GML HERITAGE

Kingston and Arthur's Vale Historic Area

Safety Hazard Scoping Study

Department of Infrastructure, Regional Development and Cities

June 2018

Report Register

The following report register documents the development and issue of the report entitled Kingston and Arthur's Vale Historic Area Safety Hazard Scoping Study, undertaken by GML Heritage Pty Ltd in accordance with its quality management system.

Job No.	Issue No.	Notes/Description	Issue Date
18-0073	1	Draft Safety Hazard Scoping Study	28 May 2018
18-0073	2	Final Safety Hazard Scoping Study	15 June 2018

Quality Assurance

GML Heritage Pty Ltd operates under a quality management system which has been certified as complying with the Australian/New Zealand Standard for quality management systems AS/NZS ISO 9001:2008.

The report has been reviewed and approved for issue in accordance with the GML quality assurance policy and procedures.

Project Manager:	Catherine Forbes	**Project Director & Reviewer:**	Rachel Jackson
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Position:	Senior Associate	**Position:**	Principal
Date:	15 June 2018	**Date:**	15 June 2018

Contents

1.0 Introduction

The purpose of this report is to identify and prioritise health and safety risks to visitors, staff and the local community within KAVHA, and to provide appropriate, practical, unobtrusive, creative and heritage sensitive solutions to mitigate the risks.

1.1 Project Brief

GML Heritage Pty Ltd (GML), together with Environmental Partnership Landscape Architecture (EP) and Structure Consulting Engineers (SCE), was commissioned by the Department of Infrastructure, Regional Development and Cities (DIRDC) to undertake a scoping study of health and safety risks to visitors, staff and the local community within the Kingston and Arthur's Vale Historic Area (KAVHA) on Norfolk Island.

The scoping study considers the findings of a Work Health and Safety Review undertaken by Susan Allen and Associates (February 2018), as well as issues identified through site investigations and by the KAVHA Advisory Committee and staff at the site.

The team was asked to consider what an acceptable level of risk is at World Heritage sites like KAVHA and to consider approaches used at other World Heritage sites in Australia and overseas in managing similar risks.

1.2 Purpose of Report

The purpose of this report is to identify and prioritise health and safety risks within KAVHA to visitors and the local community, and to provide appropriate, practical, unobtrusive, creative and heritage sensitive solutions to mitigate the risks. Where relevant, design solutions that provide an opportunity to facilitate interpretation and visitor appreciation of the site's heritage values are included among the risk management strategies.

Smaller high priority projects have been scoped to enable planning for their implementation as part of the ongoing maintenance program at the site. Major works projects, and further research projects that are required to support these, have also been identified and prioritised to enable DIRDC to plan for larger capital works projects required to improve site safety.

1.3 The Place

1.3.1 Heritage Listings

KAVHA is a place of outstanding heritage value to the people of Norfolk Island, the Australian community and internationally.

The heritage significance of the KAVHA site is recognised and protected through statutory heritage listings at national, Commonwealth and regional (local) levels. Internationally, the KAVHA site is one of 11 sites which comprise the Australian Convict Sites World Heritage property. The boundary of the KAVHA site included in the National Heritage List (NHL) and inscribed on the World Heritage List is the same. The Commonwealth Heritage List (CHL) boundary is the same as the NHL and the WHL boundary, but applies only to Commonwealth owned, managed or controlled land and therefore, excludes all private freehold land within KAVHA.

1.3.2 Historic Background and Attributes

The site was initially occupied by seafaring Polynesians, although they had ceased to occupy the island prior to the arrival of the British in 1788. The British established a settlement on Norfolk Island for the purpose of producing food for the newly established colony of New South Wales that was struggling to feed itself. This first British settlement was abandoned and destroyed in 1814, following the wreck of the Sirius on the reef off Kingston. It was replaced by a second British settlement, which was established specifically as a harsh convict penal settlement in 1825. The second British settlement was abandoned in 1855 following the cessation of deportation and criticism of the harsh and inhumane treatment of the convicts on the island. The fourth wave of settlement was established in 1856 by the descendants of the Bounty mutineers from Pitcairn Island.

KAVHA continues to play an important role in the life, identity and cultural identity of the Norfolk Island community. The cultural landscape of KAVHA is multilayered and complex and is recognised for its evocative and picturesque character, outstanding Georgian buildings and ruins, archaeological remains, and Pitcairn history, set within a bucolic coastal landscape. The place also comprises important natural systems, as well as perceptions, beliefs, stories, experiences and practices. All stages of KAVHA's history and the tangible attributes of these contribute to the significance of KAVHA.

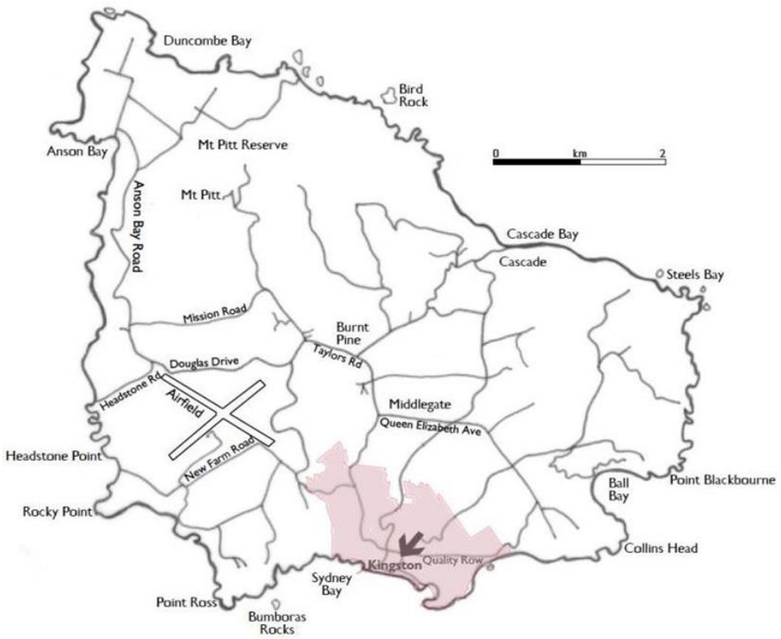

Figure 1.1 Map of Norfolk Island, showing the Kingston and Arthur's Vale Historic Area. (Source: 2007 KAVHA Conservation Management Plan [CMP] prepared by Otto Cserhalmi Partners and Jean Rice Architect in 2002 and updated with additions by Jean Rice in 2007).

1.3.3 Interpretation

At present, it is mostly the bucolic coastal landscape that dominates first impressions of the site; the earlier harsh industrial landscape of the former penal settlement for which the place is World Heritage listed is not clear to the visitor. Interpretation of the heritage attributes that were part of these earlier settlement periods, such as the gaol, the mills, lime burning kilns, stone quarries and lumber yards, is considered desirable.

1.4 The Study Area

KAVHA is located on the south coast of Norfolk Island, which is located in the Pacific Ocean between Australia and New Zealand (latitude 29˚ longitude 168˚). A location plan is provided as Figure 1.1. The site boundaries and subdivisions, with notes on ownership, are shown in Figure1.2.

For identification purposes, KAVHA is divided into precincts as shown in Figure 1.3 and as listed below.

A Government House Reserve

B Lowlands

C Cemetery Reserve

D Quality Row

E Uplands (land above the 100ft/30m contour) and Stockyard Valley

F Swamp (known as Kingston Common)

G Prisoners' Compounds

H Landing Place Ridge (known as Kingston Pier)

I not used

J Beachfront (known as Slaughter Bay and Emily Bay)

K Windmill Ridge

L Chimney Hill

M Arthur's Vale/Watermill Valley

N Bloody Bridge

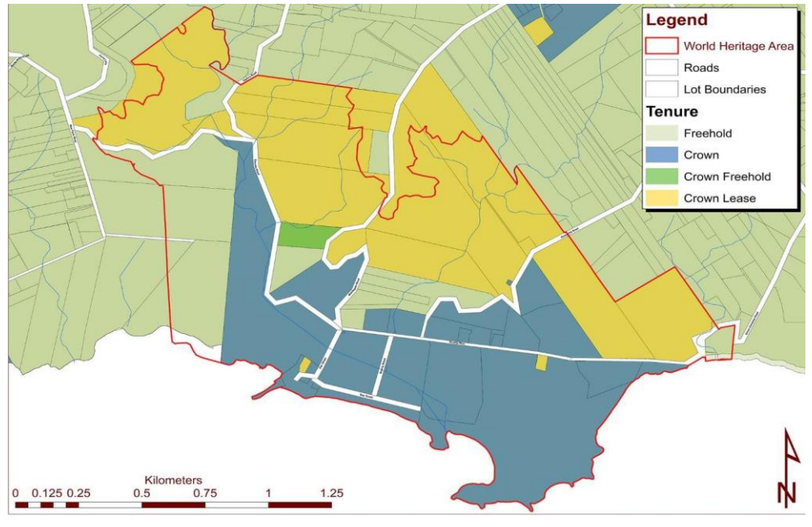

Figure 1.2 KAVHA, showing Commonwealth land, Crown land, Crown freehold, and freehold and Crown lease lands. The Commonwealth Heritage listing applies only to the Commonwealth land. (Source: Department of Infrastructure and Regional Development).

Figure 1.3 The KAVHA site, showing the listed area and division of the site into precincts. (Source: 2016 Heritage Management Plan [HMP], based on the 1980 Management Plan).

1.5 Research Methodology

1.5.1 Review of Previous Reports

The project team undertook a desktop review of reports prepared for the site over the last four years. The reports included condition assessments and structural assessments of buildings and other structures around the site, as well as studies relating to work health and safety issues, building services and emergency planning. A list of the reports and correspondence viewed is included as Appendix A. These identified a broad range of hazards affecting the site.

1.5.2 Stakeholder Consultation

The list of hazards was expanded through consultation with various stakeholders associated with the management and use of the site. Meetings and site inspections were undertaken with members of the KAVHA Advisory Committee (Eric Hutchinson, Duncan Evans and David Evans), the Commonwealth Heritage Manager (Brian Prince), museum staff (Bethany Holland, Diane Garner, Sally Davie and Margaret Clarkson), the KAVHA Works Crew (headed by Mike Johnston), the Norfolk Island Regional Council Work Health and Safety Committee, and the Norfolk Island meteorologist with the Australian Bureau of Meteorology (Adam Jauczius).

1.5.3 Site Investigations

Site inspections were undertaken over a five-day period from 30 April to 4 May 2018. Most areas of the site were inspected, but the primary focus of the assessment was around the areas most visited by tourists and locals, such as the area around the pier, the museums and offices, as well as Emily Bay and along the various walking trails. In addition, those areas identified through stakeholder consultation and in previous reports as having specific safety risks were also inspected.

1.5.4 Historic Images and Drawings

Early drawings and historic images of the buildings and site were viewed at the KAVHA Research Centre, including images of floods and burnt-out remains of buildings. The images contributed to understanding the historical context of the site and potential natural hazards affecting the site.

Documentation for repair and reconstruction of the buildings is also housed at the Research Centre and shows past interventions to the buildings and structures.

1.6 Limitations

Inspections were restricted to those areas of the site that were accessible within the timeframe allocated and those areas considered to be of higher risk due to public use and accessibility and known hazards. Assessments of risk were based on visual inspection only. Those areas that could not be inspected, such as concealed fixings and structural elements within floors, walls and roof spaces and subsurface drainage, will require further investigation. Some of these investigations will be required as precursors to the works packages identified in this scoping report.

Parts of the site that were not inspected included Government House, the blacksmith's shop, the boatsheds and some of the outlying cottages and shelters.

1.7 Authorship

This report has been prepared by Catherine Forbes, Architect and Senior Associate with GML Heritage, Adam Hunter, Landscape Architect and Director of EP, and Rob McGowan, Engineer and Director with SCE. Rachel Jackson, GML Principal, has provided strategic input and review.

2.0 Hazard Categories

Through stakeholder consultation, site investigations and review of previous reports the following categories of health and safety hazards were identified:

- **movement hazards;**
- **structural hazards;**
- **building condition hazards;**
- **building services hazards;**
- **maintenance activities;**
- **health hazards;**
- **natural hazards;**
- **emergencies; and**
- **traffic hazards.**

2.1 Movement Hazards

Movement hazards include those hazards that present potential risks to safe movement of visitors, residents, staff and workers around the site. They include uneven and slippery surfaces, steep inclines and stairs, hidden obstacles within the landscape (eg hidden archaeological remains), holes and substantial drops, and head height obstacles that obstruct the path of travel. These contribute to slips, trips and falls on the site.

Many of these types of hazards were identified in the Work Health and Safety Review undertaken by Susan Allen and Associates (February 2018). Site inspections undertaken with KAVHA staff verified these hazards and considered them in the context of the place being a living World Heritage site that is regularly visited by locals familiar with the site's irregularities, but also by visitors, many of whom are in their senior years and have physical, visual and hearing impairments. Incidents of falls and associated injuries have been recorded by the Norfolk Island WHS Committee.

2.2 Structural Hazards

Structural hazards include structures that pose a risk of structural failure and thus a serious risk to people in the vicinity at the time of the failure. Some failures, although developing slowly over time, can be sudden and catastrophic at the final moment. Several structural hazards have been reported on previously by Eric Martin, Shreeji, Northrop and Norfolk Island Consulting Engineers, and Susan Allen and Associates. These were verified and others were identified on site.

It is noted that structural hazards affect occupied buildings, above-ground archaeological ruins and retaining walls. Many of these are significant elements of KAVHA.

These hazards exist for the one or more of the following reasons:

- Key structural elements (timber, stone and metal) have decayed and no longer perform as designed.
- The structures are carrying loads they were not designed to carry.
- Tall structures (eg chimneys) are unrestrained.
- In the case of many of the ruins, the original timber structures that restrained or supported the stone walls no longer exist.
- The ground beneath the structures has moved (through settlement, invasion of tree roots, poor drainage or washout).
- The surrounding environmental conditions in which the structures were built have changed (eg ground levels have risen with fill placed against walls, water table levels have changed).

2.3 Building Condition Hazards

The buildings and other structures, many of which are up to 200 years old, are located in an environment that is highly exposed to the elements. The humid atmosphere and salt laden air combine to create conditions that contribute to the decay of the buildings and their key structural elements. Thus, steel and iron fixings corrode, and timber, stone, brick, mortar and plaster all suffer from damp and salt attack.

It must be noted that buildings in poor condition are far more vulnerable to hazards and likely to fail at times of stress (eg storms, high winds and seismic events) than buildings in good condition. The degree of failure and the risks associated with it will depend on the location of the element and its role in supporting the structure. Fixings can be critical to holding structures together, stone and timber lintels support the masonry walls above them, and beams support roofs and floors. Failure of any of these elements can have catastrophic consequences. In addition, elements falling from heights due to fabric failure could potentially land on people.

Many of these types of hazard were observed around the KAVHA site.

2.4 Building Services Hazards

Service hazards include unsafe electrical and gas installations, failing plumbing and drainage, fire services and emergency egress services. Faulty electrical services present the risk of electrocution or fire; faulty gas services the risk of explosion and fire; faulty plumbing can contribute to damp and decay of the building fabric, as well as electrical faults; and poor stormwater drainage can fail to protect the buildings from flooding during major storm events.

Issues relating to building services were raised in the Susan Allen and Associates report and the Building Services report by AECOM. A recent incident involving shorting out of a power point in the courtroom of the Old Military Barracks was reported by court staff.

Electrical point affected by damp and salt in wall, court room in the Old Military Barracks.

2.5 Maintenance Activities

Ongoing care and maintenance of the buildings and their highly significant collections is essential to keeping the place in good condition, to manage risks and ensure the survival and life of the place into the future. Some of these activities, however,

present their own risks due to restricted access, the heights at which some activities must take place (eg changing light globes in spaces with very high ceilings), or the chemicals used (eg silica beads for extracting moisture from the air around significant artefacts to prevent their decay). The latter issues were raised by museum staff who need to undertake these activities.

An annual survey of the site and buildings is undertaken by KAVHA staff each year and a small works crew, which includes carpenters, painters and horticultural staff, carry out regular maintenance activities. At present the team and maintenance budget is too small to allow the works crew to maintain all the structures and infrastructure on the site in good condition.

2.6 Health Hazards

The Susan Allen report raised the existence of several health hazards at KAVHA, including the presence of asbestos in some of the buildings and the quality of the water supply.

KAVHA has an asbestos register and an asbestos management plan, and is gradually working through a program of asbestos removal at the site. Asbestos still exists in some of the least visited areas of the site, such as roof spaces and storage areas.

Mould, which develops very quickly in the humid environment, was identified by almost everyone as a health issue.

The quality of the water in the creeks and canals passing through the site is related to leakage from septic tanks in residential areas upstream, cows defecating into the catchment and the stagnation of water in ponds within the KAVHA site. The issues are identified in a Water Quality Report by Norfolk Island Regional Council.

2.7 Natural Hazards

Norfolk Island is located in the middle of the Pacific Ocean between New Zealand and Australia. KAVHA is subject to the following natural hazards.

2.7.1 Cyclones

Norfolk Island is located at the southern edge of the tropical cyclone belt. Although tropical cyclones in this area are not as strong as those farther north, the winds can reach speeds of over 90km/hr with gusts of over 135km/hr. In recent years tropical cyclones have passed close to the island, but in 1992, three cyclones were recorded directly over the island. Cyclone Fran (19 March 1992) was the strongest (Bureau of Meteorology website). In 1987 another cyclone passed very close to the island.

Tropical cyclones come with high winds, torrential rain and storm surge. There is an early warning for tropical cyclones; however, when the cyclones breakdown to become post-tropical cyclones, their paths are far less unpredictable. Tropical cyclones are identified as a risk in the Norfolk Island Emergency Management Plan and were discussed with the local meteorologist, Adam Jauczius.

2.7.2 High Winds

High winds present strong lateral loads on structures. Although the wind speeds recorded at Norfolk Island are unlikely to cause damage to most buildings, they are strong enough to affect tall structures that are unsupported (eg high unrestrained walls of the ruins which are already cracked).

A significant storm event was recorded in 1874, resulting in destruction of the timber church and All Saints congregation relocating to the Commissariat Building (Margaret Clarkson, Commissariat Museum).

The Norfolk Island Pines are very stiff and particularly resistant to high winds. However, a tree was reported to have fallen through a wall of No. 10 Quality Row in the past (Museum staff) and another small but old tree to have fallen near the lime kiln at Chimney Hill in recent months.

2.7.3 Torrential Rain

Several locals reported torrential rain falling in 1998, resulting in flooding of houses in Quality Row. Water was reported to have flowed down the hill behind the houses, through No. 5 Quality Row, and Quality Row being under water to the extent that people were able to ride jet skis along it. Site investigations identified a possible flow path down the hill from Queen Elizabeth Lookout on the road above the houses and some evidence of landslip near the bottom of the hill between house No's 4 and 5.

Hill behind Nos 4 and 5 Quality Row showing landslip in the area between the houses.

2.7.4 Floods

Torrential rains bring floods. A significant rain and flooding event was recorded in 1936 (Margaret, Commissariat Museum).

Watermill dam in flood, Arthur's Vale, c1971–1989. (Source: KAVHA Archives)

Kingston Common flooded showing Bounty Street under water, c1971–1989. (Source: KAVHA Archives)

The historic images on this page show overflowing of the dam in Arthur's Vale and water filling the lagoon area of the KAVHA site during a major event in the 1970s–1980s.

2.7.5 Storm Surge

Storm surge is a regular event affecting the KAVHA coastline and particularly the retaining walls that have been built to prevent the land behind from being gouged out and lost to the ocean. This has been reported by many locals and KAVHA staff and is evident in the damage to retaining walls along the shoreline.

2.7.6 Tsunami

Historic records indicate that the foreshore and Kingston Common were submerged in 1834. It is unknown whether this was due to a storm event on high tide or a tsunami. Tsunami, resulting from a major seismic event in New Zealand, is a possibility and is regarded as a risk to the site (BOM / Geoscience Australia).

2.7.7 Earthquake

Norfolk Island lies in a moderate earthquake zone. Locals have mentioned earth tremors being felt in recent years (Margaret, Commissariat Museum).

2.7.8 Fire

Historically, fire, both intentionally and unintentionally started, has been an issue for many of the buildings at KAVHA. Fire protection, detection, warning and suppression services have been installed in several of the buildings, but not all. Regular inspections and testing of fire equipment are undertaken by the Norfolk Island Fire Services.

2.8 Emergencies

Norfolk Island has a disaster and emergency management plan (NORDIS Plan), which sets out the procedures for responding to disasters. An emergency plan has also been developed for the Administrator's Office in the New Military Barracks.

Safe evacuation from buildings has been partially addressed at KAVHA, but still needs further consideration. Current egress arrangements from the upper floors of the larger buildings is not safe. Consideration also needs to be given to the protection and safe evacuation of the highly significant collections within the buildings.

2.9 Traffic Hazards

Safety issues relating to the pedestrian–vehicle interface, carparking, especially during busy periods and special events, and road conditions were raised by members of the KAVHA Advisory Committee.

Buses to pick up passengers from a cruise ship. (Source: Brian Prince 2017)

Parking near the pier on a day when supplies are being unloaded from a ship moored off the coast. (Source: Brian Prince 2017)

Jazz festival parking near the historic lime kiln, Emily Bay. (Source: Brian Prince 2017)

3.0 Risk Assessment

The risk assessment in this scoping study uses a 'safety by design' approach.

The risk assessment tables included in this section identify areas of risk ranging from high to low, with those items colour coded red and orange as presenting the highest levels of risk, and those items colour coded blue and green presenting lower levels of risk.

Most of the items that are shown as presenting the highest level of risk (red) are those that endanger lives and require urgent attention.

3.1 Safety by Design

For the appraisal of safety impact assessment to persons on the KAVHA site, this scoping study has applied a typical safety by design approach, which is typically applied to contemporary design projects. However, in this instance the heritage context is also considered.

The Australian Government's Comcare website explains that:

> *Safety in design aims to prevent injuries and disease by considering hazards as early as possible in the planning and design process, which includes design of plant, structures, substance as well as the work itself.*

The aim of this process is to identify and consider potential safety hazards that may be caused by a design solution, to assess their relative importance and implications, and then to identify potential solutions.

Whilst being applied to existing features and conditions rather than new/unbuilt design elements, this process enables a relative understanding of the safety risk to be identified, which can be used to assist in making management decisions around priorities and allocation of resources.

3.2 Risk Assessment Methodology

The risk assessment methodology applies the safety by design principles to the health and safety hazards identified in Section 2.0 of this report.

Risk is calculated as a product of the likelihood of an event occurring and its potential consequence.

Although this assessment draws on a broad range of sources to identify the potential hazards affecting health and safety at KAVHA, the list of hazards considered cannot be regarded as exhaustive.

3.3 Risk Matrix

Table 3.1 provides a typical safety by design evaluation framework. This has been applied in the Risk Assessment Tables 3.2 to 3.6 inclusive.

The Risk Assessment Tables tabulate the hazards and risks identified through this process. The items are evaluated under the following headings:

Hazard Category

Issues have been identified within a series of categories related to site management and facilities.

Location

Location defines the position of the issue and, if applicable, to which facility it relates.

Issue

Details the condition causing the hazard/risk.

Hazard

Expresses the risk in terms of typical risk/hazard terminology.

Reference

Identifies the key source of the issue being flagged.

Persons Affected

Outlines the persons potentially affected by the risk.

Nature/Level of Exposure

Evaluates the level of use/activity likely in the area of the risk.

Safety Impact Assessment

An evaluation of the relative level of safety risk generated by applying a safety by design approach which considers the likelihood and potential consequence of an event (see Table 3.1 Safety by Design Risk Matrix).

Potential Mitigation Measures

Potential strategies for reducing level of risk.

Heritage Constraints Impacts and Interpretation Opportunities

Assessment of the heritage constraints around the issue, the impacts of the proposed strategies on the heritage values of the site, building or element, and the potential for opportunities to incorporate heritage interpretation in the mitigation solution.

Environmental and Access Considerations

Identifies environmental and access considerations and opportunities or other parallel issues that should be considered in relation to the site features and their management.

3.3.1 Risk Assessment Tables

The following Risk Assessment Tables include reference to a broad range of safety hazards, both typical and site specific. The list is not exhaustive and should be considered as providing a guide to typical types of hazards that are encountered across KAVHA, as well as to the specific site at which the hazard is identified.

Table 3.1 Safety in Design Risk Matrix.

Safety in Design

Risk Matrix

Step 1—Consider the Consequences		Step 2—Consider the Probability		Step 3—Calculate the Risk						
What are the consequences of this incident occurring?		What is the probability of the consequence identified in Step 1 happening?		**Step 1 Consequences—**select the correct line. **Step 2 Probability—**select the correct column. **Step 3 Risk Score—**the risk score is determined where the two ratings cross on the matrix below.						
Consequence		**Description**				**Consequence**				
						1	**2**	**3**	**4**	**5**
1	Insignificant—No injury or illness	**A**	Almost Certain— It's occurring now; or it is likely to occur within the near future; or it's a common or repeating occurrence	**Probability**	**A**	15	7	4	2	1
2	Minor—Injury or illness requiring first aid treatment	**B**	Likely—It will probably occur in the near future; it has been known to occur, or 'it has happened'		**B**	16	11	8	5	3
3	Moderate—Injury or illness requiring medical treatment	**C**	Possible—Could occur in the near future, but it most likely won't; 'I've heard of it happening'		**C**	21	17	12	9	6
4	Major—Serious or extensive injury or illness	**D**	Unlikely—May occur, but it would not be anticipated to happen		**D**	23	22	18	13	10
5	Extraordinary—Fatality or permanent disability	**E**	Rare—Occurrence is unlikely and requires exceptional circumstances, even in the long-term future		**E**	25	24	20	19	14

Calculation of Risk—1–6 are considered very high risk, 7–14 high risk, 15–20 moderate risk and over 21 considered low risk.

Hierarchy of Controls—The hierarchy of controls is to be considered in controlling risk: Elimination, Substitution, Isolation, Engineering, Administration, Personal Protective Equipment.

3.4 Risk Assessment and Mitigation Strategies

3.4.1 Movement Hazards in the Landscape

Table 3.2 Risks from Movement Hazards in the Landscape.

Item No.	KAVHA Ref.	Location	Issue	Hazard	Reference/Source	Persons Affected	Level of Exposure/ Vulnerability	Consequence	Probability	Risk Rating	Potential Mitigation Strategies	Heritage Impact/Opportunity	Environmental and Universal Access Considerations
M1	H18	Kingston Pier	Pier end subject to algae build-up	Surface slip	KAVHA staff comment	Visitors Persons on pier for work related reasons	Medium—visitors often walk out to end of pier. KAVHA staff advise that even when dry algal build-up is slippery	3 Moderate	B Likely	8	Water blast concrete to remove algae build-up at regular intervals Requires closing off to use during water blasting Recurrent maintenance cost	NA	Review potential for use of pumped seawater or harvested rainwater Review any potential impacts of wash-off on adjoining marine habitat
M2	H18	Kingston Pier	Outer steps slippery when wet	Surface slip	KAVHA staff comment	Visitors Persons on pier for work related reasons	Medium—visitors often walk out to end of pier. KAVHA staff advise that even when dry algal build-up is slippery	3 Moderate	B Likely	8	Water blast concrete to remove algae build-up at regular intervals Requires closing off to use during water blasting Recurrent maintenance cost	NA	Review potential for use of pumped seawater or harvested rainwater Review any potential impacts of wash-off on adjoining marine habitat
M3	H18	Kingston Pier	Pedestrian access and vehicles intermixed at pier concourse	Potential pedestrian/vehicle conflict	Site observation	Visitors Persons on pier for work related reasons	Low for visitors—access to pier restricted in major operational periods with a residual potential day to day	4 Major	D Unlikely	13	a. Subtle warning signage for pedestrians b. Education with staff and other operational vehicular users of pier around pedestrian safety	Potential to integrate warning signage with interpretive signage or marker	Better safety of access will enhance experience for disabled or elderly
M4	H19	Seawall waterfront at Flaghouse and at Blacksmiths compound	Narrow walkway with drop-off to water over 1m	Fall	Site observation	Visitors and workers	Low—volumes of traffic are low	3 Moderate	D Unlikely	18	a. Subtle warning signage for pedestrians b. Modification of rough mixed surface to moderate potential for tripping	Potential to integrate signage with interpretive marker	Surface stabilisation could help reduce erosion and breakdown of surfaces Area not suitable for universal access as handrail to 1m drop is not desirable
M5	H17	Landing Place	Steep drop-off from seats to sea wall and water's edge	Fall onto wall and rocks below	Site observation	Visitors	Low—no reports of any incidents in past?	3 Moderate	C Possible	12	Move seats farther back from edge of bank	NA	Seats setback from edge will enable safe assisted access and reduce erosion at the edge
M6	H53/F8 and F18/G9	Pier Street and Bounty Street	Soft and undulating grassed verges Regular vehicular traffic constrains shared use	Potential pedestrian / vehicle conflict	Site observation	Visitors Locals	Medium—regular pedestrian movement along roads, but no reports of any incidents in past?	4 Major	E Rare	19	a. Potential to identify as shared zone and provide signage to that effect. Would need traffic engineering input in context of island traffic management b. Manage one grassed verge as pedestrian friendly route	Grass verges are important to retention of bucolic setting Roads historically have not had hard edges other than at bridges Potential to integrate signage with interpretive marker	Significant pedestrian traffic to verge could cause erosion Grassed verge does not cater for universal access Roadway surface could be suitable for universal access
M7	J6	Bay Street	Uncontrolled vehicular movement on grassed foreshore east of Blacksmiths Compound			Visitors and workers	Low	3 Moderate	E Rare	20	Define parking to maintain use in area but conserve major proportion of foreshore as open space and interpretive area	Control of parking and vehicle movement through the area would protect archaeological remains and visual setting of historic site	Control of parking will significantly reduce erosion and visual scarring of ground surface and enable recreational use of grass Consider defining disabled parking space in parking zone near museums

Item No.	KAVHA Ref.	Location	Issue	Hazard	Reference/Source	Persons Affected	Level of Exposure/ Vulnerability	Consequence	Probability	Risk Rating	Potential Mitigation Strategies	Heritage Impact/Opportunity	Environmental and Universal Access Considerations
M8	D23	Quality Row	Safety of pedestrian movement along road corridor—grass verge varies in width and surface to north side, and is often parked out to south side	Potential pedestrian/ vehicle conflict	Site observation	Visitors Locals	Medium—regular pedestrian movement along roads, but no reports of any incidents in past?	4 Major	C Possible	9	Review potential for a road marked 'shared zone' on eastern edge of bitumen that can be a zone for pedestrian movement, but also used by vehicles when two vehicles need to pass Undertake traffic review		Grassed verge does not cater for universal access
M9	–	Walking steps to Flagstaff Hill	Configuration of steps/treads is not ergonomic	Step trip	Site observation	Visitors	Medium—the track is used frequently, but it is clear that it is a steep climb	2 Minor	D Unlikely	22	Subtle signage for pedestrians advising of steep climb and need to take care	Potential to integrate signage with interpretive marker	
M10	–	Coastal walking track from Cemetery to Emily Bay	Uneven track surface to top of ridge Drop offs to edge of track	Trip/fall	Site observation	Locals Visitors	Low—mostly used by locals who are familiar with the route and conditions, some element of risk for visitors who don't know the area	2 Minor	D Unlikely	22	Subtle signage for pedestrians advising of varied terrain and steep edges	Potential to integrate signage with interpretive marker	Walking track—not suitable for universal access Potential to mitigate any erosion or habitat issues of existing route
M11	–	Coastal walking track from Cemetery to Emily Bay	Proximity to several holes of golf course where stray balls could hit walkers	Walker hit by ball	KAVHA advisory committee comment	Locals Visitors	Low—mostly used by locals who are familiar with the route and conditions, some element of risk for visitors who don't know the area	3 Moderate	D Unlikely	18	a. Subtle signage for pedestrians advising of proximity to golf course b. Review route of track adjoining fairways and greens—mark route to minimise potential for conflict c. Building awareness of the risks to pedestrians among the golfers is also important	Potential to integrate signage with interpretive marker	
M12	F3 – 6	Watermill Creek channel	Steep banks—open to adjoining areas	Fall	Site observation		Low—no reports of any incidents in past?	3 Moderate	D Unlikely	16	Add warning note to track outlines in KAVHA information on website	Water bodies are an integral part of the cultural landscape	
M13	Area F	Water bodies on Common	Sheer banks/stone walls	Fall Water over 300mm depth	Site observation		Low—no reports of any incidents in past?	4 Major	E Rare	20	Add warning note to track outlines in KAVHA information on website	Water bodies are an integral part of the cultural landscape	
M14	Area F	Watermill Creek Dam	Walled edge to dam—with adjoining water depth exceeding 300mm Lack of 'walk out' gradient (that is 1:6)	Fall into water Possible drowning Difficulties of existing water	Site observation	Staff Visitors	Low	4 Major	E Rare	19	Subtle warning signage near dam edge	Potential to integrate signage with interpretive marker Barriers would be intrusive to the cultural landscape	
M15	M13+	Water Mill ruin	Steep slopes of adjoining land to mill ruin	Possible fall from walling or grassed slopes above	Site observation	Visitors	Medium—variable numbers of people in area. The hazard is somewhat difficult to perceive from above and the grassed banks can be slippery	3 Moderate	C Possible	12	Advise safe route to move around ruin on signage	Place interpretive signage to lead people away from the steep edges Potential to integrate signage with interpretive marker	Signage will assist in reducing erosion
M16	M	Watermill Creek through Arthur's Vale	Steep and eroded creek banks—open to paddocks	Fall into creek 1m to 2m	Site observation	Visitors	Low	2 Minor	D Unlikely	22	Add warning note to track outlines in KAVHA information		
M17	–	Car accidentally driven onto beach	Traffic accident	Car rolled over	KAVHA staff and Council WHS committee	Visitors	Moderate—many visitors drive hire cars, although most travel very slowly	3 Moderate	C Possible	12	Relocate barrier further back from sea wall		

3.4.2 Movement Hazards Associated with Buildings

Table 3.3 Risks from Movement Hazards in and around the Buildings.

Item No.	KAVHA Ref.	Location	Issue	Hazard	Reference/Source	Persons Affected	Level of Exposure/ Vulnerability	Consequence	Probability	Risk Rating	Potential Mitigation Strategies	Heritage Impact/Opportunity	Environmental and Universal Access Considerations
M18	H23	Pier Store	External stone stair access to verandah—steep risers and lacking handrails	Step slip/fall	KAVHA staff comment	Staff Visitors	Low—moderate Limited daily pedestrian movement to the verandah Dangerous in time of emergency evacuation	3 Moderate	C Possible	12	Investigate a heritage suitable handrail solution	Masonry stairs and balustrades are a significant feature at the front of the building	These steps are the fire escape from the upper floor of the museum
M19	H23	Pier Store	Internal timber stair—variable lighting levels and potential slip on treads	Step slip/fall	KAVHA staff comment	Staff Visitors	High—daily pedestrian traffic up steps by visitors	3 Moderate	B Likely	8	a. Provide adhesive non-slip stair nosing that reduces slip potential and increases visibility b. Improve lighting at the step landing	NA	Lack of disabled access to upper floor of museum
M20	H28	Crank Mill	Steep step risers at stairs to entry	Step slip/fall		Staff Visitors	Medium—regular pedestrian access into ruin	2 Minor	D Unlikely	22	Handrails are already in place Monitor condition of treads and review if degradation makes surface more difficult to walk on	Some original stair treads are irregular and broken	
M21	H28	Crank Mill	Low head height clearance on entry to ruin	Head injury	Susan Allen report	Staff Visitors	Lintel is clearly visible as in direct line of travel down stair	2 Minor	C Possible	11	Subtle signage for pedestrians advising of steep climb and need to take care	Potential to integrate signage with interpretive marker	
M22	H28	Crank Mill	Drop-offs from remnant walling near stairs to entry	Fall		Staff Visitors	Medium—regular pedestrian access into ruin	3 Moderate	C Possible	12	Provide low soft barrier (eg rope between posts) set back from wall to discourage people from getting too close to the edge Refer to structural hazards also	Sunken area around building is part of original building design	
M23	H28	Crank Mill	Uneven soil surface to base of ruin—potential trips for visitors who enter the space	Trip		Staff Visitors	Low—moderate pedestrian movement to the basement	2 Minor	D Unlikely	22	Consider potential for level gravel surface that would: • enable better viewing of remnants in the ground plane • enable easier movement through area • enable easier weed management	Rough and weedy surface does not assist understanding the history of the structure	Level surface would make viewing and movement through area easier
M24	H1 A	Surgeons Quarters	Worn track surface from Pier Street—uneven surface and steep gradient	Slip/fall	KAVHA staff comment	Visitors	Moderate—moderate level of pedestrian activity in area	2 Minor	C Possible	17	a. Provide hardened surface (eg asphalt) from road to verandah b. Investigate alternate route with lower incline	Investigate historic track to building for provision of more accessible route	The lack of accessible route makes it difficult for those less able to access photographic display New surface will reduce erosion and improve accessibility
M25	H1 A	Surgeons Quarters	Exposed archaeological remains near entry to photographic display	Trip	Site observation	Visitors	Moderate—moderate level of pedestrian activity in area	2 Minor	C Possible	17	Maintain visibility of archaeological remains	Archaeology is significant as evidence of early house	
M26	H1 A	Surgeons Quarters	Uneven verandah flagging	Trip	Site observation	Visitors	Low—entrance is not currently via front verandah	2 Minor	C Possible	17	Fill gaps between stone flags with soft mud or sand	Verandah flags are significant building fabric	

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											Relay flags at western end in association with structural works (see structural hazards)		
M27	H1	Surgeons Quarters Kitchen	Uneven stone slab surface at building entry	Trip/fall	Site observation	Staff Visitors	Low—open to public, but low level of activity	2 Minor	C Possible	17	Fill gaps with earth	Early building fabric	
M28	H6	Civil Hospital	Steep stone steps up to front of ruin are very steep and uneven	Fall/trip	Site observation	Staff Visitors	Low—most people use alternate route via track to Surgeons Quarters	2 Minor	C Possible	17	Use alternate access route to site	These are a visual feature marking the main entrance to the former hospital	Site is more easily accessed from Surgeons Quarters
M29	H6	Civil Hospital	Fall over wall of ruin onto steep grassy slope below	Fall	Site observation	Visitors	Low—low level of pedestrian activity	2 Minor	D Unlikely	22	Provide interpretive material back from wall so that visitors are not standing against wall	Barrier would be visually intrusive to archaeological ruin	
M30	D17	Commissariat	Open pit to rear of compound without fixed cover (makeshift cover with timber planks currently)	Fall/trip	Site observation	Staff Visitors	Low—limited pedestrian access in this area	2 Minor	D Unlikely	22	Provide safe lid to pit—can be lockable and operable to maintain access for KAVHA		
M31	D12	Old Military Barracks	Cattle grid across main entrance gate has large gaps between round rungs	Trip/fall	Site observation	Visitors	Moderate—some pedestrian activity, although most people arrive by car	2 Minor	C Possible	17	Ensure pedestrian gate is operational Replace with cattle grid with flat tops to rungs as used elsewhere on site		Cattle grid is necessary to keep cows out of barracks enclosure
M32	D12	Old Military Barracks	Variable pavement surface at rear of building	Fall/trip	Site observation	Staff Visitors	Low—moderate pedestrian movement in this area	2 Minor	D Unlikely	22	Apply a standardised approach to addressing trip hazards in unit and slab pavements		Universal access is constrained by steps to verandahs and door thresholds
M33	D12	Old Military Barracks	Uneven paving on verandahs	Trip	Site observation	Staff Visitors	Low—buildings currently not in use	2 Minor	D Unlikely	22	Remove loose rubble from surface	Retain original stone flags	
M34	D16	New Military Barracks	Uneven paving on verandahs	Trip	Site observation	Staff Visitors	Moderate—moderate pedestrian activity around building, but uneven paving not in direct path of travel to building entrance	2 Minor	C Possible	17	Lift and rebed pavers that have sunk more than 15mm	Retain original stone flags	
M35	G5 F	Sirius building	Limited handrail provision at entry to busy museum	Fall/trip	Site observation KAVHA staff	Visitors	Moderate—entrance to one of the most visited museums	2 Minor	C Possible	17	Provide second handrail to enable western side of stair Use alternate entrance on side of building	Match existing handrail, which runs parallel to wall to minimise visual impact on museum entrance	
M36	G5 F	Sirius building	Pedestrian movement from Bounty Street to building entry goes from road to grass to steep steps—difficult route for elderly and disabled	Fall/trip	Site observation	Visitors	Moderate—high level of pedestrian activity in area	2 Minor	C Possible	17	Investigate a hardened surface for pedestrians to move from Bounty Street to the Sirius steps		Hard surface would significantly improve access Solution needed to maintain overland drainage flow to road edge
M37	D15	Officers Bath	Steep steps without handrail	Fall	Site observation	Visitors	Low—no reports of any incidents in past?	3 Moderate	D Unlikely	16	Subtle warning signage at gate	Potential to integrate signage with interpretive marker	Baths are already enclosed by wall and gate to minimise risk of falling in

Item No.	KAVHA Ref.	Location	Issue	Hazard	Reference/Source	Persons Affected	Level of Exposure/ Vulnerability	Consequence	Probability	Risk Rating	Potential Mitigation Strategies	Heritage Impact/Opportunity	Environmental and Universal Access Considerations
M38	D2&3	2–3 Quality Row	Timber overlay steps have handrail to one side only	Fall	Site observation	Visitors	Low—limited pedestrian access in this area	3 Moderate	C Possible	12	Consider extra handrail to left side of steps		Would improve access safety
M39	D2&3	2–3 Quality Row	Potential slip to painted timber steps	Fall	Site observation	Visitors	Low—limited pedestrian access in this area	3 Moderate	C Possible	12	Provide a non-slip grit nosing to the timber steps (eg adhesive strip)		
M40	D2&3	2–3 Quality Row	Over 1m drop from rear retaining wall to rear yard of house	Fall	Site observation	Maintenance Staff	Low—mainly maintenance access in this area	3 Moderate	D Unlikely	18	Undertake education with maintenance staff re risks around drop-off Consider WHS safety measure during maintenance (eg safety cable)—provide cleat in ground along rear boundary for attaching harness	Safety option with least visual impact	
M41	D2&3	2–3 Quality Row	Gap between handrail and end of raised timber walkway inside buildings	Fall	Site observation	Visitors	Low—low visitor numbers to buildings	2 Minor	D Unlikely	22	Add one more board to floor Include interpretive material on barrier so that visitors step back from the edge	Provide interpretive signage regarding construction of house on balustrade—materials and technologies	
M42	D2&3	2–3 Quality Row	Open hole of privy	Fall	Susan Allen report	Visitors	Low—timber barrier has been erected in doorway	2 Minor	D Unlikely	22	Retain barrier	Provide interpretation for privy and how waste was managed in early settlement	
M43	D4	4 Quality Row	Not inspected				Ruin with low visitation						
M44	D5	5 Quality Row	Not inspected				Occupied						
M45	D6	6 Quality Row	Steep stone steps and uneven grass route to side gate from carport	Falls and trips	Site observation	Tenant/staff	Low—generally used by tenant only to access house from carport	2 Minor	C Possible	17	Consider stepping stone link in grass between gate and steps	Review heritage significance of stone steps—potentially reconstruct steps to increase width of risers	
M46	D7	7 Quality Row	Steep stone steps and uneven grass route to front gate	Falls and trips	Site observation	Tenant/staff	Low	2 Minor	C Possible	17	Consider stepping stone link in grass between gate and steps		
M47	D7	7 Quality Row	Over 1m drop from rear retaining wall to rear yard of house	Fall	Site observation	Maintenance Staff	Low—mainly maintenance access in this area	3 Moderate	D Unlikely	18	Undertake education with maintenance staff re risks around drop-off Consider WHS safety measure during maintenance (eg safety cable)—provide cleat in ground along rear boundary for attaching harness	Safety option with least visual impact	
M48	D7	7 Quality Row	Steep steps with uneven surface	Falls and trips	Site observation	Tenant	Medium	2 Minor	C Possible	17	Handrails are already in place—monitor condition of treads and review if degradation makes surface more difficult to walk on	Steps are early fabric that should be conserved	
M49	D7	7 Quality Row	Uneven rear courtyard surface with steep dish drain	Trip	Site observation	Tenant	Low	2 Minor	D Unlikely	22	Apply a standardised approach to addressing trip hazards in unit and slab pavements		Universal access is constrained by steps to verandahs and door thresholds
M50	D8	8 Quality Row	Not inspected				Occupied						

Item No.	KAVHA Ref.	Location	Issue	Hazard	Reference/Source	Persons Affected	Level of Exposure/ Vulnerability	Consequence	Probability	Risk Rating	Potential Mitigation Strategies	Heritage Impact/Opportunity	Environmental and Universal Access Considerations
M51	D9	9 Quality Row	Uneven flag paving to verandah with mixed concrete infill	Surface trips and Slips	Site observation	Staff Visitors	Medium Daily access through area	2 Minor	C Possible	17	Apply a standardised approach to addressing trip hazards in unit and slab pavements Provide lighting in areas open to the public at night	Mix of materials confuses understanding of fabric	Maintain level of access to verandahs
M52	D9	9 Quality Row	Uneven flag paving and concrete paving to rear courtyard, in particular link to annex	Surface trips and Slips	Site observation	Staff Visitors	Medium Daily access through area	2 Minor	D Unlikely	22	Apply a standardised approach to addressing trip hazards in unit and slab pavements	Stone flagging is significant early fabric to be conserved	Universal access is constrained by steps to verandahs and door thresholds
M53	D9	9 Quality Row	Over 1m drop from rear retaining wall to rear yard of house	Fall	Site observation	Maintenance Staff	Low—mainly maintenance access in this area	3 Moderate	D Unlikely	18	Undertake education with maintenance staff re risks around drop-off Consider WHS safety measure during maintenance (eg safety cable)—provide cleat in ground along rear for attaching harness	This would be the safety option with the least visual impact	
M54	D10	10 Quality Row	Entry from front gate by stepping stones	Uneven surface Surface trips and slips	Site observation	Staff Visitors	Medium Daily access through area House museum is well visited by elderly visitors to KAVHA	3 Moderate	C Possible	12	Consider replacement of stepping stones with hard surface—path could possibly echo the finish and treatment at No. 9 Alternatively, provide firm surface around stepping stones, which is level with stepping stones	Investigate historic path treatment for reinstatement if other than stepping stones	This would improve safety of access for elderly in a high visitation location
M55	D10	10 Quality Row	Handrail on only one side of front steps	Fall	Sit observation	Visitors	Moderate House museum is well visited by elderly visitors	3 Moderate	C Possible	12	Provide a second handrail to provide options for those who need to use it	Match existing	
M56	D10	10 Quality Row	Access route signed to east side of verandah—west side appears to be gentler	Irregular surface	Site observation	Visitors	Moderate House museum is well visited by elderly visitors	2 Minor	C Possible	17	Review which side of the verandah is identified as more suitable route for less mobile visitors	Introduction of universal access would need to be very carefully designed so as not to detract from heritage values of the house	Building could not be considered accessible without more major path modifications—grades may also preclude this Can only offer an assisted ambulatory route for elderly (not wheelchairs) as it is over grass
M57	D10	10 Quality Row	Uneven flag paving to verandah with mixed concrete infill	Surface trips and slips	Site observation	Staff Visitors	Medium Daily access through area	2 Minor	C Possible	17	Apply a standardised approach to addressing trip hazards in unit and slab pavements	Retain and conserve early stone flagging and make good in areas frequently accessed	Maintain access
M58	D10	10 Quality Row	Uneven flag paving and concrete paving to rear courtyard in particular link to annex	Surface trips and slips	Site observation	Visitors	Medium Daily access through area	2 Minor	D Unlikely	22	Apply a standardised approach to addressing trip hazards in unit and slab pavements Provide lighting to areas used by the public at night	Retain and conserve early stone flagging and make good in areas frequently accessed	Universal access is constrained by steps to verandahs and door thresholds
M59	D10	10 Quality Row	Well structure—rigidity and longevity of barrier mesh	Fall into well	Site observation	Visitors	Low—some visitor access through the garden	4 Major	E Rare	19	Review condition of well walls and grate		

Item No.	KAVHA Ref.	Location	Issue	Hazard	Reference/Source	Persons Affected	Level of Exposure/ Vulnerability	Consequence	Probability	Risk Rating	Potential Mitigation Strategies	Heritage Impact/Opportunity	Environmental and Universal Access Considerations
M60	D10	10 Quality Row	Over 1m drop from rear retaining wall to rear yard of house	Fall	Site observation	Staff	Low—mainly maintenance access in this area	3 Moderate	D Unlikely	18	Undertake education with maintenance staff re risks around drop-off Consider WHS safety measure during maintenance (eg safety cable)—provide cleat in ground along rear for attaching harness	This would be the safety option with the least visual impact	
M61	D11	11 Quality Row Clergyman's Cottage	Drainage pit adjoining front verandah is in a depression	Trip	Site observation	Visitors	Low	2 Minor	D Unlikely	22	Review potential to raise pit and grate or regrade falls around drain		Ground level appears to have risen with overlaying of soil and grass layering
M62	D11	11 Quality Row	Low lintels over doors	Hit head	KAVHA staff	Staff	Low—staff use only	2 Minor	B Likely	11	Induct staff using the office so that they are aware of the issue	Height of doors is integral to the original design of the cottage and cannot be changed	
M63	D1	Golf Club	Well structure—rigidity and longevity of barrier mesh	Fall into well	Site observation	Visitors	Low—some visitor access through the entry area	4 Major	E Rare	19	Review condition of well walls and top edge Replace grate with long term heritage compatible treatment		
M64	G4	New Gaol	Uneven and loose surface of archaeological remains	Trip/fall	Site observation	Visitors	Moderate—open public access to site	2 Minor	C Possible	17	Remove grass and debris and expose archaeology so that it is clearly visible Develop a path to lead people through the site Develop an interpretation plan	Opportunity to make the layout of the site more legible and provide interpretation on the panopticon design of the gaol and the harshness of the convict situation at Norfolk Island	
M65	G4	New Gaol	Open pits and drains	Trips and falls	KAVHA staff and site observation	Visitors	Moderate—visitors are unfamiliar with irregularity of the site	2 Minor	B Likely	11	Provide cover to tops of holes Provide simple barrier around the hole in the drainage system where interpretation is provided to explain the drainage system	Opportunity to interpret the drainage system employed at the site	
M66	–	Wells generally	Well structure—rigidity and longevity of barrier mesh	Fall into well	Site observation	Visitors	Low—some visitor access through the entry area	4 Major	E Rare	19	Review condition of well walls and top edge Replace grate with long term heritage compatible treatment		
M67	–	Disused septic tanks	Hidden in grass	Trip/fall	Council WHS committee	Staff Visitors	Low	2 Minor	C Possible	17	Remove or bury disused tanks		

3.4.3 Structural Hazards

Table 3.4 Risks resulting from Structural Hazards.

Item No.	KAVHA Ref.	Location	Issue	Hazard	Reference/Source	Persons Affected	Level of Exposure/ Vulnerability	Consequence	Probability	Risk Rating	Potential Mitigation Strategies	Heritage Impact/Opportunity	Environmental and Universal Access Considerations
S1	H18	Kingston Pier	Inner steps have major cracks to centre of treads	Longer term structural integrity issue to be reviewed	Engineering report and site observation	Visitors Persons on pier for work related reasons	Steps are used when loading and unloading tenders as well as by visitors	3 Moderate	D Unlikely	18	Visually monitor the building cracks to assess if they worsen over time	NA	
S2	H28	Crank Mill	No roof structure to laterally restrain the top of the walls and gable ends	Potentially unstable walls during high wind events or seismic activity	Site observation	Staff Visitors	Daily pedestrian traffic, though unlikely to be in use during high wind events	5 Extraordinary	E Rare	14	Install a new roof structure to brace the walls or adopt a wind management plan to restrict access to the site when wind speeds reach an agreed value	Roof structure would reinstate the original building form	
S3	H28	Crank Mill	No floor structure to laterally restrain the walls over their full height	Potentially unstable walls during high wind events or seismic activity	Site observation	Staff Visitors	Daily pedestrian traffic, though unlikely to be in use during high wind events	5 Extraordinary	E Rare	14	Install a new floor structure to brace the walls or adopt a wind management plan to restrict access to the site when wind speeds reach an agreed value	Beams should fit the existing wall sockets. New floor structure would give a better sense of scale of the original spaces within the structure and present an opportunity for interpreting mill layout and use within the structure	
S4	H28	Crank Mill	Effectiveness of bonding between the four perimeter walls is unknown	Walls not appropriately bonded and unable to brace each other, leading to collapse	Structural engineer assessment	Staff Visitors	Daily pedestrian traffic, though unlikely to be in use during high wind events	5 Extraordinary	E Rare	14	Investigate the typical bond between walls. Install concealed stainless steel tie rods between walls to reinforce the bond if required	Minor but acceptable heritage impact on historic fabric	NA
S5	H28	Crank Mill	Original light well around the building has been infilled causing lateral earth pressures on the main building walls	Lateral loads not considered during the original building design, leading to overstress and failure	Site observation and previous reports	Staff Visitors	Most likely that the lateral loads were not originally considered though the building has served these for a considerable time	5 Extraordinary	D Unlikely	10	Remove the earth from around the perimeter of the building and reinstate the original light well	Reopening the light well would reinstate original setting of the mill and provide less stress on the historic structure Removal of fill should be monitored by an archaeologist	
S6	H28	Crank Mill	Use of the area directly north of the building for parking	Parked cars causing surcharge lateral loads on the building walls which were not considered during the original building design, leading to overstress and failure	Site observation and previous reports	Staff Visitors	Most likely that the lateral loads were not originally considered though the building has served these for a considerable time	5 Extraordinary	D Unlikely	10	Restrict parking adjacent to the northern and southern walls of the building through use of a barrier—extend low barrier, 2m back from wall	Minor but acceptable heritage impact	N/A
S7	H28	Crank Mill	Broken stone lintel	Risk of structural failure and collapse of wall above	Site observation	Visitors	Stone lintels are no longer at full strength	3 Moderate	C Possible	12	Monitor lintel and wall for movement	Stone lintel is part of original fabric	

Item No.	KAVHA Ref.	Location	Issue	Hazard	Reference/Source	Persons Affected	Level of Exposure/ Vulnerability	Consequence	Probability	Risk Rating	Potential Mitigation Strategies	Heritage Impact/Opportunity	Environmental and Universal Access Considerations
S8	H28	Crank Mill	Decayed timber lintel	Risk of structural failure and collapse of wall above	Site observation	Visitors	Low—timber lintel is still structurally sound	3 Moderate	C Possible	12	Monitor lintel condition Replace when no longer structurally sound	Replace in timber to original detail Do not use concrete	
S9	H30	Royal Engineers Office	Entry portico has rotated to the west with evidence of cracking in the stones	Potentially unstable stonework leading to collapse	Site observation and previous reports	Staff Visitors	High Daily pedestrian traffic through entry	5 Extraordinary	D Unlikely	10	Undertake a forensic investigation of the entry portico and install stainless steel rods to tie the entry portico structure back to the main building walls	Minor but acceptable heritage impact on historic fabric	
S10	H30	Royal Engineers Office	Entry portico rotation caused by footing settlement	Potentially unsuitable footings leading to further settlement	Structural engineer assessment	N/A	Low	1 Insignificant	C Possible	21	Undertake a geotechnical investigation of the foundations of the support columns to ensure adequate bearing is achieved for the footings. Underpin if required	Minor but acceptable heritage impact Any excavation should be monitored by an archaeologist	
S11	H30	Royal Engineers Office	Northern replacement column headstock is chipped and disintegrating	Structural integrity of the column impacted leading to inability to support the portico	Site observation	Staff Visitors	Moderate Will continue to degrade if not remediated	4 Major	C Possible	9	Replace the failing column with a more durable stone column. The current column is Sydney sandstone which is not servicing the exposure conditions adequately	Use local calcarenite stone to replace the column capital	
S12	H30	Royal Engineers Office	Concern over southern column integrity—two timber posts have been inserted as a precaution to support the failed pediment	N/A	Site observation	N/A	N/A	1 Insignificant	E Rare	25	Investigate condition of original column If stable and other remedial works undertaken, remove timber posts	The timber columns detract from the aesthetic of the heritage entry porch and should be removed if possible	
S13	H30	Royal Engineers Office	Miscellaneous hairline cracks in the northern wall of the building and some internal walls	Indicative of minor differential building movement that could lead to more major maintenance issues if it worsens	Site observation	N/A	Minor	1 Insignificant	E Rare	25	Visually monitor the building cracks to assess if they worsen over time	No impact	
S14	H1	Surgeons Quarters	Honeycombed and decaying calcarenite walls around the southern verandah which have subsided Tree roots invading verandah structure	Collapse of unstable walls leading to verandah and roof structure collapse	KAVHA staff and site observation	Visitors	High Daily pedestrian traffic on verandah	3 Moderate	C Possible	12	Re-construct the verandah structure with sound bearing material and re-support the existing posts onto the rebuilt verandah Remove or bridge tree roots	Verandah is not original, but early addition Rebuild verandah to existing detail—salvage and reinstate original materials Minor heritage impact	
S15	H1	Surgeons Quarters Kitchen	Miscellaneous hairline cracks in the internal walls of the building	Indicative of minor differential building movement that could lead to more major maintenance issues if it worsens	Site observation	N/A	Minor	1 Insignificant	E Rare	25	Visually monitor the building cracks to assess if they worsen over time	No impact	

Item No.	KAVHA Ref.	Location	Issue	Hazard	Reference/Source	Persons Affected	Level of Exposure/ Vulnerability	Consequence	Probability	Risk Rating	Potential Mitigation Strategies	Heritage Impact/Opportunity	Environmental and Universal Access Considerations
S16	H1	Surgeons Quarters Privy	Bolts tying roof down have corroded	Roof could blow off building	Site observation		Moderate The corrosive environment would be affecting all metal fixings across the site	4 Major	C Possible	9	Inspect all roof tie downs across site		
S17	H1	Surgeons Quarters Privy	Timber palette over privy hole	Fall	Site observation	Visitors	Palette could be lifted if not fixed in place	3 Moderate	D Unlikely	18	Ensure that palette cannot be removed by visitors		
S18	H6	Civil Hospital	No roof structure to laterally restrain the top of the walls and gable ends	Potentially unstable walls during high wind events or seismic activity	Site observation	Staff Visitors	Daily pedestrian traffic. Though unlikely to be in use during high wind events	5 Extraordinary	E Rare	14	Install a new roof structure to brace the walls or adopt a wind management plan to restrict access to the site when wind speeds reach an agreed value	New structure should emulate original roof form	
S19	H6	Civil Hospital	Large structural crack on the northern gable at the eastern side of the building	Potentially unstable wall as it may be separating from the perpendicular restraining wall	Site observation	Staff Visitors	Daily pedestrian traffic, though unlikely to be in use during high wind events	5 Extraordinary	C Possible	6	Undertake an investigation of the cracking (surveying and monitoring). Remediate the crack through crack stitching if required	Minor, but acceptable impact on historic fabric to ensure its survival	
S20	H6	Civil Hospital	Effectiveness of the bonding between the northern gable wall and perimeter walls is unknown	Walls not appropriately bonded and unable to brace each other leading to collapse	Structural engineer assessment	Staff Visitors	Daily pedestrian traffic, though unlikely to be in use during high wind events	5 Extraordinary	E Rare	14	Investigate the typical bond between walls. Install concealed stainless steel tie rods between walls to reinforce the bond if required	Minor, but acceptable impact on historic fabric to ensure its survival	
S21	H6	Civil Hospital	The retaining walls to the northwest of the Civil Hospital are rotating and leaning towards the north	Structural failure of retaining wall leading to collapse	Site observation	Staff Visitors	Daily pedestrian traffic in this area	5 Extraordinary	B Likely	3	Erect appropriate signage and barriers to ensure visitors, staff and residents do not access the area in front of/below the retaining wall on foot or in vehicles. This mitigation strategy relates to the Arthur's Vale Retaining Wall advice as they are in the same area. Investigate cause of failure, including undermining of foundations, and undertake remedial works to stabilise wall	Remedial works necessary to long term survival of structure	
S22	H6	Civil Hospital	The east to west internal wall is leaning forward towards the north	Potentially unstable walls during high wind events or seismic activity	Site observation	Staff Visitors	Daily pedestrian traffic in this area	3 Moderate	E Rare	20	Consider installing a new roof structure to laterally brace the walls	New structure could interpret original roof form	
S23	H6	Civil Hospital	An existing timber lintel has completely decayed leaving the calcarenite blocks unsupported. Cracking in the render was observed adjacent to this lintel	Potentially unstable calcarenite blocks could come loose and fall Potential failure of wall above	Site observation	Staff Visitors	Daily pedestrian traffic in this area	3 Moderate	C Possible	12	Replace missing lintel in timber Assess condition of all existing lintels and replace as required	Match original timber detail Do not use concrete	

Item No.	KAVHA Ref.	Location	Issue	Hazard	Reference/Source	Persons Affected	Level of Exposure/ Vulnerability	Consequence	Probability	Risk Rating	Potential Mitigation Strategies	Heritage Impact/Opportunity	Environmental and Universal Access Considerations
S24	D16 B	Officers Quarters (Administrator's Office) Timber Verandah	Corrosion staining of fixings and timber decay observed on the balustrade's horizontal and vertical members	Structural failure of balustrade members under lateral load from building occupants leading to falls from height	Site observation and KAVHA staff comment	Staff	Moderate—considering the area is currently not accessed by occupants. However, it could be in the event of a fire	5 Extraordinary	E Rare	14	Replace the timber balustrades and ensure they are designed to resist current lateral loads	Balustrade is not original Design of balustrade should visually replicate the original balustrade design, even though materials and fixings may vary to ensure structural compliance	This area is currently used as a fire egress route from the first floor. The balustrades are currently unsound which presents a serious hazard to the safe exit of occupants in the event of a fire
S25	Precinct D	Retaining walls behind houses on Quality Row	Cracks in walls Possibly hollowed out behind	Structural failure	Council WHS Committee and site observation	House tenants and maintenance staff	Moderate—in areas not generally accessed by the public, except behind No. 9 and 10 Quality Row	4 Major	C Possible	9	Monitor cracks to identify any further movement over time Ensure there is adequate drainage through walls Undertake remedial works	Old stone walls are generally permeable and allow drainage Retain original stone fabric if walls must be reconstructed Avoid cementitious coatings	
S26	G5 F	Sirius Museum	High density of heavy artefacts on the Sirius Museum floor resulting in high design live load	Floor is not designed for this weight	Site observation	Staff Visitors	Daily pedestrian traffic. Though currently appears to be servicing the loads adequately	3 Moderate	D Unlikely	18	Undertake an inspection of the floor construction and confirm adequacy with structural engineer	Floor is not original	
S27	–	Cemetery Bay Sea Wall	Leaning retaining wall posts and failed timber sleepers	Structural failure of retaining wall posts leading to collapse of retaining wall	Site observation and KAVHA staff comment	Staff Visitors	Daily pedestrian activity from walkers and bathers at the beach	3 Likely	B Possible	8	Remediate the wall in the short term in accordance with Advisian report	Not heritage fabric Monitor fill removal behind wall	Wall affected by storm surge—worst at high tide
S28	H6	Arthur's Vale Retaining Wall below Civil Hospital	Excessive lateral movement and rotation of wall and observation of horizontal cracks	Structural failure of retaining wall leading to collapse	Site observation	Staff Visitors	Daily pedestrian traffic and infrequent use by vehicles Area is currently freely accessible to public and vehicles. Vehicles exacerbate the lateral load on the wall	5 Extraordinary	A Almost Certain	1	a. Erect appropriate signage to ensure visitors, staff and residents do not access the area in front of or behind the retaining wall on foot or in vehicles—area to be closed off from general public b. Adequately scope a remediation program including geotechnical investigation and structural design of a new retaining wall	Heritage wall will need to be rebuilt using original materials. Carefully document wall prior to disassembly to enable its accurate reconstruction	Ensure there is adequate drainage through the wall to prevent build-up in ground water pressure behind wall
S29	F8 +	Pier Street retaining wall	Large cracks developing in wall along Pier Street	Structural failure of retaining wall leading to collapse	Site observation	Vehicles	Pier Street in constant use by vehicular traffic	4 Major	C Possible	9	Monitor cracks and condition of wall over time	Highly significant early fabric which retains road across former lagoon	Road is essential to maintaining access to the pier area and connectivity within KAVHA
S30	F18	Bounty Street Bridge	Well documented structural issues associated with the bridge such as tilting, cracking, erosion, settlement and sedimentation at the abutments	Structural collapse of bridge leading to loss of service and risk to public safety	Site observation and previous reports	Staff Visitors	Daily pedestrian and vehicular traffic in this area	4 Major	B Likely	5	Recommendations of the Hughes Trueman report should be carried out without significant delay to ensure the structural integrity of the bridge is restored	Potential loss of exceptionally significant World Heritage structure	

Item No.	KAVHA Ref.	Location	Issue	Hazard	Reference/Source	Persons Affected	Level of Exposure/ Vulnerability	Consequence	Probability	Risk Rating	Potential Mitigation Strategies	Heritage Impact/Opportunity	Environmental and Universal Access Considerations
S31	Precinct A	Government House Reserve—Timber Bridge	Timber decay on horizontally spanning bridge deck members	Structural failure of horizontal timber members under pedestrian load leading to partial collapse of deck	Site observation	Staff	Minor Infrequent use	2 Minor	C Possible	17	Replace the timber slats	No heritage impact	
S32	F3	Watermill Creek through Arthur's Vale	Condition of timber bridges	Possible collapse—fall into creek	Site observation	Staff Visitors Locals	Minor Infrequent use	2 Minor	C Possible	17	Undertake structural review of bridges Monitor condition	Timber bridges are generally not original fabric	
S33	M13	Water Mill Building	No roof structure to laterally restrain the top of the walls and chimney structure	Potentially unstable walls during high wind events or seismic activity	Site observation	Staff Visitors	Seldom visited area, though unlikely to be in use during high wind events	5 Extraordinary	E Rare	14	Install a new roof structure to brace the walls or adopt a wind management plan to restrict access to the site when wind speeds reach an agreed value	New structure to interpret original roof form	
S34	M13	Water Mill Building	No floor structure to laterally restrain the walls over their full height	Potentially unstable walls during high wind events or seismic activity	Site observation	Staff Visitors	Seldom visited area, though unlikely to be in use during high wind events	5 Extraordinary	E Rare	14	Install a new floor structure to brace the walls or adopt a wind management plan to restrict access to the site when wind speeds reach an agreed value	New floor structure could interpret original structure within the building and present an opportunity for interpreting mill layout and use	
S35	M13	Water Mill Building	Effectiveness of bonding between the four perimeter walls is unknown	Walls not appropriately bonded and unable to brace each other, leading to collapse	Structural engineer assessment	Staff Visitors	Seldom visited area, though unlikely to be in use during high wind events	5 Extraordinary	E Rare	14	Investigate the typical bond between walls. Install concealed stainless steel tie rods between walls to reinforce the bond if required	Minor but acceptable heritage impact on historic fabric	
S36	M13	Water Mill Building	Uncertainty as to the original design loading on the building. Current banked earth is causing lateral earth pressures on the main building walls which may have not always existed	Lateral loads not considered during the original building design, leading to overstress and failure	Site observation and previous reports	Staff Visitors	Probable that the lateral loads were not originally considered though the building has served these for a considerable time	5 Extraordinary	E Rare	14	a. Undertake a desktop study to establish if the existing external walls were always retaining earth. It is noted that the walls would have had a floor structure to restrain them against lateral loads that is now gone b. Adequately scope a remediation program including geotechnical investigation and structural design of a new heritage interpretation of roof/floor structure that can brace the walls	Reopening the light well would reinstate original setting of the mill and provide less stress on the historic structure Removal of fill should be monitored by an archaeologist	
S37	–	Longridge Barracks Arches	Well documented structural issues associated with the arches such as tilting, cracking, foundation overstress	Structural collapse of arches, leading to injury or death	Site observation and previous reports	Staff Visitors	Moderate Occasionally vested	5 Extraordinary	C Possible	6	a. In the immediate term, cordon off the area to prohibit access to ensure that the risk to public safety from a potential wall collapse is mitigated b. Adequately scope a remediation program including geotechnical investigation and structural design of a new heritage interpretation of roof/floor structure that can brace the walls	Potential loss of exceptionally significant structure	

3.4.4 Other Building Hazards

Table 3.5 Risks associated with other Building Hazards, such as Fire Safety, Natural Hazards, Poor Building Condition, Health of the Work Environment and Undertaking of Regular Maintenance Tasks.

Item No.	KAVHA Ref.	Location	Issue	Hazard	Reference/ Source	Persons Affected	Level of Exposure/ Vulnerability	Consequence	Probability	Risk Rating	Potential Mitigation Strategies	Heritage Impact/Opportunity	Environmental and Universal Access Considerations
O1	H23	Pier Store	Fire door is locked with snib	People cannot escape fire	KAVHA staff	Visitors and KAVHA staff	Door is only used in case of emergency	5 Extraordinary	D Unlikely	10	Replace door lock with lock that has internal release	Retain and disable original door hardware Replace modern hardware	
O2	H23	Pier Store	Storm surge	Sea water entry through bottom doors	KAVHA staff	N/A	During storm events on high tides	2 Minor	B Likely	11	Sandbag doors if there is sufficient warning Do not store any precious materials in lowest level	Heritage collection may be impacted Decay of building fabric	
O3	H23	Pier Store	Damp and salt decay	Decay of building fabric	Museum staff and site observation	NA	Applies across whole site, but greater the closer to the coast	1 Insignificant to people	E Certain	15	Ensure buildings are well ventilated Manage drainage Avoid using cementitious mortars and finishes	Has a severe impact on the heritage fabric and contributes to decay of collections	
O4	H23	Pier Store	Leaking roof	Decay of building	Museum staff and site observation	NA	Specific to chimney	1 Insignificant to people	D Likely	15	Repair roof flashing	Has a severe impact on the heritage fabric	
O5	H30	REO	Springy floor in museum spaces—specifically near fireplace in northern room and in diagonally opposite corner	Possible collapse	KAVHA staff	Visitors	Low—located in corners of room where people do not stand	2 Minor	C Possible	17	Investigate subfloor structure for signs of rot Undertake necessary repairs	Retain original floorboards	
O6	H30	REO	Silica beads heated in oven	Potential carcinogen	KAVHA staff	Staff	Moderate—silica beads used to absorb moisture in artefact display cases, then heated for re-use	3 Moderate	3 Possible	12	Do not use oven for food preparation Develop safe work method for drying out beads Seek alternative solution to damp issues in museums	Humidity is a major issue for the historic collections	
O7	H24	Settlement Guard House	Damp and salt decay	Decay of building fabric	Museum staff and site observation	NA	Applies across whole site, but greater the closer to the coast	1 Insignificant to people	E Certain	15	Ensure buildings are well ventilated Manage drainage Avoid using cementitious mortars and finishes	Has a severe impact on the heritage fabric and contributes to decay of collections	
O8	D16 B	Officers Quarters (Administrator's Office)	Unsafe and non-compliant fire egress via first floor verandah—alternative fire egress involves going around the fire in the stair hall to get to the escape ladder	People are trapped and have no way of escaping fire Fall from ladder	KAVHA staff and site observation	Staff	Moderate Ladder is not used on a regular basis Serious safety issue in an emergency situation	5 Extraordinary	C Possible	6	a. Ensure staff have regular fire drill evacuation drills and are practised at using the fire escape b. Redesign fire egress route and provide suitable fire stair c. Ensure that there is a designated first aid officer located within the compound	Fire is a serious risk which can result in the loss of the heritage building Design of new fire stair must be considered in the context of the historic building (location, design, materials, scale)—it must not be located at the front of the building	Restricted access around central stair, window/door requires propping open, hatch to ladder also requires propping open and ladder is not ergonomic

Item No.	KAVHA Ref.	Location	Issue	Hazard	Reference/ Source	Persons Affected	Level of Exposure/ Vulnerability	Consequence	Probability	Risk Rating	Potential Mitigation Strategies	Heritage Impact/Opportunity	Environmental and Universal Access Considerations
O9	D16	New Military Barracks (Council Offices)	Unsafe and non-compliant fire egress via pull out ladders on rear wall—vertical ladders are difficult to access and operate and very unsafe to use	People are too frightened to use ladders to escape fire Fall from extreme height Multiple people trying to use the ladder at the same time	Site observation	Staff	Moderate Ladder is not used on a regular basis Serious safety issue in an emergency situation	5 Extraordinary	C Possible	6	a. Council must develop an emergency management plan for the Council offices b. Ensure staff have regular fire evacuation drills and are practised at using the fire escape c. Provide safety harness and anchor point at each window d. Redesign fire egress route and provide suitable fire stairs e. Ensure that there is a designated first aid officer located within the compound	Fire is a serious risk which can result in the loss of the heritage building. Design of new fire stair must be considered in the context of the historic building (location, design, materials, scale)—it must not be located at the front of the building Historic images show an earlier timber verandah structure of sympathetic design on the rear face of the building New structure may be contemporary in materials and detail design, but sympathetic in scale, form and location	Access to ladders is very precarious, windows must be manually propped open, and ladders pulled out from wall. The ladders are very high, not ergonomic and may have more than one person on them at a time
O10	D12	Old Military Barracks (Courthouse and judge's chambers)	Main stair is timber and flammable Cupboard under stair is not fire rated and contains electrical and communication distribution boards	Stair may burn and there will be no escape from upper floor	Site observation	Staff	Moderate—upper floor not currently occupied	5 Extraordinary	C Possible	6	Provide fire rated lining to underside of stair Do not use cupboard under stair for storage Relocate distribution boards	Fire is a serious risk which can result in the loss of the heritage building	Future use of upper floor will require addressing fire issues
O11	D12	Old Military Barracks	Electrical short in power point affected by salt and damp in wall Electrical wiring is currently not properly earthed	Potential to cause fire Electrocution	KAVHA staff and site observation	Court staff and those attending court	Moderate—numbers of people using courthouse are usually low and on a limited number of days per year	5 Extraordinary	C Possible	6	Rewire building—include circuit breakers and safety switch to disconnect power if fault occurs Reduce damp in walls	Fire is a serious risk which can result in the loss of the heritage building Building has no damp course and earth is built up against rear wall	
O12	D12	Old Military Barracks	Falling chimney caps	Injury from falling objects	Site observation	Staff Visitors	Moderate—many of the buildings have chimney caps that are corroding and liable to fall	5 Extraordinary	C Possible	6	Inspect all chimney caps and replace any that are showing signs of failure	Reinforced concrete chimney caps are not original and may be replaced New caps should match the original in design, even if made of a new material	
O13	D17	Commissariat	No fire egress from top floor	No alternate escape route	Site observation	Staff	Low for people—floor used for storage, not normally occupied by people High for archived documents	4 Major	C Possible	9	Documents currently being cleaned and relocated Digitise documents and keep backup in second location	Loss of Council archives	Asbestos removal to be undertaken
O14	D17 A	All Saints Church (Commissariat)	Exit doors are locked from outside	People cannot escape fire	Site observation	Church congregation	Doors are unlocked during services	5 Extraordinary	D Unlikely	10	Replace door lock with lock that has internal release	Retain and disable original door hardware Replace modern hardware	
O15	D17 A	Commissariat Museum	Debris falling through floorboards from above	Dust	Museum staff	Staff and visitors	Moderate—contributes to breathing problems and fire load	3 Moderate	C Possible	12	Provide lining to underside of floor structure Clean regularly	Floor structure has historically been exposed Retain visibility of columns and beams	

Item No.	KAVHA Ref.	Location	Issue	Hazard	Reference/ Source	Persons Affected	Level of Exposure/ Vulnerability	Consequence	Probability	Risk Rating	Potential Mitigation Strategies	Heritage Impact/Opportunity	Environmental and Universal Access Considerations
O16	G5 F	Sirius Museum	Changing light bulbs	Fall from height	Museum staff	Staff	Moderate—lights must be changed	4 Major	C Possible	9	Develop safe work method Use mobile scaffold and change all lights at same time Review current lighting and consider replacement with energy efficient and long-lasting lights that require less maintenance	Existing lights are not significant	
O17	G5 F	Sirius Museum	Damp and salt decay	Decay of building fabric	Museum staff and site observation	NA	Applies across whole site, but greater the closer to the coast	1 Insignificant to people	E Certain	15	Ensure buildings are well ventilated Manage drainage Avoid using cementitious mortars and finishes	Has a severe impact on the heritage fabric and contributes to decay of collections	
O18	A1 A	Government House	Leaking box gutter Risk of major failure during torrential rain event Potential safety issue with live electrical wiring	Decay of building fabric Flood within building Electrocution	KAVHA staff Not inspected	NA	Moderate—house is occupied and place of special events	4 Major	D Unlikely	13	Replace box gutter Repair roof and other rainwater goods	Roof form to be retained	
O19	–	All buildings	Mould developing constantly both on internal and external surfaces	Spores are a health hazard Mould contributes to deterioration of museum artefacts	KAVHA staff, museum staff, site observation	Staff and collections	All buildings	3 Moderate—asthma	B Likely	8	Clean surfaces regularly with antimould treatment Remove spore Dehumidify air Maintain good ventilation	Loss of highly significant records and artefacts	Affects health of staff
O20	Numerous	Museum buildings	Lack of illuminated exit signs	People cannot find exit in emergency	Museum staff	Staff and visitors	TBC	5 Extraordinary	C Possible	6	Install emergency lighting in museums and other buildings open to the public	Design and location of exit lights should be sympathetic to heritage context	
O21	Numerous	Museum buildings	Protection and safe evacuation of collections	Fire Water Damage Mould Dust	Museum staff	Collections—paper, fabric, wood, other artefacts	The museums hold highly significant collections that are currently not stored in museum conditions	5 Loss of unique items that are irreplaceable	B Likely	3	Develop a disaster risk management plan Develop a disaster kit Train staff and practise emergency evacuation procedures	Loss of exceptionally significant heritage items	
O22	D5	No. 5 Quality Row	Flooded in 1992	Flood Water damage Electrocution	KAVHA staff Not inspected	Tenant	Low—house not currently occupied	4 Major	D Unlikely	13	Review drainage behind house		

3.4.5 Civil Infrastructure Hazards

Table 3.6 Risks associated with Civil Infrastructure.

Item No.	KAVHA Ref.	Location	Issue	Hazard	Reference/Source	Persons Affected	Level of Exposure/Vulnerability	Consequence	Probability	Risk Rating	Potential Mitigation Strategies	Heritage Impact/Opportunity	Environmental and Universal Access Considerations
C1	D23	Quality Row verge to north side	Verge is too narrow for parking and pedestrian access, forcing pedestrian access to road	Pedestrian trip/fall Potential vehicle/ pedestrian incident	KAVHA staff	Pedestrians					Refer to Quality Row actions in Movement		
C2	D23	Quality Row verge to north side	Verge is subsiding	Above hazards potentially getting worse	Site observation	Visitors Locals	Low—due to the narrow nature of the verge, pedestrians tend to use other side of road	2 Minor	D Unlikely	22	Investigate the engineering cause of subsidence and upheaval—potential water movement and inadequate base course preparation to road and verge	Would improve visual impression of edge	The ongoing instability of the road edge is of concern for the structural integrity of the roadway Road edge not accessible currently—would enable use
C3	D23	Quality Row verge to south side opposite 4 Quality Row	Steep drop-off from verge—potential for vehicles to go off verge edge	Steep drop-off for vehicles	KAVHA staff	Visitors Locals	Low—no reported incidents	3 Moderate	D Unlikely	18	Investigate options for visual and heritage compatible car barrier that does not adversely impact views—potential for steep post and cable road barrier	Design and fabric of barrier is critical so as to minimise visual and character impact	Barrier can aid safety and prevent undesired carparking and access
C4	E31	Rooty Hill Road	Steep drop-offs from road—potential for vehicles to leave road	Steep drop-off for vehicles	KAVHA staff	Visitors Locals	High—high level of vehicular traffic along road to visit lookout	4 Major	D Unlikely	13	Investigate options for visual and heritage compatible car barrier that does not adversely impact views—potential for steep post and cable road barrier	Design and fabric of barrier is critical to minimise visual and character impact	High use area, to which function, safety and ease of use can be improved Safe universal access can be integrated
C5	E31	Rooty Hill Road—Queen Elizabeth Lookout	Steep drop-offs from lookout point—potential for visitors to go beyond barriers	Steep drop-off for pedestrians	Site observation	Visitors Locals	High—high level of vehicular traffic along road to visit lookout	3 Moderate	D Unlikely	18	Investigate how viewing best works and provide infrastructure to support this—this may include on grade viewing areas or low key platforms that extend viewing capacity and enable parking to be addressed	Design and fabric of barrier is critical to minimise visual and character impact	High use area, to which function, safety and ease of use can be improved Safe universal access can be integrated
C6	E31	Rooty Hill Road lookout	Lack of definition to parking zone and pedestrian area—vehicles can constrain /limit pedestrian space	Potential vehicle/pedestrian incident		Visitors Locals	High—high level of vehicular traffic along road to visit lookout	3 Moderate	C Possible	12	Review how traffic and parking need to work with aims of: • subtly defining some parking zones for buses and vehicles; • defining how visitors move from parked vehicles to lookout; and • a practical and attractive lookout zone (see above).	Design and fabric of barrier is critical to minimise visual and character impact	Road verge is getting eroded High use area, to which function, safety and ease of use can be improved Safe universal access can be integrated
C7	–	Emily Bay road and carpark	Steep drop-off from edge of road/track access leading to Point	Steep drop-off for vehicles		Visitors Locals	Low—no reported incidents in this area—note vehicle driving onto beach from carpark	3 Moderate	D Unlikely	18	Investigate options for visual and heritage compatible car barrier that does not adversely impact views—potential for steep post and cable road barrier	Design and fabric of barrier is critical so as to minimise visual and character impact	Vehicular movement beyond defined road is creating extensive erosion and limits the recreational potential of area as a grassed gathering and event space Recurrent maintenance of grassed areas required Fixing of eroded surfaces reduced

Item No.	KAVHA Ref.	Location	Issue	Hazard	Reference/Source	Persons Affected	Level of Exposure/Vulnerability	Consequence	Probability	Risk Rating	Potential Mitigation Strategies	Heritage Impact/Opportunity	Environmental and Universal Access Considerations
C8	–	Emily Bay road and carpark	Definition of drop-off from end of road to point	Drop-off for vehicles		Visitors Locals	Low—no reported incidents	3 Moderate	D Unlikely	18	Review extent of vehicular traffic / movement desired in the area—is it necessary for vehicles to be able to drive right up to end of point—preferable to restrict vehicular access to the lower area and carpark Upper area could be grassed for day to day recreation and events	Design and fabric of barrier is critical so as to minimise visual and character impact	Vehicular movement beyond defined road is creating extensive erosion and limits the recreational potential of area as a grassed gathering and event space Recurrent maintenance of grassed areas required Fixing of eroded surfaces reduced
C9	–	Emily Bay road and carpark	Definition of drop-off from edge of carpark at beach (scene of 2018 accident)	Drop-off for vehicles/proximity to beach users		Visitors Locals	Medium Regular parking area use	3 Moderate	C Possible	12	Review carparking barrier and extend robust vehicle proof barrier along beach edge—ensure alignment maintains breaks for through pedestrian access	Design and fabric of barrier is critical so as to minimise visual and character impact	Barrier can aid safety and prevent undesired carparking and access
C10	–	Driver Christian Road (west of Bloody Bridge)	Steep drop-off from verge—potential for vehicles to go off verge edge			Visitors Locals	Medium Regular traffic through the area	4 Major	C Possible	9	Investigate options for visual and heritage compatible car barrier that does not adversely impact views—potential for steep post and cable road barrier	Design and fabric of barrier is critical so as to minimise visual and character impact	Barrier can aid safety and prevent undesired car parking and access
C11	–	Creek system	Poor water quality entering Emily Bay from Watermill Creek and Town Creek catchments	Human health risk Risk to Emily Bay ecology Risk of flooding from severe weather events	Council WHS committee	Visitors Locals	High	3 Moderate	B Likely	8	Develop an integrated water management project for the KAVHA site as outlined in the CLMP, including: • upstream water quality control in basins; • progressive weed control and native revegetation moving from upstream to downstream; • reinstatement of Serpentine water course as heritage interpretation measure; • creation of offline wetland within the Common as a final filter for water quality; • provision of upstream water quality management to Town Creek; • pursuit of sewering within the Town Creek catchment and Watermill Creek catchment; • management of livestock entry to creek lines.	Conservation of cultural landscape	Conservation of marine environment and recreational use of Emily Bay Recurrent and preventative maintenance of the creek system is required Universal access could be improved through area as part of works

Item No.	KAVHA Ref.	Location	Issue	Hazard	Reference/Source	Persons Affected	Level of Exposure/Vulnerability	Consequence	Probability	Risk Rating	Potential Mitigation Strategies	Heritage Impact/Opportunity	Environmental and Universal Access Considerations
C12	–	Emily Bay Camping Area	Potential for limb drop (or even tree fall) from Norfolk Island Pine trees within existing groves during high winds	Campers or other people in area to be hit by falling branches or trees	KAVHA Advisory Committee	Visitors Locals	High during summer months (eg Jan–Feb) when camping and beach days are popular and cyclonic conditions more frequent	5 Extraordinary	C Possible	6	Undertake annual arborists' inspection of trees through camping area Establish protocols for camping area management where camp site is evacuated when forecast/ expected winds exceed threshold (threshold to be determined)		
C13	D23	Quality Row Kingston Common	Cattle jump fences	Manure Traffic hazard Damage to landscape	KAVHA maintenance crew	Visitors, staff	Cattle are free to roam around site	1 Insignificant	D Likely	16	Review management of cattle at KAVHA Restrict access to Quality Row	Part of the bucolic landscape setting, but contrary to the harsh industrial landscape of the convict settlement	If cattle removed, grass will need mowing in some areas

3.5 Hazard Maps

The location of the hazards identified in the above risk assessment tables are noted on the following maps.

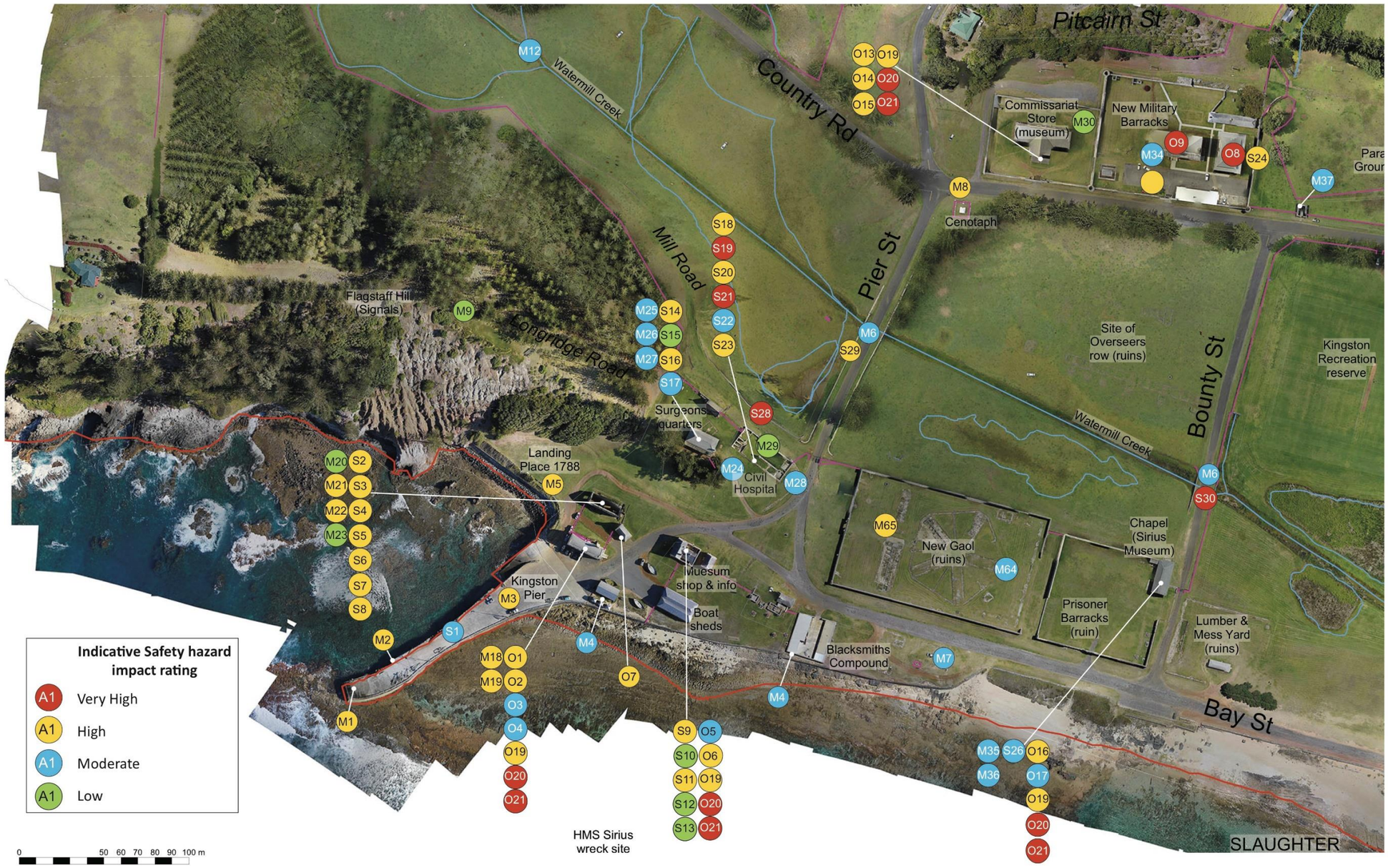
The item number indicated on the maps cross reference to the item numbers in the tables (column 1).

- Those items identified with an 'M' number correspond with movement hazards in the landscape and in and around the buildings. These are assessed in tables 3.2 and 3.3 above.
- Those items identified with an 'S' number correspond with structural hazards. These are assessed in table 3.4.
- Those items identified with an 'O' number correspond with other hazards, such as fire safety, natural hazards, building Condition, and health. These are assessed in table 3.5.
- Those items identified with a 'C' number correspond with civil infrastructure hazards, which are assessed in table 3.6

The colour of the item number indicates the risk rating and also corresponds with the colours used in the tables above.

KAVHA Safety Hazard Scoping Study 2018

HAZARDS ASSESSMENT TABLE MAP REFERENCES 1 OF 5

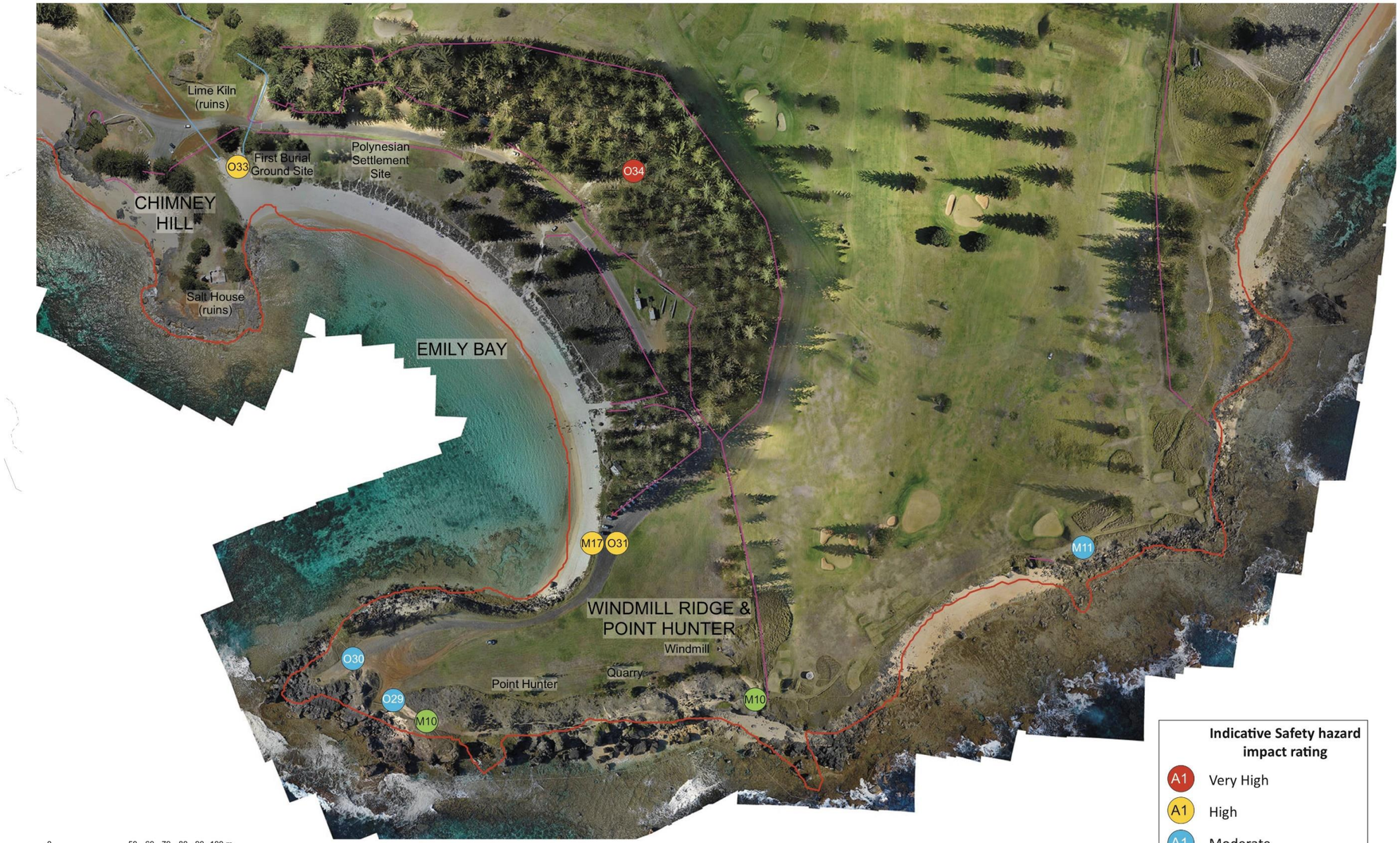


KAVHA Safety Hazard Scoping Study 2018

HAZARDS ASSESSMENT TABLE MAP REFERENCES 2 OF 5

KAVHA Safety Hazard Scoping Study 2018

HAZARDS ASSESSMENT TABLE MAP REFERENCES 3 OF 5



KAVHA Safety Hazard Scoping Study 2018

HAZARDS ASSESSMENT TABLE MAP REFERENCES 4 OF 5

KAVHA Safety Hazard Scoping Study 2018

HAZARDS ASSESSMENT TABLE MAP REFERENCES 5 OF 5

4.0 Approach to Risk Mitigation—Typical Hazards

This section includes risk mitigation recommendations suitable for addressing common hazards that occur across KAVHA. It includes suitable heritage sensitive approaches for addressing access issues, including common slip, trip and fall hazards and traffic hazards. It also considers management of risks associated with poor building condition, drainage, health and fire issues, as well as tree management.

4.1 Safe Access to Site and Buildings

4.1.1 The Issues

KAVHA comprises over 250 hectares and features a range of buildings, ruins, roads and other features that draw visitors to the site in addition to the active working (pier) and recreational areas (beachfront / Emily Bay) used by the local Norfolk Island community and visitors.

Historically for both locals and visitors the nature and character of access through the area has been informal. Although roads are defined, parking is largely uncontrolled and there are very limited defined pedestrian pathways.

Previous reports, along with this current review, have identified that movement through the site by pedestrians has an element of risk for slips, trips and falls, and generally is not sympathetic to universal access.

The challenge to this is matching potential access interventions to the desire for the precinct to retain its casual character, particularly for locals, heritage conservation constraints and potential interpretation opportunities.

4.1.2 Strategies

Within KAVHA, from Quality Row to the foreshore, each element needs to be addressed separately, but within a framework of consistent and unified materials and design.

Fundamentally a decision needs to be made for each building or other heritage element as to the nature of access that is desirable and appropriate within the context of heritage management objectives.

The subsection on walking routes discusses the potential for an organisational framework for categorisation of access which reflects the principles of AS 2156 Walk Track Infrastructure (see ‘Walking Routes’, following). This type of system could help inform decision making around access provision, with major high visitation facilities potentially justifying a higher level of access provision and quality.

Museum Buildings

It could be assumed that all museums including the Pier Store and Museum, REO Store and Museum, Surgeons Quarters photographic display, Sirius Museum, Commissariat Museum and the facilities at Nos 9 and 10 Quality Row are likely to be visited by persons of varied capabilities on a consistent and regular basis. In the categorisation framework access to these facilities would likely be category 1 or 2, requiring a functional hardened path surface from adjoining roadways to the access point to the buildings. A Finishes Manual should be developed to inform the surfacing alternatives appropriate for use.

Ruins

For ruinous structures, such as the Crank Mill and Civil Hospital, and many of the archaeological sites other than the New Gaol and Convict Barracks, it will generally not be feasible from a heritage perspective and landform constraints to provide hardened access paths. These will continue to be accessed from adjoining grassed areas, with issues such as steep steps and drop offs individually addressed as per the risk assessment table.

Example of museum entry access in core KAVHA precinct - Sirius Museum

Example of museum entry access in core KAVHA precinct - Surgeons Cottage photo display

4.2 Universal Access

4.2.1 The Issues

The provision of universal access throughout KAVHA is challenged by a number of factors, not the least being the topography and the heritage context and its sensitivity to the level of physical change required to make universal access possible.

4.2.2 Strategies

Accessibility of the most visited areas of KAVHA, such as the areas around the pier and the museums, should be prioritised. Accessibility of the archaeological sites that are located on relatively level ground, such as the New Gaol and Convict Barracks, should also be considered.

As noted above, application of a categorisation system would enable KAVHA to design an equitable access network that would afford those of all abilities and interests equal opportunity to appreciate the site, its landscape and heritage values.

It is desirable that there is a plan for disabled access to each of the museum facilities when it is required. This is currently in place to some degree with a variety of interventions implemented, such as fixed ramp facilities to No. 9 Quality Row (Research Centre), to handrails on stairs to most buildings, and quite loose and 'pop-up' methods such as side door entry to the Sirius Museum. These should be reviewed and where it is possible within conservation goals to provide a permanent solution for universal access this should be implemented. The actual solution selected will depend on the impacts on the heritage fabric, values and setting of each building or site.

It is noted that in many cases ground levels have risen around the buildings over time due changing landscape and ground surface treatments. When considering modifications to existing paths or planning new paths, it will be important to refer to historic photographs and undertake archaeological investigations to determine whether an earlier path still exists below the existing surface. These should not be disturbed when undertaking the new work.

Entry to No 10 Quality Row

Side entry used for temporary "pop up" disabled / wheelchair access to Sirius Museum

Universal access ramp from carparking at No 9 Quality Row

4.3 Walking Routes

4.3.1 The Issues

A key means of appreciating and enjoying the KAVHA site is to walk amongst the buildings and ruins and generally through the landscape. The KAVHA website identifies a series of potential self-guided walking routes that enable key site features to be visited.

Initial examination of many of these routes indicate that, in most cases, there are no defined surfaces. Rather they are informal routes supporting a casual and 'natural' experience of being in the landscape. Along a number of these routes, such as the foreshore track, there are points at which the surface is quite varied and there are drop offs along the edges.

As for much of the site, the provision of infrastructure to address safety hazards can have a significant impact on the cultural and natural landscape experience and so needs to be carefully considered.

4.3.2 Strategies

The application of an organisational framework for categorisation of access which reflects the principles of AS 2156 Walk Track Infrastructure could provide a basis for decision making. Categorisation of pathways and tracks provides the scope to tailor particular paths to their role and landscape context on the basis of criteria such as:

- intended level of accessibility;
- surface finish; and
- width.

The application and use of a categorisation system would enable KAVHA to:

- make a systemised decision about the level of infrastructure required in areas according to location and level or type of use;
- design an equitable network of access affording all abilities and interests equal opportunity; and
- provide clear expectations for users as to the suitability of a given track to their abilities and equipment (footwear etc).

Beyond the ongoing application of an organisational structure and hierarchy to path and track access there are several short-term strategies that should be considered.

A series of markers can be used to identify the routes.

For tracks or walking routes within KAVHA that have variable surfaces and drop offs, generally the preference is to alert users at the starting or entry points to the route as to track conditions. This could take the form of discreet and heritage-compatible marker signage alongside the track. This signage should form part of a coordinated suite of signage through KAVHA including interpretive signage.

For walking routes with variable surfaces and edges that can be a potential hazard to walkers (for example the Coast Track from Emily Bay to the Cemetery) it is preferred that structured solutions such as rails and walling are avoided unless environmental degradation is occurring. Where stabilisation is required for unstable track edges or to create steps, stone walling is preferred.

Example of undulating and variable surface on walking route / accessible areas near Emily Bay

Example of drop off from walking route / accessible areas foreshore near Kingston Pier

Quality Row

4.4 Traffic Management

4.4.1 The Issues

The core KAVHA area between Quality Row and the foreshore is connected by the north–south road links of Pier Street and Bounty Street. There are no defined pedestrian pathway routes on these roads and pedestrians—both visitors and locals—use either the grassed verge or the roadway. However, the grassed verge is often soft and uneven, and not comfortable for some pedestrians.

Vehicular traffic to Pier Bay and Bounty Street should ideally be low speed, being destination access to the precinct, while Quality Row is a through-route linking through to Driver Christian Road and typified by faster traffic speeds by drivers.

4.4.2 Strategies

The separation of pedestrians and vehicles would be the neatest strategy but would require development of a hardened verge or other path route through the Common which is difficult from a conservation perspective.

In keeping with existing character of informal and shared pedestrian and vehicular access, it is suggested that the potential for 10km/hr shared zones to Pier Street, Bay Street and Bounty Street be established. This should be subject to traffic engineering review and consideration as to required supporting infrastructure/signage.

A pedestrian movement zone could be defined to one edge of the roadway as the designated ‘shared zone’.

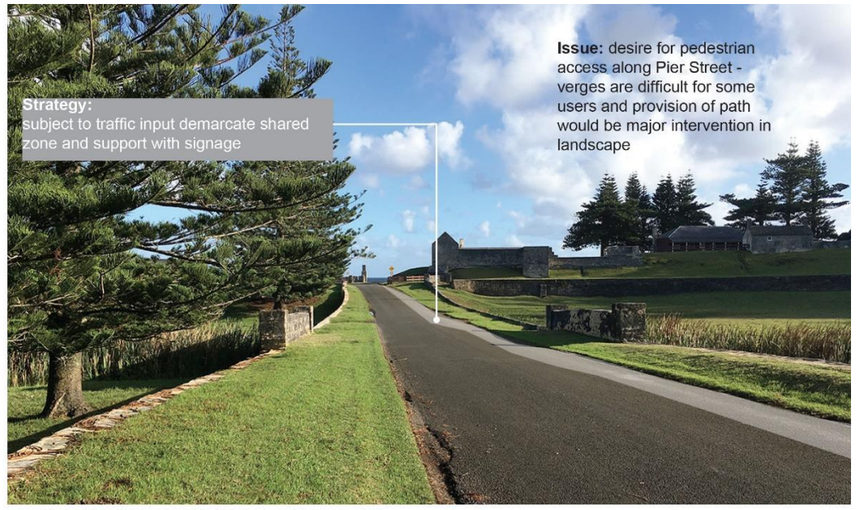
To Quality Row, similarly, a defined shared zone (subject to traffic engineering advice) to the north edge could cater for shared use being trafficked by vehicles when two vehicles need to pass.

Alternatively, a road edge path in a shot-blasted concrete could be established to the north road edge. This could be integrated with rehabilitation of the road edge through the zone from No. 6 to No. 10 and in other sections would require part of the existing grassed verge to be converted.

4.4.3 Driving and Parking Over Ruins

Parking and driving over archaeological ruins should be discouraged and avoided as this causes damage, erosion and compaction, particularly in areas where there are consistent parking patterns. Mounds or exposed archaeological ruins are generally more vulnerable to these issues. Wet conditions due to heavy rain and flooding further increase this vulnerability. Thus, it is important to know where archaeological ruins are. Therefore, it is recommended that an archaeological assessment and zoning plan be prepared.

Additionally, cars, buses and works crew trucks parking among the historic buildings and ruins are visually intrusive and reduce the ability of the site to transmit its values. The CLMP makes recommendations for designated parking areas at key locations around KAVHA. Implementation of control measures at these locations will reduce pressure on more sensitive sites. Refer to Section 6.7 of this report for further recommendations relating to establishment of parking zones and regulation of vehicular across the site.



Pier Street linking from Quality Row to Bay Street and Pier

Bounty Street linking Bay Street and Quality

Chesters Roman Fort, Hadrian's Wall, UK. (Source: English Heritage)

Roman Vindolanda, Hadrian's Wall, UK. (Source: Ian Bracegirdle)

View of New Gaol and Convict Barracks sites from Flagstaff Hill.

4.5 Archaeological Remains

KAVHA contains extensive archaeological remains that provide tangible evidence of the site's settlement history and various phases of development. Although there are many structures that survive as standing ruins and thus are clearly visible within the landscape, there are many more from both the first and second settlement periods that survive only as footings or subsurface remains. In many instances these present a potential trip hazard as they are very irregular and hard to see in the long grass, and even more difficult to understand.

In order to reduce the risk to people walking around the site and to make the site more intelligible, it is proposed that the archaeological remains be made more visible within the landscape. In some areas, the grass over the footings is regularly poisoned to make them more visible. It is proposed that this practice continue in the open grassed areas, but as recommended in the CLMP, the practiced should be phased out where other surfaces are able to be provided to assist with interpretation.

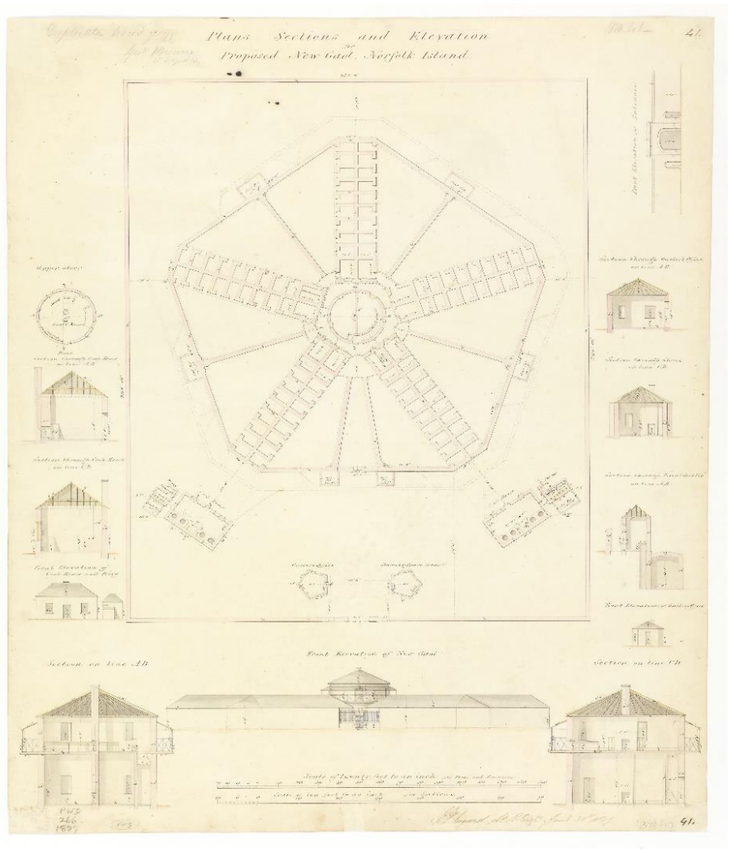
4.5.1 New Gaol

In the case of the New Gaol, it is proposed that the layout of the buildings be more clearly defined to enable them to be far more legible, interpreted and better understood by the public. It is proposed that the structural remains of the buildings be fully uncovered and the floors and lower walls exposed so that the size and layout of the cells are clearly visible. It is also proposed that the exercise yards between the cell blocks of the pentagonal gaol be gravelled to indicate their being outside the building but inside the enclosing circular wall. An accessible path from the entrance and through the New Gaol would enable all visitors to visit the site and gain some understanding of the panopticon design of the gaol and the implications this had for the lives of prisoners.

A similar approach could be adopted for the Prisoner Barracks in the adjoining compound. The interpretation of these two sites would add considerably to the visitor experience and understanding of the convict history of Kingston. As the site is located on a relatively level part of KAVHA, it could also be included on a fully accessible trail that would be available to all visitors to the island.

Work within this precinct should be supported by archaeological and documentary evidence and undertaken in conjunction with development of an interpretation plan for the site. The legibility of the site would be improved in views from Flagstaff Hill, but the visitor experience of the New Gaol could be further enhanced by provision of a raised platform either at the centre of the panopticon (possibly a contemporary interpretation of the central guard tower) or around the edges of the compound, as this would allow people to look out over the site and understand its scale and geometry.

Separate Prison, Port Arthur. (Source: Port Arthur Historic Site website)



Plan of the New Gaol, Kingston, Norfolk Island. (Source: Tasmanian Archives)

Loose material should be removed, but the verandah flagging should be retained in situ, Old Military Barracks.

Decayed margin stones may need replacement to provide protection to the verandah walls, Old Military Barracks.

4.6 Stone Flagging

Many of the buildings within KAVHA have stone flagged verandahs, floors or courtyards. In many cases these are extremely uneven and in various stages of decay. However, even though they present a trip hazard to visitors, they are a significant and original feature of the historic buildings and, as such, should be retained and conserved.

In considering the paving in and around the buildings, a graded approach is recommended.

- In the main path of travel externally (eg to the entrance of the building), if the difference in height between pavers is more than 10–15mm, the existing stone flags should be lifted and relevelled to create a more even path.
- Internally, if there is one flag that is substantially lower than the surrounding flags, a timber inset piece may be used over the existing flag to fill the gap and level the floor.
- Severely decayed bull-nosed margin stones to verandah edges may need replacement to provide protection to the verandah walls.
- If a stone flag is shattered and crumbling, the flag should be replaced with one that matches the original flags in material and size.
- If the flag is cracked or broken, but not displaced, it should be retained in situ.
- If the flagging is not in the main path of travel it should be retained in situ.
- Where the flagging has already been replaced with modern materials, it may be relayed using stone (if that is what is known to have been used originally in that particular location) or in a modern alternative, such as large sized locally made precast concrete pavers. The colour and texture of the pavers should match the original stone as closely as possible.

Plywood infill panel to level a hollow stone in the floor of the Commissariat Museum.

4.7 Steps

Most of the stairs leading up to the entrances of the historic buildings were not originally built with handrails. These have been retrofitted over the years, either in timber or steel, and vary in design from building to building. The addition of handrails is acceptable. However, the location and design of the handrails must respect the symmetry of the buildings to which they are being added and must not detract from their visual presentation.

- Generally, avoid handrails placed down the centre of the stairs.
- Side handrails frame the entrances and do not obscure them.
- Avoid fixing the handrails into the historic stone treads.
- Handrails should be painted a neutral colour that does not jar with the colour scheme of the historic building (not white).
- In the long term it would be desirable to unify the handrail design across the site. The preferred material needs to be determined.

In the case of the Sirius Museum, a second handrail may be added to the stair. It should balance the existing handrail and run parallel to the wall on the opposing side of the stair. This will provide options for people to use one or other of the handrails depending on their need.

4.8 Preventing Falls from Heights

Timber barriers have been erected across many parts of the site to prevent falls into pits, such as old disused cesspits, privies and wells and the lime kiln near Chimney Hill. Many of these elements provide important interpretation opportunities for developing an understanding of life in the early convict settlement. In these situations, the barriers generally comprise timber posts and rails that have been tailored to fit each particular situation. Most of the more recent barriers are free standing and set into the ground, whereas some of the earlier barriers are bolted into the stone walls. Where possible, the latter solution should be avoided so as not to damage the heritage fabric of the site.

Barriers have not been erected along the tops of retaining walls, sea walls or walls within the archaeological ruins scattered around the site, as these would visually intrude on the landscape setting of the historic site. Other means of guiding people away from edges may include provision of firm walking surfaces, seating, gentle warning signs and interpretive signage set back from the walls. Low barriers, such as logs on the ground, have also been used across parts of the site to provide visual, but not physical, barriers.

4.8.1 Wells

Wells within the KAVHA site are generally deep and covered so as to minimise the risk of someone falling in. For most wells the covers comprise steel mesh laid over timber supports set into the sides of the well walls. The quality and condition of the mesh varies considerably (from light chicken wire to heavy steel reinforcement). The strength of the covers needs to be tested to ensure they can take the weight of a person, and the condition of both the mesh and its supports (particularly the ends of the timber supports where they are set into the well walls) must be monitored.

It is recommended that a standardised, robust, durable and heritage sensitive grating be developed to replace the existing well covers when they reach the end of their life.

Wells at No. 10 Quality Row and the Old Military Barracks.

4.8.2 Retaining Walls behind Quality Row

The properties on Quality Row are excavated into the hillside and have variable height retaining walls behind each of the buildings. The landscaped curtilage of the slopes above are generally maintained grass down to the edge of this wall, with gardens in some cases. There is a potential for people walking through these zones to fall if too close to the wall edge. However, this is a zone that visitors are unlikely to regularly be in, and an area in which a barrier would be visually intrusive. As such, subtle control of visitor access to limit movement through these areas is preferred.

These landscaped areas are maintained by KAVHA staff, who may potentially be at risk when cutting grass close to these walls. As such, it is recommended that WHS practices are followed and a safe work method be developed that could involve staff working along the wall edge being attached to safety harnesses anchored to cleats in the ground at the high points of each site.

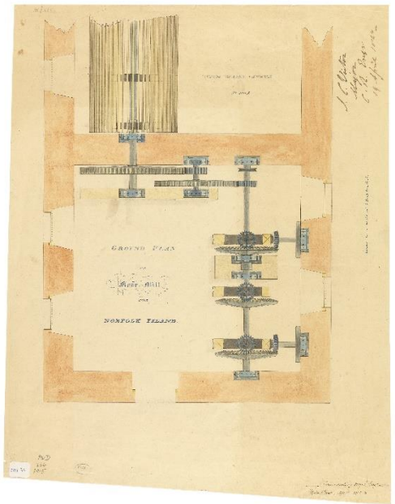
Typical rear wall at No 9 Quality Row

Typical rear wall at No 7 Quality Row

Issues: wall height over 1m - danger of fall from grassed areas above by visitors or during maintenance

Strategy:
Limit visitor access to above wall areas
Provide tieback cleats for safety harness for maintenance staff

Lighter near the boat shed at Kingston Pier.



Mechanism design for crank mill. (Source: Tasmanian Archives)

4.8.3 Crank Mill

A sunken area, more than 1m deep, surrounds the Crank Mill. Currently this is partly filled. However, the proposal is to reopen this for structural reasons and thus it will present a potential hazard for people walking around the site.

A low barrier, potentially timber or soft (eg timber posts with a rope between), is suggested to deter people from walking close to the edge. At the eastern end of the building this could be accompanied by a display of elements that interpret the former mill use of the building. At the western end, which was associated with the building's use as a boat shed, it may be appropriate to strategically place a lighter to stop people falling into the sunken area.

4.9 Condition and Preventative Maintenance

Regular inspections and preventative maintenance are absolutely essential to ensuring that the buildings and other structures on the site remain in good condition and do not pose unnecessary risk through structural or other failures. Preventative maintenance assists in prolonging the life of the buildings and minimising risk.

Elements that are showing early signs of failure must be closely monitored, investigated and repaired as necessary. This will ensure that more extensive and expensive remedial works are not required in the future.

4.9.1 Materials

It is important to use the correct materials when undertaking repairs.

Many of the buildings at KAVHA have been bagged with cement render and structural timber elements replaced with concrete. Cement mortar is much harder and less permeable than traditional lime mortar. Thus, even though it appears to provide a hard protective coating to the structures, it can contribute to increased damp problems and accelerate decay. Concrete lintels have less tensile strength than timber elements and are far less flexible when there is movement, such as during an earthquake. The report by Purcell analyses the original building materials used on the site and should be used as a guide for undertaking repairs to significant heritage fabric.

4.9.2 Chimney Caps

It is noted that some replacement elements employed at the site since the 1960s, such as the chimney caps, are made of reinforced concrete, which is now reaching the end of its life due to corrosion of the steel reinforcement. These elements, which will fall from a considerable height, pose a serious safety risk if they fail and must be monitored closely and replaced as necessary.

Failed reinforced concrete chimney caps which have fallen on the entrance steps to the neighbouring building, Old Military Barracks, 4 May 2018.

4.9.3 Unrestrained Masonry Walls and Chimneys

Annual condition inspections should be undertaken of any tall unrestrained elements that would be vulnerable in extreme conditions, such as high winds, flooding events or earthquake. Structures in poor condition are less resilient to such hazards than those in good condition and thus pose a higher risk. Elements in this category would include chimneys and the high unrestrained walls of the ruins scattered around the site.

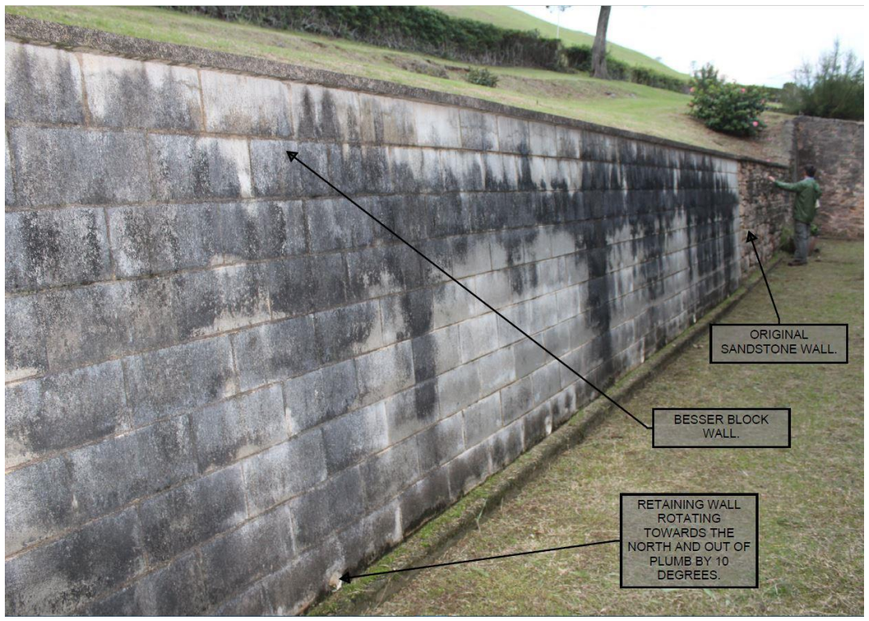
4.9.4 Verandah Subsidence

Several of the buildings within the precinct have stone flagged verandahs, which are subsiding. The verandahs need to be assessed on a case by case basis. Generally, unless the subsidence is substantial and affects the structural stability of the verandah or seriously affects the safety of people using the verandah, it is not proposed to undertake any remedial action. In more serious cases, such as the Surgeons Quarters, underpinning may be required.

4.9.5 Retaining Walls

Several cracks were observed in retaining walls to the north of the Quality Row houses indicating some structural distress. Some sections of wall have been replaced, such as that behind the Research Centre at No. 9 Quality Row, indicating that historically there have been failures. The wall has been rebuilt in concrete Besser blockwork and has weepholes to allow drainage of ground water from behind the wall. The traditional dry-stone walls are generally porous and allow ground water to drain through. However, cementitious mortars and coatings used in repairs can trap water behind them, causing a build-up in ground water pressure behind the walls.

Retaining walls should also be included in the annual inspections of the site to monitor movement and potential failure.



Retaining wall behind the Research Centre, No. 9 Quality Row.

4.10 Ground Levels

Ground levels around buildings must not be raised as this tends to increase damp and accelerate decay of the building fabric. Higher ground levels also increase the lateral loading on the walls of the buildings. This is of particular concern in relation to the standing ruins which lack lateral support.

Consideration must be given to lowering ground levels that have already been raised, such as around the Crank Mill and the Water Mill. As it is unknown how long the fill has been building, this work should be monitored by an archaeologist.

4.11 Drainage

As most of the buildings do not have damp proof courses, it is very important to manage drainage around the buildings to minimise its impact on the buildings through rising damp and salt decay. Quality drainage that takes the water away from the buildings is also important for minimising the risk of flooding.

Broken drainage pipes can not only cause the development of holes into which people can fall, such as at the Old Military Barracks, but also washouts that affect the foundations of the buildings and thus their structural stability. Thus, broken pipes must be repaired as soon as they are identified.

Good drainage is also essential to the stability of retaining walls as water pressure behind the walls can cause their collapse.

Consideration must be given to the drainage of the water coming down the hill behind the houses in Quality Row so that there is not a disaster during a major rain event. This may involve redirection of water coming down the road above.

4.12 Fire Egress

Safe fire egress is an issue for several of the buildings at KAVHA, particularly those accommodating offices and museums. Egress from most of these buildings does not comply with current building codes (BCA). However, alternate solutions have been considered and there are regular inspections by the Norfolk Island Fire Brigade.

Most of the stairs in KAVHA are non-compliant for emergency egress. However, they comprise early fabric and are significant elements of the buildings and site. Thus, they should not be altered. External secondary fire egress has been provided to the rear of the Council Offices and Administrator's Office located in the New Military Barracks. However, the two egress routes—which comprise pull out ladders, some of considerable height—present substantial safety risks to users in the event of an emergency. These need to be reconsidered and are discussed in more detail under 'Major Projects'.

Pull out ladders are fixed to the rear wall of the Old Military Barracks to provide an alternate fire escape. Access to the ladders is through the windows.

Access to the secondary escape ladder in the Administrator's Office involves squeezing around the edge of the primary egress stair which may be on fire and use of the fire escape ladder,w hich requires practice to set up safely.

Designated fire doors should have hardware that allows the doors to open from the inside even though they may be locked from the outside. Early hardware should not be removed from the doors but may need to be disabled so that the new one-way hardware can override it in emergencies.

No flammable materials should be stored under any of the staircases in the heritage buildings and the underside of the stairs should be enclosed with fire rated materials. This will make them safer for emergency egress from the buildings.

4.13 Museum Collections

The various museum collections, some of which are of national significance, are located in several of the historic buildings around Kingston. These are vulnerable to damp, mould, dust and fire. A disaster management plan is currently being developed by museum staff. Emergency kits are located in each museum, but staff have not yet been trained in how to use them.

The new disaster management plan should address both in situ protection of the collections, as well as the safe evacuation of the most significant pieces. The evacuation procedures for the collections must also consider the safety of museum staff.

4.14 Health Issues

Mitigation measures for addressing health hazards include:

- Ensuring that all workers are aware of the asbestos present in the buildings when they undertake work. The Asbestos Management Plan should be followed.
- Mould treatment should include measures that kill and safely dispose of mould spore—museums currently have mould kits, which include masks and gloves, and safe cleaning methodology to protect staff.
- Damp in the buildings should be managed through good maintenance of rainwater goods (gutters and downpipes) and stormwater drainage.
- Ideally, the buildings should remain well ventilated. However, it is recognised that this may contradict best practice for museum management.
- The use of dehumidifiers to reduce humidity within the museums is currently being tested. However, the impact of dehumidifying the air on the building fabric must be monitored as closely as its impact on the museum collections. Excessive drying may bring more salts to the wall surface, accelerating decay.

4.15 Tree Management

The predominant tree planting within the KAVHA precinct is the Norfolk Island pine. This is a large tree with significant weight which, if limbs or a tree itself should fall, could cause catastrophic injury to anyone below. One of the key concerns raised by members of the KAVHA Advisory Committee and meteorologist, Adam Jauczius, was the potential for trees to become unstable in high winds. In particular, concern was raised regarding those located in the low lying and damp area behind Emily Bay popular for camping. The dropping of pine cones was also noted as a risk in this area.

It is necessary for trees in high use areas such as the summer camp grounds, to be regularly inspected to determine if there is visual evidence of problems that would be of concern. In addition, an emergency protocol needs to be put in place during camping use times to facilitate the evacuation of the camp ground when threatening winds are forecast.

Norfolk Island Pines in the camping ground

5.0 Major Works—Capital Works Projects

The following projects are regarded as critical to improving health and safety at KAVHA. These are larger capital works projects that need further scoping and development prior to implementation.

Even though some of these projects are identified as long-term projects, such as water management (for flood mitigation and improving water quality), others are identified as being extremely urgent due to the imminent risk of catastrophic failure, such as Arthur's Vale retaining wall.

5.1 Water Management

5.1.1 Issues

Water quality and water management, including for flooding, remain major issues for KAVHA. Historically the area of the Kingston Common was a natural lagoon, which would have been flush occasionally during storm events when the sand dunes that contained it were broken. Since the earliest convict settlement, there has been a concerted effort to drain the wetland to create more usable land for both building and agriculture. A series of canals were built to take the water from the creeks that flow into the Kingston Common out to the ocean. However, a build-up of water plants and silt has clogged the system and the water is currently not discharging as intended.

The Watermill Creek and Town Creek systems, which drain to the low-lying watercourse in the Common, are both prone to flood and variable water quality. A range of reports have investigated the water management issues and made recommendations as to potential solutions. Ongoing issues around quality of water in the creeks and their discharge into Emily Bay have the potential to degrade the water quality of the bay for both recreational use and the natural habitat and ecosystems of the new marine park.

5.1.2 Water Management Strategy

The Draft KAVHA Cultural Landscape Management Plan (CLMP) has made recommendations for a holistic and integrated water management project for Watermill and Town Creeks to address ongoing issues related to flooding and water quality. The key steps in the process will involve:

- additional investigations and development of project feasibility and budget;
- concept design of integrated water management project as per the CLMP;
- applications for Australian Government grant/other funding;
- detailed design for integrated project; and
- staged approach to implementation as set out below.

5.1.3 Process/Sequence for Implementation

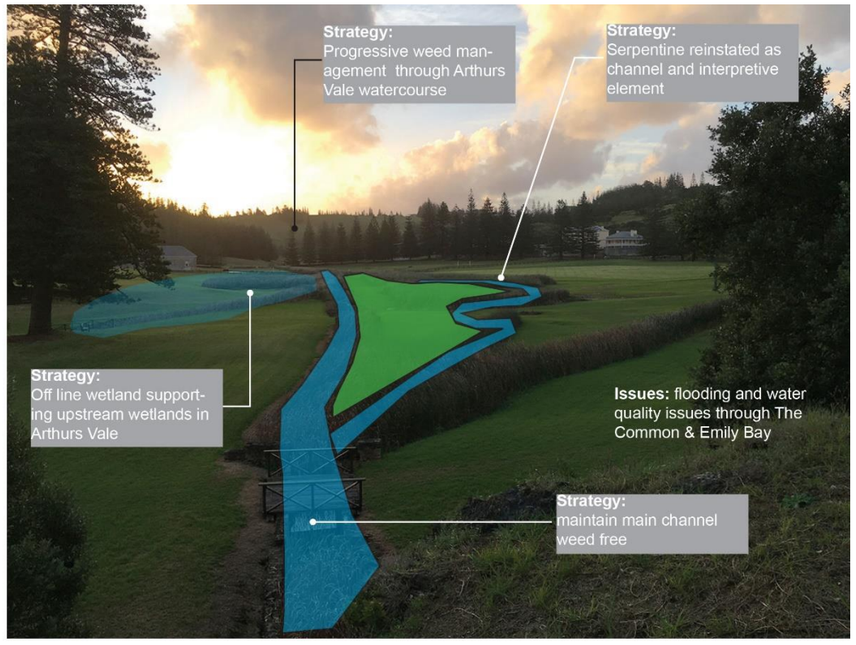
The CLMP describes the initial concept for the integrated water management project. This is to follow a sequence that will enable the implementation to be most effective. In broad terms this assumes working from upstream to downstream. It also assumes that broader catchment strategies such as ongoing implementation of sewering upstream areas and point source controls will progressively continue. The indicative sequence includes:

1. introduction of upstream wetlands (water quality control basins) to Watermill Creek;
2. progressive weed control, channel management and native revegetation moving from upstream to downstream;
3. provision of upstream water quality management to Town Creek;
4. creation of offline wetland within the Common as a final filter for water quality;
5. weed management of main channel;
6. modification of existing wetlands; and
7. reinstatement of Serpentine water course as heritage interpretation measure.

5.1.4 Externally Related Projects

Other measures that require coordination with other external parties to KAVHA include:

- implementation by Norfolk Island Regional Council; sewering of properties within the Town Creek and Watermill Creek catchments; and
- management of livestock entry to the creek lines (see figure below).



Potential water management system to The Commons

5.1.5 Related Internal Projects

Repair of the Bounty Street Bridge should be coordinated with this project.

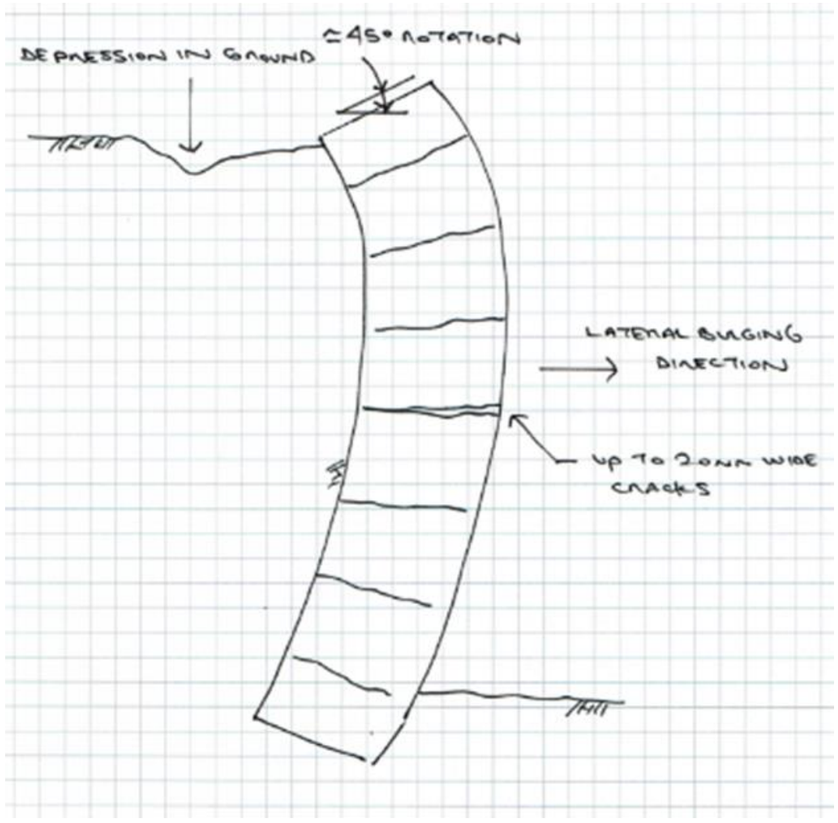
5.2 Arthur's Vale Retaining Wall

5.2.1 Issues

The existing calcarenite retaining wall to the north of the Surgeons Quarters and Civil Hospital is showing severe signs of structural distress. A large section of the wall has bulged laterally towards the north. The observed bulging has caused rotation at the top of the wall and several large horizontal cracks (up to 20mm wide) were observed in the bed joints between the stone blocks. The wall is approximately 2800mm high at the tallest section and measures 450mm wide at the top. It is not known if the wall thickness increases at the base. The below sketch shows the current scenario diagrammatically.

5.2.2 Recommendations

These issues suggest that the wall has technically failed as a retaining element. There is extreme concern that the wall could collapse imminently. In the short term, it is recommended that appropriate signage be erected to ensure visitors and residents are aware of the dangers of entering the area and that they are prevented from doing so. Vehicles trafficking the ground immediately south of the retaining wall would be particularly onerous as this would apply a lateral surcharge to the wall which could easily result in a catastrophic collapse. In the long term, the wall will need to be rebuilt to ensure that the structural integrity is restored. A full remediation strategy will need to be developed which should include a detailed geotechnical investigation and structural engineering design.



Bulging and rotating retaining wall. (Source: Rob McGowan, 2018)

Bulging retaining wall below Civil Hospital.

5.3 Bounty Street Bridge

5.3.1 Issues

The structural issues and recommended remediation associated with Bounty Street Bridge are well documented in the Hughes Trueman report dated April 2010. These are further reiterated in Northrop Report No. CR140642e02 dated December 2014. Whilst the existing conditions observed on site suggest that the visible parts of the bridge have not worsened significantly since the reports were written, the structural integrity of the bridge is a significant cause of concern. The Hughes Trueman report outlines such issues as bridge tilting and vertical settlement, significant cracking within the arches and erosion/honeycombing of the calcarenite blocks.

5.3.2 Recommendations

Given the nature of the above issues it is surprising that the bridge still has capacity to carry load. The recommendations of the Hughes Trueman report should be carried out without significant delay as a matter of priority to ensure the structural integrity of the bridge is restored and maintained.

Crack pattern on the western side of the Bounty Street Bridge.

5.3.3 Related Project

Water management of Watermill Creek is a related project.

5.4 Longridge Barracks Arches

5.4.1 Issues

The structural issues and recommended remediation measures associated with Longridge Barracks Arches are well documented in the Shreeji Consultant Pty Ltd Report No. 000505 dated April 2002. These are further reiterated and expanded upon in Northrop Report No. CR140642e02 dated December 2014. Both reports acknowledge cracking and significant leaning of the arched colonnade walls. Additionally, Northrop suggests that the cause of the lean is a result of differential foundation movement which results in a significant risk of wall instability under high wind loads.

5.4.2 Recommendations

We echo the recommendations of both these reports and strongly suggest that the following course of action be undertaken:

- In the immediate term, cordon off the area to prohibit access to ensure that the risk to public safety from a potential wall collapse is mitigated.
- Resurvey the walls to compare the results of the 2002 report with current conditions.
- Engage a geotechnical engineer to investigate the existing foundations and to provide commentary on the assessed differential foundation movement. Advice on foundation strengthening or underpinning, if deemed appropriate, should be provided in this report.
- Design and construct a steel or timber roof and floor frame to provide additional lateral stability to the colonnade walls. This framing could be designed to mimic the original floor structure and double as heritage interpretation.

Colonnade walls at Longridge Barracks.

5.5 Crank Mill

5.5.1 Issues

The Northrop Report No. CR140642e02 dated December 2014 highlights several structural issues associated with the Crank Mill building. Further to our review of this report and our subsequent overview of the building on site, it is our opinion that the following structural items represent the greatest risk to visitors and the general public.

- No roof structure to laterally restrain the top of the walls and gable ends, leading to potential collapse.
- No floor structure to laterally restrain the walls over their full height, leading to potential collapse.
- Effectiveness of bonding between the four perimeter walls, leading to separation of the gable from the restraining perpendicular wall.
- Infilling of the assumed original light well around the building causing lateral earth pressures on the main building walls which were originally not retaining earth (refer to sketch).
- Use of the area directly north of the building for parking which laterally surcharges the main building walls which were originally not retaining earth (refer to sketch).

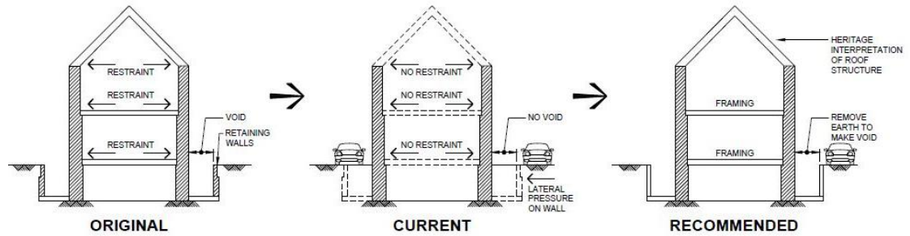
5.5.2 Recommendations

As the main structural risks are associated with changes to the original design loads and restraint to the building walls, we recommend that the original conditions be reinstated as much as is reasonably practicable. Our recommendations are:

- Reinstate the original light well surrounding the building to ensure that the lateral earth pressures on the main building walls are removed. By doing this, parking will not be possible immediately adjacent to the building, which will also remove potential surcharge lateral loads.
- Investigate the effectiveness of the bonding between the four perimeter walls. This can be further strengthened if required by drilling horizontal stainless steel rods through the wall junction to provide lateral tying action.
- Construct a capping beam on top of the north and south walls of the building to assist with lateral restraint of the wall.
- Construct a steel or timber roof and floor frame to provide additional lateral stability to the north and south walls and gable ends. This framing could be designed to mimic the original floor structure and double as heritage interpretation.

The assumed original, existing and proposed conditions are also described diagrammatically in the adjacent sketch.

Backfill in light well and location of potential parking.



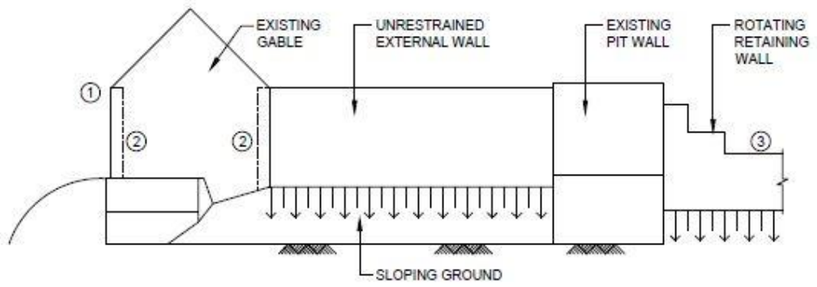
Crank Mill—diagrammatic representation.

5.6 Civil Hospital

5.6.1 Issues

Typical of other buildings in the KAHVA precinct, the Civil Hospital is also in a state of ruin and has several observed structural issues as outlined below:

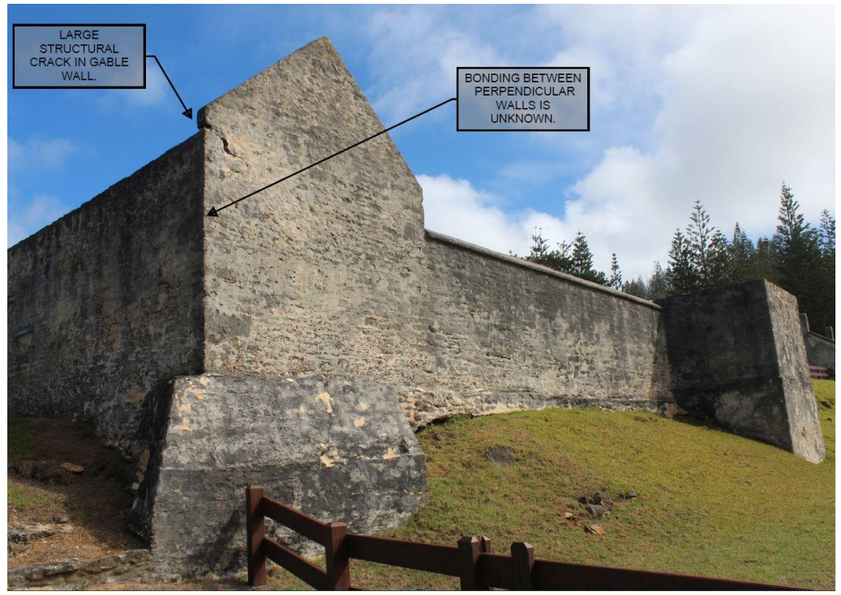
- Large structural crack on the northern gable at the eastern side of the building. This gable apex is approximately 7m above the natural ground level to the north and has lost its lateral restraint which would have been provided by the original roof structure that is no longer present. This wall is potentially unstable during high wind loads and represents a risk to the public. Refer to 'Location 1' on elevation below.
- Effectiveness of the bonding between the northern gable wall and perimeter walls is unknown. Inadequate bonding between these walls could potentially lead to an exacerbation of the above noted issue of instability. Refer to 'Location 2' on elevation below.
- The retaining walls to the northwest of the Civil Hospital are rotating and leaning towards the north. The walls were measured as being approximately 10 degrees out of plumb and are potentially unstable, representing a risk to the public. Refer to 'Location 3' on elevation below.
- The east to west internal wall is leaning forward towards the north.
- An existing timber lintel has completely decayed, leaving the calcarenite blocks unsupported. Cracking in the render was observed adjacent to this lintel.



CIVIL HOSPITAL NORTHERN ELEVATION

5.6.2 Recommendations

- In the short term, limit access to the dangerous areas.
- A full remediation strategy will need to be developed which should include a detailed geotechnical investigation and structural engineering design. The strategy may include underpinning of walls, stitching of cracks and addition of an internal timber or steel frame that reinstates the original roof form to provide lateral stability to the walls.



Northern gable end showing structural crack.

Northwest retaining wall showing rotation.

5.6.3 Related Project

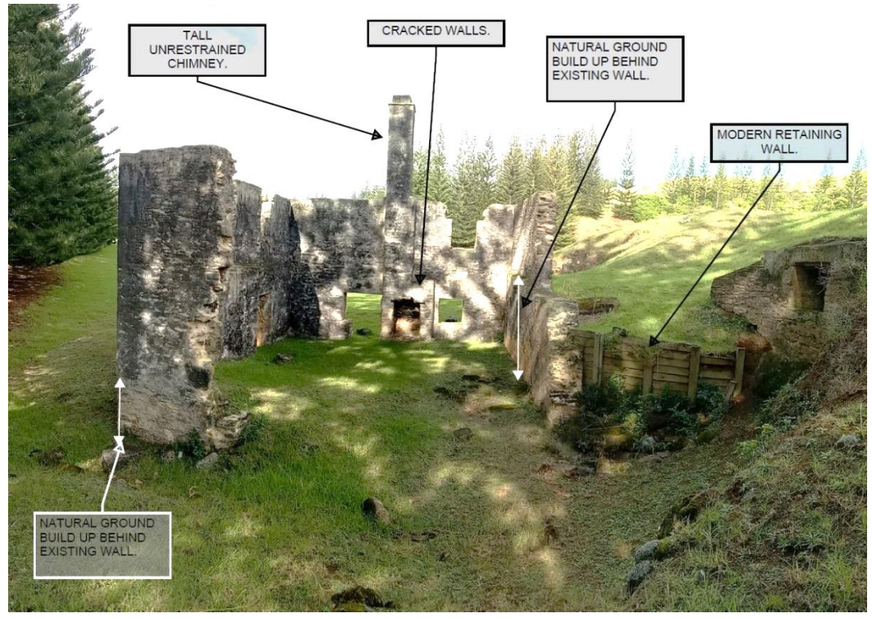
Arthur's Vale Retaining Wall is a related project.

5.7 Water Mill

5.7.1 Issues

The Water Mill Building near the junction of Country Road and Taylors Road is in a state of ruin. The remains have similar issues to the Crank Mill Building and are specifically:

- No roof structure to laterally restrain the top of the remaining walls and chimney stack leading to potential collapse.
- No floor structure to laterally restrain the walls over their full height leading to potential collapse.
- Effectiveness of bonding between the remaining perimeter walls leading to separation of wall from perpendicular restraining wall.
- Miscellaneous structural cracking on the southern wall adjacent to the chimney indicative of differential movement.
- Uncertainty as to the original design parameters for the building walls: judging by the below image, it is plausible that the surrounding topography has changed significantly since the building was originally constructed. Internally within the building footprint, the natural ground appears to be banked up as high as the internal window level. On the right-hand side of the photo, the level of the ground externally is approximately 2300mm higher than the internal floor level. This means that the existing calcarenite external wall is now required to be a retaining wall. There is historical evidence of flooding through this area which could have caused sediment to build up in the areas shown.



Water Mill Building—looking south.

5.7.2 Recommendations

- In the short term, limit access to the dangerous areas.
- A full remediation strategy will need to be developed which should include a detailed geotechnical investigation and structural engineering design. The strategy may include removal of fill from behind walls, stitching of cracks and addition of an internal timber or steel frame that replicates the original floors and roof form to provide lateral stability to the walls.

5.7.3 Related Projects

Water management of Watermill Creek is a related project.

5.8 Cemetery Bay Sea Wall

5.8.1 Issues

The structural issues and recommended remediation measures associated with the Cemetery Bay sea wall are well documented in the Advisian Report No. 301015-03754 dated December 2017. Also documented is a proposed remediation strategy that aims to re-use the failed retaining wall. However, the proposed design life for the remediated retaining wall is 12 months. We concur that the failed sections of the retaining wall are dangerous and need to be reconstructed. Consideration could be given to two other alternative strategies that may deliver a longer design life. These are described below in the following paragraphs and diagrammatically in concept sketch format.

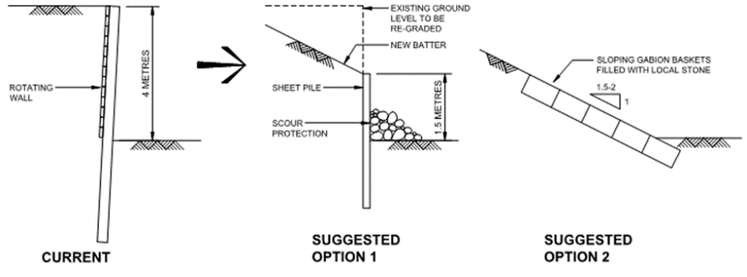
5.8.2 Option 1: Concrete-filled Sheet Piled Wall

An effective sea wall strategy is in operation at the existing pier. The retaining walls in this area use concrete filled sheet piled retaining walls which have scour protection in the form of large boulders at the base of the wall. Consideration could be given to adopting this strategy at the Cemetery Bay Sea Wall as follows:

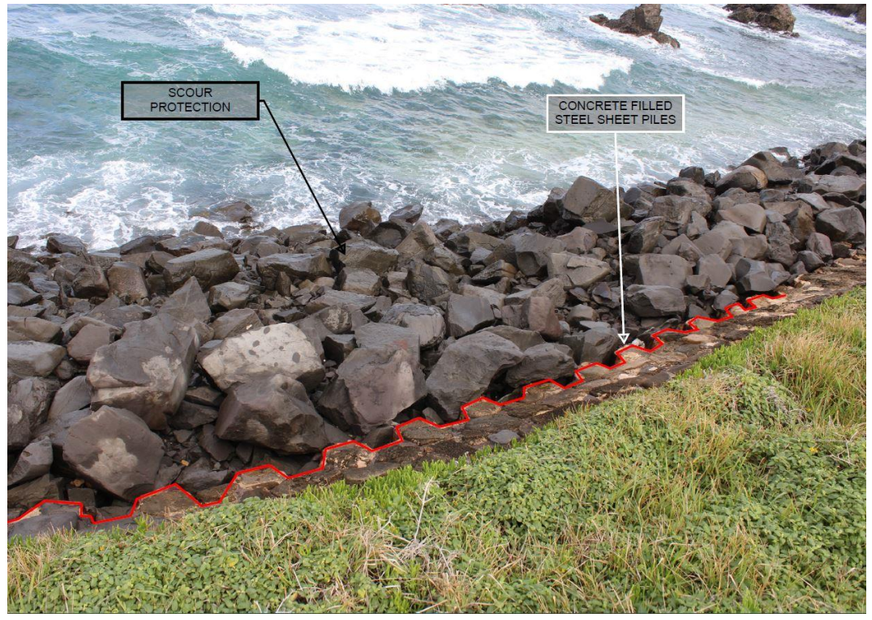
- Batter back the ground immediately behind the higher sections of existing retaining wall to enable a lower retained height to be achieved. While the archaeological sensitivity of this area is currently unknown, it could be addressed by undertaking an initial desktop analysis.
- Construct a concrete-filled sheet piled retaining wall.
- Install scour protection at the base of the retaining wall.

5.8.3 Option 2: Stone-filled Gabion Baskets

Another medium-term strategy is to install stone-filled gabion baskets instead of the existing retaining wall. Gabions are wire mesh baskets filled with cobbles or crushed rock. They are filled in situ, often with locally available material, and therefore have a relatively low capital cost. Because they are flexible and porous they can absorb some wave and wind energy, thereby reducing the scour problems associated with impermeable walls such as the existing timber retaining wall. Gabions can be placed as sloping ‘mattresses’ or as near vertical cubic baskets.



Sea wall replacement strategy—Options 1 and 2.



Option 1—Adopt sea wall strategy similar to Pier.

Option 2—Gabion baskets.

5.8.4 Supply Issue

No local rock supply at present.

The stair in the Old Military Barracks is timber and not fire rated. The switchboard under the stair is a potential fire source.

5.9 Fire Safety

5.9.1 Issues

A comprehensive review of fire safety measures, including fire egress from the upper floors of the larger heritage buildings—including the Commissariat Store, the Administrator's Office, the New Military Barracks (Council Offices), the Old Military Barracks (including Courthouse) and the Pier Store—needs to be undertaken at KAVHA.

Current measures appear to be a compromise between heritage and safety and have been implemented with the intention of minimising impacts on the heritage fabric and form of the buildings. However, in several instances, the current fire egress measures are non-compliant with current building codes and are not safe to use.

5.9.2 Recommendations

Fire egress and mitigation strategies need to be reviewed in line with current fire safety standards. Consideration needs to be given to:

- the number of people accessing the upper floors (few or many?);
- the distance of travel to the main stairs within each building;
- the construction of the stairs (masonry or timber—will it burn?);
- items located under the stairs (are they a likely fire source?);
- the construction of the walls surrounding the stairs (do the walls effectively isolate the stairs in a fire to provide safe egress?);
- the type of doors opening onto the stairs (are they fire resistant? Do they seal against smoke? Can they be upgraded with an approved heritage door fire kit?);
- fire egress door hardware (does it release easily to allow escape?);
- emergency lighting (is there emergency lighting to enable people to find the exit?);
- type of items being stored on the upper floors (are they contributing to the fuel load? Are they significant and should they be protected?); and
- fire detection (are existing fire detection and suppression systems adequate?).

Careful consideration must also be given to the potential heritage impact of the proposed fire upgrades on the heritage values and attributes of the place.

It may be that in some of the buildings, such as those with masonry stairs enclosed by masonry walls, simple alterations (such as fire upgrades to the underside of the doors opening onto the stair and hardware) can provide adequate escape without causing major impacts on the heritage fabric. Provision of fire rated linings to the underside of timber stairs and removal of electrical boards from under the stairs may also provide an adequate level of protection.

However, in the case of the New Military Barracks (Council Offices) and possibly the Commissariat building, new external stairs may be required. This solution should be possible if they are located on the rear of the buildings and are designed using Burra Charter principles.

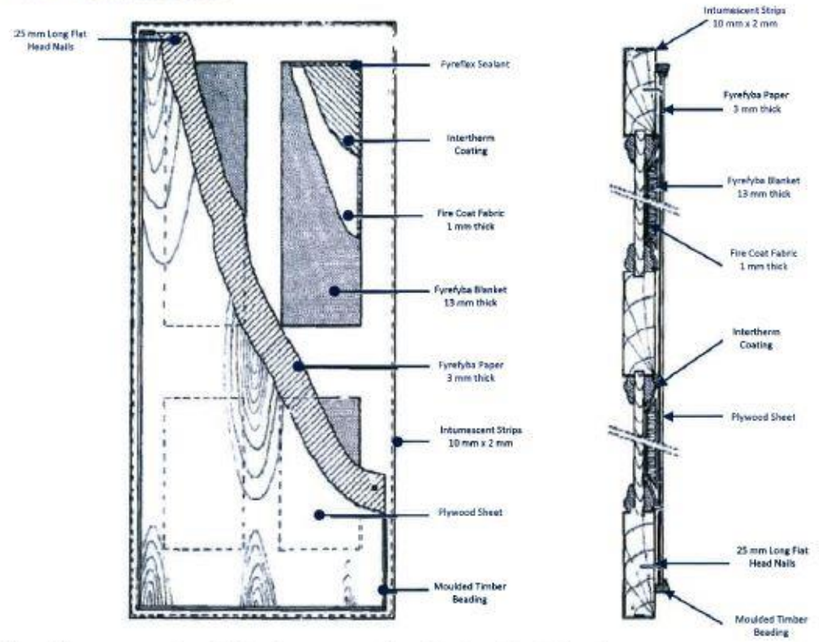
THE E-CORE® FIRE DOOR HANDBOOK

E-Core® Specialist Applications 48

Heritage Doors

Modified panelled door leaf incorporated into a timber-framed doorset up to 2100 mm high x 920 mm wide.

DOOR TREATMENT DETAIL



Note: The treatment is applied to the tenancy side of the door (inside face).

Door Type	Maximum Size of Door Leaf (H x W) (mm)	Fire Resistance Level	Reference Number (s)
Modified panelled door leaf	2100 x 920	Up to NA/28/29[1]	SI 1871

Note: Refer E-Core® Technical Bulletin ECFD - 108 for further detail.

The above heritage door kit enables panel doors to be upgraded to meet a minimum standard. It includes the addition of fire resistant fabric and ply sheet to the back of the panel doors, intumescent paint and smoke seals added to the timber frames. This type of approach may be applicable to heritage doors at KAVHA.

6.0 Small Projects for Short to Medium Term Implementation

The following projects for mitigating health and safety risks at KAVHA have been identified for implementation in the short to medium term.

6.1 Surgeons Quarters—Verandah Repairs

6.1.1 Issues

The structure of the verandah comprises low level calcarenite retaining walls and has a flagstone paver finish. The calcarenite walls have eroded (honeycombed) and subsided, and the flagstone pavers are undulating badly due to this subsidence. The western end of the verandah, which is a later addition and not bonded into the earlier structure, is of the most concern. This portion of the verandah also appears to have been invaded by tree roots.

The calcarenite walls and flagstone pavers support eight structural columns which in turn support the timber framed roof structure.

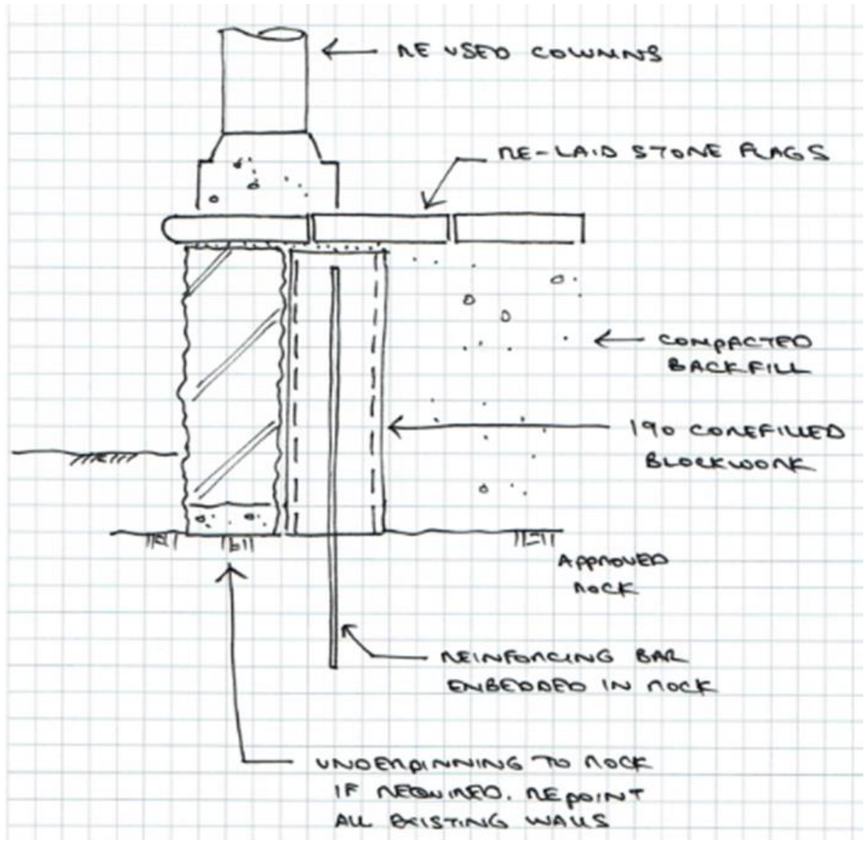
6.1.2 Recommendations

It is recommended that the western end of the verandah base structure be rebuilt to ensure that the structural integrity of the roof structure is maintained. The roof is currently relying on failed walls for support, which is unsafe and could potentially lead to structural failure of the roof above the verandah.

A possible solution discussed with KAHVA Work Crew member Mike Johnstone was to construct a new retaining wall inside of the existing calcarenite wall. The calcarenite wall may need to be underpinned to a suitable bearing stratum to ensure that further subsidence is prevented in the future. The roof structure would need to be temporarily propped and then re-supported on the rebuilt walls. A concept diagram is provided.

Tree root removal must be undertaken with great care. The roots must be cut and left to dry out for 12 months prior to endeavouring to remove them from the structure.

Southwestern end of verandah showing subsidence.



Proposed remediation solution for verandah structure.

6.2 Officers Mess (Administrator's Office)—Verandah Balustrade

6.2.1 Issues

The timber verandah structure of the Officers Mess (Administrator's Office) has recently been upgraded in accordance with the recommendations of previous engineering reports provided by Northrop and Norfolk Island Consulting Engineers. However, it was noted that the balustrades around the upper level of the verandah have not been repaired or upgraded to comply with current Australian Standards for balustrade design: AS1170.1—*Permanent, Imposed and Other Actions*.

It was observed that there were numerous corroded fixings and decay of the vertical and horizontal timber members. Some of the horizontal members could be moved laterally by hand, indicating that they are unsafe. It is recommended that the balustrades be rebuilt to current standards.

6.2.2 Recommendations

The design of the balustrade should be based on documentary evidence. However, whilst it is recognised that the original spacing of the balusters and the height of the handrail may not comply with current standards, it is also noted that the current verandah is a modern reconstruction that varies from the original verandah design, and even though it is rarely used by building occupants, it is currently part of a designated fire egress route and must be made safe.

Repairs to or reconstruction of the balustrade will require both building code and engineering input. The following investigations and works are recommended:

- Assess condition of individual elements (columns, handrail and balusters).
- Identify any building code non-compliance issues. These are likely to include height of balustrade and spacing of balusters.
- Obtain engineering advice regarding adequacy of structural design of balustrade (including fixings to posts).
- Replace decayed elements to match existing.
- If the balustrade is too low, consider the heritage implications of either raising the balustrade by raising the blocks under the balusters, or providing a new handrail above the existing handrail. The second handrail should be as unobtrusive as possible.
- If balusters are too far apart, consider adjusting their spacing and adding additional balusters, or adding secondary balusters between the existing ones. The addition of a glass balustrade behind the timber balustrade is not considered visually appropriate in this situation due to the high level of anticipated salt deposit on the glass.

Corrosion staining on timber post from rusting steel fixings.

Decayed timber on vertical members of balustrade.

6.3 Sirius Museum—Floor Loading

6.3.1 Issues

The Sirius Museum has an extensive range of artefacts on display that were retrieved from the wreck site of the HMS *Sirius*. Artefacts include carronades, the ship's anchor and miscellaneous ballast blocks. These artefacts are cast iron or wrought iron with an estimated density of 7300kg/m3. The following weights of the iron items retrieved from the HMS *Sirius* were provided by Bethany Holland, Collections Officer for Norfolk Island Regional Council:

ITEM	WEIGHT (kg)
Carronade	483
Anchor	1720
Ballast Blocks NI 36 SI37 SI563 SI597 SI619 SI620 SI623	 106 127 150 147 147 124 150
Additional timber from display and anchors	Approx 250kg
TOTAL APRROX WEIGHT	3400kg

The total weight of the above items is distributed over a foot print of approximately 4m x 3m on plan. Subsequently, the corresponding design imposed action on the floor is approximately 2.8kPa.

6.3.2 Recommendations

It is recommended that an inspection of the subfloor be undertaken to confirm:

- the size and spacing of the floor joists;
- the size and spacing of the bearers;
- the timber species utilised; and
- the centres of the brick or concrete pier supports for the bearers.

Following on from this inspection, the structural capacity of the floor should be calculated to ensure that it can support the design load nominated above. If not, then the display may need to be reorganised to spread the load or implement a design solution that will provide adequate support.

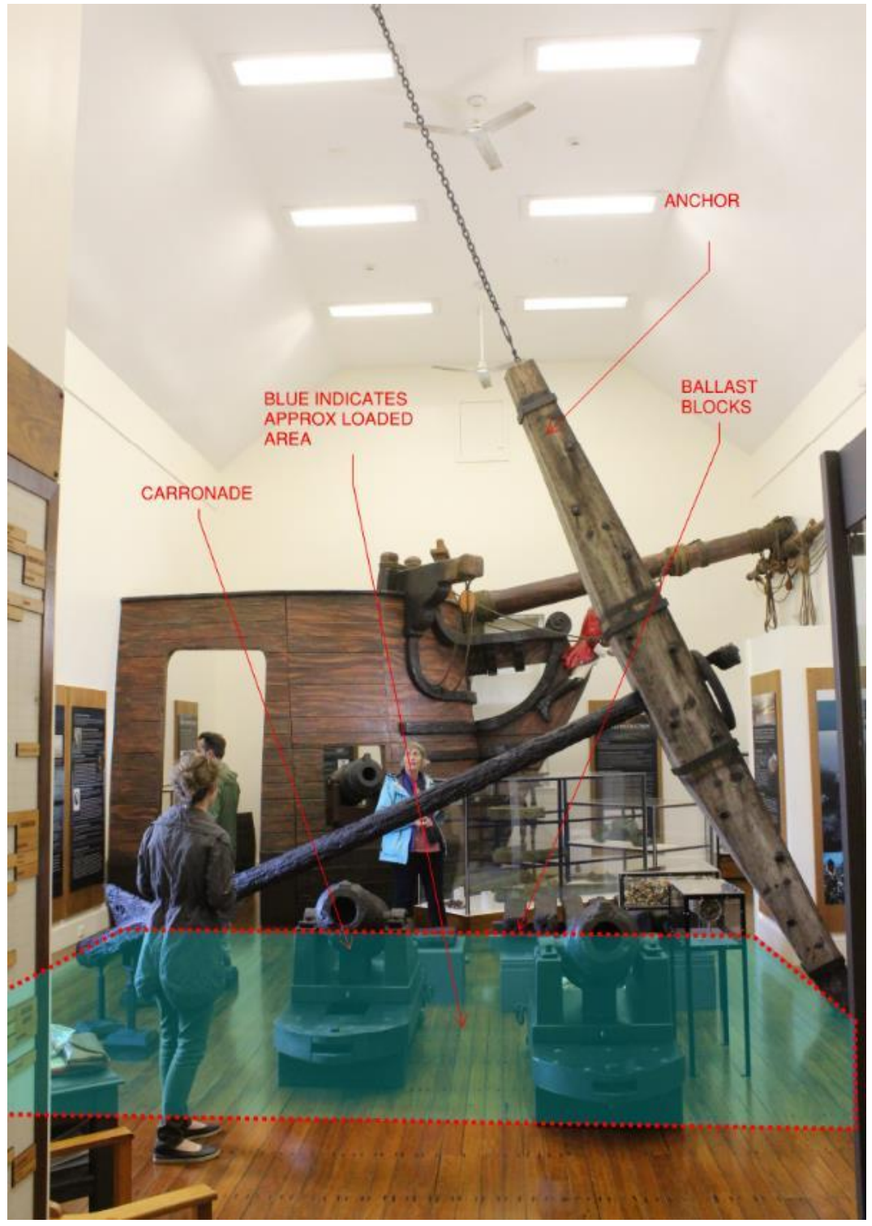


Illustration showing area of floor in Sirius Museum that is carrying excessive load from heavy items on display, including *Sirius* anchor and carronades.

6.4 REO Entry Portico

6.4.1 Issues

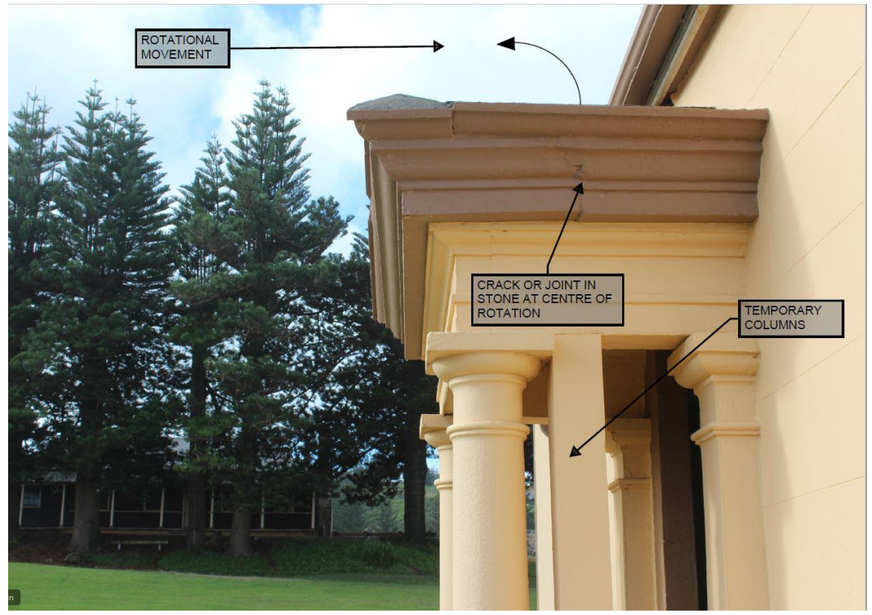
The stone portico above the western entry to the REO Building is displaying signs of structural movement. The portico roof structure appears to have rotated in the westerly direction about the central joint or crack which was visible from the north and south sides of the portico structure. Two timber posts have been installed to the southern corner of the portico by the Works Team as a precautionary measure. It was also noted that the head stock to the capital of the northern stone column has decayed, which may potentially be impacting its ability to support the portico structure. It is not known what interventions have already been undertaken to remediate movement within the structure.

6.4.2 Recommendations

It is recommended that a thorough forensic investigation of the entry portico structure be undertaken to establish how the portico stone elements are constructed and the likely cause of rotational movement, and to determine what is required to ultimately reset the stone work to its original alignment.

It is recommended that the portico be restrained by installation of stainless steel rods that would tie the structure back to the main building façade. It is also recommended that the foundation material under the columns be inspected to ensure that the re-installed stone columns have adequate bearing.

- Confirm whether previous structural interventions have been undertaken.
- Undertake geotechnical investigations to determine condition of foundations.
- Check condition of columns, including bases and capitals.
- Engage structural engineer to inspect portico roof structure and develop remediation strategy. This may include underpinning of columns and/or insertion of stainless steel pins or tie rods.
- As asbestos is present within the roof space of the REO, an asbestos removal program may need to be instituted prior to the works commencing.
- Implement remediation works and allow for replacement of the severely decayed capital on sandstone column. Remove timber propping.



Southern façade of entry portico.

Decayed northern column capital and stone base to REO portico.

6.5 Surgeons Quarters Kitchen Walls

6.5.1 Issues

Cracking was observed in a few of the internal walls within the Surgeons Quarters Kitchen. This may be indicative of differential movement between parts of the building.

6.5.2 Recommendations

We recommend that these cracks be monitored using tell tales to establish if the movement is ongoing or whether it has arrested. If the movement continues then a more detailed assessment of the building foundation material may be required to establish the cause of the differential movement. Ultimately the wall cracks could be rectified utilising a proprietary crack stitching methodology, such as installation of Helifix ties within the joints.

6.5.3 Related Projects

This cracking does not pose an immediate risk to people or the building. However, due to its location, it should be considered in relation to other more serious subsidence issues occurring in relation to the Arthur's Vale retaining wall and the Civil Hospital.

Internal wall cracking in Surgeons Quarters Kitchen.

Internal wall cracking in Surgeons Quarters Kitchen.

6.6 Government House Reserve—Timber Bridge

6.6.1 Issue

The timber bridge which crosses the creek in Government House Reserve is showing signs of timber decay at the ends of the horizontal timber member which span across the creek channel. The decay impacts on the structural integrity of the members.

6.6.2 Recommendations

These timber members should be replaced. Given the exposure conditions and proximity to the ground, it would be preferable if a hardwood species of timber was utilised.

Decayed timber members spanning across the creek channel in the Government House Reserve.

6.7 Definition of Parking Zones and Extent of Vehicular Access

6.7.1 Issues

The CLMP identified that ad hoc parking through KAVHA presents a risk to a number of sensitive archaeological sites and, furthermore, intrudes on the visual character and appreciation of the World Heritage site. The risk assessment has identified that the ongoing erosion of certain grassed areas reduces their usability for recreation and that in some cases vehicles and pedestrians may potentially come in conflict. As such it is desirable that areas in which vehicle access and parking is to be limited are effectively demarcated with a low-key and visually compatible barrier.

6.7.2 Recommendations

To date, there has been a roll-out of oiled low timber barriers to some areas of KAVHA. It would be desirable that this roll-out be continued to individual sites as resourcing allows. Key priority areas would include the areas of Pier and Bay Street. The key steps in the process:

1. Refer to CLMP for areas identified for parking.
2. Determine extent and alignment of barriers proposed—keep vehicles at least 3–5m away from walls of buildings, including sunken areas, archaeological sites and foreshore areas. Ensure there is sufficient space for free movement of pedestrians.
3. Determine proposed surface treatment to parking areas (differentiate from grassed areas where parking should be discouraged) and barrier type to be used, which would depend on location and visual sensitivity (possibly low fence in open areas and log on ground or similar around buildings).
4. Consult with relevant stakeholders to confirm designated parking areas.
5. Implement works.

Existing barriers to waterfront grassed zone at Kingston Pier.

6.8 Access Warning Signage

6.8.1 Issues

The CLMP recommends that access management across KAVHA reflects a hierarchical approach that prioritises the level of accessibility to key areas and recognises that other access routes, including many walking routes, will remain lower level access with a low level of infrastructure and varied level of surface and terrain. This approach, having regard for AS 2156 Walking Tracks, enables KAVHA to reconcile a degree of risk on certain access routes on the basis that they are lower level facilities. The reality is that the provision of rails and other infrastructure to secure all drop-offs/potential falls would not be suitable to the visual environment, nor in terms of heritage management.

6.8.2 Recommendations

This system and the hierarchy of access does need to be conveyed to users. One avenue is through the website, publications and maps that identify available access on the site. The other will be through discreet and sensitive information on the site that alerts users to the track conditions and related risks on particular routes.

As such, the implementation of warning signage is a project that could proceed once the approach and format of signage information is determined.

The key steps in the process are suggested to involve:

1. Develop graphic and materials approach to signage and wayfinding fabric.
2. Develop signage masterplan to identify signage and wayfinding locations including interpretive opportunities.
3. Fabricate signage.

Examples of simple pedestals in the landscape and the top of warning information for trail systems used elsewhere– where possible signage plates may be able to mount to existing structures.

7.0 Conclusions and Recommendations

7.1 Conclusion

This study has identified a broad range of health and safety hazards across KAVHA. These range from common slip, trip and fall hazards that may have minor to moderate consequences for those affected, to those hazards that may have much more serious consequences, possibly even resulting in death, such as structural and fire hazards. Other hazards identified include natural hazards, such as extreme weather events, hazards arising from the interaction of pedestrians and vehicles, and health hazards associated with the care and maintenance of the collections housed in the various museums located on the site.

The level of risk associated with each hazard is identified in the tables in Section 3.0 of this report. Those items that are considered to pose a high or very high level of risk, either due to their likelihood of occurring or the potential consequence of their failure, require mitigation strategies to be implemented that are sensitive to the heritage context of the place, whilst reducing the potential risks.

7.2 Recommendations

Taking into consideration the budgetary and programming constraints, the proposed mitigation measures are divided into those that may be undertaken as part of the ongoing maintenance program for the site, and those that would be categorised as capital works projects to be undertaken in the short (within 12 months), medium (within three years) or longer term (within five years).

Some of the larger projects are broken down and staged to enable the necessary investigations to be undertaken in one year, prior to design solutions being developed, approved and implemented in another year. It is recognised that some projects are interrelated and others need to be undertaken in a particular order to be most effective.

7.2.1 General Management and Maintenance Activities

The following mitigation strategies should be implemented as part of the ongoing management, care and maintenance of the site.

- Continue regular cleaning of the Pier.
- Continue to poison grass around archaeological remains and extend this to sites currently hidden in long grass on Kingston Common.
- Continue to treat mould.
- Develop and implement safe work methods.
- Induct staff regarding health and safety risks.
- Train museum staff in use of the disaster kits located in each museum.
- Undertake regular fire evacuation drills with staff.
- Undertake regular monitoring of unsafe sites/structures (eg Civil Hospital and Arthur's Vale retaining wall).
- Develop and institute extreme weather event protocols (eg restricted access to dangerous sites in high winds or floods).
- Undertake annual inspections and immediately replace critical fixings that have decayed and are no longer functional (eg roof tie downs, chimney pots).
- Undertake annual inspections and immediately repair/replace damaged well covers and safety barriers.
- Check and clear drains around buildings.
- Monitor condition of retaining walls.
- Monitor condition of trees with arborist.

7.2.2 Works to be Undertaken within 12 Months

The following projects should be undertaken in the next 12 to 18 months. These include urgent repair works to make structures safe or keep people away from unsafe structures, investigative work to enable critical larger projects to be progressed, and implementation of smaller safety measures that can be undertaken incrementally, such as erection of barriers, improvements to path surfaces, installation of handrails and design and implementation of a signage strategy.

- Improve path access to the most visited buildings (eg No. 10 Quality Row, the Surgeon's Quarters).
- Provide handrails to stairs where these are not currently sufficient (Sirius Museum, Nos 2 and 3 Quality Row).
- Install non-slip nosings to non-heritage stairs.
- Add floorboards to walkways in Nos 2 and 3 Quality Row.
- Relocate existing barriers and seats to move people away from edges where there are significant drops.
- Install new barriers to create safe movement zones for people and vehicles and to keep them away from drops.
- Install new barriers to restrict vehicular access and parking where this endangers the structures or there is danger from structures (Crank Mill, Civil Hospital).
- Design and install discreet directional and warning signage to facilitate safe movement around the site, including on walking tracks, whilst encouraging engagement with the site, and its natural and heritage attributes.
- Check all chimney caps and replace as necessary to match existing.

- replace missing or severely decayed timber lintels over openings (Crank Mill and Civil Hospital);
- check stability of fractured stone lintels and provide necessary support;
- undertake repairs to Surgeon's Quarters verandah (already planned);
- undertake scoping for remedial works to Bounty Street Bridge
- undertake temporary remedial works to Cemetery Bay retaining wall (already planned) and identify materials for more durable long-term solution;
- undertake geotechnical investigations to identify ground conditions of Arthur's Vale retaining wall and rebuild to match existing using existing stone (urgent);
- remove asbestos from REO;
- undertake geotechnical and structural investigations to enable design, documentation and implementation of repairs to REO portico;
- repair/replace verandah balustrade on the Officers Mess (Administrator's Office);
- review fire safety compliance requirements and appropriate heritage options for the multi-storey buildings on the site (New and Old Military Barracks, Officers Mess, Pier Store);
- install heritage sensitive easy release hardware on fire exit doors;
- undertake geotechnical investigations to inform design solutions to structural issues at Civil Hospital, Water Mill and the Arches;
- investigate drainage around buildings—subsidence issues, flooding issues, ongoing damp issues contributing to decay and mould;
- Investigate wall structure and bonding, particularly at corners of freestanding ruins (Crank Mill, Civil Hospital, Water Mill).
- Provide temporary stabilisation where failure is considered likely or imminent (eg Civil Hospital wall, retaining wall at Water Mill).
- Remove fill from around the Crank Mill walls.
- Investigate floor loading and subfloor structure in Sirius Museum.
- Replace lighting in Sirius Museum (energy efficient, longer life, less maintenance, easier to maintain).
- Following current testing of dehumidifiers in some of the museums, provide dehumidifiers to all other museums.

Expertise and preliminary studies required to undertake this work:

- Many items will require expert heritage input to ensure that the proposed remediation works do not negatively impact the heritage fabric of the buildings and place.
- Engineering advice must be given by an engineer with expertise in traditional load bearing stone (specifically the irregularly coursed stonework of the KAVHA buildings) and timber construction, and design for seismic and cyclonic conditions, which responds to the traditional construction materials and typologies.
- Any works requiring excavation will need to include archaeological monitoring.
- A materials palette needs to be developed for new works.
- A signage strategy needs to be developed to ensure an appropriate hierarchy and consistency of design is used across the site.

7.2.3 Works to be Undertaken within Three Years

The following larger projects should be undertaken within two to three years. They require investigative works to be undertaken in the short term to enable appropriate design solutions to be developed and implemented.

- Install fire rated lining to underside of timber stair in Old Military Barracks; relocate or fire isolate electrical boards.
- Design and implement other fire upgrade solutions to larger multistorey buildings at KAVHA, including installation of emergency lighting, upgrade of fire doors and new fire stairs if required.
- Strengthen floor structure in Sirius Museum if found to be under-designed for the load.
- Undertake remedial works to Bounty Street Bridge.
- Design and implement longer term solution to Cemetery Bay retaining wall.
- Stitch cracks in standing ruins (Civil Hospital).
- Underpin walls where foundations are found to be unstable (Civil Hospital and Arches).
- Replace decayed supporting structure to No. 4 Quality Row.
- Undertake investigations into stability of REO porch.
- Install safety harness points for undertaking work in high risk areas.
- Develop an interpretation plan for the Crank Mill.
- Design new supporting structures to the standing ruins (Crank Mill and Civil Hospital), integrating them with interpretation opportunities.
- Develop a detailed interpretation plan for the New Gaol and Convict Barracks sites.
- Develop an accessible path through the New Gaol and Convict Barracks sites.
- Develop an interpretation strategy for the whole of KAVHA.
- Develop a water management plan and begin implementation starting upstream at the pond in Arthur's Vale.

7.2.4 Works to be Undertaken within Five Years

The following larger projects should be undertaken and completed within five years. They require investigative works to be undertaken in the short to medium term to enable appropriate design solutions to be developed and implemented.

- Provide new viewing areas and implement interpretive elements for the New Gaol and Convict Barracks ruins.
- Implement interpretive elements at the Crank Mill.
- Rebuild the retaining wall at the Water Mill.
- Design and build new supporting structures to standing ruins (Water Mill and Arches).
- Prepare a disaster risk management plan for the site and its significant attributes.
- Improve drainage around building sites to minimise risks to retaining walls and foundations and from flash flooding during extreme weather events (may include air drains to minimise rising damp and decay).
- Review traffic management and establish a shared vehicle pedestrian zone on roads where necessary to improve pedestrian safety.
- install new interpretive new signage around the site.

7.3 Further Studies Required

The following studies are necessary to the development and implementation of some of the proposed risk mitigation measures proposed in this report.

7.3.1 Water Management Plan

Develop a plan for managing creek systems to mitigate flood risk and water quality issues. This will need to be undertaken in close collaboration with the Norfolk Island Regional Council and Parks Australia.

7.3.2 Disaster Risk Management Plan

KAVHA is a place of immense cultural significance as reflected by its inclusion on the World Heritage List. A disaster risk management plan (DRMP) is required for the whole place to ensure that it survives for future generations, not just the museums. The DRMP should consider risks to the cultural landscape (Kingston Common, Arthur's Vale, Emily Bay, Slaughter Bay and Cemetery Bay), the bridges and road infrastructure, the pier, the historical buildings and archaeological sites, as well as the collections.

The plan should consider natural and human hazards affecting the site (including cyclone, high wind, torrential rain, landslip, flood, tsunami, fire, industrial accident—explosion, chemical contamination) and include a full risk assessment, development and implementation of appropriate mitigation strategies, preparation measures to be undertaken, emergency response procedures for the heritage attributes of the site, procedures for evacuation, salvage, emergency stabilisation, and then recovery and reconstruction.

This plan will need to be developed in collaboration with staff, local emergency services and local residents.

7.3.3 Archaeological Zoning Plan

An archaeological zoning plan would identify areas of archaeological sensitivity, so that these areas may be managed, interpreted or avoided.

7.3.4 Interpretation Plan

An interpretation plan is required to identify where and how on the site particular stories should be told to enhance the visitor experience and understanding of the site and its values.

7.3.5 Signage Strategy

A signage strategy needs to be developed to guide people around the site, to identify walking tracks, accessible routes, safety risks and to support the interpretation of the site for the public. The strategy must establish an appropriate hierarchy and consistency of design for use across the site.

7.3.6 Master Plan

The site is in need of a master plan to identify where specific activities may be accommodated on the site. It would include reference to appropriate building use, land use, locations for special events, parking for locals, tourists and special events. It should also identify key water and flood management areas and address cattle management at KAVHA.

7.3.7 Traffic Management Plan

Traffic management was raised as an issue by KAVHA staff during the preparation of this report. However, traffic management is an area that needs to be considered in a broader context, which is beyond the scope of this report. A traffic study should be undertaken for the master plan and should include management of parking on a daily basis, on ship days and for special events.

Appendix A—Reference List

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A.2 Emergency Plans

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A.3 Condition and Conservation Advice

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A.5 Archives

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Appendix B—Norfolk Island Regional Council—Museum Collections and Reference Material

A.1 Sirius

Excavated maritime archaeology items from HMS Sirius wreck (includes mostly metal items, but does have some wood fragments, glass, stone and ceramics).

A.2 KAVHA

Artefacts excavated from KAVHA area (includes ceramics, bones, shells, metal artefacts, stones and fragments of buildings, items from the Polynesian settlement).

A.3 Norfolk Island Museum Trust

Items donated by NI community members.

Photographs, slides, and postcards: postcards depict early scenery of Norfolk (particularly Kingston), Melanesian Mission individuals, NI locals and life on the island.

Oral histories: Interview recordings of elders and locals.

Books relating to history of Norfolk Island and Pitcairn community.

Reports on archaeology completed in KAVHA area and related reports completed on buildings.

Geology reports completed on Norfolk Island.

Books on Australian law.

Newspapers published on Norfolk Island.

Items from the Melanesian Mission.

Items from the Whaling industry.

Items and documents relating to troops staying on Norfolk Island during WWII.

Items relating to the Australian and New Zealand Cable Station (ANZCAN).

Items relating to farming industry on Norfolk Island.

Items representing Norfolk Island and Pitcairn traditional arts.

Items relating to Norfolk Island tourism industry.

Documents relating to Governance debate.

Biography files on important figures during First and Second European settlements and local Norfolk Islanders.

Subject files on items in the collection, important events, groups on the island and research questions previously posed to the museum.