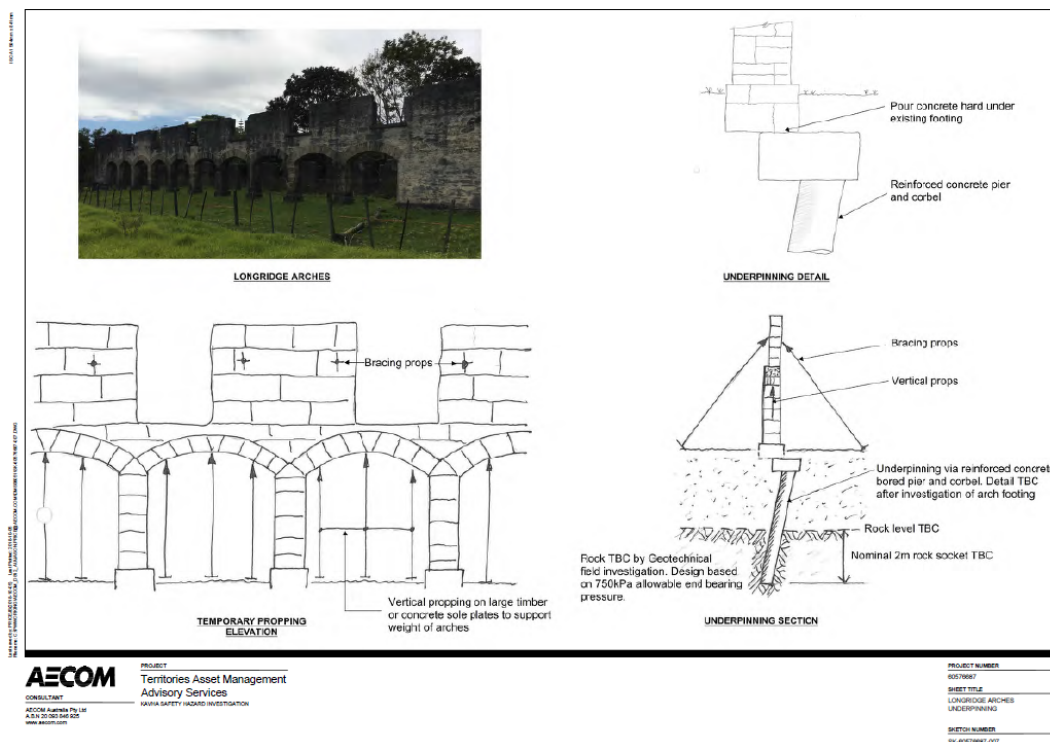


Figure 9 – Proposed works for underpinning of arches [Source: AECOM]

Purcell also agree that given the potential impact of any such works on original fabric and archaeological remains that a heritage impact statement be developed to assess the significance of the proposed changes, recommend appropriate mitigations, and support approvals as required.

Comment on project staging and feasibility

The AECOM report recommends, in likely chronological order, the following works:

- Undertake supervised excavation around arch footings to determine footing extent, depth and type. This to facilitate underpinning and steel brace column footing design.
- Undertake supervised geotechnical field investigation to determine depth to rock and rock quality to enable completion of underpinning design and steel brace column footings.

The AECOM report recommends detailed design and construction documentation to undertake the following works:

- Temporary propping of arches
- Underpinning design
- Steel bracing columns to the rear of the arches. This will require architectural, heritage and structural input
- Footings for the steel bracing columns
- Detailed design, drawings, specifications
- Heritage review & approvals
- Contract documentation.

Purcell agree with the approach proposed above.

5. Royal Engineer's Office (REO)

Description (from AECOM Report)

The Royal Engineer's Office (REO) is located in the KAVHA precinct of Norfolk Island, one of the 11 properties forming part of the Australian Convict Sites World Heritage Listing. The REO was constructed in 1851, made from stone and built by convicts who were brought over to the settlement in 1830s. The REO is one of the restored buildings found within KAVHA, with major repair work done to the roof structure during the twentieth century.

The REO is a significant building within KAVHA and is currently a working building. The REO is now used as a book store and tourist shop on Norfolk Island, and is a tourist attraction for the site.



Figure 9 (left) and Figure 10 (right) – Royal Engineer's Office (REO) with detail of portico [Source: AECOM]

Condition Summary and Structural Assessment (based on both reports)

The Royal Engineer's Office is in generally good condition, with the focus of both reports being the structural integrity of the front portico, in particular the southern column. The portico is said to have suffered damage some years ago as the result of a car accident, following which the northern column was replaced entirely and the southern column was flanked by two timber posts for additional support. Currently, the northern replacement column has a damaged capital and base, and the current Sydney sandstone column itself is "not servicing the exposure conditions adequately" and eventually these matters will affect its structural integrity. There is also a concern that the gable face itself is not adequately tied back to the roof of the portico, and a lean has developed in this structure.

Inconsistencies and Matters Affecting Site Safety

There is some inconsistency between the two reports in terms of both cause and effect for the current condition of the portico, and also a difference of opinion in terms of risk. The GML report maintains that the portico rotation is caused by footing settlement, and that underpinning may be required. GML suggest that this has led to cracking of the stones which are now potentially unstable and at risk of collapse. Given the daily pedestrian activity through the portico, GML consider this to be a high-risk situation. They recommended that following a "forensic investigation" stainless steel rods are inserted "to tie the entry portico structure back to the main building walls". Following insertion of these rods, if the southern column is found to be in good condition, the report recommends removing the timber posts to the southern column and replacing the northern column with a more durable stone. Purcell question whether the removal of the timber posts would present an undue level of risk.

The AECOM report states that "the ground conditions and base stone (of the southern column) appeared to be stable and showed little sign decay... (with) little to no evidence of settlement of the foundation below the portico." The report suggests that rather than the settlement noted in the GML report, the apparent rotation of the portico can instead be attributed to the fact that the replacement northern column is in fact slightly larger than the original column, and this "may have contributed to the lean in the top of the portico".

To determine the structural condition of the southern column and if any repairs are necessary or the timber props can be removed, the report recommends the paint on the column be stripped in order to determine the extent of cracking.

In relation to the gable face of the portico, AECOM do not support the GML recommendation of using tie rods to tie the portico back into the main building as this “may induce added stress onto the walls of the main building and cause further damage”.

AECOM Report Recommendations and Proposed Solution

The AECOM report does not share the same concerns regarding the stability of the structure as the GML report, and in fact recommends that “given that the portico appears to be structurally stable in the short term, the ‘do nothing’ approach is likely to be the most in keeping with the conservation aims of the HMP.”

Purcell support the recommendation to strip the paint to the southern column to determine the extent of cracking and agree with the AECOM recommendation that a heritage specialist and archaeologist be present for such work. Given that the column capital and stone base of the northern column show signs of decay, with the capital being eroded by wind and salt action, and the incorrect height of the column itself causing the lean in the portico, the replacement of this element with a column of more appropriate dimension and material is supported by Purcell.

Given that the apparent damage to the portico was initially caused by a car accident, the AECOM report recommends that vehicular access to the grassed area in front of the building be restricted through the installation of a visually discreet barrier or kerb. Purcell view this as a sensible suggestion.

Review against best heritage practice

The final recommendation in the AECOM report that “the proposed long-term solution for the Royal Engineer’s Office portico is to deconstruct and rebuild the portico structure” is somewhat contentious in heritage terms, even considering that the northern column is a replacement. The report maintains that rebuilding the portico would present the best opportunity to “straighten the roof of the portico and replace the decayed sections of stone”.

Purcell agree with the GML report that “the timber columns detract from the aesthetic of the heritage entry porch and should be removed if possible” but would note that if these posts are allowing the retention of original fabric (ie: the original southern column) the posts can be supported in heritage terms.

The demolition and rebuilding of any building element, along with the replacement of a large amount of original significant fabric, is always to be considered the last resort in heritage terms. Given the high volume of pedestrian traffic to the building and the ongoing use of the building being a key factor in its long-term conservation, the rebuilding of the portico may be considered acceptable should this be proposed.

Comment on project staging and feasibility

The AECOM report recommends detailed design and construction documentation to undertake the following works:

- Detailed design, drawings, specifications
- Heritage review & approvals
- Contract documentation.

The extent of works to the portico and the impact on other significant fabric will be a key factor in any future heritage assessment for these works.