

Water Quality Improvements in Emily Bay

Options Analysis Report



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Infrastructure, Transport, Regional Development, Communications, Sport and the Arts

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Stormwater Mitigation Works on Norfolk Island
 Water Quality Improvements in Emily Bay
 Commercial-in-Confidence

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Options Analysis Report

Client: Department of Infrastructure, Transport, Regional Development and Communications

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1.0 Executive Summary

The Department of Infrastructure, Regional Development, Transport, and Communications (Department) has commissioned AECOM to progress short-term options to ameliorate problems caused by ground and/or surface water runoff into Emily Bay on Norfolk Island. It is understood that water contamination stems from a combination of poorly maintained septic tanks and unrestricted livestock grazing. Heavy rainfall mobilises contamination, which travels through ground and/or surface water into Emily Bay, affecting its reef. When rain falls, surface water pools in the wetland to the east of Bounty Street in the Kingston and Arthurs Vale Historic Area, and eventually breaks through a sand plug at the western corner of Emily Bay, as occurred in November 2020.

Eighteen options from the Bligh Tanner report (Improving the water quality at Emily Bay Norfolk Island Dec 2020) were evaluated. A further option was developed by the AECOM project team (#19). A multi-criteria analysis process was used to weight and rank the desirability of these options. Criteria and weightings used were: Cost (30%), Environmental Performance (40%), Construction & Constructability (10%), Maintenance (5%), Social Factors (impacts to property) (5%), Approvals (5%) and Local Acceptance (5%). Based on the multi-criteria analysis, the following options were shortlisted (in order of rank):

1. # 19 Lowering water levels in wetlands & discharge to land
2. # 2 Package treatment plant
3. # 14 Septic tank pump-out (12 weeks duration)
4. # 13 Leaky weir systems
5. # 4 Constructed Wetland
6. # 16 Upgrade STP.

However, when the requirement to implement the solution prior to the wet season was considered, only three options were considered viable for implementation in that timeframe (#19, #14, #13).

A Strengths-Weaknesses-Opportunities-Threats (SWOT) Analysis was completed to assess these options in greater detail. Further, after the MCA had been concluded, the Norfolk Island Administrator asked for an additional option to be included – a flow control near the sand plug outlet (Option # 20). This was also considered in the SWOT analysis. Results were as follows:

- **[Unfeasible] #19 Lowering Water Levels in Wetlands & Discharge to Land.** Not considered feasible because dewatering activities in the past have demonstrated that groundwater recharge rates are too high to be able to maintain a reduced water level in the wetlands.
- **[Preferred option] #14 Septic Tank Pump-out.** Can be commenced immediately, has few risks and is expected to directly reduce contaminants of concern from the catchment. This option is expected to provide the greatest pollutant removal of the shortlisted options because pollutants would be actively removed from the catchment. A 12-week program was assumed to provide environmental protection through most of the wet season. Approvals are unlikely to be required.
- **[2nd Preference] #13 Leaky Weir Systems.** Few constraints to implementation, would be expected to reduce contaminants of concern by detaining water in pools and encouraging infiltration, and can be constructed with the materials and skills available on Norfolk Island. This option would provide the third-highest pollutant removal. Although similar to Additional Option 20, the volumes of water detained are expected to be smaller due to the position being higher in the catchment, and it would take 1-2 years for vegetation to reach sufficient maturity to contribute substantially to pollutant filtration. Local approvals are likely to be required.
- **[3rd Preference] #20 Flow Control Near Sand Plug Outlet.** The same as for leaky weirs but more risks associated with implementation (potential for flooding and landscape impacts). This option would be expected to reduce contaminants of concern by detaining more water for longer periods in the existing wetlands. This option would provide the second-highest pollutant removal due to the larger potential volumes of water that could be detained at the bottom of the catchment, and the established mature wetland vegetation. This option may trigger requirements

for approvals due to the larger extent of works and potential for off-site impacts and may require delays of 2-3 weeks for hydraulic modelling for potential flood impacts.

Preliminary order of cost estimates has been prepared for the shortlisted options that were considered feasible. These were:

- Option #14 Septic tank pump out (12-week program assumed with fortnightly pump outs, representing the approximate duration of the wet season) with a budgeted cost of \$47,800 per pump out (allowing for 138 Septic Tanks each round or a total of \$286,800 for 6 pump outs over 12 weeks)
- Option 13 Leaky Weirs (4 weirs assumed) with a budgeted cost of \$204,500 per weir (\$818,000 in total)
- Option 20 Flow control with a budgeted cost of \$ 760,000 (with an optional extra of \$283,000 to provide sand protection to the beach outlet at Emily Bay).

Recommendations

Based on the information available to us, and the assessment completed in this Report, Option #14 is considered the most feasible option to meet the Department's objectives for the project in the short term. Option 14 carries some risks associated with equipment availability, sewerage treatment plant capacity and community perception detailed in section 5.3.

Option #13 scored the second highest in the SWOT analysis, however was also the highest in terms of cost. The Department should consider carrying Option #13 forward for further consideration and detailing at the same time as Option #14. Both options can be delivered independently. Option #13 requires the development of flow modelling, this having a significant lead time (2-3 weeks). As such, progression of the option in parallel will reduce the Department's risk associated with Option #14 threats.

The next phase of the project is to develop a detailed design of the preferred option pending the Department's confirmation.

2.0 Introduction

AECOM Australia Pty Ltd (AECOM) have been commissioned by the Department of Infrastructure, Transport, Regional Development and Communications (Department) to undertake a feasibility study including detailed options analysis, design and costings for short-term solutions to mitigate stormwater impacts on the marine ecosystem from Emily Bay.

Norfolk Island is an external Australian territory approximately 1,600 km northeast of Sydney. The island has diverse cultural value and a complex history of Polynesian and British settlement up to the mid-1800s. In 1856, the site was settled by the Pitcairn Island descendants of the Bounty mutineers, many of whom still reside on the island. The island is home to the UNESCO World Heritage Kingston and Arthurs Vale Historic Area (KAVHA). Emily Bay and the Kingston Common are the focus of this study.

2.1 Project Location

The project involves assessing a number of options to reduce the runoff into Emily Bay on the southern side of the island run (refer to Figure 1).



Figure 1: Norfolk Island Locality Map (Source: CSIRO)

Runoff from upper catchments of Watermill and Town Creeks converge in the Kingston Common in KAVHA (refer to Figure 2) and discharge in Emily Bay and Slaughter Bay. Majority of the options proposed, involve works primarily in KAVHA, but some involve works in the upper catchments.

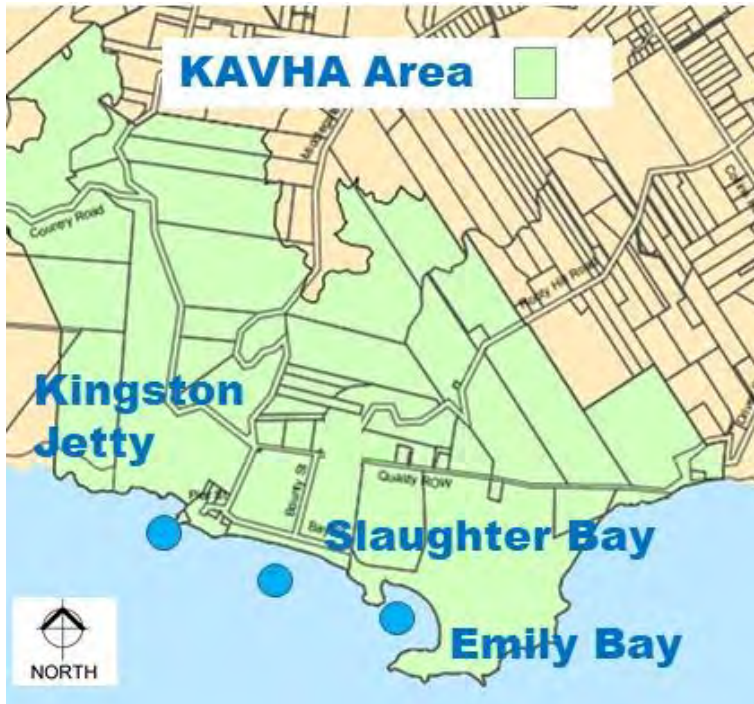


Figure 2: KAVHA Area (Source: Department of Environment and Heritage)

2.2 Project Objectives

Historically, stormwater runoff from Kingston Common enters Emily Bay and is reported to have negative impacts on the marine ecosystem. The intent is to develop solution/s that can be implemented in the very near term, March 2021. This timing aligns with a likely increase in rainfall and runoff from the Kingston Lowlands due to the La Nina pattern and warm currents predicted for Emily Bay. The aim of the project is to develop solution/s that will mitigate stormwater impacts in the Emily Bay catchment on Norfolk Island and limit the negative impacts on the marine ecosystem.

This study comprises two stages. The first stage is to assess the options provided in the reports prepared for Park Australia and Norfolk Island Regional Council (NIRC), as well as options provided by AECOM. These will then be developed into a shortlist of viable options.

In the second stage, the viable option/s will be considered for construction in the near term i.e. March/April 2021. These options will be assessed against the effectiveness of the expected improvement to water quality and availability of resources (plant, materials and labour).

This report will document the initial feasibility assessment of the options and provide a recommended shortlist of options. This shortlist will be further assessed using a Strengths-Weaknesses-Opportunities-Threats (SWOT) analysis leading to recommended option/s for consideration by the Department.

2.3 Background Information

The Kingston and Arthurs Vale Historic Area (KAVHA) is a low-lying area that drains Watermill Creek and Town Creek. Watermill Creek generally flows from west to east and discharges to Emily Bay via a convict-built tunnel. The waterway is not currently free-draining due to siltation and vegetation (reeds and water hyacinth). Various drains have been constructed during the convict period between 1798 and 1940. The vegetation growing in the creek and wetlands is considered beneficial in improving water quality.

The Serpentine Channel was constructed circa 1835 and included a tunnel under Chimney Hill that formed a new outlet into Emily Bay. The channel under the bridge (bridge was constructed circa 1940) south of Chimney Hill has since been filled in so the only remaining discharge is through the tunnel

under Chimney Hill. This tunnel is the 'choke' that controls the discharge from Watermill Creek and likely controls the hydrology of water in the wetlands.

It is understood that poor water quality in ground and/or surface water runoff into Emily Bay has impacted the coral reef off Slaughter Bay (Temperate East Marine Park). Furthermore, water contamination stems from a combination of poorly maintained septic tanks, livestock grazing and erosion. Heavy rainfall mobilises contamination, which travels through ground and/or surface water into Emily Bay, affecting its reef. When rain falls, surface water pools in the wetland to the east of Bounty Street in the Kingston and Arthurs Vale Historic Area, and eventually breaks through a sand plug at the western corner of Emily Bay. This occurred in November 2020 (refer to Figure 1).

The KAVHA on the plain beside Emily Bay, and the catchment above, are the most likely areas for works to reduce the movement of contamination or contaminated water. This catchment area stretches to the hills to the west of Country Road, northward to around Queen Elizabeth Avenue and eastward to Collins Head Road and Driver Christian Road

As the basis of the feasibility study, the Department has provided the following two reports, prepared for Parks Australia and NIRC respectively:

- 2020.0659-RP01 Improving the water quality at Emily Bay Norfolk Island (Bligh Tanner, Dec 2020)
- Upgrade of Norfolk Island's Sewerage Treatment Plant (Balmoral Group Australia and Public Works Advisory, Oct 2019)

Supplementary information provided included:

- Kingston and Arthur's Vale Historic Area, Cultural Landscape Management Plan (GML Heritage, Sep 2019)
- CSIRO Norfolk Island Water Resource Assessment (NIWRA) update (CSIRO, Undated)
- All the dirt on soils (CSIRO PowerPoint Presentation, Feb 2020)
- Biophysical environment and contextual information (extract Acid Sulfate Soils on Norfolk Island) (CSIRO, Undated)
- Groundwater recharge extract from unknown publication (CSIRO, Undated)
- NI Water Assurance Scheme Test Report No. 0039 (Biotec H2O, Dec 2020)
- Microbiological Results Report (CSIRO, Dec 2020)

In addition, AECOM has accessed the following documentation:

- Emily Bay and Upper Cascade Creek Catchments, Norfolk Island Water Quality Study (AECOM, May 2017)
- Norfolk Island Water Quality Study, Emily Bay & Upper Cascade Creek Catchments (URS, May 2013) *
- Norfolk Island LIDAR Sept 2019 data (CSIRO)

* Note that AECOM acquired URS Corporation in 2014.

Salient points (extracted in full) from the Bligh Tanner Report (Section 1.4 Our Understanding) (Bligh Tanner, Dec 2020) include the following:

- Emily Bay suffers from poor water quality as evidenced by algae blooms and coral bleaching
- Groundwater is contaminated, principally due to ongoing use of septic tanks and soakage trenches

- There is limited water quality data that can reliably characterise nutrient concentrations in both surface and groundwaters
- Borehole samples undertaken by CSIRO, which also reflected some testing sites from a 2007 study, indicates that there has been some improvement to groundwater quality. The extent of improvement, the pollutants improved, and the location of these samples are unknown
- Groundwater naturally upwells at Emily and Slaughter Bays
- Dye tracer tests suggests that the residence time of groundwater to the point of discharge is in the order of hours (Department of Local Government and Department of Housing and Construction, 1982). However, discussions with CSIRO indicate that these boreholes were close to a preferential flow path within the rock. The proximity of these two boreholes and complexity of the underlying geology signifies that these behaviours are unlikely to be representative of the whole-of-island groundwater system
- The quality of surface water from the Upper Cascade and Watermill Creek catchments should see progressive improvements due to recent restrictions on livestock access to waterways
- Town Creek has good riparian vegetation that should be providing some treatment to the surface waters
- The water in Town Creek has a low nutrient concentration, but high Enterococcus concentration. This indicates that there may be a connection between groundwater and the wetland
- Reefs are normally resilient to incidental pollution events. The continual deterioration of the reef indicates that there is a combination of stressors. It is likely that contaminated groundwater is acting as a chronic source of pollutants and incidental outbursts of the Emily Bay plug are the 'trigger' to noticeable health incidents. This is further exacerbated by increased temperatures.

The report on the Sewerage Treatment Plant Upgrade ostensibly is a Business Case prepared for the NIRC and recommends a preferred option to replace the existing plant as it is nearing the end of its useful life. The existing sewerage system, known as the Water Assurance Scheme, primarily services the area around Burnt Pine.

Salient points noted in the report include:

- The current plant is expected to completely fail within 5 years (i.e. by 2024)
- Discharge into the Norfolk Island Marine Park is unacceptable to Parks Australia and does not meet the EPA's current guidelines
- Water security is compromised due to declining rainfall and reliance on rainwater tanks and groundwater in the absence of reticulated water supply
- Water quality reports indicate that septic tanks are the cause of contamination in surface water flows that lead into Emily Bay and Slaughter Bay.
- Council has identified Little Cutters Corn and Longridge Estate as priority areas for sewerage connections as these areas discharge to the Kingston Common and directly contribute to the poor water quality (32 houses and 1 tourist accommodation)
- Preferred option is to replace the existing plant with a Membrane Aerated Bio-film Reactor (MABR) treatment plant and pipework. This includes an option to connect Little Cutters Corn and Longridge Estates.

The timing of the Sewerage Treatment Plant Upgrade works is unknown. Nevertheless, the short-term nature of the current feasibility study dictates that no benefits will be forthcoming for a number of years.

3.0 Assessment Process

3.1 Multicriteria Analysis (MCA)

To critically evaluate the long list of options presented, AECOM has used the MCA process that requires identification of the key objectives of the project and criteria (indicators) that will signify the option has value. Each criterion is assigned a numerical score that indicates the relative importance. Given the high-level nature of the assessment, a 3-point scale has been used.

In this instance, the primary indicators which account for the majority of the weighting revolve around two key areas:

- Environmental performance (40%)
- Economic (30%)

However, to further inform the decision, secondary criteria have also been used to broaden the range of issues considered and to better understand risks that may impact the delivery of the design and construction stages. The following criteria have also been used:

- Construction & Constructability (10%)
- Maintenance (5%)
- Social Factors (5%)
- Approvals (5%)
- Local acceptance (5%).

After each option is assessed and assigned a score against the criteria, a sensitivity analysis is undertaken and each criterion 'weighted' against the others when that criteria has an elevated importance (a value of 10% has been adopted). This results in a 'weighted' score and allows the options to be ranked from highest to lowest in order of value for money.

3.2 Assessment Criteria

Following a review of the information provided by the Department and AECOM's understanding, a project specific set of criteria have been developed to allow a high-level assessment of each option. This involves identifying those options which represent value for money, in terms of being viable options, that will provide short-term benefit in improving water quality and can be constructed within the required timeframe (Mar/Apr 2021).

The criteria are listed in Table 1 and a complete list including the basis for scoring in Appendix B.

Table 1: MCA Criteria

CRITERIA				
ID	Category	Criterion	Indicator	Measure
A	Economic	High level construction costs based on preliminary design scope development	High level comparative construction costs (includes measurable items and % CV for unmeasured items, with contingency)	\$
B	Environmental performance	Effectiveness or longevity of the option in improving upstream water quality and preventing stormwater impacts on Emily Bay	Effectiveness of the solution in dealing with long term water quality issue	Qualitative assessment – identified buffers that are known to contribute to pollutant reduction i.e. water passes through wetland vegetation
C	Construction & constructability	Constructability	Constructability of the solution including availability of plant, materials and resources on-island or able to be procured in required timeframe (Mar/Apr 2021).	Assessment of on island capability
D	Maintenance	Expected level of ongoing maintenance over design life	Option provides a solution that can be relatively easily maintained over the design life, nominally 3 to 5 years	Qualitative – frequency and intensity of maintenance activities
E	Social factors	Impact on non-Government property owners and on the community.	Number of property and non-government properties impacted and overall impact on Norfolk Island Regional Council	Number of partial properties
F	Approvals	Requirement for DA or EPBC Act referral	Where excavation is required, it is expected that options will require referral and/or DA approval, which may delay works	Sustainability assessment
G	Local acceptance	Solution is consistent with current visual environment, and is expected to be acceptable to the community	Solution is consistent with the natural and cultural environment of Norfolk Island and is expected to be acceptable to the community	Qualitative assessment based on experience of team and stakeholders

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3.3 Assessment Weightings

Weightings were assigned to each category based on the information provided and the collective inputs of AECOM's project team. Project outcomes and feedback from the Department following the MCA Analysis and Options Assessment meeting on 1 February 2021 lead to the following amended weightings:

- Construction cost weighting increased from 10% to 30%
- Constructability weighting reduced by the same percentage.

To assess the sensitivity of the assigned percentages, analysis was undertaken and each criterion 'weighted' against the others when that criteria has an elevated importance. A value of 10% was adopted for the analysis and results in a 'weighted' score where the effect of increasing each criterion by 10%. This allows the options to be ranked from highest to lowest in order of value for money. MCA weightings are shown in Table 2 below

Sensitivity Testing		A	B	C	D	E	F	G	TOTAL
Sensitivity Case	Description	High level comparable construction costs	Effectiveness or longevity of the option in improving upstream water quality and preventing stormwater impacts on Emily Bay	Constructability	Expected level of ongoing maintenance over design life	Impact on non-Government property owners and on the community.	Requirement for DA or EPBC Act referral	Solution is consistent with current visual environment, and is expected to be acceptable to the community	
Base Case	AECOM Weighting	30.00%	40.00%	10.00%	5.00%	5.00%	5.00%	5.00%	100.0%
1	Economic	40.0%	38.33%	8.33%	3.33%	3.33%	3.33%	3.33%	100.0%
2	Environmental performance	28.33%	50.00%	8.33%	3.33%	3.33%	3.33%	3.33%	100.0%
3	Construction & constructability	28.33%	38.33%	20.00%	3.33%	3.33%	3.33%	3.33%	100.0%
4	Maintenance	28.33%	38.33%	8.33%	15.00%	3.33%	3.33%	3.33%	100.0%
6	Social factors	28.33%	38.33%	8.33%	3.33%	15.0%	3.33%	3.33%	100.0%
7	Approvals	28.33%	38.33%	8.33%	3.33%	3.33%	15.00%	3.33%	100.0%
8	Local acceptance	28.33%	38.33%	8.33%	3.33%	3.33%	3.33%	15.0%	100.0%

Table 2. MCA Weightings

4.0 Options Assessment

4.1 Options

The 18 options presented by Bligh Tanner were used as a starting point for the MCA analysis. A further option, #19, was presented by AECOM and included in the assessment. This option is a variation to #18, (lowering the water levels in the wetland area by discharging polluted water to Headstone Reserve via the existing sewerage treatment plant) except that water would be pumped to nearby available space in the adjacent areas such as Lowlands in the Golf Club and behind the Polynesian Settlement site.

The Bligh Tanner options have been replicated and included in Appendix A.

4.2 Initial scoring

Following an initial assessment and scoring by the AECOM team, the preliminary results were presented to the project stakeholders via a Teams meeting on Monday 1 February 2021. Feedback was received from the Department and Marine Parks Australia. The feedback included local information, commentary on the weightings assigned, initial assessment and scoring, and has been incorporated into the results presented below.

The feedback included a request to consider 2 further options, these have been included in the shortlist (refer to Section 5.1), i.e. they have not been assessed through the MCA process. This is because the additional options were provided after the MCA had been undertaken.

The results, in order of ranking (where the highest score receives the lowest ranking) are presented below in Table 3 and a copy of the unweighted scores for each option against the criteria is included in Appendix C.

Table 3: Summary of MCA results unweighted

Option	Rank	Score
14 Septic tank pump out: Pump out of up to 138 existing septic tanks with waste to be trucked up to existing STP for treatment and release. 12 week scenario assumed to provide environmental protection for the wet season.	1	25
4 Wetland: Excavate areas of Kingston Commons or Lowlands area to construct wetlands, potential to pump and circulate groundwater through the wetland	1	25
13 Leaky weir system: Construction of one/or multiple 'leaky weirs' to help attenuate surface runoff, promote infiltration and minimise waterway erosion, thereby reducing sediment loads	1	25
19 Lowering water levels in wetland areas: Construct services of pumps with lengths of flexi hose to pump water up to nearby open space	1	25
5 Nualgi / diatomix: Treatment with proprietary products to stimulate diatom growth in water body, thus drawing down nutrient levels and limiting nuisance algal growth. Treatment would be applied to existing ponded water at KAVHA with ability to pump and circulate groundwater through waterbody prior to discharge to receiving environment	5	23
2 Package plant: Containerised water treatment plants to remove nutrient and produce water of a suitable quality for release to receiving environment. Potential to reuse treated water for irrigation	5	23

Option	Rank	Score
3 Denitrification trenches: Excavation to pass water through carbon rich anerobic trenches. Potential to use trees on island as carbon source for trench	5	23
6 Macro algae: Deliberate attempt to grow suitable species of freshwater algae to remove nutrients. Treated water could be directly discharged to the reef lagoon or recirculated within the wetland. Algae when grown can be used as fertiliser or sent to landfill	8	21
7 Aeration: Installation of pump to aerate water body	9	19
1 Groundwater dam: Excavation of dam with impermeable sheet or betonite lined trench to limit flow of groundwater to Emily Bay	9	19
8 Golf course: Irrigate existing golf course with a total area of approximately 10 ha	9	19
9 Plantation: Potential to irrigate two existing plantations totalling 7 ha	9	19
16 Upgrade STP: Upgrade of the existing STP	9	19
11 Irrigation of airport green space: Irrigate green space located around existing airport with a total land area of approximately 2 ha	14	17
12 Headstone Reserve discharge: Emergency release of water to Headstone Reserve which has an existing outfall	14	17
15 Extend sewer network: Extension of existing sewer network to service houses currently utilising septic tanks	14	17
17 Flushing of Emily Bay: Construction of a pumping system that would transfer water beyond the reef where it might be dispersed by ocean currents or conversely pumping cool cleaner water from offshore to displace the warmer polluted water	14	17
18 Lowering water levels in wetland areas: Construct services of pumps with lengths of flexi hose to pump water up to existing STP	14	17
10 Emily Bay tidal release: Construct outfall deep underwater to dilute releases to Emily Bay	19	15

4.3 Sensitivity testing (weighting)

The options were then subjected to a sensitivity test based on each criterion being assigned a value 10% higher than the weighting shown in Table 2. For these calculations, in each case when the value was increased by 10%, the weighting of each of the remaining 6 criteria were reduced by 1.67% (10% / 6).

The results in order of ranking are presented in Table 4. A copy of the weighted scores for each option against the criteria is included in Appendix D.

Based on this analysis, a shortlist of 6 options was obtained.

Table 4: Summary of MCA results weighted

Option number / Title	Brief Description	Weighted Score	Ranking
19 Lowering water levels in wetland areas	Construct services of pumps with lengths of flexi hose to pump water up to nearby open space	30.4	1
2 Package plant	Containerised water treatment plants to remove nutrient and produce water of a suitable quality for release to receiving environment. Potential to reuse treated water for irrigation	29.6	2
14 Septic tank pump out	Pump out of up to 138 existing septic tanks with waste to be trucked up to existing STP for treatment and release. 12 week program assumed.	26.4	3
13 Leaky weir system	Construction of one/or multiple 'leaky weirs' to help attenuate surface runoff, promote infiltration and minimise waterway erosion, thereby reducing sediment loads	25.6	4
4 Wetland	Excavate areas of Kingston Commons or Lowlands area to construct wetlands, potential to pump and circulate groundwater through the wetland	25.6	5
16 Upgrade STP	Upgrade of the existing STP	24.1	6
6 Macro algae	Deliberate attempt to grow suitable species of freshwater algae to remove nutrients. Treated water could be directly discharged to the reef lagoon or recirculated within the wetland. Algae when grown can be used as fertiliser or sent to landfill	24.0	7
5 Nualgi / diatomix	Treatment with proprietary products to stimulate diatom growth in water body, thus drawing down nutrient levels and limiting nuisance algal growth. Treatment would be applied to existing ponded water at KAVHA with ability to pump and circulate groundwater through waterbody prior to discharge to receiving environment	23.2	8
8 Golf course	Irrigate existing golf course with a total area of approximately 10 ha	23.2	8
9 Plantation	Potential to irrigate two existing plantations totalling 7 ha	23.2	8
15 Extend sewer network	Extension of existing sewer network to service houses currently utilising septic tanks	23.2	11

Option number / Title	Brief Description	Weighted Score	Ranking
11 Irrigation of airport green space	Irrigate green space located around existing airport with a total land area of approximately 2 ha	22.4	12
3 Denitrification trenches	Excavation to pass water through carbon rich anerobic trenches. Potential to use trees on island as carbon source for trench	20.8	13
1 Groundwater dam	Excavation of dam with impermeable sheet or betonite lined trench to limit flow of groundwater to Emily Bay	19.2	14
18 Lowering water levels in wetland areas	Construct services of pumps with lengths of flexi hose to pump water up to existing STP	18.4	15
12 Headstone Reserve discharge	Emergency release of water to Headstone Reserve which has an existing outfall	18.4	15
7 Aeration	Installation of pump to aerate water body	17.6	17
17 Flushing of Emily Bay	Construction of a pumping system that would transfer water beyond the reef where it might be dispersed by ocean currents or conversely pumping cool cleaner water from offshore to displace the warmer polluted water	17.6	18
10 Emily Bay tidal release	Construct outfall deep underwater to dilute releases to Emily Bay	16.8	19

5.0 Options Assessment

5.1 Shortlisted options

Based on the MCA results, the shortlisted options are shown in Table 5

Table 5. Shortlisted options from MCA

Rank	Option No.	Name	Implement for wet season?
1	# 19	Lowering water levels in wetlands & discharge to land	Yes
2	# 2	Package treatment plant	No
3	# 14	Septic tank pump-out (12 weeks)	Yes
4	# 13	Leaky weir systems	Yes
5	# 4	Constructed Wetland	No
6	# 16	Upgrade STP	No

These options were shortlisted based on the strength of the following criteria:

- Moderate to high environmental performance (the highest weighting in the MCA at 40 %).
- Moderate to high ratings for the other criteria combined.

However, when the requirement to implement the solution prior to the wet season was considered, only the first three options were viable (refer to Table 6).

Table 6. Viable shortlisted options

Rank	Option No.	Name	Implement for wet season?
1	# 19	Lowering water levels in wetlands & discharge to land	Yes
3	# 14	Septic tank pump-out	Yes
4	# 13	Leaky weir systems	Yes

5.2 Additional options by stakeholders

5.2.1 Option 20 Weir/structure to reduce flow rate into Emily Bay

After the MCA had been developed, the Norfolk Island Administrator asked for an additional option (Option 20) to be included – a flow control near the sand plug outlet.

The additional option is for a structure (possibly a weir or sandbag embankment) near the sand plug outlet to Emily Bay behind the Bridge. The structure could contain or slow down the water flow into Emily Bay by blocking the channel and letting water build up behind it in the channel and Kingston commons area. The bridge is heritage listed so the structure would need to be designed to prevent it from collapsing and damaging the heritage bridge, and it would need to be designed to prevent waterlogging the foundations of the bridge. (Coonan, 2021)

This option was not part of the MCA process; however, a description and assessment has been included in more detail in the SWOT analysis.

5.2.2 Option 21 Realign Town Creek to Serpentine Course

A further option was put forward by Brendon Christian, of the Department's Norfolk Island team, during the meeting on 1 February 2021. It was proposed that it could be possible to re-shape Town Creek to run along its original course, rather than the straight course which was constructed circa 1840. The extract from the KAVHA Cultural Landscape Management Plan (GML Heritage, Sep 2019) in Figure 3 shows the historical flow path as it was circa 1835, prior to the straightening works mentioned above.

This option was not part of the MCA process, but a description and assessment has been included below.

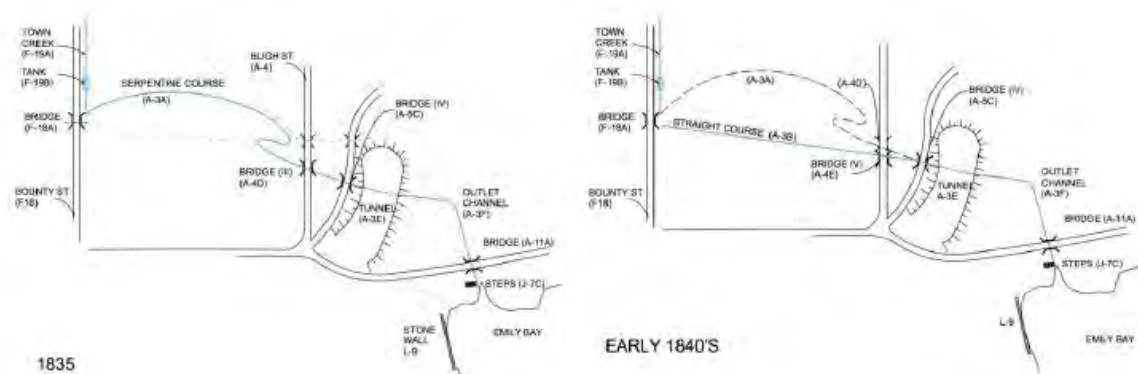


Figure 3: Serpentine Course in 1835 (Source: (CLMP, 2019))

The construction of a channel for Watermill Creek along its original course would involve some excavation and landscape planting, followed by an establishment period of one growing season (i.e. one summer). Once established, water from the current channel could be diverted into the established channel. Water would also be allowed to flow into the existing wetland vegetation in order to sustain the existing wetland hydrology and the plants in this area.

Pollutants can be removed from water in streams through the physical process of particle settling or screening, the chemical process of adsorption to soils and organic matter, and the biological process of uptake and transformation by microbes and plants. It is likely that these processes are active in the KAVHA area wetlands and are responsible for the observed improvements in water quality downstream of the wetlands.

Water quality benefits for in-stream works can only be achieved if there is an increase in the volume of runoff that interacts with the soils and vegetation, as a greater proportion of runoff would be subject to pollutant removal processes. Similarly, if the duration of time that water spends in contact with the wetland vegetation can be increased (detention time), there is the opportunity for enhanced treatment.

If the realigned stream is built with similar dimensions to the existing stream, realigning the stream channel to its original course is unlikely to increase either the volume of runoff that can be held by the stream, or the duration of time that the water spends in contact with the vegetation. Water from the realigned stream would need to be directed into the wetland vegetation to continue to harness the filtration processes that the wetlands provide.

In re-aligning the stream, it may be possible to increase the volume of temporary water storage available amongst the wetland vegetation so that pollutant removal can be enhanced. However, these areas would require excavation and an establishment period before the enhanced filtration can be realised.

Given that this project has limited potential for enhanced pollutant removal, and would require a lengthy establishment phase for the wetland and stream vegetation, it has not been considered further in the SWOT analysis, as it would not yield water quality improvements in the short timeframe required.

5.3 SWOT analysis

The three shortlisted viable options and the additional flow control near the sand plug outlet are considered in further detail as part of a Strengths-Weaknesses-Opportunities-Threats (SWOT) analysis. Herein is a brief summary of the options considered:

- **[Unfeasible] #19 Lowering Water Levels in Wetlands & Discharge to Land.** Not considered feasible because dewatering activities in the past have demonstrated that groundwater recharge rates are too high to be able to maintain a reduced water level in the wetlands.
- **[Preferred option] #14 Septic Tank Pump-out.** Can be commenced immediately, has few risks and is expected to directly reduce contaminants of concern from the catchment. This option is expected to provide the greatest pollutant removal of the shortlisted options because pollutants would be actively removed from the catchment. A 12-week program was assumed to provide environmental protection through most of the wet season.
- **[2nd Preference] #13 Leaky Weir Systems.** Few constraints to implementation, would be expected to reduce contaminants of concern by detaining water in pools and encouraging infiltration, and can be constructed with the materials and skills available on Norfolk Island. This option would provide the third-highest pollutant removal. Although similar to Additional Option 20, the volumes of water detained are expected to be smaller due to the position higher in the catchment, and it would take 1-2 years for vegetation to reach sufficient maturity to contribute substantially to pollutant filtration.
- **[3rd Preference] #20 Flow Control Near Sand Plug Outlet.** The same as for leaky weirs but more risks associated with implementation (potential for flooding and landscape impacts). This option would be expected to reduce contaminants of concern by detaining more water for longer periods in the existing wetlands. This option would provide the second-highest pollutant removal due to the larger potential volumes of water that could be detained at the bottom of the catchment, and the established wetland vegetation already being mature. This option may trigger requirements for approvals due to the larger extent of works and potential for off-site impacts.

Each of these options is described in more detail in the below table.

Table 7 Outcomes of SWOT Analysis

Option #19 Lowering Water Levels in Wetlands & Discharge to Land	
Strengths	<p>Environmental Effectiveness: Moderate level of environmental protection. (AECOM, May 2017) reported that water samples taken downstream of water bodies had reduced pollutant concentrations. Some groundwater is likely to be intercepted by wetland, and this water would also be removed. Disposal on golf course/plantation provides further pollutant removal as pollutants likely to be sequestered by the plant root zone.</p> <p>Approvals: No formal approvals required</p>
Weaknesses	<p>Maintenance: Moderate. Generator will need to be monitored. Pipes will need to be inspected after rain. Land disposal areas should be monitored to ensure there is no erosion or impacts to plant health.</p>
Opportunities	<p>Potential water supply for golf course or other irrigation purpose</p>
Threats	<p>Constructability: Agreements required with landowners for land disposal areas</p> <p>Groundwater Recharge: Anecdotal information suggests that the rapid recharge rates of groundwater into the KAVHA wetlands would make pumping ineffective. Pumping will need to maintain about 0.5 m of available buffer storage in the wetlands, and this is not likely to be achievable given the high recharge rates for groundwater observed during even dry periods. Other unknown parameters such as potential impacts to groundwater and acid sulphate soils make this a riskier option.</p> <p>Groundwater dependent ecosystems: Locally lowering the groundwater could impact nearby ecosystems. However, this should be reversible if pumping is stopped as soon as impacts are noted.</p>

Option #14 Septic Tank Pump-out	
Strengths	<p>Environmental Effectiveness: Moderate. (AECOM, May 2017) study indicated that pathogens are often associated with surface contamination from leaky septic tanks and sewer facilities. Ensuring that septic tanks are operating within their design capacity should reduce contamination of surface runoff. A 12 week program has been assumed for the purposes of assessment. This would provide environmental protection for approximately the duration of the wet season.</p> <p>Approvals: Commonwealth and local approvals unlikely to be required.</p>
Weaknesses	<p>Maintenance: High. Requires 2 staff and sullage trucks in daily operation.</p> <p>Environmental Effectiveness: Environmental protection stops once the pump-out program ceases.</p>
Opportunities	<p>Timeline for Implementation: Can be commenced immediately.</p> <p>Directly supports local economy.</p>
Threats	<p>Constructability: Availability of sullage trucks and staff to be considered. Depending on number of sites identified and the duration of the pump-out program, additional truck may need to be sea-freighted. Two trucks are available on the island and it is expected that these are required to service other septic systems at times.</p> <p>Maintenance: Approval may be required to service tanks on private property.</p> <p>Septic tanks may be in poor condition, which could make maintenance more difficult than anticipated</p> <p>Local Acceptance: The Australian Government is not responsible for private infrastructure, and undertaking such a pump-out service may face criticism and difficulties with residents, as it would only be undertaken on parts of the island (perceived fairness), and access to private property would be required (privacy concerns).</p> <p>Approvals: While unlikely to trigger EPBC as not significant impact on the environment with an improvement of environmental conditions, principal concern will be the ability of the existing Sewage Treatment Plant to treat the increased effluent and increased ocean discharge (impacting on Commonwealth Marine Area).</p>

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Option #13 Leaky Weir Systems	
Strengths	<p>Environmental Effectiveness: Moderate. Leaky weirs are used to help attenuate flow. (AECOM, May 2017) reported that water samples taken downstream of water bodies had reduced pollutant concentrations. Some groundwater also likely to be intercepted by streams and thus treated by pools. Plants will establish in the long-term (one to two growing seasons/summers), further contributing to pollutant removal. From discussions with personnel on island, examples that revegetation and stabilisation is possible with positive outcomes from recent fencing program.</p> <p>Maintenance: Low. Annual inspection coupled with inspections post heavy rainfall events.</p> <p>Timeline for Implementation: Each weir can be constructed in 1-2 weeks.</p> <p>Approvals: Unlikely to require Commonwealth approval.</p>
Weaknesses	<p>LIDAR data was obtained from the CSIRO website, however no detailed hydrology/hydraulic assessment has been undertaken in the optioneering phase. If the Leaky Weir System is taken forward to detailed design AECOM suggests a hydrologic/hydraulic model (TUFLOW or similar modelling software) is undertaken to gain an appreciation of the peak flow and velocities for a range of storm events. If the Department does not have funding or time (model would likely take 2-3 weeks) it is possible to use the Rational Method to determine peak flows/velocities, however it would provide a conservative outcome and would be testing the limitations of the Rational Method given the size of the catchment (~5 km²). The rational method is likely to overestimate peak flows, and cannot provide estimates of velocity, which may result in structures being 'over-engineered'.</p>
Opportunities	<p>Local Acceptance: High. Stream stabilisation will improve the amenity and habitat value of the streams and will reduce erosion.</p>
Threats	<p>Constructability: Availability of materials. Rock and timber can be used. Leaky weirs would require some rock armour even if the weir was made of timber. Rock armour is needed for energy dissipation downstream of the weir crest.</p> <p>Assuming a crest height of 0.5 m, and a timber and rock constructed weir width of approx. 4 m, the length of the rock armour required is about 50 m/weir. Rock size required about D50 of 200 – 250 mm. If timber piling was not used, rock requirements increased by about 50%.</p> <p>Approvals: Likely to require a DA with local impacts assessed through description of the environment.</p> <p>Social Factors: Design would need to consider the impact of the increased water level upstream of the leaky weir, ensuring that no private property is adversely affected.</p>

Additional Option #20 Flow Control Near Sand Plug Outlet	
Description	<p>A flow control could be installed upstream of the outlet hole in the rock. Various locations have been considered in this assessment and the exact placement would depend on this option being preferred, to be developed with further design.</p> <p>Purpose: To retain water for longer periods in the KAVHA area wetlands. The KAVHA wetlands are densely vegetated and would be expected to be providing water filtration in their current condition. (AECOM, May 2017) reported that water samples taken downstream of these water bodies had reduced pollutant concentrations. Some groundwater is also likely to be intercepted by the watercourses upstream and would be thus treated by the wetlands. Therefore, attenuating flows at the outlet allows water to be held for longer in the wetlands and provides an opportunity for a greater volume of water to be treated. The design would focus on retaining small frequent flows and allowing rarer, larger events to bypass. Stormwater quality treatment devices are typically designed for the 1 in 3-month event, which allows 90 % of the mean annual runoff to be treated.</p> <p>Design: Weir designed with a crest level that does not adversely affect upstream government and non-government (private) infrastructure. The weir would be designed to provide an extended detention/temporary water storage with the additional height of storage to be confirmed in detail design. Any water above this height would bypass over the top of the weir. Limiting the extended detention to this height will minimise the impacts of inundation on upstream terrestrial landscapes. The weir would detain water in the wetlands after which it would drain to its normal water level. A further consideration for this option is a sand protection structure, downstream of the rock outlet. This could be used to stabilise the sand plug outlet to the beach. It would comprise nominally rock and geofabric constructed parallel to the existing rock wall.</p> <p>Hydraulic Considerations: If this option is the preferred approach, during detailed design a hydraulic model should be considered to determine the quantity of water able to be detained to set the weir crest height at a level that does not adversely impact upstream private property. Development of a hydraulic model would likely require an additional 2-3 weeks work (about 100 hours full-time equivalent). If the Department does not have funding or time to undertake a hydrologic/hydraulic model it is possible to use the rational method. If it is used, peak flows are likely to be overestimated, with the design of the weir potentially 'over-engineered' to compensate for uncertainty. Using the rational method would require the assumption that the extent of flooding would be estimated from existing LIDAR and the design level of the weir.</p>
Strengths	<p>Environmental Effectiveness: Moderate with an immediate incremental improvement expected. Wetlands on the island are known to provide pollutant removal (AECOM, May 2017). Further engaging the existing wetlands is an efficient means of increasing their filtration capacity. Filtration effectiveness would be ongoing provided that the wetland vegetation and hydrology remained intact.</p> <p>Timeline for Implementation: A flow control (leaky weir and associated earth bunding) would take 3-4 weeks for construction.</p> <p>Constructability: Rock and cement can be used. The quantity of rock and cement required is dependent on the final location of the weir i.e. if weir is located in narrow cross section immediately upstream of the outlet hole less material would be required versus placing the weir further upstream in the lowlands where significantly more fill, rock and cement would be required. A weir placed upstream of the Bay Street bridge is unlikely to impact the bridge or</p>

	<p>its foundations. Geotechnical investigation and structural design would likely be required depending on the final siting of the weir.</p> <p>Maintenance: Low. Periodic landscape inspections coupled with inspections post heavy rainfall events. Terrestrial/turfed landscapes upstream, if more frequently inundated.</p> <p>Approvals: Unlikely to require Commonwealth approval.</p>
Weaknesses	<p>Hydrology/hydraulics needs to be carefully considered to ensure that the weir does not lead to flooding of infrastructure or roads upstream. Weir designs should not create turbulence sufficient to erode the adjacent stream banks.</p> <p>Maintenance: Increased wetness may lead to a change in the vegetation surrounding the wetland areas. Terrestrial/turfed landscapes upstream, if more frequently inundated, may be too wet for routine mowing at times, and may begin to sustain more wetland vegetation. These changes to the park landscape could be accommodated in adaptive landscape design provided the inundated areas are not extensive.</p>
Opportunities	<p>Construction Costs: medium-high (refer to section 4.4.3)</p>
Threats	<p>Approvals: Likely to require a DA with local impacts assessed through a description of the environment.</p> <p>There may also be local requirements to assess the impact of the weir on drainage and flooding in the creek as required in the DA.</p> <p>This option requires a larger extent of works with greater potential to impact the floodplain and surrounding land uses than the leaky weirs option #13.</p> <p>Social Factors: Design would need to consider the impact of the increased water level upstream of the weir, ensuring that no private property or public infrastructure is adversely affected.</p>

5.4 Cost Considerations

Preliminary order of cost estimates have been prepared for the shortlisted options that were considered feasible:

- Option 14 Septic tank pump out (12-week program assumed, representing the approximate duration of the wet season)
- Option 13 Leaky Weirs
- Option 20 Flow control including optional sand protection at Emily Bay

Note: The SWOT analysis determined that Option 19 Lowering Water Levels in Wetlands & Discharge to Land was not considered feasible.

Costs have been based on concept designs with indicative quantities developed by the AECOM team and should be considered as indicative only. A more detailed analysis for the option selected for detailed design will be prepared as part of the next stage of the project.

Construction costs have been calculated using previous rates and industry standard allowances for detail design and documentation, preparation works, traffic management, EMP and preliminaries and overheads (25%) to develop a Construction Cost for each option. Allowances for Administration costs (25%), Contingency (30%) and rounding have also been applied to develop a Net construction Cost.

If the optional sand protection is considered a viable option, given environmental and visual impacts, this could be considered in isolation or in conjunction with any options to be progressed.

5.4.1 Option 14 Septic Tank Pump-out

The scope of work involves pumping out of 138 septic tanks within the catchment area of Kingston as shown in Figure 4. From information provided, the contributing area includes the following:

1. Little Cutters Corn – 12 houses
2. Rooty Hill Road (left hand side) – 13 houses
3. Taylors Road – 17 houses
4. Rooty Hill Road/Collins Head Road – 24 houses
5. Long Ridge – 19 houses, 1 tourist accommodation
6. Middlegate Road – 13 houses
7. Short Ridge – 19 houses
8. 8 Driver Christian Road – 9 houses, 1 tourist accommodation
9. Kingston accommodation (shown by red dots).

Costing has been based on clearing all tanks 6 times over a 12-week period. Information from Bligh Tanner suggests that the 2 trucks could complete a cycle in 10 working days. They do note that there are only 2 sullage trucks on the island, so additional trucks or drivers may be required, depending on commitments. The assumed rate of progress is 10 pump outs per day.

Advice received from PJ Wilson (NIRC) is that the privately owned sullage carts are currently licenced to dispose of the sewerage at the STP with no additional charges. As such, no allowance for disposal of waste has been included in the estimate.

It is considered that data is to be collected based on the septic tank condition and the volumes removed as part of the work .

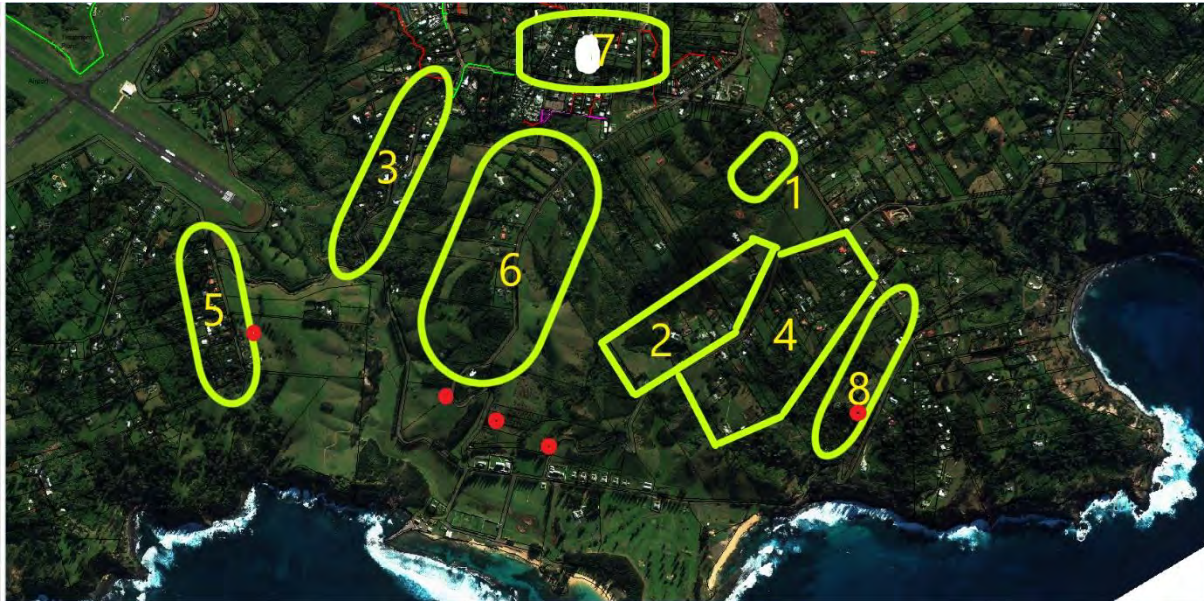


Figure 4: Septic Tanks

5.4.2 Option 13 Leaky weir systems

The scope of works for this option involves the construction of four (4) leaky weirs at the locations shown by Bligh Tanner in their report, as shown in Figure 5 and Figure 6. The locations provided are appropriate from a constructability and potential detention storage point of view i.e. area is relatively easy to get material and personnel into, coupled with the topography of the existing channel providing opportunity to detain water behind weir. Based on those locations, a concept design was developed for costing purposes and is shown in Figure 7.

It should be noted that alternate locations may also be suitable, subject to land tenure, access and constructability considerations. Alternative locations would need further investigation in relation to the topography of the existing flow path and potential impacts on increased afflux on private property.

Advice from the Norfolk Island team on island has indicated that sufficient rock is available and local timber (spotted gum) is available for use. Further advice suggested that fill, topsoil and turf is also available. It has been assumed that geofabric layers required to line the rock aprons, will be available.



Figure 5: Leaky weir locations (Bligh Tanner, Figure 7, 2020)



Figure 6: Long sections at weir locations (Bligh Tanner, Figure 8, 2020)

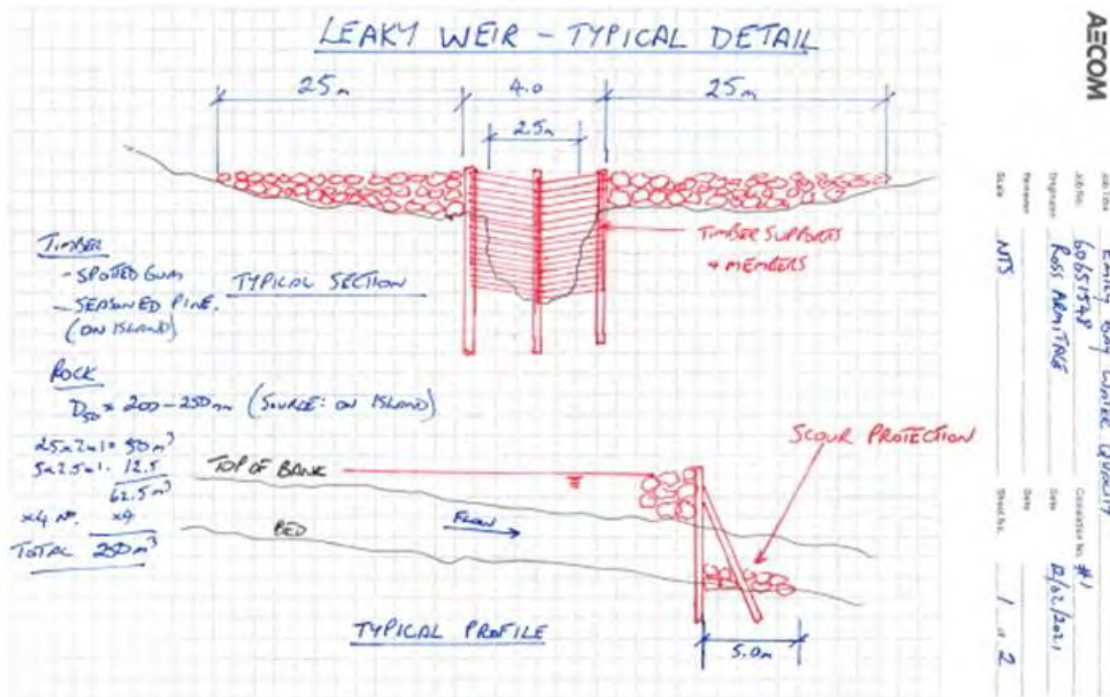


Figure 7: Concept leaky weir for costing purposes

5.4.3 Additional Option 20 Flow control near sand plug outlet.

The scope of works for this option involves the construction of a flow control device, nominally a rock and earth weir upstream of the channel through the rock as shown in Figure 8. A typical detail is shown in Figure 9 and was the basis for costing of this option.

This option would allow a significant retention of flows in major events and a further consideration is a sand protection structure, nominally rock and geofabric constructed parallel to the existing rock wall.

It should be noted that a weir height of 1.0 m has been used. However, the impact of any ponding has not been modelled, but will need to be considered during the detailed design, if this option is selected for the next stage of the project. It is noted that alternate locations have been suggested by the on-island team including upstream of Pier St Bridge or at the entrance to rock tunnel at Chimney. These locations, or alternatives, may be suitable for the final siting of the weir - subject to the effects of upstream detention as well as land tenure, access and constructability considerations.



Figure 8: Flow control weir location

AECOM	Job Title	EMILY BAY WATER QUALITY	Calculation No.	#1
	Job No.	60651547	Date	12/2/2021
	Originator	ROSS ARMITAGE	Date	
	Reviewer		Date	
	Scale	NTS	Sheet No.	2 of 20

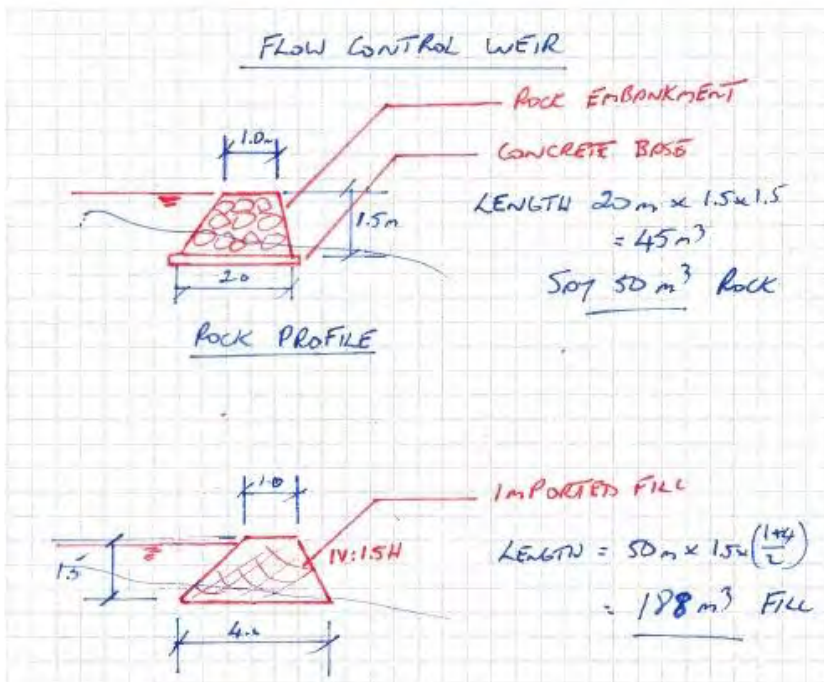


Figure 9: Concept flow control weir for costing purposes

5.4.4 Cost Summary

Based on the above cost considerations, Table 8 summarises the indicative design and construction costs as well as typical industry allowances for the Department's costs (25%) and Contingency (30%).

A copy of the Options Analysis Cost Report is included in Appendix E.

Table 8: summary of option costs

Description	Design and Construction Cost (\$)	Department's Cost 25% (\$)	Contingency 30% (\$)	Total (\$)
Option 14 – Septic tank pump out options (6 pump outs over 12 weeks)*	239,000	Nil	47,800	286,800
Option 13 – Leaky Weirs (4 numbers)	503,125	125,781	189,094	818,000
Option 20 – Flow Control including **	468,075	117,019	174,906	760,000
Sand Protection at Beach	174,375	43,594	65,031	283,000

*The costs for pumping the Septic tanks (incl Contingency) equates to \$47,800 each pump-out for a total of 138 Septic Tanks. If the Council choose to pump out more or less times the cost is scalable. e.g. for 26 pump-outs over 1 year the cost would cost \$1,242,800 excl GST.

**Option #20 costs included in the initial draft to the Client was based on design information that was subsequently superseded and included in the draft report. These costs have now been adjusted to reflect the final scope of work included in this report.

6.0 Recommendations

Based on information available at the time of writing, the only option that is considered feasible to implement immediately is:

- **Option #14 Septic Tank pump-out.** If sullage trucks are available, the septic tank pump-out can be quickly commenced, with immediate reductions of pollutant loads from the catchment at a total net construction cost in the order of \$286,800 excluding GST, which is for 6 rounds of pump outs. The cost is scalable with each round costing \$47,800.

Implementation of the other preferred options depend on resolution of the threats listed in the SWOT analysis above. These are:

- **Option #13 Leaky weir systems¹.** If suitable materials are available, in-stream stabilisation works such as leaky weirs can be built with little impact to other land uses, and no need for approvals. This option has a very low risk of negative impacts to external or downstream areas at a total net construction cost in the order of \$818,000 excluding GST.
- **Additional Option #20 Flow control near sand plug outlet.** If approvals are not required for the construction of an in-stream weir, a weir (likely rock) could be installed within a few weeks. Since the impacts of a weir cannot be assessed within the scope of this project stage, it is suggested a hydraulic model is undertaken for the broader regional catchment before recommending a low weir to optimise water detention. As mentioned in the SWOT analysis, this option carries some risk of negative impacts to the upstream areas at a total net construction cost in the order of \$760,000, excluding the sand protection works (separated, shown below) and GST.

Sand protection works. If suitable materials are available, the sand protection works can be built within a few weeks with minimal impact. The sand protection works have been estimated to be in the order of \$283,000 excluding GST.

The next phase includes developing a detailed design of the preferred option, pending the Department's confirmation on the assessment of the options.

¹ No allowance has been made to do hydraulic modelling, however if leaky weirs is option that proceeds to detailed design an assessment of peak flows/velocities will need to be carried out – likely via rational method. Given the tight timeframe we would likely need 2-3 weeks to undertake a hydraulic model.

7.0 References

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Appendix A

Bligh Tanner Options

Extract from Bligh Tanner Report (Section 2.)

Option No.	Option	Option	Commentary	Implementable before summer	Effectiveness at protecting Emily Bay
1	Interception	Groundwater dam	<p>This prevents the intrusion of polluted groundwater by installing an impermeable sheet or bentonite filled trench to limit the flow of groundwater into Emily Bay. In isolation, this measure would lead to raised groundwater levels and so would need to be coupled with a treatment and disposal measure.</p> <p>This option would require excavation works within KAVHA which could involve complex and lengthy approvals, although the finished works would be largely invisible. Appropriate erosion and sediment control should prevent the large release of sediments into the bay during construction.</p>	N	M
2	Treatment	Package plant	<p>Several containerised water treatment plants are capable of advanced nutrient removal and producing water of suitable quality for release. A key challenge will be the transportation and delivery of the package plant. The plant would be most effective treating a consistent flow of water and may not provide effective treatment in larger storm events.</p> <p>Treated water would likely need to be used for golf course irrigation and any excess discharged into the bay. It could also be used to treat wastewater from the KAVHA properties.</p>	N	H
3		Denitrification trenches	<p>An experimental technology which passes water through a carbon rich, anaerobic trench. This water completes the denitrification cycle and converts nitrates and ammonia to nitrogen gas. Trials in Queensland sugarcane farms show promising results, with up to 44% nitrate removal efficiency and averaging 3.4g/m³/day nitrate with a 2.5 hr residence time.</p> <p>The CLMP notes an issue with excess Norfolk Pines in KAVHA, so those trees could be used as the source of woodchips. This option would require excavation works within KAVHA which could involve complex and lengthy approval, although the finished works would be largely invisible.</p>	N	M

AECOM

Stormwater Mitigation Works on Norfolk Island
Water Quality Improvements in Emily Bay
Commercial-in-Confidence

B

Option No.	Option	Option	Commentary	Implementable before summer	Effectiveness at protecting Emily Bay
4		Wetland	<p>A portion of the Kingston Commons or Lowlands areas could be re-established as wetlands, similar to pre-European settlement. This wetland will be able to treat surface water from the upstream catchment and provide some detention to prevent uncontrolled release of freshwater into the bay. Groundwater could also be pumped and circulated through the wetland.</p> <p>A wetland would also take up to two years to establish, and water quality performance is variable. The CRC Water Sensitive Cities recently reported that it is unclear whether constructed wetlands effectively remove a significant amount of nitrogen from stormwater over time.</p> <p>This option would require excavation works within KAVHA which could involve complex and lengthy approval.</p>	N	L
5		Nualgi / diatomix	<p>There are a range of proprietary products that can be used to stimulate diatom growth in water bodies, thereby drawing down nutrient levels and limiting nuisance algal growth. There is limited data on the efficacy of treating larger scale waterbodies or more complex ecological systems, as these are commonly used in ornamental ponds. Parks Australia believes that this option would trigger an Environmental Impact Assessment.</p> <p>This treatment could be applied to the existing ponded water at KAVHA, and groundwater could also be pumped and circulated through the waterbody prior to release.</p> <p>It would likely be a relatively cheap measure with limited side effects and could be implemented quickly as a short-term no-regrets measure.</p> <p>The product comes in 5 L jerry cans and needs to be continually dosed. Assuming a dosage of about 5 l/week based on suppliers estimates, the cost would be about \$1,000/week. A solar powered automated dosing system costs about \$10,000 ex Brisbane.</p>	N	Unknown

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Option No.	Option	Option	Commentary	Implementable before summer	Effectiveness at protecting Emily Bay
6		Macro algae	Remediation of wastewater by macroalgae is a process whereby a suitable species of freshwater algae is deliberately grown to remove nutrients (nitrogen and phosphorus) from contaminated water. There are some recent full scale trials (for example at Home Hill in Burdekin Shire Council) where a particular species of macroalgae (believed to be Oedogonium) is being used to remove nutrients from secondary treated wastewater to minimise the export of nutrients to the Great Barrier Reef. Our concept would be to construct a temporary pond through which water is circulated to "feed" the algae. Treated water could be directly discharged to the reef lagoon or recirculated within the wetland. Algae when grown can be used as a fertiliser or sent to landfill.	N	M
7		Aeration	This is a strategy that is often implemented in ponds in urban cities, although their ability to reduce nutrient concentrations is not well studied. It is unlikely that much denitrification would occur and so the benefits to Emily Bay are likely to be limited. This option would require a pump to operate.	Y	L
8	Disposal of surface / groundwater	Golf course	There is over 10 ha of turf that could be irrigated. Care would be required to ensure that no ponding or runoff occurs. Deep drainage could still discharge into Emily Bay and Cemetery Bay, which anecdotally remains in good condition. Public access presents a significant limitation to this option (the club may need to close). NIRC will need to produce an agreement contract with the property owner.	N	H

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Option No.	Option	Option	Commentary	Implementable before summer	Effectiveness at protecting Emily Bay
9		Plantation	Two plantations totalling 7 ha have been identified near Rooty Hill Road and Country Road, which will have high potential for water uptake. Consideration into effluent storage will be required. Low public exposure. PFAS mobilisation was flagged as an issue. NIRC will need to produce an agreement contract with the property owner. It is recommended for MEDLI modelling to be undertaken to better understand the impacts of irrigation with effluent on the underlying soils and groundwater.	N	H
10		Emily Bay tidal release	The outfall will need to be placed deep underwater to ensure that sufficient dilution occurs and will need to withstand ocean currents. Likely to have significant implications on design and cost of outfall. If progressed, it is recommended that a coastal engineer be engaged to provide technical advice regarding the feasibility and engineering requirements of the outfall to prevent the risk of backwashing into Emily Bay.	N	M
11		Irrigation of airport green space	Excess runoff could be managed by irrigating the surrounding land (2 ML over 20 ha). This does not provide substantial improvements to water quality, and percolation into the groundwater system may still discharge into the bay. As elevated levels of PFAS have been detected adjacent to the airport, there is a risk of mobilising PFAS with irrigation. Low public exposure. It is recommended for MEDLI modelling to be undertaken to better understand the impacts of irrigation with effluent on the underlying soils and groundwater.	N	H

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Option No.	Option	Option	Commentary	Implementable before summer	Effectiveness at protecting Emily Bay
12		Headstone Reserve discharge	Environmental Authority could allow for emergency release jurisdiction. The existing ocean outfall allows for the rapid dilution of polluted water. Reduced environmental risk.	N	H
13	Preventative Measures	Leaky weir system	As recommended in Water Quality in the KAHVA Catchment, leaky weir systems could be installed downstream of Watermill Dam. This would help attenuate surface runoff, promote infiltration and minimise waterway erosion, thereby reducing sediment loads (not noted as a pressing issue). The benefits to Emily Bay are likely be modest, as polluted water infiltrating into the groundwater would still ultimately discharge into the bay, and there is no evidence to suggest much nutrient attenuation would occur within the groundwater system. This option is permitted under the existing Cultural Landscaping Management Plan.	Y	M

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Option No.	Option	Option	Commentary	Implementable before summer	Effectiveness at protecting Emily Bay
14		Septic tank pump out	<p>There is potential for septic tanks to be frequently pumped out and transferred to the STP, which will reduce land disposal and prolonged system leakages. There are currently two 2.5 kL pump out trucks on the island, and Council estimates that there are 138 properties that discharge near Town Creek. Conversations with local operators suggest that these tanks could be emptied within a fortnight, assuming ten pump outs per day. We have also estimated that each septic tank would reach full capacity in ten days. This means that this pumping regime would be very time sensitive and have minimal allowance for delays. Importing additional trucks is recommended to increase pump out capacity.</p> <p>This strategy does not address the existing body of polluted water in the Town Creek Wetland. There is also likely to be a significant lag between starting the pump out scheme and observable improvements in water quality in Emily Bay due to existing groundwater contamination.</p> <p>Future assessment of logistics and operating costs and CO2 emissions is recommended.</p>	Y	M
15		Extend sewer network	Refer to Upgrade of Norfolk Island's Sewerage Treatment Plant Business Case Report	N	H
16		Upgrade STP	Refer to Upgrade of Norfolk Island's Sewerage Treatment Plant Business Case Report	N	H

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Option No.	Option	Option	Commentary	Implementable before summer	Effectiveness at protecting Emily Bay
17	Other	Flushing of Emily Bay	<p>There is already nutrient rich water in Emily Bay as shown by the deterioration of the reef. The Draft SIMS report found “evidence of high seawater turnover within the Slaughter and Emily Bay lagoons, with low residence time, high tidal variation (at time of survey) and connectivity between the inshore and offshore lagoonal waters.”</p> <p>A pumping system that transfers this water beyond the reef where it might be dispersed by ocean currents (or conversely, pumping cooler cleaner water from offshore to displace the warmer, polluted water) could mitigate this issue. The volumes of water would be substantial although the pumping head is low. The system would involve significant technical investigations to determine its feasibility, including understanding coastal dynamics, pipeline and pumping system design.</p>	N	Unknown
18	From Bligh Tanner Addendum B	Lowering water levels in wetland areas	<p>Migration pathways and bacterial loadings suggests the contaminated groundwater is the source of pollutants. Partial removal of polluted water from the Town Creek wetland will mitigate the risk of overflows and increase surface water capacity. Discharge to Headstone Reserve via the STP is an option.</p>	N	M

Appendix B

MCA Criteria and Weightings

CRITERIA					SCORING		
ID	Category	Criterion	Indicator	Measure	5 Most desirable	3 Moderate	1 Undesirable
A	Economic	High level comparable construction costs	High level comparative construction costs (includes measurable items and % CV for unmeasured items, with contingency)	\$	Comparative opinion of high-level construction cost <\$500k (Costing estimate based on AECOM team experience)	Comparative opinion of high-level construction cost >\$500k to < \$1M (Costing estimate based on AECOM team experience)	Comparative opinion of probable construction cost >\$1M (Costing estimate based on AECOM team experience)
B	Environmental performance	Effectiveness or longevity of the option in improving upstream water quality and preventing stormwater impacts on Emily Bay	Effectiveness of the solution in dealing with long term water quality issue	Qualitative assessment – identified buffers that are known to contribute to pollutant reduction i.e. water passes through wetland vegetation	Options provides long term solution to water quality issue (3+ years)	Option provides medium term solution to water quality (1-3 years)	Option provides short term solution to water quality issue (< 1 year)
C	Construction & constructability	Constructability	Constructability of the solution including availability of plant, materials and resources on-island or able to be procured in required timeframe (Mar/Apr 2021).	Assessment of on island capability	All plant, materials and resources are available and have capacity in the required timeframe (Advice from Norfolk Island Team required)	Option requires an item/s of specialised plant, materials or resources from off island and may be available in the required timeframe (Advice from Norfolk Island Team required)	Option requires procurement of specialist plant, materials or resources from off island and is not expected to be available in the required timeframe (Advice from Norfolk Island Team required)
D	Maintenance	Expected level of ongoing maintenance over design life	Option provides a solution that can be relatively easily maintained over the design life, nominally 3 to 5 years	Qualitative – frequency and intensity of maintenance activities	Option requires only minimal routine maintenance (e.g. annual cleaning) over the design life (Qualitative estimate only)	Option requires spasmodic routine maintenance (e.g. bi-annually, after rainfall events etc) over the design life (Qualitative estimate only)	Option requires regular ongoing routine maintenance (e.g. fortnightly/monthly) over the design life (Qualitative estimate only)
E	Social factors	Impact on non-Government property owners and on the community.	Number of property and non-government properties impacted and overall impact on Norfolk Island Regional Council	Number of partial properties	No impact to private properties (existing businesses/residential property), Limited impact on NIRC (AECOM to provide number of properties impacted)	Some properties impacted including minor resumptions to businesses, moderate impact on NIRC (AECOM to provide number of properties impacted)	Significant number of properties impacted including sensitive properties and businesses. Resumptions possibly lead to delays in project approvals. Significant impact on NIRC (AECOM to provide number of properties impacted)
F	Approvals	Requirement for EPBC Act referral or Development approval*	Where excavation is required, it is expected that options will require referral and/or DA approval, which may delay works	Sustainability assessment	Option has minimal impact and no requirement for referral and/or DA approval	Option may be permitted under the existing Cultural Landscaping Management Plan so no detailed assessment of heritage impacts and required referral and/or DA approval is expected prior to construction	Option will require detailed assessment of heritage impacts and required referral and/or DA approval prior to construction
G	Local acceptance	Solution is consistent with current visual environment, and is expected to be acceptable to the community	Solution is consistent with the natural and cultural environment of Norfolk Island and is expected to be acceptable to the community	Qualitative assessment based on experience of team and stakeholders	Option provides a non-intrusive visual impact to the locality and is unlikely to be supported by the community	Option may be opposed by some of the community based on the size of the footprint, construction materials or visual amenity	Option is likely to be opposed by the community based on the size of the footprint, construction materials or visual amenity

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*Approvals and Permits

There are two pathways that may require approval for any works undertaken:

a. **Commonwealth Approval (EPBC Act)**

EPBC Approvals

A referral is required under the EPBC Act if actions may result in significant impact to:

- national environmental matters (threatened species and communities, heritage),
- Commonwealth land
- or actions by the Commonwealth.

A self-assessment can be undertaken to consider if there is likely to be a significant impact that would require a referral to be submitted to DAWE.

The location where the works are proposed are already highly disturbed and unlikely to contain any significant populations of threatened species or communities.

From a whole of environment perspective, the works have the potential for minor change in the vegetation species and population. However, this will likely result in changes of exotic and endemic species that will be localised and have little difference on the functions of the ecological system.

Impacts to Commonwealth marine areas will be net positive as a result of the proposed works. With the intention of the works to reduce nutrient and contaminant loading through increasing holding time and microbial action, there will be an improvement to the groundwater and surface water discharge to the bay.

b. **Local Approvals (Public reserve, building application, development application)**

Development Approval

All uses, developments and activities on land identified under the KAVHA heritage overlay may only be carried out with development approval (even if allowed for based on the land use zone as per the tables of use or development in the Norfolk Island Plan). Exemption is possible where the activities are undertaken under an approved conservation management, public reserves or other plan or where an executive member is satisfied that the activity would not adversely affect the heritage significance of any land. It is possible that exemption could be gained through the executive member pathway as the proposed works would not result in impacts to heritage values.

If a development approval is required, an analysis of the environmental impacts will be required. The depth of the impact analysis may range from a description of the environment through to an Environmental Impact Statement as provided for in the local regulations. Engagement with Council will be required to determine the level and extent of environmental assessment that is required.

Appendix C

MCA Unweighted Scores

Option number / Title	Brief Description	A	B	C	D	E	F	G	Unweighted Scores
		High level comparable construction costs	Effectiveness or longevity of the option in improving upstream water quality and preventing stormwater impacts on Emily Bay	Constructability	Expected level of ongoing maintenance over design life	Impact on non-Government property owners and on the community.	Requirement for DA or EPBC Act referral	Solution is consistent with current visual environment, and is expected to be acceptable to the community	
19 Lowering water levels in wetland areas	Construct services of pumps with lengths of flexi hose to pump water up to nearby open space	5	3	5	3	3	3	3	25
14 Septic tank pump out	Pump out of up to 138 existing septic tanks with waste to be trucked up to existing STP for treatment and release	3	3	5	1	3	5	5	25
13 Leaky weir system	Construction of one/or multiple 'leaky weirs' to help attenuate surface runoff, promote infiltration and minimise waterway erosion, thereby reducing sediment loads	3	3	3	3	3	5	5	25
4 Wetland	Excavate areas of Kingston Commons or Lowlands area to construct wetlands, potential to pump and circulate groundwater through the wetland	3	3	3	3	5	3	5	25
2 Package plant	Containerised water treatment plants to remove nutrient and produce water of a suitable quality for release to receiving environment. Potential to reuse treated water for irrigation	3	5	1	3	5	1	5	23
5 Nualgi / diatomix	Treatment with proprietary products to stimulate diatom growth in water body, thus drawing down nutrient levels and limiting nuisance algal growth. Treatment would be applied to existing ponded water at KAVHA with ability to pump and circulate groundwater through waterbody prior to discharge to receiving environment	5	1	3	1	5	3	5	23
3 Denitrification trenches	Excavation to pass water through carbon rich anaerobic trenches. Potential to use trees on island as carbon source for trench	1	3	3	3	3	5	5	23
6 Macro algae	Deliberate attempt to grow suitable species of freshwater algae to remove nutrients. Treated water could be directly discharged to the reef lagoon or recirculated within the wetland. Algae when grown can be used as fertiliser or sent to landfill	3	3	3	1	3	3	5	21
16 Upgrade STP	Upgrade of the existing STP	1	5	1	3	3	1	5	19
8 Golf course	Irrigate existing golf course with a total area of approximately 10 ha	3	3	3	3	1	3	3	19
9 Plantation	Potential to irrigate two existing plantations totalling 7 ha	3	3	3	3	1	3	3	19
1 Groundwater dam	Excavation of dam with impermeable sheet or bentonite lined trench to limit flow of groundwater to Emily Bay	1	3	3	3	3	1	5	19
7 Aeration	Installation of pump to aerate water body	3	1	3	3	3	3	3	19
15 Extend sewer network	Extension of existing sewer network to service houses currently utilising septic tanks	1	5	1	3	1	1	5	17
11 Irrigation of airport green space	Irrigate green space located around existing airport with a total land area of approximately 2 ha	3	3	3	3	1	1	3	17
18 Lowering water levels in wetland areas	Construct services of pumps with lengths of flexi hose to pump water up to existing STP	1	3	3	3	3	1	3	17
12 Headstone Reserve discharge	Emergency release of water to Headstone Reserve which has an existing outfall	1	3	3	3	3	1	3	17
17 Flushing of Emily Bay	Construction of a pumping system that would transfer water beyond the reef where it might be dispersed by ocean currents or conversely pumping cool cleaner water from offshore to displace the warmer polluted water	1	3	1	3	5	1	3	17
10 Emily Bay tidal release	Construct outfall deep underwater to dilute releases to Emily Bay	1	3	1	3	5	1	1	15

Appendix D

MCA Weighted Scores

Option number / Title	Brief Description	Unweighted Scores	Weighted Scores									Weighted Score	Ranking
			AECOM Weighting	Economic	Environmental performance	Construction & constructability	Maintenance	Social factors	Approvals	Local acceptance			
19 Lowering water levels	Construct services of pumps with lengths of flexi hose to pump water up to nearby open space	25	3.80	3.97	3.73	3.97	3.73	3.73	3.73	3.73	30.4	1	
2 Package plant	Containerised water treatment plants to remove nutrient and produce water of a suitable quality for release to receiving environment. Potential to reuse treated water for irrigation	23	3.70	3.67	3.90	3.43	3.67	3.90	3.43	3.90	29.6	2	
14 Septic tank pump out	Pump out of up to 138 existing septic tanks with waste to be trucked up to existing STP for treatment and release	25	3.30	3.23	3.23	3.47	3.00	3.23	3.47	3.47	26.4	3	
13 Leaky weir system	Construction of one/or multiple 'leaky weirs' to help attenuate surface runoff, promote infiltration and minimise waterway erosion, thereby reducing sediment loads	25	3.20	3.13	3.13	3.13	3.13	3.13	3.37	3.37	25.6	4	
4 Wetland	Excavate areas of Kingston Commons or Lowlands area to construct wetlands, potential to pump and circulate groundwater through the wetland	25	3.20	3.13	3.13	3.13	3.13	3.37	3.13	3.37	25.6	5	
16 Upgrade STP	Upgrade of the existing STP	19	3.00	2.80	3.27	2.80	3.03	3.03	2.80	3.27	24.0	6	
6 Macro algae	Deliberate attempt to grow suitable species of freshwater algae to remove nutrients. Treated water could be directly discharged to the reef lagoon or recirculated within the wetland. Algae when grown can be used as fertiliser or sent to landfill	21	3.00	3.00	3.00	3.00	2.77	3.00	3.00	3.23	24.0	6	
8 Golf course	Irrigate existing golf course with a total area of approximately 10 ha	19	2.90	2.93	2.93	2.93	2.93	2.70	2.93	2.93	23.2	8	
9 Plantation	Potential to irrigate two existing plantations totalling 7 ha	19	2.90	2.93	2.93	2.93	2.93	2.70	2.93	2.93	23.2	8	
5 Nualgi / diatomix	Treatment with proprietary products to stimulate diatom growth in water body, thus drawing down nutrient levels and limiting nuisance algal growth. Treatment would be applied to existing ponded water at KAVHA with ability to pump and circulate groundwater through waterbody prior to discharge to receiving environment	23	2.90	3.10	2.63	2.87	2.63	3.10	2.87	3.10	23.2	8	
15 Extend sewer network	Extension of existing sewer network to service houses currently utilising septic tanks	17	2.90	2.73	3.20	2.73	2.97	2.73	2.73	3.20	23.2	11	
11 Irrigation of airport grounds	Irrigate green space located around existing airport with a total land area of approximately 2 ha	17	2.80	2.87	2.87	2.87	2.87	2.63	2.63	2.87	22.4	12	
3 Denitrification trenches	Excavation to pass water through carbon rich anaerobic trenches. Potential to use trees on island as carbon source for trench	23	2.60	2.33	2.57	2.57	2.57	2.57	2.80	2.80	20.8	13	
1 Groundwater dam	Excavation of dam with impermeable sheet or bentonite lined trench to limit flow of groundwater to Emily Bay	19	2.40	2.20	2.43	2.43	2.43	2.43	2.20	2.67	19.2	14	
18 Lowering water levels	Construct services of pumps with lengths of flexi hose to pump water up to existing STP	17	2.30	2.13	2.37	2.37	2.37	2.37	2.13	2.37	18.4	15	
12 Headstone Reserve di	Emergency release of water to Headstone Reserve which has an existing outfall	17	2.30	2.13	2.37	2.37	2.37	2.37	2.13	2.37	18.4	15	
7 Aeration	Installation of pump to aerate water body	19	2.20	2.23	2.00	2.23	2.23	2.23	2.23	2.23	17.6	17	
17 Flushing of Emily Bay	Construction of a pumping system that would transfer water beyond the reef where it might be dispersed by ocean currents or conversely pumping cool cleaner water from offshore to displace the warmer polluted water	17	2.20	2.03	2.27	2.03	2.27	2.50	2.03	2.27	17.6	18	
10 Emily Bay tidal release	Construct outfall deep underwater to dilute releases to Emily Bay	15	2.10	1.97	2.20	1.97	2.20	2.43	1.97	1.97	16.8	19	

Appendix E

Preliminary Order of Cost Estimate Report

Water Quality Improvements in Emily Bay

Option Analysis Cost Report

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 Water Quality Improvements in Emily Bay
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Water Quality Improvements in Emily Bay

Option Analysis Cost Report

Client: Department of Infrastructure, Transport, Regional Development and Communications

ABN: 86 267 354 017

Prepared by

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 Water Quality Improvements in Emily Bay
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Document Water Quality Improvements in Emily Bay

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Date 23-Feb-2021

Prepared by s 47F

Reviewed by s 47F

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
0	12-Feb-2021	Draft Issue	s 47F	
1	23-Feb-2021	Revised Draft Issue		

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Stormwater Mitigation Works on Norfolk Island
Water Quality Improvements in Emily Bay
Commercial-in-Confidence**D R A F T****Table of Contents**

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	Cost Breakdown	A

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1.0 Introduction

This Preliminary Order of Cost Estimate for the Option Analysis has been prepared for the Department of Infrastructure, Transport, Regional Development and Communications for the proposed stormwater mitigation works located at Norfolk Island.

This report has been prepared from the documents listed in Section 4.0 of the report. We have also attached those documents in Appendix B.

A summary of cost for the options for the water quality improvement works are as shown in Section 2.0 of this report.

No allowance has been made for GST. Please note the inclusions, exclusions and assumptions made in preparing for this report is listed under Section 3.0.

2.0 Costs

2.1 Option Analysis

Table 1 Estimated Cost Summary

Description	Design and Construction Cost (\$)	*Client Cost (25%)	Contingency (30%)	Total (\$)
Construction Costs				
Option 14 – Septic tank pump out options (6 pump outs over 12 weeks)	239,000	Nil	47,800	286,800
Option 13 – Leaky Weirs (4 numbers)	503,125	125,781	189,094	818,000
Option 20 – Flow Control	468,075	117,019	174,906	760,000
Option 20a – Sand protection at beach	174,375	43,594	65,031	283,000

* Client cost is currently an allowance and it covers for the department's administration, supervision, travel, legal, media and any PR cost, general expenses and any other costs incurred by the department relating to this project.

Detail cost breakdown also attached in Appendix A.

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3.0 Inclusions, Assumptions and Exclusions

3.1 Generally

The following was assumed and included:

- Head Contractor's Preliminaries including Overhead and Margin – 25%
- No Locality Factor – assume local labour, plant and material available
- No allowance for the effects / impacts of Covid-19
- Allowance for Detail Design and Investigation Works (Geotech, survey, heritage, etc.)
- Excludes Engineer's Supervision
- Client supervision and administration costs – 25%
- Contingency allowance at 20% for pump out option and 30% for others
- No allowance for Goods and Services Tax (GST)
- No allowance for escalation
- This estimate excludes any allowance for after-hours work
- Materials to be sources locally where possible
- Labour to be sources locally where possible
- No allowance for any services diversion works
- The estimate assumes work will be competitively tendered
- No allowance for any removal of contaminated or hazardous materials
- No allowance for any structural upgrade works
- No allowance for any architectural feature

4.0 Information Used in Preparing the Estimate

The following information is used in preparing the 100% Design Estimate, refer to Appendix B:

- AECOM's Draft Water Quality Improvements in Emily Bay Report dated 5 Feb 2021
- AECOM's Memo for shortlisted options for costing dated 8 Feb 2021

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Appendix A

Cost Breakdown

Project : Norfolk Island

Cost Plan : Water Quality Improvement Works Emily Bay

Revision : Initial



PROJECT SUMMARY

Item	Description	Quantity	Unit	Rate	Total
	<p><u>NORFOLK ISLAND</u></p> <p>STORMWATER MITIGATION WORKS</p> <p><u>Option Analysis</u></p> <p>Opt 14 - Septic tank pump out option</p> <p>Opt 13 - Leaky Weirs (4 No.)</p> <p>Opt 20 - Flow Control</p> <p>Opt 20a - Sand Protection at Beach</p>				<p>286,800</p> <p>818,000</p> <p>760,000</p> <p>283,000</p>

Project : Norfolk Island

AECOM

Cost Plan : Water Quality Improvement Works Emily Bay

Revision : Initial

Opt 14 - Septic tank pump out option

Item	Description	Quantity	Unit	Rate	Total
	<u>BREAKDOWN OF OPTION 14 - SEPTIC TANK PUMP OUT</u>				
	<i>6 Pump outs over 12 weeks</i>				
1	Pump out with 2 x 2.5kL pump out truck	6	No.	39,834.00	239,004
2	Contingency (20%) - each pump out	6	No.	7,966.00	47,796
	TOTAL NET CONSTRUCTION COST				286,800

Project : Norfolk Island

AECOM

Cost Plan : Water Quality Improvement Works Emily Bay

Revision : Initial

Opt 13 - Leaky Weirs (4 No.)

Item	Description	Quantity	Unit	Rate	Total
	<u>SUMMARY OF OPTION 13 - LEAKY WEIRS (4 NO.)</u>				
1	Detail Design and Documentation	1	Item	91,000.00	91,000
2	Site Establishment	1	Item	5,000.00	5,000
3	Implementation Environmental Management Plan	1	Item	7,500.00	7,500
4	Allowance for traffic / safety management	1	Item	10,000.00	10,000
5	Preparation Works incl shoring and dewatering	1	Item	100,000.00	100,000
6	Construct Weirs	1	Item	175,000.00	175,000
7	Reinstate Vegetation	600	m2	15.00	9,000
8	Allowance for maintenance	1	Item	5,000.00	5,000
9	Preliminaries and Overheads	25	%	402,500.00	100,625
	Subtotal Construction Cost				503,125
	Locality Allowance - assume local labour and material				Excluded
	Escalation				Excluded
10	DIRDC Administration Costs	25	%	503,125.00	125,781
11	Contingency	30	%	628,906.25	188,672
12	Rounding	1	Item	422.00	422
	TOTAL NET CONSTRUCTION COST				818,000

Item	Description	Quantity	Unit	Rate	Total
Project : Norfolk Island					
Cost Plan : Water Quality Improvement Works Emily Bay					
Revision : Initial					
Opt 13 - Leaky Weirs (4 No.)					
<u>Detail Design and Documentation</u>					
<u>BREAKDOWN OF DESIGN AND INVESTIGATION WORKS, ITEM IN OPTION 13 - LEAKY WEIRS (4 NO.)</u>					
1	Survey	1	Item	5,000.00	5,000
2	Geotechnical Investigation	1	Item	15,000.00	15,000
3	Detailed design, drawings, specifications	1	Item	15,000.00	15,000
4	Heritage review & approvals	1	Item	10,000.00	10,000
5	Contract documentation	1	Item	10,000.00	10,000
6	Expenses (travel, accommodation etc.)	1	Item	6,000.00	6,000
7	Site Investigation	1	Item	30,000.00	30,000
Total					91,000
<u>Preparation Works incl shoring and dewatering</u>					
<u>BREAKDOWN OF PREPARATION WORKS, ITEM IN OPTION 13 - LEAKY WEIRS (4 NO.)</u>					
8	Allow for minor temporary shoring and removal at completion (PROVISIONAL)	4	Item	10,000.00	40,000
9	Allowance for dewatering (Provisional)	4	Item	5,000.00	20,000
10	Excavate and remove soil	4	Item	10,000.00	40,000
Total					100,000
<u>Construct Weirs</u>					
<u>BREAKDOWN CONSTRUCTION OF WEIRS, ITEM IN OPTION 13 - LEAKY WEIRS (4 NO.)</u>					
<u>Leaky Weirs</u>					
11	Timber pile	36	m	200.00	7,200
12	Pile driver (1 day each)	32	Hrs	200.00	6,400
13	250 x 75 unseasoned pine	200	m	140.00	28,000
14	Labour (4men x 8hrs x 2.5 days each)	320	Hrs	70.00	22,400
<u>Scour Protection</u>					
15	Geofabric Bidum A14	200	m2	65.00	13,000
16	Rock	250	m3	300.00	75,000
17	Front end loader	64	Hrs	150.00	9,600
18	Labour - 2 men x 2 days each	64	Hrs	70.00	4,480
<u>Sundries</u>					
19	Allowance for unmeasured sundries	5	%	166,080.00	8,304
20	Ronding	1	Item	616.00	616
Total					175,000
AECOM Project No. NWA					
22-Feb-2021					
Page 4					

Project : Norfolk Island

AECOM

Cost Plan : Water Quality Improvement Works Emily Bay

Revision : Initial

Opt 20 - Flow Control

Item	Description	Quantity	Unit	Rate	Total
	<u>SUMMARY OF OPTION 20 - FLOW CONTROL</u>				
	<u>Flow Control</u>				
1	Detail Design and Documentation	1	Item	91,000.00	91,000
2	Site Establishment	1	Item	5,000.00	5,000
3	Implementation Environmental Management Plan	1	Item	7,500.00	7,500
4	Allowance for safety management	1	Item	2,500.00	2,500
5	Preparation Works incl shoring and dewatering	1	Item	60,460.00	60,460
6	Construct Flow Control	1	Item	193,000.00	193,000
7	Allowance to make good existing	1	Item	10,000.00	10,000
8	Allowance for maintenance	1	Item	5,000.00	5,000
9	Preliminaries and Overheads	25	%	374,460.00	93,615
	Subtotal Construction Cost - Flow control				468,075
	Locality Allowance - assume local labour and material				Excluded
	Escalation				Excluded
10	DIRDC Administration Costs	25	%	468,075.00	117,019
11	Contingency	30	%	585,093.75	175,528
12	Rounding	1	Item	-622.00	-622
	TOTAL FLOW CONTROL				760,000
	TOTAL NET CONSTRUCTION COST				760,000

Item	Description	Quantity	Unit	Rate	Total
Project : Norfolk Island					
Cost Plan : Water Quality Improvement Works Emily Bay					
Revision : Initial					
AECOM					
Opt 20 - Flow Control					
<u>Detail Design and Documentation</u>					
<u>BREAKDOWN OF DESIGN AND INVESTIGATION WORKS, ITEM IN OPTION 20 - FLOW CONTROL</u>					
1	Survey	1	Item	5,000.00	5,000
2	Geotechnical Investigation	1	Item	15,000.00	15,000
3	Detailed design, drawings, specifications	1	Item	15,000.00	15,000
4	Heritage review & approvals	1	Item	10,000.00	10,000
5	Contract documentation	1	Item	10,000.00	10,000
6	Expenses (travel, accommodation etc.)	1	Item	6,000.00	6,000
7	Site Investigation	1	Item	30,000.00	30,000
Total					91,000
<u>Preparation Works incl shoring and dewatering</u>					
<u>BREAKDOWN OF PREPARATION WORKS, ITEM IN OPTION 20 - FLOW CONTROL</u>					
8	Allow for temporary shoring and removal at completion (PROVISIONAL)	1	Item	15,000.00	15,000
9	Allowance for dewatering (Provisional)	1	Item	10,000.00	10,000
10	Allow for diversion works and cap at completion	1	Item	15,460.00	15,460
11	Excavate and remove soil	1	Item	20,000.00	20,000
Total					60,460
<u>Construct Flow Control</u>					
<u>BREAKDOWN CONSTRUCTION OF FLOW CONTROL, ITEM IN OPTION 20 - FLOW CONTROL</u>					
<u>Rock Protection - 20m</u>					
12	Rock - 1.5m high	60	m3	300.00	18,000
13	Low strength concrete	100	m2	695.00	69,500
14	Front end loader	32	Hrs	150.00	4,800
15	Labour - 2 men x 4 days each	64	Hrs	70.00	4,480
16	Geofabric	200	m2	65.00	13,000
<u>Earth Sides</u>					
17	Imported fill	300	m3	60.00	18,000
18	Excavator including operator	48	Hrs	150.00	7,200
19	Labour - 2men x 8 days	128	Hrs	70.00	8,960
20	Geofabric	500	m2	65.00	32,500
21	Turfing	500	m2	15.00	7,500
<u>Sundries</u>					
22	Allowance for unmeasured sundries	5	%	183,940.00	9,197
23	Rounding	1	Item	-137.00	-137
Total					193,000
AECOM Project No. NWA					
22-Feb-2021					
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Project : Norfolk Island



Cost Plan : Water Quality Improvement Works Emily Bay

Revision : Initial

Opt 20a - Sand Protection at Beach

Item	Description	Quantity	Unit	Rate	Total
	<u>SUMMARY OF OPTION 20a - SAND PROTECTION AT BEACH</u>				
	<u>Sand Protection at Beach</u>				
1	Detail Design and Documentation	1	Item	40,000.00	40,000
2	Site Establishment	1	Item	5,000.00	5,000
3	Implementation Environmental Management Plan	1	Item	5,000.00	5,000
4	Allowance for safety management	1	Item	2,500.00	2,500
5	Preparation Works incl shoring and dewatering	1	Item	35,000.00	35,000
6	Construct Sand Protection	1	Item	42,000.00	42,000
7	Allowance to make good existing	1	Item	10,000.00	10,000
8	Preliminaries and Overheads	25	%	139,500.00	34,875
	Subtotal Construction Cost - Sand Protection				174,375
	Locality Allowance - assume local labour and material				Excluded
	Escalation				Excluded
9	DIRDC Administration Costs	25	%	174,375.00	43,594
10	Contingency	30	%	217,968.75	65,391
11	Rounding	1	Item	-359.00	-359
	TOTAL SAND PROTECTION				283,000
	TOTAL NET CONSTRUCTION COST				283,000

Item	Description	Quantity	Unit	Rate	Total
Project : Norfolk Island					
Cost Plan : Water Quality Improvement Works Emily Bay					
Revision : Initial					
Opt 20a - Sand Protection at Beach					
<u>Detail Design and Documentation</u>					
<u>BREAKDOWN OF DESIGN AND INVESTIGATION WORKS, ITEM IN OPTION 20a - SAND PROTECTION</u>					
1	Survey	1	Item	5,000.00	5,000
2	Geotechnical Investigation	1	Item	10,000.00	10,000
3	Detailed design, drawings, specifications	1	Item	15,000.00	15,000
4	Heritage review & approvals	1	Item	5,000.00	5,000
5	Contract documentation	1	Item	5,000.00	5,000
6	Expenses (travel, accommodation etc.)	1	Item	Incl	Incl
7	Site Investigation	1	Item	Incl	Incl
Total					40,000
<u>Preparation Works incl shoring and dewatering</u>					
<u>BREAKDOWN OF PREPARATION WORKS, ITEM IN OPTION 20a - SAND PROTECTION</u>					
8	Allow for temporary shoring and removal at completion (PROVISIONAL)	1	Item	15,000.00	15,000
9	Allowance for dewatering (Provisional)	1	Item	10,000.00	10,000
10	Excavate and remove soil	1	Item	10,000.00	10,000
Total					35,000
<u>Construct Sand Protection</u>					
<u>BREAKDOWN CONSTRUCTION OF SAND PROTECTION, ITEM IN OPTION 20a - SAND PROTECTION</u>					
<u>Retaining wall (currently only 1 side)</u>					
11	Stone retaining wall	30	m2	350.00	10,500
<u>Rock Protection - 20m</u>					
12	Rock	50	m3	300.00	15,000
13	Front end loader	16	Hrs	150.00	2,400
14	Labour - 2 men x 2 days each	16	Hrs	70.00	1,120
15	Geofabric	200	m2	65.00	13,000
<u>Sundries</u>					
16	Rounding	1	Item	-20.00	-20
Total					42,000
AECOM Project No. NWA					
22-Feb-2021					
Page 8					

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Stormwater Mitigation Works on Norfolk Island
Water Quality Improvements in Emily Bay
Commercial-in-Confidence

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Protection and management of wetlands with acid sulfate soils in the Kingston and Arthurs Vale Historic Area (KAVHA)



Brief summary report dated: Tuesday 16th August, 2022.

Rob Fitzpatrick^{1,2}; Brett Thomas² and Seonaid Philip³

¹CSIRO Mineral Resources; ²Acid Sulfate Soils Centre, The University of Adelaide; ³CSIRO Land and Water

Confirmation of occurrences of acid sulfate soils in wetlands within KAVHA

The sampling campaign conducted by CSIRO in December 2021 in the KAVHA wetlands with abundant 6 m high reeds following rewetting, which resulted from 18 months of “just below” average rainfall and the laboratory analyses of samples confirmed the occurrence of deep (> 1.5 m) organic rich acid sulfate soils with both monosulfidic and hypersulfidic materials (i.e. Monosulfidic-Hypersulfidic organic soils) [See Figures 1 (a) & (b)].

	
<p>Figure 1 (a) Pier street bridge wall (right hand side) and adjacent abundant 6 metre high reeds in December 2021 (the rewetting of this wetland was caused by 18 months of “just below” average rainfall).</p>	<p>Figure 1 (b) Photograph of the saturated surface soil horizons (0 to 30 cm depth) of the Monosulfidic-Hypersulfidic organic Acid Sulfate Soil taken within the 6 metre high reeds at street bridge (see adjacent photograph) in December 2021 (the rewetting of the wetland was caused by 18 months of “just below” average rainfall)</p>

If these Monosulfidic-Hypersulfidic organic soils are disturbed they can rapidly transform to Sulfuric organic soils (pH <4) and if left untreated they can pose risks to water quality, and have potential impacts on human and animal health, agriculture and the environment. In extreme cases direct contact with Sulfuric organic soils can also cause skin irritation or burns.

Monosulfidic materials in these soils can also cause strong odours. Significantly, these acid sulfate soils damage calcarenite building blocks by dissolution of calcium carbonate (calcite) as shown in Figure 2 for the Pier street bridge but also for several heritage structures, such as the Watermill dam within the Kingston and Arthurs Vale Historic Area (KAVHA).



Figure 2. Pier street bridge showing exposed corrosion / dissolution of cement mortar and calcarenite used in the construction of the Pier street bridge – photograph taken in February 2020 during the drought/ dry period.

In summary, the various acid sulfate soil types identified in the KAVHA wetlands with abundant reeds need to be carefully and effectively managed or treated.

Management options for protection of the KAVHA riparian zone

The riparian zone adjacent to the KAVHA streams and wetlands provides important functions for the stream and acts as a “buffer” against the impacts of drainage discharges, especially into the ocean outlet. In order to protect KAVHA wetlands:

- Wetland vegetation should not be cleared unless necessary. However, see below management recommendations and options for “limiting the significant accumulation of pyrite and organic matter in these wetlands”.
- Maintain stream levels to prevent wetland random drainage and subsidence (in some places in the KAVHA erosion has occurred as a result of the water level dropping in the recent drought, leading to the formation of Sulfuric organic soils).
- Prevent the soil from being disturbed by humans (e.g excavation and human traffic) and especially by animals (e.g. pugging by cattle,) and consider treatment and management options (see below).

Finally, we recommend that the KAVHA wetlands with abundant reeds be cut or slashed at least once every 3 to 5 years (the cut reeds must be removed from the wetlands and likely used as feed for cattle) to reduce the amount organic carbon in the soils and hence the subsequent formation of pyrite in the soils (i.e. to limit the formation of Hypersulfidic material).

Support for this KAVHA wetland management activity is based on the following findings from CSIRO's and the University of Adelaide's Acid Sulfate Soils Centre (ASSC) successive soil sampling and investigations at Banrock Station in South Australia (Fitzpatrick et al. 2016) where soil sampling at most Banrock Station wetland sites over six year wet-dry cycles between 2005 and 2016 found:

- (i) previously Hypersulfidic soils were transformed to Hyposulfidic soils, which substantially reduced acidification risk and
- (ii) previously Sulfuric soils were transformed to either Hypersulfidic or Hyposulfidic soils, which substantially reduced acidification risk

The best time to conduct the slashing would be during autumn, when the area is driest and the soils are firmest. This will reduce disturbance from trafficking the sides of the drain and allow the machinery to access and clear more area.

Using a side cut long reach flail mower (see Figure 3 example) would enable the vegetation to be slashed without disturbing the acid sulfate soils. The flail mower would cut the reeds near the base to enable the trash to be more easily raked and removed, which would then be more suitable as stock feed. If a flail mower is not available then a slasher would certainly work.



Figure 3: Side cut long reach flail mower example

The trash should be raked and removed, to the extent practical, to reduce the organic C input. Raking could be by hand or with a long reach excavator, taking care to minimise disturbance of acid sulfate soil (minimise over excavating).

The raked trash (and any associated root mass and minor soil) could be used as mulch, but may first need to be composted if weed management is required.

If acid sulfate soils are to be excavated to further improve drainage then a management plan should be prepared for the earthworks.

References

Fitzpatrick, RW, Shand P, Merry RH, Marschner P, Jayalath N, Grocke S and Mosley LM (2016) Acid Sulfate Soil Assessment and Monitoring of the Banrock Station wetland. Acid Sulfate Soils Report No ASSC_035 (V13); 93 pp.

<https://www.adelaide.edu.au/directory/robert.fitzpatrick?dsn=directory.file;field=data;id=36917;m=view>



Our Ref: N22056 s 47 /lt
F

12 December 2022

s 47F
[Redacted]

Dear s
47F

Re: **Monitoring Survey Certification**
KAVHA Pier Street Norfolk Island

We have undertaken a monitoring survey of the Pier Street Bridge, KAVHA, Norfolk Island and report as follows:

Four (4) monitoring targets were placed on each side of the structure as per the images below. The Pier Street bridge structure was only accessible with waders, so the image below is another localised bridge and used only as a diagram to display the monitoring locations and layout.



s 47F
Registered Surveyor
B. Surv.
MISNSW

s 47F
Registered Surveyor
B. Surv. (Hons)
MISNSW

Released under the Freedom of Information Act 1982 by the Department of Infrastructure, Transport, Regional Development, Communications, Sport and the Arts

s 47F

s 47F

s 47F

Prepared for
Department of Infrastructure, Transport, Regional Development,
Communications and the Arts
AS: 136 167 354 017



Environmental Impact Assessment

13-Oct-2023
Bounty Street Bridge Conservation Works

AECOM

Bounty Street Bridge Conservation Works
Environmental Impact Assessment

Environmental Impact Assessment

Client: Department of Infrastructure, Transport, Regional Development, Communications and the Arts

ABN: 86 267 354 017

Prepared by

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13-Oct-2023

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1.0 Introduction

The Kingston and Arthur's Vale Historic Area (KAVHA) on Norfolk Island is one of eleven sites that comprise the Australia Convict Sites World Heritage Property. It is recognised for being one of the best surviving examples of large-scale convict transportation and colonial expansion of European powers through the presence and labour of convicts. Today it remains a living showcase of Polynesian, convict and Pitcairn Islander history. In addition to its World Heritage status, KAVHA is also included on the National Heritage List, the Commonwealth Heritage List and the Norfolk Island Heritage Register.

The KAVHA comprises a series of structures, each contributing to the collective heritage value of the area. Among these structures is the Bounty Street Bridge (the Bridge), which provides a crossing point for Bounty Street across Watermill Creek, between Quality Row and Bay Street (refer to **Figure 1**).

The *Kingston and Arthur's Vale Historic Area Safety Hazard Scoping Study Draft Report* (GML, May, 2018) identified a number of 'very high risk' structural hazards that threatened the integrity of various heritage structures within KAVHA. The Bounty Street Bridge was identified as one of the structures posing a very high risk of loss of structural integrity. To address this risk, it is proposed to carry out structural reinforcement of the Bridge through installation of a structure concrete arch beneath it. The reinforcing arch would protect the structural integrity and heritage value of the Bridge, including its contribution to the heritage values of the KAVHA. The reinforcing arch would be designed to carry a minimum two tonne dead weight load, allowing the Bridge to be reopened to general traffic once the works are complete.

This document presents an environmental impact assessment of the proposed heritage protection works, involving the construction and ongoing use of a reinforcing concrete arch beneath the Bridge (the Project).

1.1 Project location

The Project area would be located on Bounty Street, as it crosses Watermill Creek, at Kingston, Norfolk Island (refer to **Figure 1** and **Figure 2**). The footprint for the Project would be approximately 15 metres upstream and downstream of the Bounty Street Bridge and 50 metres along Bounty Street on either side of the Bridge. The Project area is subject to pre-existing disturbance.

The Bounty Street Bridge is a convict-built stone bridge, constructed circa 1835, is located between Quality Row and Bay Street and provides access to Slaughter Bay and Emily Bay (Higginbotham & Associates, 2010). The Bridge straddles Kingston Commons and Kingston Recreation Reserves, which are characterised by flat open pasture interspaced with roadside plantings of Norfolk Island Pine. The Bridge crosses Watermill Creek, which flows from the northwest to the southeast and discharges into the South Pacific Ocean at Emily Bay located about 370 metres downstream.

Watermill Creek is a channelised shallow creek vegetated with exotic weeds. It flows through a low-lying area with Serpentine Channel, a remnant wetland, located 30 metres downstream of the Bridge.

The nearest residential premises to the Bridge is located about 170 metres to the northeast. The nearest heritage structure is the Museum Theatre located 50 metres to the south.

The works area would be located in the Kingston Recreation Reserve and the Common Reserve. The reserves are located in the centre of the KAVHA precinct which is characterised by flat open pasture interspaced with roadside plantings of Norfolk Island Pine. The areas are highly disturbed.



PROJECT FEATURES

Legend

- KAVHA boundary
- Cadastral boundaries
- Project boundary



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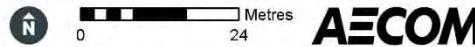
Figure 1 Project site location



PROJECT FEATURES

Legend

- Project boundary
- Town creek outlet
- Restricted area
- Earth bunds (clean fill)
- Existing stone bridge
- Diversion pipe



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Figure 2 Bounty Street Bridge Project features

1.2 The Project

The design of the Project has been informed by a Heritage Impact Assessment (HIA) undertaken by a qualified heritage specialist. The Project would involve the construction and ongoing use of a structural concrete arch beneath the Bridge. Construction of the concrete arch would involve:

- Preliminary works, including installation of earth bunds and diversion of Watermill Creek via a temporary diversion pipe
- Excavation beneath and around the Bridge to allow construction access and to form a base for the concrete arch
- Cleaning and repair of the underside of the Bridge
- Construction of foundations for the concrete arch
- Construction of the structural concrete arch
- Remediation of the sides of the Bridge
- Reinstatement and rehabilitation of disturbed areas of Watermill Creek.

Further details of each of these activities is provided below.

1.2.1 Installation of earth bunds and diversion of Watermill Creek

To allow for dewatering and installation of the concrete support structure, two coffer dams, made of uncontaminated earthen bunds would be constructed upstream and downstream of the Bounty Street Bridge. The earth bunds would be located away from the Bridge structure and site of the potential water tanks located at the north-eastern corner of the Bridge. The upstream earth bund would be installed first before installing the downstream earth bund.

Watermill Creek would be diverted around the works site via a temporary pipe installed in a trench around the northern abutment of the Bridge (refer to indicative alignment in **Figure 2**). The diversion pipe would be constructed to allow for continued normal flow of Watermill Creek during construction of the Project. A cross section of the diversion trench and pipe are shown in **Figure 3**. The diversion pipe would be installed within the potential water tank site which has heritage value. A site inspection by an archaeologist in 2023 did not locate any water tank features in the proposed area; as a precaution, works in this area would be supervised by an archaeologist and has been referred to as a 'restricted area'. Works within the restricted area would require consultation with the Project archaeologist.

The trench would be constructed east to west, and a pipe would be installed along its length and backfilled. Downstream of the diversion, a rock check would be placed to reduce scour erosion potential and diffuse flow discharge. There would be an additional pipe placed to connect the Town Creek outlet to this diversion.

Prior to disturbance, baseline water quality samples would be collected up, mid and downstream of the works area and at the Emily Bay discharge point. These would be used to establish an existing baseline for water quality and water quality management criteria for the works, having regard to the Australia and New Zealand Water Quality Guidelines (ANZG) 2018.

Whilst the earth bunds are being installed, dewatering of the works area would be required to allow for access to clean the bridge and install formwork. Due to the current water level elevation being at or below sea level, as well as the continuous flow from the hydraulic head in the upper Watermill catchment, it is anticipated there would be the requirement to continuously dewater each 24 hours during the conservation works, as water slowly seeps back into the works area between the earth bunds. This water would be pumped out into Watermill Creek, downstream of the works area. Water quality discharge standards would be set to comply with the ANZG 2018.

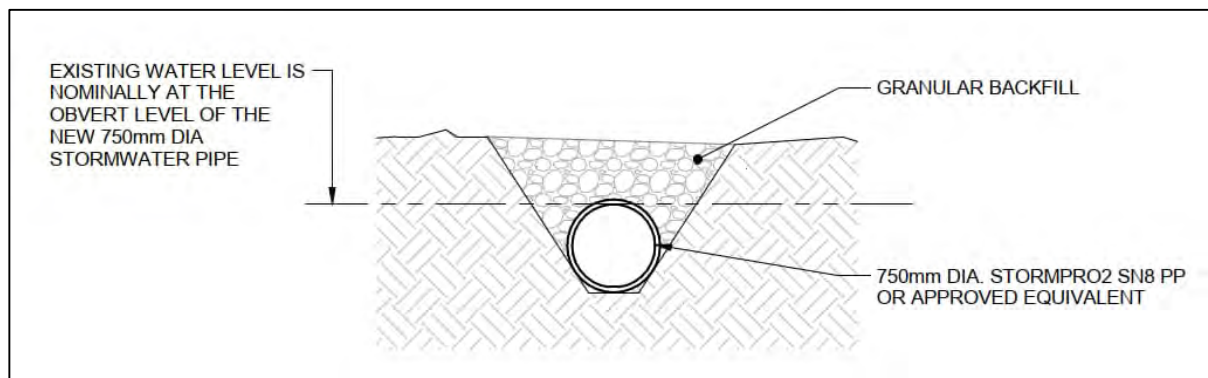


Figure 3 Typical diversion trench cross section

1.2.2 Excavation beneath and around the Bridge

The creek bed would be excavated below the base of the Bridge foundations and a lean concrete binding layer would be constructed as a working platform. The excavation would progress from upstream to downstream and areas close to the Bridge structure would be excavated by hand. All excavated material would be covered or saturated to manage potential acid sulfate materials and protection of high walking traffic areas would be provided by plywood or equivalent to minimise disturbance of sediments.

In addition to this, a handheld pH meter would be used during construction, to assess the pH of the material against the Australian and New Zealand Guidelines for Fresh and Marine Water Quality criteria for 95% species protection in fresh water (ANZG, 2018). The pH would be reviewed at the beginning and end of the construction shift, and reviewed 4-5 times per day using handheld monitors. All excavated material would be chemically tested on site and temporarily held for preferably stabilisation and re-use.

Supporting props would be installed to support the Bridge structure as required for the works. A qualified archaeologist would be available to provide a watching brief when required.

1.2.3 Cleaning and repair of the underside of the Bridge

Mud would be cleaned from the Bridge stone using potable water. No cleaning chemicals would be used. Eroded stone would be filled with hydraulic lime mortar. The mortar composition and mortar application methods would be confirmed in consultation with a heritage specialist. A hydraulic lime mortar render would be applied to the underside of the arch.

1.2.4 Construction of arch foundations

Corrosion resistant glass fibre polymer reinforcement bars would be used for the base slab of the foundation beneath the width of the Bridge. Ready mixed concrete would be used for the base slab which would be designed to meet a 100 year design life.

1.2.5 Construction of the structural concrete arch

Formwork and reinforcement bars would be installed to form the lining under the Bridge arch. Concrete would be injected through holes drilled from the top of the Bridge arch at regular intervals. The concrete lining would be set back from the upstream face of the Bridge and would retain the concrete lintel on the downstream face of the Bridge as evidence of previous modifications to the Bridge in line with the Burra Charter.

1.2.6 Remediation of the sides of the Bridge

Point stonework would be carried out to all sides of the Bridge below the water level with hydraulic lime mortar after cleaning with potable water. Severely eroded stone would be replaced with equivalent stone installed under the direction of a stonemason experienced in heritage restoration.

Remnants of Portland cement render would be removed from all faces of the Bridge (upstream both faces, downstream both faces and for the full length of the stone walls) without damaging the underlying stone and replaced with lime mortar. The existing capping stones would be set in place using lime mortar.

The design has been informed by a HIA undertaken by a qualified heritage specialist. Stoneworks would be carried out by a stonemason who is experienced in heritage stonework. The works would be overseen by a qualified archaeologist to ensure the mitigation measures recommended in the HIA are effectively implemented and the heritage values of the Bridge are not impacted.

1.2.7 Reinstatement of Watermill Creek

Upon completion of works the earth bunds would be removed with controlled dewatering pumping to prevent a sudden flow of water through the works area. Watermill Creek would be reinstated as a minimum to its original condition upon completion of works.

2.0 Project objectives

The aim of the Project is to rectify and “make safe” the Bridge structure while safeguarding the heritage values in accordance with the Kingston and Arthur’s Vale Historic Area Heritage Management Plan 2016 (KAVHA HMP) (GML Heritage and Jean Rice Architects, 2016). The Project would enable the Bridge to be reopened to vehicular traffic and cater for a minimum two tonne dead weight load.

2.1 Project options

Four options have been considered to identify the preferred approach to the management of Bounty Street Bridge and conservation of its heritage values:

1. Do nothing
2. Convert the crossing of Watermill Creek to a culvert structure
3. Reinforce the existing Bounty Street Bridge with a steel arch
4. Reinforce the existing Bounty Street Bridge with a concrete arch.

Each of these options is summarised below. The preferred option (reinforcement with a concrete arch) was selected to balance design requirements and protection of the heritage values of the Bridge.

2.1.1 Option 1 – Do nothing

This option would have seen no works undertaken on the Bridge. In the do-nothing scenario, it was estimated that the Bridge would collapse in between five to 50 years. This option was rejected as not fulfilling the Australian Government’s obligations to protect and conserve the physical fabric of a listed World, National and Commonwealth heritage site. It would also not comply with the *Burra Charter* conservation principles of safeguarding significance, which includes averting the risk of collapse (Article 2.4) or with ensuring the on-going use of the Bridge, which has been identified as contributing to the significance of the structure. This option would eventually allow collapse of the Bridge in contravention of the KAVHA HMP Policy 8.3.

2.1.2 Option 2 – Culvert conversion

This option would consist of inserting two 1500 mm concrete pipes beneath the Bridge and infilling of the surrounding area with concrete. This option was rejected as not being sensitive to the heritage values of the Bridge. The culvert conversion would not respect the existing fabric of the Bridge and therefore would not comply with Article 3 of the *Burra Charter* – by converting the Bridge to a culvert the design intent of the structure would be distorted (Article 3.2).

2.1.3 Option 3 – Structural steel arch

This option would consist of inserting a structural steel frame to support the arch of the Bridge. This option was not progressed based on cost and constructability considerations. The frame would need to be fabricated on the mainland, which would have posed challenges and have significant cost implications. Given the moist environment and the potential presence of acid sulfate soils, a steel structure would likely not be resilient and would deteriorate (ie rust) more rapidly over time relative to other potential construction materials. This option would also require the steel arch to be bolted or in some way connected to the stonework of the Bridge and would therefore have a direct negative impact on the integrity of its heritage values.

2.1.4 Option 4 – Structural concrete arch

This option would consist of inserting a concrete support to hold the arch of the Bridge. This option was identified as preferred on the basis that the concrete would withstand the potential acid sulfate soils, little preparation of materials off-Island would be required and potential heritage impacts could be minimised. Key to the minimisation of heritage impacts would be the installation a layer of lime mortar between the Bridge and the structural concrete arch. The lime mortar would form a sacrificial layer between the original and new fabric and would make the works reversible, in line with Article 15 of the *Burra Charter*.

Concrete can form an impervious barrier to water that can result in rising damp in the adjacent natural materials thereby speeding their deterioration. However, given that the natural stone of the Bridge is

usually waterlogged by the water of Watermill Creek, this risk was considered consistent with existing conditions and unlikely to materially accelerate natural deterioration of the Bridge over time.

2.1.5 Other Considerations

Other considerations taken into account during the design process and the reasons why they were not adopted are outlined below.

- Use of lime mortar to create structural arch – the structural abilities of lime mortar are not sufficient to provide the required load ratings.
- Underpinning of the Bounty Street Bridge - the Bridge appears to be stable and has settled to a point of homeostasis within its environment. Underpinning is therefore not warranted as further settlement is considered unlikely. Underpinning is also invasive and would not provide strength to the eroded stone arch. The stone arch would still require structural support.
- Stone repair and/or replacement – due to the location and extent of the deteriorated stone, the Bridge would need to be de-constructed from the top, stone replaced and the upper parts of the Bridge reconstructed. These are highly invasive works that would impact on the integrity of the Bridge and have a high cost.

3.0 Regulatory context

3.1.1 World Heritage Convention

KAVHA is part of the Australian Convict Sites properties, which is listed on the World Heritage List of the *Convention Concerning the Protection of the World Cultural and Natural Heritage* (i.e. the World Heritage Convention). The Proposal is located within the KAVHA and is managed by the Advisory Committee through the KAVHA Heritage Management Plan (GML 2016).

Administratively the Australian Government manages listed world heritage items in accordance with the Operational Guidelines prepared by the World Heritage Centre through the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act). Compliance of the Project with the requirements of the EPBC Act would ensure conformance with obligations under the World Heritage Convention.

3.1.2 Commonwealth legislative framework

3.1.2.1 Environment Protection and Biodiversity Conservation Act 1999 (Cth)

The *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) is the principal legislation protecting matters of national environmental significance (MNES) and the environment of Commonwealth land. Actions that may significantly affect a MNES or the environment of Commonwealth land require assessment and approval under the EPBC Act.

The Project may directly or indirectly affect three MNES protected under the EPBC Act:

- Direct impacts on KAVHA as a World Heritage site (site ID: 106209, World Heritage List)
- Direct impacts on KAVHA as a National Heritage Place (site ID: 105962, National Heritage List; site ID: 105606, Commonwealth Heritage List)
- Potential indirect impacts through site runoff on the downstream Norfolk Marine Park, a Commonwealth marine area.

In addition to these MNES, the Project would be carried out on Commonwealth land (and would therefore affect the environment of Commonwealth land within the meaning of the EPBC Act). The Project also constitutes as action by a Commonwealth agency, being the Department of Infrastructure, Transport, Regional Development, Communications and the Arts (DITRDCA).

This environmental impact assessment (EIA) and an associated heritage impact assessment (HIA) have been prepared to support a referral under the EPBC Act to determine whether the Project is a controlled action requiring assessment and approval. The EIA and HIA conclude that the Project would not have a significant impact on a MNES, and would therefore not require assessment or approval under the EPBC Act.

3.1.2.2 Protection of Movable Cultural Heritage Act 1986 (Cth)

The *Protection of Movable Cultural Heritage Act 1986* (Cth) protects Australia's movable cultural heritage and provides for the return of foreign cultural property which has been illegally exported from its country of origin and imported into Australia.

A chance find procedure that addresses the requirements of this Act has been developed and is set out in the *Kingston and Arthur's Vale Historic Area (KAVHA) Archaeological Zoning and Management Plan* (Extent Heritage Pty Ltd, 2019). The chance find procedure would be implemented and the construction contractor's personnel should be made aware of the requirements through appropriate training.

3.1.3 Norfolk Island legislative framework

3.1.3.1 Planning Act 2002 (NI)

The *Planning Act 2002* (NI) aims to promote the conservation and preservation of the natural environment, landscape, unique cultural and built heritage as well as the proper management, development and conservation of the natural and man-made resources of Norfolk Island. The Act sets out the requirements that govern the permitted developments and development approval process.

Under the Norfolk Island Plan 2022 (as amended by the Norfolk Island Plan 2002 Housekeeping Amendment 2022), the Project is exempt from the need for development approval because the works include activities listed under clause 81(1)(b) on land the subject of the Heritage Overlay, and would be

undertake in accordance with an approved heritage management plan (clause 82(2)(ii)). The Project has been designed and would be carried out in accordance with the provisions of the *Kingston and Arthur's Vale Historic Area (KAVHA) Archaeological Zoning and Management Plan* (Extent Heritage Pty Ltd, 2019).

3.1.3.2 Building Act 2002 (NI)

All building activity on Norfolk Island, is controlled by the *Building Act 2002* and the Norfolk Island Building Code. Section 5 of the Building Act defines “building work” as “the actual physical work for or in connection with the construction, erection, alteration, demolition or removal of a building or structure or services.

The Project may require Building Approval from the Norfolk Island Regional Council in relation to the structural arch to be installed beneath the Bounty Street Bridge.

3.1.3.3 Environment Act 1990 (NI)

The *Environment Act 1990* (NI) is the key legislation that covers planning approval and environmental regulatory requirements on Norfolk Island. The objects of the Act cover conservation of the natural environment and landscape beauty of Norfolk Island to ensure that physical works are in harmony with the natural environment. It provides for the establishment of the Norfolk Island Planning and Environment Board and sets out regulatory frameworks for requiring approvals for building control, uses of land and some earthworks as well as for preparation of an EIS for proposals. The Act stipulates requirements covering water supply, garbage, nuisances, animals and sewerage.

The following sections cover aspects that are applicable to the Proposal:

- Section 48 specifies that an earthworks approval is required for the removal or excavation of a total of 50 cubic metres of earth, topsoil, spoil or fill that is excavated, shifted or deposited; or if the earthworks cover an area totalling more than 50 square metres. Should the construction of coffer dam bunds exceed this trigger, an earthworks approval may be required prior to commencement of work
- Sections 72 – 76 provide for regulation of garbage which includes refuse, rubbish and sewage
- Section 77 covers nuisance which includes emissions of smoke, soot, dust, effluvia, smell or noise that may become injurious to health or that is offensive.

3.1.3.4 Heritage Act 2002 (NI)

The *Heritage Act 2002* (NI) sets out the criteria, management framework and procedures for establishing the Norfolk Island Heritage Register as well as specifies requirements for Heritage Impact Statement (HIS) and Conservation Management Plans (CMP).

KAVHA (including Bounty Street Bridge) is listed on the Norfolk Island Heritage Register and is subject to management control set out in *Arthur's Vale Historic Area (KAVHA) Archaeological Zoning and Management Plan* (Extent Heritage Pty Ltd, 2019). The Project would be carried out in accordance with this conservation management plan. A separate heritage impact assessment (HIA) has been completed for the Project, and is summarised in Section 5.2.

3.1.3.5 Protection of Moveable Cultural Heritage Act 1987 (NI)

The *Protection of Moveable Cultural Heritage Act 1987* (NI) protects Norfolk Island's movable heritage items as well as other Australian and protected items. This Act protects against any heritage items found on or below ground during construction work to be removed.

With regard to the Project, a chance find procedure that addresses the requirements of this Act has been developed and is set out in the *Kingston and Arthur's Vale Historic Area (KAVHA) Archaeological Zoning and Management Plan* prepared by Extent Heritage Pty Ltd (2019) for DITRDC. The chance find procedure would be implemented and the contractor's personnel would be made aware of the requirements through appropriate training.

3.1.3.6 Public Reserves Act 1997 (NI)

The Proposal straddles the Kingston Commons and Kingston Recreation Reserves. A permit would be required from the Conservator of Public Reserves for the Project and the works would comply with any conditions stipulated.

3.1.3.7 Traffic Act 2010 (NI)

The temporary closure of Bounty Street Bridge to vehicular traffic has already been implemented by the NIRC for public safety reasons and would remain closed during the works.

3.1.3.8 Waste Management Act 2003 (NI)

The *Waste Management Act 2003* provides for waste management, funding for waste management operations and related purposes on Norfolk Island. The Act specifies requirements for disposing waste in approved receptacles, vehicles transporting waste to be securely covered, fees to be imposed for disposal of waste to designated places (i.e. the Waste Management Centre) and recovery of clean-up cost. Management of all waste generated during construction works would be managed in compliance with this Act.

3.1.3.9 Noxious Weeds Act 1916 (NI)

The *Noxious Weeds Act 1916* (NI) specifies a list of declared noxious weeds and provides for the Minister to issue notices to land owners where infestation has occurred to eradicate noxious weeds from land. The construction contractor would implement best management practice to prevent and control noxious weeds during construction of the Project.

4.0 Stakeholders and consultation

Key Project stakeholders include:

- Department of Infrastructure, Transport, Regional Development, Communications and the Arts [DITRDCA](including the Norfolk Island Team and the ACT, NT and KAVHA Team) (formerly Department of Infrastructure, Transport, Regional Development, and Communications [DITRDC])
- Department of Climate Change, Energy, the Environment and Water (DCCEEW) (incl. Parks Australia, Historic Heritage and Environment Approvals and Wildlife Trade Branch) (formerly Department of Agriculture, Water and Environment [DAWE])
- Norfolk Island Regional Council (incl. Planning Officer, Museum Team Leader, Conservator of Public Reserves, Team Leader - Waste and Environment, Works Crew)
- Norfolk Island Water Quality Working Group
- KAVHA Advisory Committee KAVHA Community Advisory Group
- Construction contractor
- Members of the community.

Consultation has been undertaken with a range of stakeholders and would continue during implementation of the Project.

5.0 Environmental assessment

5.1 Key features

Key features of the existing environment within and around the Project area include:

- The Kingston Commons and Kingston Recreation Reserves
- Watermill Creek and Emily Bay
- Bounty Street Bridge.

Relevant characteristics of the existing environment with respect to each of these features is provided below.

5.1.1 Kingston Commons and Kingston Recreation Reserves

The area around the Project was previously disturbed during construction of the KAVHA site dating back to the early 1820s. The Bridge is located on modified land vegetated with exotic pasture, i.e. Kikuyu grass, which is subject to cattle grazing or is maintained. The Bridge is not located in the vicinity of native habitats and there are no significant plant species within the Kingston Commons and Kingston Recreation Reserves (Norfolk Island Parks and Forest Service 2003). The aquatic vegetation in Watermill Creek comprises introduced species including Bulrush and Water Hyacinth.

5.1.2 Watermill Creek and Emily Bay (Norfolk Marine Park)

Historical anecdotal reports indicate that water pollution of Watermill Creek and Emily Bay has been occurring for more than 40 years (NIRC 2017). Pendoley Environmental Pty Ltd (2015) highlighted the issue of poor water quality from Watermill Creek, with elevated nutrient levels adversely impacting the water quality of Emily Bay (part of the Norfolk Marine Park), and killing the coral in Emily Bay along a transect extending from the outlet to Lone Pine and to the reef outlet channel. The die-off of coral, increased algae growth, both on the floor of the bay and covering the dead coral habitat, plus the decrease in the number and diversity of small fish has been occurring for the past 50 years which has accelerated in the past five years (Pendoley Environmental (2015)). This report noted that the accelerated rate of decline will wipe out the corals of the entire Emily and Slaughter Bay Lagoon within five to 10 years and recovery of the ecosystem will be delayed by the lack of immigration of coral spawn from external reef systems (e.g. Lord Howe) due to the isolated nature of Norfolk Island (Pendoley Environmental 2015).

Water quality of Watermill Creek is poor with elevated concentrations of phosphate (1.21-1.32 mg/L), ammonia (0.09 -1 mg/L), nitrate (2.73 mg/L) and ammonium (1.9 mg/L) due to pollution by sewage, detergents and livestock within the catchment (NIRC 2017). The phosphate and ammonium concentrations in Watermill Creek were 26 and 95 times higher than the ANZECC trigger levels respectively. The results show that the water quality in KAVHA and particularly Watermill Creek is degraded relative to the ANZECC Guidelines for Lowland rivers in South-East Australia. Comparison of monitoring results between 2010 and 2017 indicate that contamination in the Watermill Creek catchment has increased over the seven years with higher pollution loads discharging into Emily Bay (NIRC 2017).

The monitoring data supports anecdotal evidence that the high nutrient loads discharging into Emily Bay have resulted in significant degradation of the coral reefs where seagrass and algae have developed at the expense of corals (NIRC 2017; Pendoley Environmental 2015).

Microbial analysis of surface water in Town Creek and Watermill Creek during the dry season confirmed the presence of Enterbacteriaceae, including *Salmonella* spp. and *Escherichia coli* (333-52100 CFU/100mL), and the pathogens *Pseudomonas aeruginosa* and *Enterobacter cloacae* (NIRC 2017). Total coliforms were recorded at 2800 - 90010 CFU/100mL (NIRC 2017).

At the point Watermill Creek discharges into Emily Bay, the *E. coli* concentrations were up to 27 times higher than the acceptable levels for primary contact while total coliforms are 86 times higher than the secondary contact limits (NIRC 2017). Water quality monitoring conducted at the Bridge on 24 July 2020 (Biotech H2O Testing) confirmed microbial contamination with *E. coli* at 23,000 CFU/100mL, total coliforms at 40,000 CFU/100mL and *Enterococcus* spp. at 15,000 CFU/100mL. These very high

coliform concentrations and the presence of pathogens provide evidence that the Watermill Creek catchment and Emily Bay are contaminated by human and/or cattle faeces. High rainfall events exacerbate discharge of polluted waters from the Watermill Creek catchment getting flushed into Emily Bay.

5.1.3 Bounty Street Bridge

Bounty Street Bridge carries a single asphalted lane, with grassed verges on either side. The wing walls of the Bridge are constructed primarily of calcarenite (limestone). The wing walls terminate with square posts, projecting slightly beyond the width of the Bridge. A shorter retaining type wall is evident on the southern side of the Bridge, which extends for a short distance to the south. The gabled coping stones are missing on the west side wall, except in one small section on the short retaining type wall. The integrity of the coping stones on the eastern side is mostly complete.

The arch facing on the western side is constructed of dressed sandstone. The arch is similar in construction and quality to that on the main entrance of the Prisoners Barracks. The arch facing on the eastern side appears to have been partially lost, being replaced with an asphalt-like lintel during the 1970s. The eastern side has been remodelled into a rectangular opening about 1.9 metres wide, compared to the inlet on the western side, which is about 4.2 metres wide probably severely inhibits water flow under the Bridge.

The arch soffit is constructed of calcarenite except the keystones, which appear to be sandstone. The calcarenite shows significant signs of erosion in a honeycomb manner, where depth of erosion may extend in excess of 600 mm. The condition of the Bridge is poor.

The Bridge has settled as a single unit, tipping and rotating to the north, probably as a result of inadequate bearing material and possibly exacerbated by high velocity flows from Town Creek. Settlement is in the order of 1.2 metres and significant sectional loss of stonework through erosion has occurred (AECOM 2020). Based on a field assessment, AECOM was unable to provide a load rating or an expected remaining design life and recommended that the Bridge be closed to vehicular and pedestrian traffic, which was achieved in March 2020.

The archaeological potential beneath and around the Bridge area is high, with potential evidence relating to the former channels of Watermill Creek, the water tanks and artefact deposits likely to be evident in this area.

5.2 Heritage

A separate detailed heritage impact assessment (HIA), *Bounty Street Bridge: Heritage Impact Assessment* (AECOM, 2023) has been completed to assess potential impacts of the Project in the heritage values of Bounty Street Bridge and KAVHA (refer to **Appendix A**). The HIA concludes that with the application of appropriate mitigation and management measures, the Project would not have a significant impact on the heritage values of the Bridge or KAVHA, in the context of its listings as World Heritage, National Heritage and Commonwealth Heritage items. Key outcomes of the HIA are summarised here.

Existing environment

The existing environment of the Bounty Street Bridge is described in Section 5.1.3.

Potential Project impacts

Based on a structural assessment of the Bridge, the structure is likely to continue to deteriorate and is at risk of collapse over the short to medium term (five to 50 years). The Project would therefore be fundamental to protecting its heritage value intact, and without which the loss of heritage value would be significant. The Project has been specifically designed to avoid or minimise potential impacts on the heritage values of the Bounty Street Bridge and the KAVHA more broadly. The works would not result in a change to the layout, spaces or form of the landscape. Retention of the Bounty Street Bridge in operable condition would in fact preserve the layout of the site, and the heritage values associated with maintaining the Bridge in a structurally sound and complete form. As an additional protection, and to provide a more secure record of the heritage values of the Bridge, an archival recording would be completed following dewatering of Watermill Creek and prior to the commencement of subsequent construction activities.

The Project has been developed through an options process, with input from a heritage specialist at each stage. This process has served to select the option that limits impacts to the masonry fabric, archaeological potential and significance of the Bounty Street Bridge. Notwithstanding, the Project would involve the introduction of significant amounts of new fabric. While these would largely be invisible once works are complete, the addition of the structural concrete arch would substantially alter the Bounty Street Bridge from its current and original forms. In addition, approximately six 150 mm cores would be drilled through the deck and soffit of the Bridge to allow the concrete to be poured. This would not be visible but would constitute a direct impact to significant fabric. Despite these changes, on balance, the remediation works are considered warranted and a positive heritage outcome overall noting the significant deterioration in the Bridge and the risk of collapse. The works have been designed to be reversible, through the insertion of a lime mortar lining between the original and new fabric, allowing the concrete to be removed at a later date with limited or no damage to the original fabric.

The HIA considers the potential impacts of Project in the context of:

- The listing of the KAVHA on the National Heritage List and against the individual significance of the Bounty Street Bridge
- The impact parameters for World Heritage properties/ National Heritage places identified in the EPBC Act *Significant Impact Guidelines 1.1* (Department of the Environment, 2013)
- The Outstanding Universal Values for World Heritage sites. The assessment fulfils the requirements for such an assessment outlined in item 5-10 of *Guidance on Heritage Impact Assessments for Cultural World Heritage Places* (ICOMOS, 2011)
- The *Kingston and Arthur's Vale Historic Area Heritage Management Plan* (Godden Mackay Logan Pty Ltd 2016) (KAVHA HMP).

National Heritage listing under the EPBC Act

Against the listing criteria under the EPBC Act for National Heritage places, the HIA assesses the Project as likely to have a negligible to minor beneficial effect across most criteria, with the exceptions of:

- A minor adverse impact under Criterion C (*The place has significant heritage value because of the place's potential to yield information that will contribute to an understanding of Australia's natural or cultural history*) - the excavation to allow for the installation of the earth bunds and the diversion pipe has the potential to disturb evidence of the previous alignment of the Watermill Creek channel and the water tanks adjacent to the north eastern wing wall. The HIA recommends that an Archaeological Research Design and Methodology be prepared and implemented, including consideration of archaeological investigations to inform potential reinstatement of the serpentine alignment of Watermill Creek in the future. Subject to this recommendation, the HIA concludes that potential impacts under Criterion C could be reduced to 'neutral'
- A negligible adverse impact under Criterion E (*The place has significant heritage value because of the place's importance in exhibiting particular aesthetic characteristics valued by a community or cultural group*) - the Bounty Street Bridge has been assessed as contributing to the aesthetic qualities of the KAVHA and for the form of the arch, now only evident on the western elevation. The insertion of the structural concrete arch would preserve the arch and the Bridge more broadly, thereby allowing it to continue to contribute to the bucolic character of KAVHA. Due to the water level and being set back 300 mm behind the arch facings, the structural concrete arch would be largely invisible most of the time
- A minor adverse impact under Criterion H (*the place has significant heritage value because of the place's special association with the life or works of a person, or group of persons, of importance in Australia's natural or cultural history*) – the Bounty Street Bridge, together with the Pier Street Bridge and other swamp improvements is associated with the life and works of Major Joseph Anderson and the convicts who undertook the labour. The installation of the structural concrete arch would result in impacts to the fabric that relates to these associations.

World Heritage/ National Heritage significance – Significant Impact Guidelines

The HIA identifies that the Project would not generate most of the types of impacts identified in the *Significant Impact Guidelines 1.1* (Department of the Environment, 2013) for World Heritage properties and National Heritage places with two exceptions:

- Permanently remove, destroy, damage or substantially alter the fabric of a World Heritage property/ National Heritage place – the Project would include the introduction of significant amounts of new fabric. While these would largely be invisible once works are complete, the addition of the structural concrete arch is considered to substantially alter the Bounty Street Bridge. In addition, approximately six 150 mm cores would be drilled through the deck and soffit of the Bridge to allow the concrete to be poured. This would not be visible but would constitute a direct impact to significant fabric
- Possibly permanently remove, destroy, damage or substantially disturb archaeological deposits or artefacts in a World Heritage property/ National Heritage place – the *Arthur's Vale Historic Area (KAVHA) Archaeological Zoning and Management Plan* (Extent Heritage Pty Ltd, 2019) has identified the area as being of high archaeological potential and significance. The excavation associated with installation of the concrete footings under the Bounty Street Bridge arch has limited potential to expose artefacts or features, having been previously heavily disturbed by desilting. The installation of the earth bunds and diversion pipe have the potential to destroy or obscure evidence of the previous channels associated with Watermill Creek. The diversion of water from the Town Creek outlet via a diversion pipe and the installation of the earth bunds may impact on the water tank on the north eastern side of the Bounty Street Bridge. The requirements of the Archaeological Zoning and Management Plan would be implemented to manage these identified impacts. For the Town Creek and Watermill Creek diversion works a qualified archaeologist would be consulted, with further site investigations and archival recording if necessary.

World Heritage Outstanding Universal Values

The HIA highlights that the Project would act to preserve the Bounty Street Bridge and its contribution to the KAVHA World Heritage property. The Project would be consistent with and would not detract from the World Heritage Outstanding Universal Values.

Kingston and Arthur's Vale Historic Area Heritage Management Plan

The HIA notes that the Project has been developed in response to the requirements of the KAVHA HMP, and the HIA has responded to the applicable impact assessment requirements.

HIA conclusions and recommendations

On balance, the HIA concludes that the Project is warranted and a positive heritage outcome overall noting the significant deterioration in the Bridge and the risk of collapse. Although the Project would impact the Bridge and its heritage value, individually and as a contribution to the KAVHA, these impacts are considered acceptable in the context of restoring and maintaining the Bridge. Potential impacts to the Bridge and its heritage values have been avoided or minimised through design, with potential residual impacts manageable through the application of mitigation measures recommended in the HIA. These mitigation measures are detailed in **Section 6.1** and broadly relate to:

- Archival recording of Bounty Street Bridge, and a general requirement for inspection and oversight by a qualified archaeologist
- Restrictions and requirements on the selection and application of new materials, and removal of older (non-original) materials
- Requirements for restoration works to minimise the potential for further impacts to the Bridge or its structural integrity, and a general requirement for reconstruction works to be carried out by a stonemason with experience in reconstructing historical structures
- Preparation of an archaeological research design and methodology, and micro-siting of coffer dams, the diversion pipe and ground disturbing works to avoid or minimise impacts on archaeology
- Restrictions on the use of vibration-intensive plant and equipment to protect heritage structures.

5.3 Water

Existing environment

Surface water

The Project area would be located on the relatively flat floodplain of Watermill Creek. Bounty Street Bridge is constructed over the channelised Watermill Creek which flows generally from west to east and discharges to Emily Bay via a convict-built tunnel.

The current drainage consists of a straight channel running west to east from the Pier Street Bridge to the Bounty Street Bridge. It continues straight for a short distance below the Bridge before branching off to the south-east through a 1940s concrete lined cutting to discharge into Emily Bay. There is also a remnant channel of an earlier alignment that continues east beyond the 1940s diversion through a tunnel in a rock outcrop and thence also to Emily Bay. Upstream of the Pier Street Bridge the channel is a more natural stream through grassy paddocks as it flows through Arthur's Vale. The channels have extensive reed beds and build-up of aquatic plants. During wet periods water ponds upstream of the Bridge can stand without drainage for many weeks.

The floodplain of the creek is low-lying (the top of the arch of the bridge is reportedly below high tide level), and the surrounding area shows signs of long-term water-logging. During visual inspections of the site, high standing water levels were observed such that only the top of the upstream arch was visible. Reeds and other weeds were prevalent. The adjacent open drain in Town Creek was also overgrown and with high water levels.

The 1940s channel that had been originally provided as an alternative drainage for the creek was filled after the Bridge/culvert under the road reached its end of life. The original channel outlet, which runs through a tunnel underneath rock to exit via the beach, has a build-up of sand and debris which has raised the water level at the Bridge to a point where it is probably saturating the earth fill over the stone arch.

Further upstream of Watermill Creek is Watermill Dam. The dam has been noted to be leaking with water heard flowing underneath the concrete overflow spillway. The open drain at the outlet is overgrown with bamboo impeding access. There is flow and siltation control upstream at the Watermill Dam where the stream is dammed. The stream can be traced back to the headwater of Watermill Creek to the east of the Burnt Pine Township.

Immediately downstream of the northern abutment of the Bridge there is a discharge point for Town Creek. Town Creek flows down the valley to the north of Quality Row, passes through the Officer's baths and through a covered channel under Quality Row. Just below to the east of the Bridge the channel widens a little. This probably relates to more turbulent water at the confluence of Watermill and Town Creek scouring out the banks.

The Norfolk Island Water Quality and Sewerage Infrastructure Management Strategy 2014 suggests the alluvial soils in the Kingston lowlands are likely to have rapid vertical drainage, with less depth to unconfined water tables. There is potential for increased salinity contamination of groundwater in the area due to increased sea water incursion facilitated by waterway channel clearing.

Groundwater

Permanent groundwater is expected to correspond closely to the sea levels in nearby Emily Bay/Slaughter Bay, and could rise when there are significant flows along Watermill Creek. Permanent groundwater was encountered at 0.8m/1.2m depth in site investigation boreholes, and the foundation soils were wet/saturated (AECOM 2020). Water testing in April 2010 indicated pH of 8.0 at the Bounty Street Bridge and 8.8 upstream. These are relatively alkaline readings.

Potential Project impacts

Surface water

Changes to hydrology and drainage would be temporary and short term, with earth bunds and a diversion pipe employed to maintain surface water flow around disturbance areas. Drainage conditions would be maintained as close as possible to existing conditions for the duration of Project works, and returned to pre-disturbance conditions upon completion of works.

During construction of the Project, activities that have the potential to adversely affect water quality and which would form the key areas of focus for environmental management measures would include:

- Removal of reeds and desilting of Watermill Creek in the Project area, resulting in a short term reduction in biological filtration/ water quality management capacity
- Soil disturbance, including construction of earth bunds and the trenched diversion pipe, resulting in an increased risk of erosion and sedimentation
- Changes in hydrology around the Project area, resulting in an increased risk of scour and erosion
- Potential disturbance of acid sulfate soils

The Project would require the removal of reeds and silt from the works area to allow access to carry out Bridge restoration works. Once the Project is complete, affected parts of Watermill Creek would be stabilised and returned to pre-disturbance conditions, with reed beds allowed to re-establish over time.

The Project would be planned and carried out with the aim of minimising soil erosion and sedimentation impacts. This would include implementation of the Watermill Creek diversion as an initial activity, to allow subsequent construction of the earthen coffer dams under low or no flow conditions. Works would generally be carried out in a downstream to upstream direction to allow turbid water to be collected and managed if required. Detailed construction planning and design would include consideration of erosion and sedimentation management measures consistent with *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom, 2004). This would include consideration of measures such as silt collection/ screening methods, segregation of potentially 'clean' and 'dirty' water, site stabilisation methods, and control of water flow velocities to provide natural opportunities for sediment to settle out from the water column.

The diversion pipe would be designed, installed and managed to emulate existing hydrology where possible. It would be designed to minimise the potential for scour and geomorphological change at the upstream entrance and downstream exit of the pipe. Similar considerations would be applied to the design of the earthen coffer dams, with the aim of minimising short term changes in hydrology and geomorphology, and associated erosion and sedimentation risk, during construction of the Project. Once completed, the Project area would be returned to its pre-disturbance state to avoid or minimise longer term changes in geomorphology and erosion potential.

Natural soils at the Project have been characterised as containing high loading of iron sulfides, and therefore have the propensity to generate acid sulfate soil conditions when disturbed or rapidly oxidised. To manage the potential for oxidation and acid generation, soil management measures would be developed and applied. These measures would be developed consistent with the guidance provided in *Acid Sulfate Soils: Assessment Guidelines* (NSW Acid Sulfate Soils Management Advisory Committee, 1998).

Materials, plant and equipment with the potential to leak or spill fuels and oils would be located away from Watermill Creek and disturbance areas where possible, and subject to bunding and spill management measures where appropriate. Quantities of fuels and oils would be minor and not bulk stored at the Project area. Vehicles would be excluded from parking adjacent to Watermill Creek, and any refuelling that may be required would be carried out in areas that do not or are prevented from draining to natural water courses. The EMP for the Project addresses spill management and clean up measures.

In managing surface water quality, the key driver would be the protection of Norfolk Marine Park and Emily Bay. The Project would be carried out with the aim of not materially affecting water quality at these key sensitive receivers, and this would be achieved by providing initial baseline testing of surface water using mainland Australia NATA accredited laboratories. During works, daily visual, odour and pH inspections would occur and the primary control measure would be observations of change from the baseline conditions. Chemical samples would be obtained at the completion of works to compare against baseline and assess the efficacy of controls during works.

Trigger criteria is are included in the EMP, and response actions and contingency measures would be developed to provide a multi-layered precautionary approach to the protection of water quality during Project construction works.

Overall the Project is not anticipated to result in a material change in water quality which may adversely impact on biodiversity, ecological integrity, social amenity or human health in Emily Bay and the Norfolk Marine Park. The risk of potential impact on the marine waters of Emily Bay are considered to be manageable to acceptable levels employing conventional mitigation measures through implementing of typical construction erosion and sedimentation control approaches.

Groundwater

Impacts to groundwater as a result of the Project are expected to be negligible. The works would be temporary and unlikely to result in any long term drawdown impacts on local or regional groundwater levels.

5.4 Biodiversity

Existing environment

Most of the original native vegetation in the area was cleared during the first settlement period on the island. The Project area straddles the Kingston Commons Reserve and Kingston Recreation Reserve which are vegetated with exotic pasture (i.e. Kikuyu grass) that has been subjected to cattle grazing for a considerable period. The Norfolk Island Parks and Forestry Service (2003) notes there are no significant plant species within these reserves. There is no native vegetation within or in the vicinity of the Project area. There are exotic reeds growing in Watermill Creek which would be removed prior to the works.

Historical information records the area near Bounty Street as a swamp. A short section of Watermill Creek immediately downstream from the Watermill Dam spillway is heavily infested with Wild Tobacco (*Solanum mauritianum*) and Hawaiian Holly (*Schinus terebinthifolia*). There is a large clump of bamboo growing along the left bank of Watermill Creek adjacent to the spillway. Small numbers of thistles, Hawaiian Holly, Wild Tobacco, Crank and Poison Bush (*Solanum sodomaeum*) occur occasionally in the Kikuyu pasture and the banks of Watermill Creek channel. Water Hyacinth (*Eichhornia crassipes*) grows densely on the surface of Watermill Dam, drainage channels and on the ponded areas adjacent to Watermill Creek (Norfolk Island Parks and Forestry Service 2013). Watermill Creek has been subject to periodic maintenance where reeds are removed during desilting works which recolonises the creek.

Serpentine Channel, which is located about 30 metres downstream of the Bridge, is a remnant wetland which has been colonised by exotic reeds and weeds. The aquatic vegetation within Watermill Creek and adjacent swamps act as a filter and pollutant sink for sewage pollution originating upstream from Town Creek and Watermill Creek catchments and improves surface water quality discharging into Emily Bay.

Watermill Creek drains into Emily Bay which is located approximately 370 metres to the south east of the Project area. The inshore waters of Norfolk, Phillip and Nepean Islands support one of the southern-most coral assemblages in the world. While the corals are a sub-set of the of the Great Barrier Reef, they are part of an inshore marine ecosystem that includes a number of endemic species, with global biodiversity value. A survey on the reefs in 1999 found that there are 57 species of scleractinian corals, in 27 genera in 11 families which comprises a unique association of tropical and temperate species of global biodiversity value (Pendoley Environmental 2015). The Emily and Slaughter Bay lagoon system is also habitat to EPBC Act listed species including juvenile Green Turtles (*Chelonia mydas*). This unique inshore marine ecosystem is vulnerable to environmental change such as sediment and nutrient inputs from discharge into Emily Bay.

A search using the EPBC Protected Matters Search Tool identified records for 30 taxa of fauna within one kilometre of the Project area, however, the majority of these species are birds and marine animals and therefore highly mobile. Five species of reptiles have been recorded, all of which are marine turtles. They include Green Turtle (*Chelonia mydas*), Hawksbill Turtle (*Eretmochelys imbricata*), Flatback turtle (*Natator depressus*), Leatherback Turtle (*Dermochelys coriacea*) and Loggerhead Turtle (*Caretta caretta*). One bird and two plant species have been identified with habitat known or likely to occur, including the Eastern Curlew (*Numenius madagascariensis*), *Senecio hooglandii* (daisy) and Chaff Tree (*Achyranthes arborescens*).

There are also a number of migratory species that have been recorded to be present or have foraging, feeding or related behaviour likely to occur within area. According to the Norfolk Island Parks and

Forestry Service, between September and May a few migratory waders (especially Pacific Golden Plover (*Pluvialis fulva*), Bar-tailed Godwit (*Limosa lapponica*) and one or two Greenshank (*Tringa nebularia*)) may be found feeding around the edges of flooded pasture (Norfolk Island Parks & Forestry Service, 2003). The area is not suitable for breeding seabirds.

There are no significant plant species in the reserve. The only species known to occur in the broader area to the east of the Project are *Senecio evansianus* and *Senecio hooglandii* (species of daisies) and *Achyranthes arborescens* (Chaff tree).

Potential Project impacts

Potential impacts of the Project on biodiversity may include:

- Loss of potential benthic habitat
- Erosion and sedimentation causing silt laden and nutrient rich surface runoff to impact water quality and aquatic ecology of Watermill Creek and Emily Bay
- Mortality of aquatic fauna (eels, shrimp and fish) due to being sucked into the pumps used to dewater the upstream earth bund
- Introduction or spread of weeds, pests or pathogens from contaminated materials and the potential to import new weed or pest species (e.g. Argentine Ants) into the site on machinery.

Impacts to biodiversity would be temporary during the works. The reinstatement of Watermill Creek and channels would allow flora and fauna to re-establish following disturbance and reinstatement of the site.

The Project would not cause a significant impact to protected threatened ecological communities or species or migratory species.

Loss of benthic habitat

Construction of a concrete footing in Watermill Creek would result in a permanent loss of habitat for benthic fauna (about 12 square metres). Considering that Watermill Creek is about 1.5 kilometres in length from Watermill Dam to Emily Bay, the loss of benthic habitat beneath the Bridge (i.e. 0.8 per cent) is considered negligible.

Erosion, sedimentation and downstream impacts

Watermill Creek discharges into Emily Bay which is a Commonwealth Marine Area (Norfolk Marine Park). There are fringing coral reefs along the shoreline of Emily Bay and the beach is a popular tourist and community area. The water quality in Emily Bay and the coral reefs has been historically impacted by bacterial contamination including *E.coli* pollution from Watermill Creek. Uncontrolled sediment discharges from the Project could potentially adversely impact the marine water quality at Emily Bay and smother the coral reefs, exacerbating marine pollution that is already occurring, particularly during wet events.

The risk of material changes in water quality in Watermill Creek would be managed as outlined in **Section 5.3**.

Fauna mortality

Watermill Creek supports native eels and shrimp which are of local conservation importance. Precautionary and best management practices would be implemented to minimise impacts on aquatic biota during construction. Suitable protective filter mesh would be installed on suction lines and the diversion pipe to prevent native eel, shrimp and fish being sucked into the dewatering pump intakes and causing mortality. Any native eels, shrimp, fish of other aquatic fauna found in the dewatered section of Watermill Creek between the earth bunds would be immediately rescued and placed in a bucket filled with creek water, before being released at a suitable location upstream.

Introduced species and biosecurity

The Bounty Street Bridge is located on land vegetated with exotic pasture (i.e. Kikuyu grass), which is subject to cattle grazing or is maintained. The bridge is not located in the vicinity of native habitats and is readily accessible without the need to clear vegetation.

There are exotic reeds growing in Watermill Creek which would be removed from the stretch between the earth bunds within the Project area prior to the works. Watermill Creek has been subject to periodic maintenance where reeds are removed during desilting works.

All construction materials brought onto Norfolk Island would be subject to existing biosecurity control protocols. Considering that no machinery or equipment and only limited construction materials would be required to be brought into Norfolk Island for the Project, the Project would not specifically increase the biosecurity risk to biodiversity on Norfolk Island. The sourcing of uncontaminated soil to construct the earth bund for the coffer dam would avoid locations of known Argentine ant (*Linepithema humile*) infestation.

5.5 Soil and landform

Existing environment

The topography of the Kingston Commons and Kingston Recreation Reserves within which the Bridge sits is a relatively flat low lying area and ranges from about six metres above sea level along Quality Row and gently tapers to the Watermill Creek channel. The Kingston Recreation Reserve and Kingston Commons have been levelled in the past and Watermill Creek has been channelised to facilitate drainage of the once swampy area to create arable pasture (Norfolk Island Parks and Forest Service 2003). To the south of Watermill Creek channel and adjacent low lying areas, the land rises to the remains of a calcarenite ridge that parallels the Slaughter Bay foreshore and along which Bay Street runs.

Serpentine Channel lies about 30 metres downstream of the Bridge and is one of the larger remnant low lying swamps located between the Bridge and Slaughter Bay. The outlet of Watermill Creek to Emily Bay sits between the high and low tide levels and gets blocked with sand and sediment. This hinders drainage of the lower extents of Watermill Creek and results in runoff being retained within Serpentine Channel and the adjacent swampy area.

The Bridge site is documented to be covered in Quaternary age alluvial deposits, associated with Watermill Creek. These alluvial deposits are underlain by Quaternary age, cross-bedded and massive calcarenite, with interbedded, black, carbonaceous, lagoonal clay and Norfolk Aeolianite (fossil dune sand), overlying basalt bedrock. Calcarenite is a type of limestone that is composed predominantly, more than 50 percent, of detrital (transported) sand-size (0.0625 to 2 mm in diameter), carbonate grains. The grains consist of sand-size grains of either corals, shells, pellets, fragments of older limestones and dolomites, other carbonate grains, or some combination of these.

The dip of the cross-bedding indicates that the calcarenite was laid down by southerly winds, partly re-worked by currents, during a low sea level stand in the Late Quaternary. A sequence of younger massive beach rock, derived in part from the underlying aeolianite by erosion and re-deposition, also contain basalt pebbles and fragments of algae and coral.

A field investigation was carried out by AECOM on 28 January 2020, comprising two boreholes designated 1A and 2A, to determine the subsurface profile. Borehole 1A was drilled adjacent to the southern abutment of the Bridge, while borehole 2A was drilled adjacent to the northern abutment (both on the western, upstream side of the Bridge). The investigations found the topsoil to be clayey silty sand and silty clayey sand and silty clay in the alluvial soils below 0.3 metres.

A geotechnical soils investigation carried out by Parsons Brinckerhoff in 2005 has mapped the Project area soil type as 'Basaltic Colluvium mixed with calcareous sand (Class M) to the north of the Bridge, Emily Bay calcareous sand (class S) to the south of the Bridge and Unnamed swamp soil in the Watermill Creek riverbed.

The unprecedented drought conditions experienced in early 2020 led to a considerable drop in water table levels on Norfolk Island, exposing the hypersulfidic soils along sections of wetlands and streambanks. This led to the rapid formation of sulfuric soils in most wetlands across the Island. The corrosion/dissolution of cement mortar and calcarenite of Watermill Dam and nearby Pier Street Bridge is evidence of sulfuric organic soils and monosulfidic organic soils present in the area of Watermill Creek and the Project area which used to be wetland. Highly acidic levels were recorded in soils from Watermill Dam from depths of 0-50 cm which ranged from pH 3.3 - 4.8 (Fitzpatrick 2020).

Potential Project impacts

There is a high risk of encountering acid sulfate soils in the carrying out of the Project, which has been confirmed through preliminary soil testing. To manage acid sulfate soils, the potential to generate acid leachate and impact on water quality in Watermill Creek, detailed acid sulfate soil management measures would be developed and applied. These measures would be developed consistent with the guidance provided in *Acid Sulfate Soils: Assessment Guidelines* (NSW Acid Sulfate Soils Management Advisory Committee, 1998) and is addressed in the Project EMP.

All disturbance areas would be returned to pre-disturbance conditions upon completion of Project works.

5.6 Noise and vibration

Existing environment

The acoustic environment in and around the Project site experiences very low noise levels, contributed to mainly through non-anthropogenic noises sources (ie typically wind and fauna). Noise contributions are occasionally made by passing vehicles.

Potential Project impacts

The Project would generate temporary, short term noise impacts on the surrounding environment through:

- Truck movements
- Operation of plant and machinery, such as gen-sets, excavator, etc.
- Use of power tools such as for cutting and grinding
- Stonemasonry works.

Noise is not anticipated to be an issue of concern at the site as the nearest receptor is 175 metres away. Construction activities would be carried out during the day time to avoid potential impacts during the quieter night time period.

Construction planning would include selection of plant and equipment with the aim of not exceeding the structural damage criteria (peak particle velocity) for structures that are particularly sensitive to vibration and have intrinsic value, as detailed in German standard *DIN 4150-3: 1992-02 Vibration in Buildings – Part 3: Effects on Structures*, at any heritage building/ structure. Where plant and equipment is required to be used in proximity to a heritage building/ structure (ie the Bounty Street Bridge) and cannot satisfy structural damage criteria for vibration, additional site- and activity-specific mitigation and management measures would be developed and applied. This may include vibration monitoring, structural reinforcements, and/ or amelioration of structural damage.

5.7 Air emissions and odour

Existing environment

The Project site currently experiences very good air quality, with no significant emissions sources in the region apart from motor vehicles and agricultural activities.

Potential Project impacts

Vehicle movement, transportation of materials and earthworks have the potential to generate dust during dry weather periods. Drilling works for concrete grouting may generate localised dust if the dust filter on the drilling rig is not functioning effectively.

Odours noticeable at the site boundary can cause nuisance to offsite sensitive receivers, and may be generated through exposure of odour-producing sediments. Desilted material from Watermill Creek and exposure of the creek bed which has been historically polluted with high levels of bacterial contaminants, including *E.coli* and may including acid sulphate soil, both of which have the potential to release odours upon exposure.

Overall, the potential generation of dust and odours would be managed through application of good practice environmental management measures during the Project works. This would include

maintaining soils in a moist condition, covering and/ or treating potential odorous materials, managing cutting and grinding works to minimise dust generation, and careful selection of plant and equipment to minimise air pollution from fuel combustion.

5.8 Landscape character and visual impact

Existing environment

Norfolk Island is almost completely volcanic in origin, with the rocks dominantly comprising fine to medium grained olivine basaltic lavas and pyroclastic tuff (layered volcanic ash). The significant feature of the Kingston reserve is the relatively flat valley of Watermill Creek. Watermill and Town Creeks have carved the deep valleys into the southern part of the Island's deeply weathered volcanic plateau. The catchments of Watermill and Town creeks together comprise approximately 450 hectares.

The Bridge is located in an area that was formerly swamp that has been drained through channelisation of the creek. The ground has been modified over the years with the swamp being drained by excavated channels. Historic records indicate that the routes of drainage channels have varied over the years associated with various stages of development and modification to land form.

The wetland along Watermill Creek and low-lying areas downstream of the Bridge provide an important relic habitat for aquatic flora and fauna that is virtually non-existent elsewhere on Norfolk Island (Norfolk Island Parks and Forestry Service 2003). The wetland is also important for improving the water quality of surface waters that flows into Emily Bay. The wetland vegetation traps sediment, accelerated accretion, absorbs nutrients and retains microbes from being discharged directly into Emily Bay. Watermill channel is also known to support native aquatic fauna.

Watermill Creek discharges into Emily Bay which is a Commonwealth Marine Area. There is only minimal fall between the Bridge and the outfall into Emily Bay which is located about 370 metres to the southeast of the Bridge. Emily Bay is the main swimming area on the island for locals and tourists. There are fringing coral reefs along the shoreline.

Potential Project impacts

Construction of the Project would have a temporary and short term impact on local landscape and visual amenity. Installation of earth bunds, traffic bollards and site perimeter fencing would cause a temporary impact to the visual landscape of the Bridge which sits in the open field of Kingston Commons which is visible from various viewpoints. Construction of earthen coffer dams and the presence of plant, equipment and workers would be visually intrusive over a limited visual catchment, and would be removed at the conclusion of the works. The site would be reinstated to its pre-disturbance condition following the works, and would be returned to a visually indistinguishable state once vegetation has re-established.

The Bridge restoration works, and particularly the concrete supporting arch, would introduce a new physical element into the structure. As noted in the heritage impact assessment (refer to **Section 5.2**), the extent of work has been minimised and is generally limited to areas of the Bridge that are not visually prominent.

The Project would employ reinforcement below the Bridge arch set back 300 mm from the face of the Bridge, use similar construction materials (i.e. calcarenite, sandstone and lime mortar) and would remove Portland cement render to reveal the original Bridge fabric. Overall these works would contribute to a positive visual effect in some areas by removing materials that are not original.

5.9 Traffic and access

Existing environment

The Bounty Street Bridge is currently closed to traffic based on a risk assessment of the bridge's structural integrity. Traffic volumes on the surrounding road network, including Quality Row and Bay Street are very low.

Potential Project impacts

Changes in traffic movement and movement of heavy machinery to the site has the potential to temporarily disrupt local traffic. Transportation of desilted material and waste to landfill and

transportation of earth material for the earth bunds could result in spillage on roads if not properly controlled.

With appropriate management of construction vehicles, potential Project impacts to traffic and access are likely to be limited. These impacts would be temporary and short term.

The Project would have a positive impact on traffic and access by allowing the Bounty Street Bridge to be reopened to traffic.

5.10 Socio-economic

The Project would return the Bridge to service of the local community which would facilitate access to the foreshore of Slaughter Bay and Emily Bay. Short term and temporary socio-economic impacts that may arise during construction would be minimised through careful management of potential construction impacts (eg dust, noise, traffic).

5.11 Resource use and waste

Construction waste materials that would be generated include:

- Packaging waste such as plastic, cardboard, paper, wooden crates and metal straps
- Construction waste from fabrication and concreting works and temporary bracing structures such as fibre glass reinforcement rods off cuts, metal, wood, mortar and rocks
- Spoil from excavation of bridge footings, drilling works and removal of coffer dam earth material
- Silt and biomass from desilting Watermill Creek
- Waste chemicals such as solvents, used oil and chemical containers
- Solid waste and sewage from workers on site.

Resource use and waste management would be controlled through the implementation of the Environmental Management Plan for the Project.

6.0 Environmental management

The Project would be subject to an Environmental Management Plan (EMP), which details how the Project is to be carried out to mitigate and manage potential environmental impacts. Where relevant, the EMP may be supplemented by separate, issue-specific management sub-plans (such as for heritage and surface water management).

The EMP has been developed by qualified environmental specialists, and has included consultation with key stakeholders including Norfolk Island Regional Council, the Commonwealth Department of Climate Change, Energy, the Environment and Water, and Parks Australia. Any required sub-plans to the EMP would be prepared under the same conditions.

Based on the assessment presented in this report, a series of mitigation and management measures have been identified for application to the Project (refer below). These measures are reflected in the EMP, would be reflected in sub-plan(s), and where relevant, would be passed through as obligations on construction contractors.

6.1 Heritage

Archival recording of the Bridge

1. Once de-watering of the Watermill Creek has been accomplished, an archival recording of the Bounty Street Bridge would be completed prior to construction works commencing. The archival recording would include a laser scan and photographic recording.
2. Access holes to allow pouring of concrete through the deck of the Bounty Street Bridge are to be examined by the Project archaeologist to identify previous surfaces, if present.

Construction and restoration materials

3. Calcarenite for stone replacement, if necessary, would be sourced from Norfolk Island, if possible.
4. Source of the sandstone extant within the Bridge would be analysed and the replacement stones sourced from the same location, if possible and if necessary.
5. Any coping stones found during excavation under the bridge would be placed back into position on the bridge parapet, if they are in suitable condition.

Construction and restoration approach

6. Cleaning of the mud from the Bridge during construction would not involve high-pressure cleaning. Water pressure would be limited to 7,000psi or less. The method would be tested to ensure suitability and altered if it is found to cause undue damage.
7. Options to minimise the number of cores in the bridge would be explored. Propping of bridge during construction would avoid drilling holes into the stone.
8. Reconstruction of the downstream (eastern) face of the bridge would be undertaken by a stonemason with experience in reconstructing historical structures. The stones would be marked in an unobtrusive location with the year or other similar marker to differentiate the original and new works, as specified under the *Burra Charter*.
9. The method for removing concrete render would protect the remnant original finishes. Where original finishes are identified, these would be reflected in the final finish of the bridge above the water line.

Protection and management of archaeology

10. The location of the earth bunds and trench for the diversion pipe would be determined on site, in conjunction with the Project archaeologist. Preference should be to avoid impacts to potential archaeological deposits, but where these are unavoidable, the research questions would be directed towards gathering information that could be used in the future to implement the recommendation in the KAVHA HMP that the serpentine form of Watermill Creek be reinstated. Works within the restricted area would be supervised by an archaeologist.

11. An archaeological research design and methodology would be prepared and implemented. Archaeological works would be carried out before and in conjunction with the construction works by a suitably qualified archaeologist. At the conclusion of works, an Archaeological Excavation Report would be prepared outlining the results of all investigation works.

Vibration-related impacts

12. Construction planning would include selection of plant and equipment with the aim of not exceeding the structural damage criteria (peak particle velocity) for structures that are particularly sensitive to vibration and have intrinsic value, as detailed in German standard DIN 4150-3: 1992-02 *Vibration in Buildings – Part 3: Effects on Structures, at any heritage building/structure*. Where plant and equipment is required to be used in proximity to a heritage building/structure and cannot satisfy structural damage criteria for vibration, additional site- and activity-specific mitigation and management measures would be developed and applied. This may include vibration monitoring, structural reinforcements, and/ or amelioration of structural damage.

6.2 Water

13. A surface water monitoring program would be developed and applied, including baseline surface water quality monitoring prior to Project construction and water quality monitoring during the works.
14. The Project would be subject to water quality criteria developed consistent with the guidance in *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC, 2000) for the protection of 95% of species.
15. Where possible and practical, Project works would be scheduled during the dry season and/ or periods of low water flow in Watermill Creek.
16. Detailed erosion and sedimentation control measures would be developed and applied consistent with the guidance in *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom, 2004)
17. Detailed acid sulfate soil management measures would be developed and applied consistent with the guidance provided in *Acid Sulfate Soils: Assessment Guidelines* (NSW Acid Sulfate Soils Management Advisory Committee, 1998).

6.3 Biodiversity

18. Stock proof fencing would be installed around the construction boundary, upstream of the bridge with a 20-metre buffer zone on either side of the Watermill Creek for desilting work..
19. Clearing of reeds in Watermill Creek would be minimised.
20. Weed and pest prevention and control protocols would be implemented.
21. Suitable protective filter mesh would be installed on suction lines and the diversion pipe to prevent native eel, shrimp and fish being sucked into the pipe intakes and causing mortality. Any native eels, shrimp, fish or other aquatic fauna found in the dewatered section of Watermill Creek between the earth bunds would be immediately rescued and placed in a bucket filled with creek water, before being immediately released at a suitable location upstream.

6.4 Soil and landform

Relevant soil and landform measures are addressed under Water (refer to **Section 6.2**) and Waste Management (refer to **Section 6.5**).

6.5 Noise and vibration

22. Construction planning would include selection of plant and equipment with the aim of not exceeding the structural damage criteria (peak particle velocity) for structures that are particularly sensitive to vibration and have intrinsic value, as detailed in *German standard DIN 4150-3: 1992-02 Vibration in Buildings – Part 3: Effects on Structures, at any heritage building/ structure*. Where plant and equipment is required to be used in proximity to a heritage building/ structure and cannot

satisfy structural damage criteria for vibration, additional site- and activity-specific mitigation and management measures would be developed and applied. This may including vibration monitoring, structural reinforcements, and/ or amelioration of structural damage.

23. Plant and equipment would be selected and used to maximise the distance between noisy plant and sensitive receivers, direct noise-emitting plant away from receivers and be subject to regular inspection and maintenance.
24. Construction works would be carried out during standard hours, being:
 - Mondays to Fridays from 7:00am to 6:00pm
 - Saturdays from 8:00am to 1:00pm
 - At no time on Sundays or public holidays.

6.6 Air emissions and odour

25. Plant and equipment would be maintained to minimise air emissions.
26. Dust generating materials would be kept moist, covered or otherwise managed to minimise the potential for dust generation.

6.7 Landscape character and visual amenity

27. Watermill Creek and disturbed areas would be reinstated to their original condition or better upon completion of construction.

6.8 Traffic and access

28. Construction vehicles would not be permitted to park on the grass verge on the Bridge.
29. The NIRC and emergency services would be consulted with respect to maintaining emergency access during construction works.

6.9 Socio-economic

Relevant socio-economic measures are addressed under Noise and vibration (refer to **Section 6.5**), Air emissions and odour (refer to **Section 6.6**) and Traffic and access (refer to **Section 6.8**).

6.10 Resource use and waste

30. Spoil from desilting and excavation of Watermill Creek would be managed to contain potential acidic leachate from Acid Sulfate Soils in accordance with Acid Sulfate Soils: Assessment Guidelines (NSW Acid Sulfate Soils Management Advisory Committee, 1998); and disposed at an approved site.
31. Wastes generated during construction would be collected in a central waste storage area, prior to offsite disposal at an appropriately permitted facility.
32. The waste management hierarchy of 'reduce, reuse, recycle' would be applied to the use of materials on site.
33. An emergency spill management and response procedure would be developed and applied to the Project.
34. Vehicles transporting waste would be properly covered.

7.0 Project justification and conclusion

The aim of the Project is to rectify and “make safe” the Bridge structure while safeguarding the heritage values throughout design and construction in accordance to the Kingston and Arthur’s Vale Historic Area Heritage Management Plan 2016. The Project presents the best approach to meet the heritage considerations, protect the existing heritage structure from collapse, and allow for bridge use by the local community.

The Bounty Street Bridge support structure has been designed for a life expectancy of 100 years with construction materials chosen to reflect this design life. The traffic loading originally requested by the client was to allow for a small 2 tonne truck to cross the bridge. The actual loading used in design of the structure was based on the 1992 Austroads T44 Bridge loading that allows for a 44-tonne gross truck to travel across the bridge. This loading was used to optimise use of the bridge for Norfolk Island residents and ensure structural integrity and longevity. The load is also within the nominal capacity of a concrete arch that has been sized for a 100-year design life.

There is a low environmental impact of the Project. Environmental impacts are managed and mitigated through the EMP.

For heritage impacts, consideration of the minimal heritage impacts has been included in the design to determine the best option. A heritage impact statement has been completed. On balance, the remediation works are considered warranted and a positive heritage outcome overall noting the significant deterioration in the Bridge and the risk of collapse. Although the remediation works would impact the Bridge and its heritage value, individually and as a contribution to the KAVHA, these impacts are considered acceptable in the context of restoring and maintaining the Bridge.

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ABN: 86 21 139 139



Environmental Management Plan

13-Oct-2023
Bounty Street Bridge Conservation Works

AECOM

Bounty Street Bridge Conservation Works
Environmental Management Plan –

Environmental Management Plan

Client: Department of Infrastructure, Transport, Regional Development, Communications and the Arts

ABN: 86 267 354 017

Prepared by

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1.0 Introduction

1.1 Project Overview

1.1.1 Background

The Kingston and Arthur's Vale Historic Area (KAVHA) on Norfolk Island is one of eleven sites that comprise the Australia Convict Sites World Heritage Property. It is recognised for being one of the best surviving examples of large-scale convict transportation and colonial expansion of European powers through the presence and labour of convicts. Today it remains a living showcase of Polynesian, convict and Pitcairn Islander history. In addition to its World Heritage List (WHL) status, KAVHA is also included on the National Heritage List (NHL), the Commonwealth Heritage List (CHL) and the Norfolk Island Heritage Register (NIHR) (Table 1).

The KAVHA comprises a series of structures, each contributing to the collective heritage value of the area. Among these structures is the Bounty Street Bridge (the Bridge), which provides a crossing point for Bounty Street across Watermill Creek, between Quality Row and Bay Street.

Table 1 Summary of Heritage Listings

Place	WHL	NHL	CHL	NIHR
Kingston and Arthur's Vale Historic Area	106209	105962	105606	Listed

The *Kingston and Arthur's Vale Historic Area Safety Hazard Scoping Study Draft Report* (GML, May, 2018) identified a number of 'very high risk' structural hazards that threatened the integrity of various heritage structures within KAVHA. The Bounty Street Bridge was identified as one of the structures posing a very high risk of loss of structural integrity. To address this risk, it is proposed to carry out structural reinforcement of the Bridge through installation of a structure concrete arch beneath it. The reinforcing arch would protect the structural integrity and heritage value of the Bridge, including its contribution to the heritage values of the KAVHA.

WHL, NHL and CHL places are all protected under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act), while the NIHR places are protected under the *Heritage Act 2002* (NI). Works to elements within KAVHA, including the Bounty Street Bridge, need to be managed in accordance with national and local legislation.

An Environmental Impact Assessment (EIA) (AECOM, 2023) and Heritage Impact Assessment (HIA) (AECOM, 2023) have been completed to assess potential impacts associated with conservation works of the Bounty Street Bridge. This Environmental Management Plan (EMP) should be read in conjunction with the EIA and HIA, and provides management measures to address these potential impacts. In the event of discrepancy between the EMP, EIA and HIA, the measures provided in this EMP take precedence.

1.1.2 The Project

The aim of the project is to rectify and "make safe" the bridge while safeguarding the heritage values throughout design and construction in accordance to the HMP. The project has been designed based on the now obsolete 1992 Austroads Bridge design code T44 Bridge loading, and informed by the HIA undertaken by a qualified heritage specialist.

The Bounty Street Bridge location plan and project site plan are shown in Figure 1 and Figure 2 while the cross section of the earth bund is shown in Figure 3. The diversion trench cross section is depicted in Figure 5.

A full project description is provided in the EIA and HIA. Key features of the Project are:

Preliminary works

- Trenching and installation of a diversion pipe for the Town Creek flow and to maintain flow in Watermill Creek

- Installation of earth bunds upstream and downstream of the Bridge, dewatering and desilting

Construction sequence

The construction sequence consists of the following stages:

- Stage 1 – Excavation
 - Overseen by Archaeologist
- Stage 2 – Point and render arch soffit
- Stage 3 – Pour foundation
 - Using fibre glass reinforcement to resist corrosion and ready mixed concrete
- Stage 4 – Construct concrete lining
 - Injected via holes drilled from the top of the bridge
- Stage 5 – Remediate bridge sides (Figure 4).
 - Using similar rock material and lime mortar as per original in accordance to Heritage requirements

Reinstatement of Watermill Creek


- Upon completion of works the earth bunds would be removed with controlled dewatering pumping to prevent a sudden flow of water through the project area.
- Watermill Creek would be reinstated as a minimum to its original condition




PROJECT FEATURES

Legend

- KAVHA boundary
- Cadastral boundaries
- Project boundary





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Figure 1 Bounty Street Bridge Location Plan

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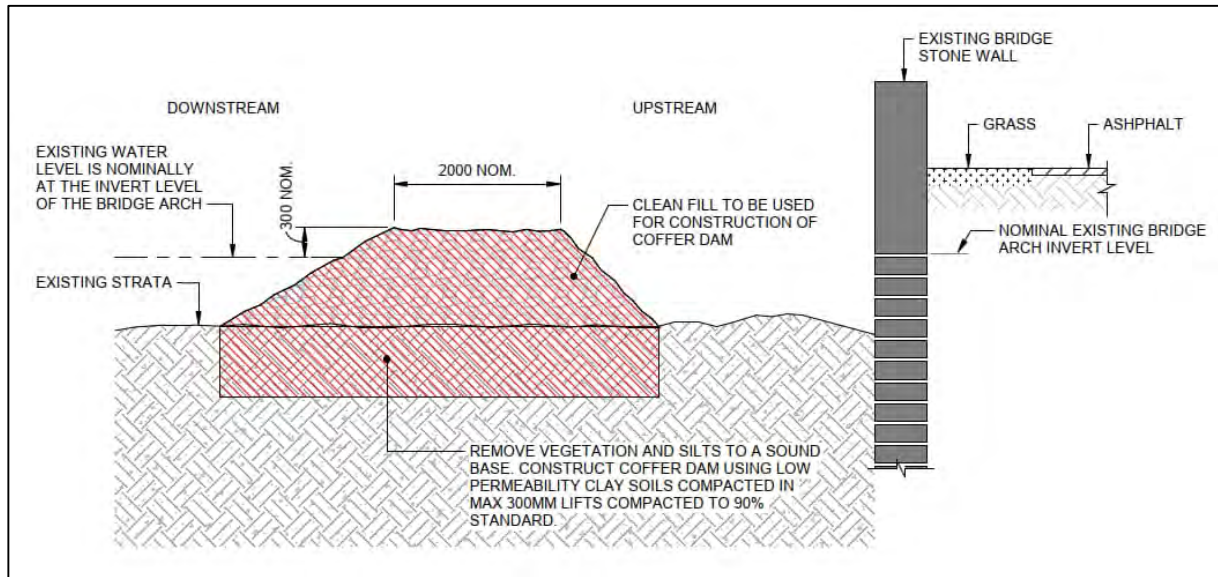


Figure 3 Cross Section of Earth bund

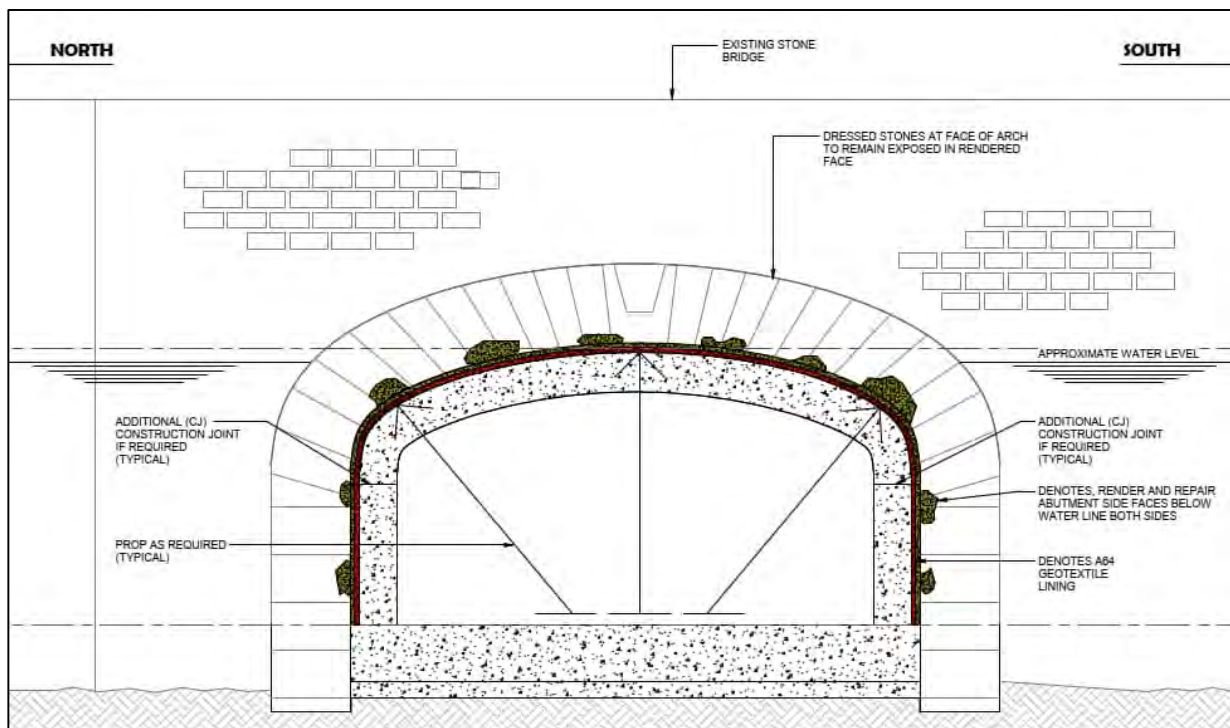


Figure 4 Construction Sequence Stage 5

Released under the Freedom of Information Act 1982 by the Department of Infrastructure, Transport, Regional Development, Communications, Sport and the Arts

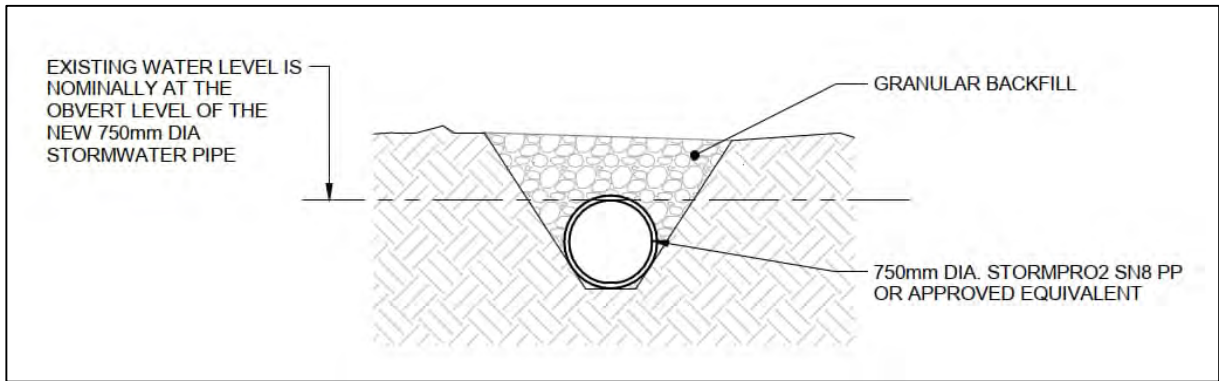


Figure 5 Typical diversion trench cross section

Released under the Freedom of Information Act 1982 by the Department of Infrastructure, Transport, Regional Development, Communications, Sport and the Arts

1.2 Scope and Purpose of EMP

1.2.1 Scope

This EMP sets out the procedures that would be implemented to manage the project from an environmental perspective, to achieve environmental and heritage statutory requirements through the Contractor's environmental commitments.

1.2.2 Objectives / Purpose of this EMP

This EMP provides specific environmental management steps to ensure that works undertaken during the project mitigate identified environmental risks.

The objectives of this EMP are to:

- Provide a summary of the potential environmental issues that will require management during the project
- Outline the necessary management strategies, actions, monitoring and reporting measures to be undertaken during the project
- Minimise safety risks and inconvenience to activities at the site and the surrounding communities relating to the proposed activities of the project.

The EMP addresses the interactions between project elements and environmental receptors including air, soil, surface and marine water, flora and fauna, heritage items and local community.

1.3 Stakeholders

Key project stakeholders include:

- Department of Infrastructure, Transport, Regional Development, Communications and the Arts [DITRDCA] (including the Norfolk Island Team and the ACT, NT and KAVHA Team) (formerly Department of Infrastructure, Transport, Regional Development, and Communications [DITRDC])
- Department of Climate Change, Energy, the Environment and Water (DCCEEW) (incl. Parks Australia, Historic Heritage and Environment Approvals and Wildlife Trade Branch) (formerly Department of Agriculture, Water and Environment [DAWE])
- Norfolk Island Regional Council (incl. Planning Officer, Museum Team Leader, Conservator of Public Reserves, Team Leader - Waste and Environment, Works Crew)
- Norfolk Island Water Quality Working Group
- KAVHA Advisory Committee KAVHA Community Advisory Group
- Construction contractor
- Members of the community.

2.0 Tasks and Responsibilities

2.1 Environmental Management Plan

The tasks and responsibilities for updating this plan are outlined in Table 2.

The EMP is to be reviewed by the Project Manager. Where there is a requirement for review identified, it would be undertaken, and the plan reissued to relevant stakeholders for information.

Table 2 Plan Reviews

Task Description	Start	Finish	Responsible Officer
Review and update Draft EMP, as required	Contract Award Date	Within 14 days of Award Date	Appointed Project Manager
Approve EMP	Upon receipt of Plan	Within 14 days of submission from contractor	Contractor Project Manager
Review EMP	When required	When required	Contractor Project Manager

3.0 Environmental Objectives

3.1 Environmental Objectives

Specific environmental objectives of this project are detailed in Table 3.

Table 3 Environmental Objectives

Environmental Factor	Objective
Cultural heritage items and artefacts	<ul style="list-style-type: none"> Minimise impact on heritage values through design Works to be mindful of the potential for accidental damage to heritage items or identifying archaeological artefacts and implementing appropriate procedures to address impacts
Soil and water	<ul style="list-style-type: none"> Minimise the impact of erosion and sedimentation Minimise the impact to water quality of receiving waterbodies Avoid disturbance of potential acid sulfate soils Prevent exposure of acid sulfate soils
Waste generation	<ul style="list-style-type: none"> Minimise waste generation Maximise reuse and recycling waste
Traffic and access	<ul style="list-style-type: none"> Minimise the impact of the project on traffic and access in the vicinity of the project area
Visual amenity	<ul style="list-style-type: none"> Minimise the visual impact to the heritage item as a result of the project
Air quality	<ul style="list-style-type: none"> Minimise the impact on air quality, including odour and dust impacts
Noise	<ul style="list-style-type: none"> Minimise noise and vibration of the construction works on sensitive receivers, including the heritage structure itself
Odours	<ul style="list-style-type: none"> Minimise any impacts resulting from unpleasant odours on community activities, including summer camping
Interaction with flora and fauna (including weeds and overabundant species)	<ul style="list-style-type: none"> Minimise impacts of the project on flora and fauna on site, in the adjacent areas and receiving waterbodies (Watermill Creek and Emily Bay) Minimise the potential threat to the introduction of noxious weeds and plants

General project environmental objectives include:

- Encourage best practice environmental management through planning, commitment and continuous improvement
- Implement measures to ensure consistent compliance to legislative and other requirements
- Prevent and minimise adverse impacts on the environment
- Identify the potential for, and respond to, environmental incidents, accidents (including damage to heritage structures) and emergency situations and take corrective action
- Identify and control possible environmental hazards associated with the project
- Recognise and protect any special environmental characteristics of the project (particularly site-specific cultural heritage significance)
- Define roles and responsibilities of personnel for environmental management
- Ensure environmental training and awareness programmes are provided to employees and sub-contractors
- Describe all monitoring procedures required to identify impacts on the environment as a result of the project

- Implement complaint reporting procedures and maintain records of complaints and response to complaints
- Establish and maintain programs and procedures for periodic EMP audits to be carried out.

4.0 EMP Framework / Statutory Requirements

4.1 Management Framework

This section outlines the parties involved with the project and how they relate to each other.

4.2 Roles and Responsibilities

The following parties would be responsible for ensuring that this EMP is adhered to throughout the life of the project:

- Appointed Project Manager
- Contractor Project Manager.

4.3 Regulatory Context

4.3.1 World Heritage Convention

KAVHA is part of the Australian Convict Sites properties, which is listed on the World Heritage List of the *Convention Concerning the Protection of the World Cultural and Natural Heritage* (i.e. the World Heritage Convention). The Project is located within the KAVHA and is managed by the KAVHA Advisory Committee through the KAVHA Heritage Management Plan (GML 2016).

Administratively the Australian Government manages listed world heritage items in accordance to the Operational Guidelines prepared by the World Heritage Centre through implementing the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act). Compliance of the Project with the requirements of the EPBC Act would ensure conformance with obligations under the World Heritage Convention.

4.3.2 Commonwealth legislative framework

4.3.2.1 Environment Protection and Biodiversity Conservation Act 1999 (Cth)

The *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) is the principal legislation protecting matters of national environmental significance (MNES) and the environment of Commonwealth land. Actions that may significantly affect a MNES or the environment of Commonwealth land require assessment and approval under the EPBC Act.

The Project may directly or indirectly affect three MNES protected under the EPBC Act:

- Direct impacts on KAVHA as a World Heritage site (site ID: 106209, World Heritage List)
- Direct impacts on KAVHA as a National Heritage Place (site ID: 105962, National Heritage List; site ID: 105606, Commonwealth Heritage List)
- Potential indirect impacts through site runoff on the downstream Norfolk Marine Park, a Commonwealth marine area.

In addition to these MNES, the Project would be carried out on Commonwealth land (and would therefore affect the environment of Commonwealth land within the meaning of the EPBC Act). The Project also constitutes as action by a Commonwealth agency, being the Department of Infrastructure, Transport, Regional Development, Communications and the Arts (DITRDCA).

The EIA and HIA prepared to assess potential impacts concluded that the Project would not have a significant impact on a MNES. Despite this, a referral under the EPBC Act has been submitted to DCCEEW to confirm that the Project does not require further assessment or approval under the EPBC Act. This EMP, along with the EIA and HIA, form supporting documents to the EPBC Referral.

4.3.2.2 Protection of Movable Cultural Heritage Act 1986 (Cth)

The *Protection of Movable Cultural Heritage Act 1986* (Cth) protects Australia's movable cultural heritage and provides for the return of foreign cultural property which has been illegally exported from its country of origin and imported into Australia.

A chance find procedure that addresses the requirements of this Act has been developed and is set out in the *Kingston and Arthur's Vale Historic Area (KAVHA) Archaeological Zoning and Management Plan* (Extent Heritage Pty Ltd, 2019). The chance find procedure would be implemented and the construction contractor's personnel should be made aware of the requirements through appropriate training.

4.3.3 Norfolk Island legislative framework

4.3.3.1 Planning Act 2002 (NI)

The *Planning Act 2002* (NI) aims to promote the conservation and preservation of the natural environment, landscape, unique cultural and built heritage as well as the proper management, development and conservation of the natural and man-made resources of Norfolk Island. The Act sets out the requirements that govern the permitted developments and development approval process.

Under the Norfolk Island Plan 2022 (as amended by the Norfolk Island Plan 2002 Housekeeping Amendment 2022), the Project is exempt from the need for development approval because the works include activities listed under clause 81(1)(b) on land the subject of the Heritage Overlay, and would be undertaken in accordance with an approved heritage management plan (clause 82(2)(ii)). The Project has been designed and would be carried out in accordance with the provisions of the *Kingston and Arthur's Vale Historic Area (KAVHA) Archaeological Zoning and Management Plan* (Extent Heritage Pty Ltd, 2019).

4.3.3.2 Building Act 2002 (NI)

All building activity on Norfolk Island, is controlled by the *Building Act 2002* (NI) and the Norfolk Island Building Code. Section 5 of the Building Act defines "building work" as "the actual physical work for or in connection with the construction, erection, alteration, demolition or removal of a building or structure or services.

The Project may require Building Approval from the Norfolk Island Regional Council in relation to the structural arch to be installed beneath the Bounty Street Bridge.

4.3.3.3 Environment Act 1990 (NI)

The *Environment Act 1990* (NI) is the key legislation that covers planning approval and environmental regulatory requirements on Norfolk Island. The objects of the Act cover conservation of the natural environment and landscape beauty of Norfolk Island to ensure that physical works are in harmony with the natural environment. It provides for the establishment of the Norfolk Island Planning and Environment Board and sets out regulatory frameworks for requiring approvals for building control, uses of land and some earthworks as well as for preparation of an EIS for proposals. The Act stipulates requirements covering water supply, garbage, nuisances, animals and sewerage.

The following sections covers aspects that are applicable to the Project:

- Section 48 specifies that an earthworks approval is required for the removal or excavation of a total of 50 cubic metres of earth, topsoil, spoil or fill that is excavated, shifted or deposited; or if the earthworks cover an area totalling more than 50 square metres. Should the construction of earth bunds exceeds this trigger, an earthworks approval may be required prior to commencement of work
- Sections 72 – 76 provides for regulation of garbage which includes refuse, rubbish and sewage
- Section 77 covers nuisance which includes emissions of smoke, soot, dust, effluvia, smell or noise that may become injurious to prejudicial to health or that is offensive.

4.3.3.4 Heritage Act 2002 (NI)

The *Heritage Act 2002* (NI) sets out the criteria, management framework and procedures for establishing the Norfolk Island Heritage Register as well as specifies requirements for Heritage Impact Statement (HIS) and Conservation Management Plans (CMP).

KAVHA (including Bounty Street Bridge) is listed on the Norfolk Island Heritage Register and is subject to management control set out in *Arthur's Vale Historic Area (KAVHA) Archaeological Zoning and Management Plan* (Extent Heritage Pty Ltd, 2019). The Project would be carried out in accordance with this conservation management plan. A separate heritage impact assessment (HIA) has been completed for the Project.

4.3.3.5 Protection of Moveable Cultural Heritage Act 1987 (NI)

The *Protection of Moveable Cultural Heritage Act 1987* (NI) protects Norfolk Island's movable heritage items as well as other Australian and protected items. This Act protects against any heritage items found on or below ground during construction work to be removed.

With regard to the Project, a chance find procedure that addresses the requirements of this Act has been developed and is set out in the *Kingston and Arthur's Vale Historic Area (KAVHA) Archaeological Zoning and Management Plan* prepared by Extent Heritage Pty Ltd (2019) for DITRDCA. The change find procedure would be implemented and the contractor's personnel should be made aware of the requirements through appropriate training.

4.3.3.6 Public Reserves Act 1997 (NI)

The Project straddles the Kingston Commons and Kingston Recreation Reserves. A permit would be required from the Conservator of Public Reserves for the Project and the works would comply with any conditions stipulated.

4.3.3.7 Traffic Act 2010 (NI)

The temporary closure of Bounty Street Bridge to vehicular traffic has already been implemented by the NIRC for public safety reasons and would remain closed during the works.

4.3.3.8 Waste Management Act 2003 (NI)

The *Waste Management Act 2003* (NI) provides for waste management, funding for waste management operations and related purposes on Norfolk Island. The Act specifies requirements for disposing waste in approved receptacles, vehicles transporting waste to be securely covered, fees to be imposed for disposal of waste to designated places (i.e. the Waste Management Centre) and recovery of clean-up cost. Management of all waste generated during construction works would be managed in compliance with this Act.

4.3.3.9 Noxious Weeds Act 1916 (NI)

The *Noxious Weeds Act 1916* (NI) specifies a list of declared noxious weeds and provides for the Minister to issue notices to land owners where infestation has occurred to eradicate noxious weeds from land. The construction contractor would implement best management practice to prevent and control noxious weeds during construction of the Project.

4.3.3.10 Protection of Moveable Cultural Heritage Act 1987 (NI)

The *Protection of Moveable Cultural Heritage Act 1987* (NI) protects Norfolk Island's movable heritage items as well as other Australian and protected items. This Act protects against any heritage items found on or below ground during construction work to be removed.

With regard to the Project, a chance find procedure that addresses the requirements of this Act has been developed and is set out in the *Kingston and Arthur's Vale Historic Area (KAVHA) Archaeological Zoning and Management Plan* prepared by Extent Heritage Pty Ltd (2019) for DITRDCA. The change find procedure would be implemented and the contractor's personnel should be made aware of the requirements through appropriate training.

4.4 Other Relevant Requirements

4.4.1 Induction and Training

An important component of environmental management planning is to ensure that all Site personnel are adequately educated and trained in environmental awareness, to the point that they understand their role in implementing this EMP.

The Project Manager would be responsible for ensuring that personnel under their control have the requisite competencies, skills and training to carry out their assigned tasks and for identifying additional training and competency requirements. The Project Manager is also responsible for ensuring training records are maintained.

All personnel would complete a comprehensive induction, which would include the approved Work Health, Safety and Environmental Plan, Safe Work Method Statements, traffic and access, heritage, environmental and management requirements.

5.0 Risk Assessment

A Risk Assessment has been undertaken as part of the EMP. The identified risks have been summarised in Table 7.

This risk management process involved an assessment of all specific project activities/aspects and resulted in the development of a list of environmental risks (effects and impacts) and a corresponding risk mitigation strategy and risk ranking. Each environmental risk was categorised, based on the following:

- Environmental aspect
- Relative scale of the potential impact
- Type of potential impact
- Likelihood of occurrence.

The mitigation measures in the risk assessment align with the management measures in Section 6.0 of this EMP.

5.1 Risk Assessment Process

The following tables outline the risk assessment process using three steps to identify the appropriate management measures required.

Table 4 is used to determine the likelihood that the aspect would have an impact on the environment.

Table 5 is used to determine the potential consequence rating of the risk identified.

From these two tables, a risk rating can then be assigned using Figure 6 to determine the potential severity of the risk and the appropriate management response as per Table 6.

Table 4 Likelihood descriptor

	Likelihood	Description
A	Rare / improbable	The event may only occur in exceptional circumstances.
B	Unlikely / remote	The event may occur at some time (about once every five years).
C	Possible	The event is likely to occur at some time (about once every year).
D	Likely	The event will probably occur in most circumstances (at least once every six months).
E	Almost certain	The event is expected to occur in most circumstances (at least once every month).

Table 5 Consequence descriptor

	Consequence (impact)	Description
1	Insignificant/negligible	<ul style="list-style-type: none"> • Short-term disturbance with minor environmental release/ impact or damage that is non-reportable • No impact outside site boundary. • No community complaints or media reports.
2	Minor/low	<ul style="list-style-type: none"> • Minor violation of regulation or guideline with minimal damage/ impact to the environment and small clean-up. • Immediately contained on site. • Local government action, minor community complaints. • Potential or actual breach of legislation.

Consequence (impact)		Description
3	Moderate	<ul style="list-style-type: none"> Violation of regulation or guideline with moderate temporary damage/ impact to the environment and significant clean-up or rectification costs. Release of pollution off site. Detrimental media reports, community concerns and complaints.
4	Major	<ul style="list-style-type: none"> Major environmental damage with potentially permanent damage. Release of pollution off site. Significant loss of environmental resources. Detrimental media reports in the national or state media, organised community concern. High likelihood of fine or court action.
5	Catastrophic	<ul style="list-style-type: none"> Long-term environmental harm. Permanent irreparable damage to the environment. Sustained detrimental state and national media reports and sustained community outrage. Penalty Infringement Notice/court action.

Figure 6 Risk severity ranking

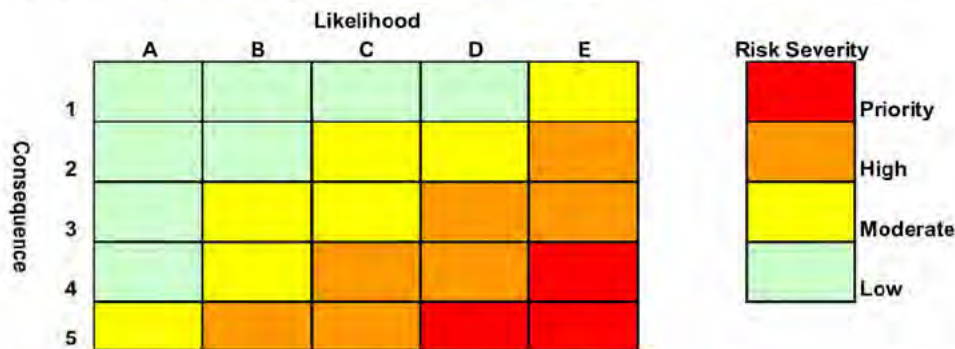


Table 6 Risk severity and management response

Risk severity	Management response
Priority	Immediately and detailed management action required (e.g. stop or change activity)
High	Priority management action warranted
Moderated	Management action warranted
Low	Management action should be considered, particularly for low-level impacts that nevertheless occur on a continual basis

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Table 7 Bounty Street Bridge Environmental Risk Assessment

Activity	Construction Aspect	Environmental Aspect	Potential Impact	Risk level pre-mitigation	Mitigation measure	Risk level post-mitigation
Site compound/ lay down area establishment	Site personnel travel to/from site; deliver of materials to the site	Additional traffic	Additional traffic	Low (B2)	Table 8, Table 16, Table 19	Low (B1)
	Installation of temporary fencing/ screens/ barricade	Visual aesthetic	Visual interruption of landscape	Moderate (D2)	Table 12, Table 17	Low (B2)
Chemical/ fuel use	Chemical/ fuel use onsite	Contamination	Site and Watermill Creek contamination due to chemical/ fuel oil runoff	Low (B2)	Table 10, Table 14	Low (B2)
Construction of earth bunds	Haulage of earth for earth bund	Additional traffic	Additional traffic	Low (B2)	Table 8, Table 16, Table 19	Low (B1)
	Construction of earth bunds	Biodiversity	Mortality, disturbance, loss or habitat of aquatic fauna	Moderate (C3)	Table 12	Low (B2)
		Weed and pest management	Spread of weeds and pests	High (D4)	Table 12	Moderate (B4)
		Sedimentation	Sedimentation/ pollution of Watermill Creek, Emily Bay	High (D4)	Table 10, Table 12, Table 19	Moderate (C2)
		Heritage	Damage of known heritage items/ fabric	High (C5)	Table 8, Table 20	Low (B2)
		Noise and vibration	Nuisance to local residents	Low (B2)	Table 20	Low (B1)
		Emissions to air	Air pollution	Low (B2)	Table 18	Low (B1)
		Visual aesthetic	Visual interruption of landscape	Moderate (D2)	Table 17	Low (B2)

Activity	Construction Aspect	Environmental Aspect	Potential Impact	Risk level pre-mitigation	Mitigation measure	Risk level post-mitigation
		Disturbance / exposure of PASS / ASS	Acidification, deoxygenation of water bodies, impact to biodiversity, human health, historic structures	High (D4)	Table 10, Table 14	Moderate (C2)
Dewatering earth bund	Pumping to dewater earth bund	Biodiversity	Mortality, disturbance, loss of habitat of aquatic flora and fauna	High (D4)	Table 10, Table 12	Moderate (C2)
		Erosion and sedimentation	Sedimentation/ pollution of Watermill Creek, Emily Bay	High (D4)	Table 10	Moderate (C2)
		Hydrology of Watermill Creek	No flow/ altered flow downstream of earth bund impacting aquatic biota	High (C4)	Table 10	Low (B2)
		Disturbance / exposure of PASS / ASS	Acidification, deoxygenation of water bodies, impact to biodiversity, human health, historic structures	High (D4)	Table 10, Table 14	Moderate (C2)
Desilting work area	Desilting	Biodiversity	Mortality, disturbance of habitat of aquatic flora and fauna	High (D4)	Table 12	Moderate (C2)
		Erosion and sedimentation	Sedimentation/ pollution of Watermill Creek, Emily Bay	High (D4)	Table 10	Moderate (C2)
		Disturbance / exposure of PASS / ASS	Acidification, deoxygenation of water bodies, impact to biodiversity, human	High (D4)	Table 10, Table 14	Moderate (C2)

Activity	Construction Aspect	Environmental Aspect	Potential Impact	Risk level pre-mitigation	Mitigation measure	Risk level post-mitigation
			health, historic structures			
		Waste generation - silt and biomass	Dispose at landfill	Moderate (C2)	Table 10, Table 14	Low (B2)
		Odour generation	Odour from exposed creek bed and dumped sediments removed from under the bridge	Moderate (C2)	Table 18	Low (B2)
Excavation	Excavation of creek bed for foundation works	Heritage values	Damage to known heritage items/ fabric, loss of unknown archaeological items	Moderate (C2)	Table 8,	Low (B2)
		Sedimentation	Sedimentation/ pollution of Watermill Creek, Emily Bay	Moderate (C2)	Table 10	Low (B2)
		Acid Sulphate Soil	Dispose at landfill	Moderate (C2)	Table 14	Low (B2)
Install props to stabilise structure	Install props	Visual aesthetic	Visual interruption of landscape; visual impact of heritage item	Low (B2)	Table 17	Low (B2)
		Heritage values	Damage to known heritage items/ fabric	Low (B2)	Table 8,	Low (B2)
Point and render arch soffit	Cleaning mud from stone and render works	Sedimentation	Sedimentation/ pollution of Watermill Creek, Emily Bay	Low (B2)	Table 10	Low (B1)
		Heritage values	Damage to known heritage items/ fabric	Moderate (C2)	Table 8,	Low (B2)
Foundation works	Fabrication of formwork and reinforcement and concreting footing	Waste generation	Excess waste to landfill	Moderate (C2)	Table 14	Low (B2)

Activity	Construction Aspect	Environmental Aspect	Potential Impact	Risk level pre-mitigation	Mitigation measure	Risk level post-mitigation
Construction of concrete lining	Fabrication and installation of formwork and reinforcement	Heritage values	Damage to known heritage items/ fabric	High (C5)	Table 8,	Low (B2)
		Visual aesthetic	Visual interruption of landscape	High (D3)	Table 17	Low (B2)
	Use of plant and power tools	Emissions	Air pollution and stakeholder complaints	Low (B1)	Table 18	Low (A1)
		Noise generation	Community disturbance	Low (B1)	Table 20	Low (A1)
		Contamination	Site and surrounding area contamination due to oil/ fuel spill/ leak	Low (B2)	Table 10, Table 14	Low (B2)
	Drilling holes for pouring concrete	Heritage values	Damage to known heritage items/ fabric	High (C5)	Table 8, Table 20	Low (B2)
		Noise and vibration	Nuisance to local residence	Low (B2)	Table 20	Low (B1)
		Dust emissions	Air pollution	Low (B2)	Table 14, Table 19	Low (B1)
		Contamination	Site and surrounding area contamination due to oil/ fuel spill/ leak	Low (B2)	Table 10, Table 14	Low (B2)
	Concreting lining	Waste generation	Excess waste to landfill	Moderate (C3)	Table 14	Low (B2)
Remediate bridge sides	Stone works and render	Heritage values	Damage to known heritage items/ fabric	High (C5)	Table 8,	Moderate (C2)
		Visual aesthetic	Visual interruption of landscape	High (D3)	Table 17	Low (B2)
Removal of earth bunds	Removal of earth bunds	Noise generation	Community disturbance	Low (B1)	Table 20	Low (A1)

Activity	Construction Aspect	Environmental Aspect	Potential Impact	Risk level pre-mitigation	Mitigation measure	Risk level post-mitigation
		Sedimentation	Sedimentation/ pollution of Watermill Creek, Emily Bay	High (D4)	Table 10, Table 12	Moderate (C2)
		Waste spoil generation	Reused off site, disposal to approved landfill	Moderate (D2)	Table 10, Table 14	Low (B2)
		Disturbance / exposure of PASS / ASS	Acidification, deoxygenation of water bodies, impact to biodiversity, human health, historic structures	High (D4)	Table 10, Table 14	Moderate (C2)
Reinstatement of work site	Turfing exposed areas	Weed and pest management	Spread of weeds and pests	High (D4)	Table 12	Moderate (B4)
	Reinstatement of Watermill Creek	Biodiversity	Loss of habitat	Low (B2)	Table 10, Table 12, Table 14, Table 17	Low (B2)
Waste management	Construction waste, hazardous waste	Waste generation	Excess waste to landfill/ Waste Management Centre	Moderate (D2)	Table 14	Low (B2)

6.0 Management Measures

6.1 Overview

This section covers the various mitigation and management measures proposed to minimise the potential risks identified for the Project. Specific mitigation and management measures apply to the Bounty Bridge site. Where there are discrepancies between the EIA and HIA documents, the mitigation measures in this EMP take precedence.

Below are the key environmental issues to be considered during the Planning Phase.

6.2 Cultural Heritage

6.2.1 Activities and Impacts

The design of the Project has been informed by a HIA undertaken by a qualified heritage specialist. Measures are required during construction to prevent degradation of the cultural heritage values of the Bridge.

In the absence of management measures, key construction activities that could result in damage to the structures and heritage values of the Bounty Street Bridge include:

- Ground disturbance at the creek banks for installation of the earth bunds. This area is considered to have high archaeological potential and significance. These works have the potential to impact:
 - Evidence of the previous creek alignments; and
 - The water tanks appended to the north eastern wing wall of the Bounty Street Bridge. A site inspection by an archaeologist in 2023 did not locate any water tank features in the proposed area; as a precaution, works in this area would be supervised by an archaeologist and has been referred to as a 'restricted area'. Works within the restricted area would require consultation with the Project archaeologist.
- Nominal excavation under the Bounty Street Bridge arch for the insertion of the concrete footings and arch. This area is considered to have low archaeological potential.
- Construction of a structural concrete arch. The impacts relate to the introduction of new materials.
- Drilling holes through the deck of the Bounty Street Bridge, including through the stone soffit, to pour the concrete.
- Removal of existing concrete render;
- Hydraulic lime mortar render below the water level; and
- Natural lime mortar render above the water level.

The bridge has been closed to traffic and would remain closed throughout construction. Off road movement of heavy machinery and trucks in close proximity to heritage items, may result in damage to heritage structures and values.

The design, materials used (i.e. mortar) and colour (i.e. paint) of the rectification works may degrade the heritage value of the heritage items.

The Archaeological Zoning and Management Plan (AZMP) identifies Arthur's Vale Retaining Wall and a portion of the Watermill Dam as having high archaeological potential (Extent Heritage Pty Ltd 2020). In order to assist in the management of the archaeological potential of the KAVHA, Extent has created delineated archaeological 'Zones'. The Bounty Street Bridge is located in Zone 1, meaning in addition to high archaeological potential, the site has been identified as having high research potential and significance.

All ground disturbing works may uncover or impact archaeological heritage items and would need to be properly managed in accordance with the policies included in the KAVHA AZMP.

6.2.2 Objectives

- To ensure cultural heritage items and values are protected.
- To maximise the beneficial heritage outcomes of the rectification works.
- To ensure that any new heritage items uncovered during excavation works are not damaged or lost and are retrieved and conserved.

6.2.3 Management Strategy and Actions

The heritage issues would be managed by the measures outlined in Table 8.

Table 8 Cultural heritage mitigation measures

Ref	Mitigation measures	When to implement
H_01	Once de-watering of the Watermill Creek has been accomplished, an archival recording of the Bounty Street Bridge would be completed prior to construction works commencing. The archival recording would include a laser scan and photographic recording.	Pre-construction/ construction
H_02	Access holes to allow pouring of concrete through the deck of the Bounty Street Bridge are to be examined by the Project archaeologist to identify previous surfaces, if present.	Construction
H_03	Calcarenite for stone replacement, if necessary, would be sourced from Norfolk Island, if possible.	Construction
H_04	Source of the sandstone extant within the Bridge would be analysed and the replacement stones sourced from the same location, if possible and if necessary.	Construction
H_05	Any coping stones found during excavation under the bridge would be placed back into position on the bridge parapet, if they are in suitable condition.	Construction
H_06	Cleaning of the mud from the Bridge during construction would not involve high-pressure cleaning. Water pressure would be limited to 7,000psi or less. The method would be tested to ensure suitability and altered if it is found to cause undue damage.	Construction
H_07	Options to minimise the number of cores in the bridge would be explored. Propping of bridge during construction would avoid drilling holes into the stone.	Construction
H_08	Reconstruction of the downstream (eastern) face of the bridge would be undertaken by a stonemason with experience in reconstructing historical structures. The stones would be marked in an unobtrusive location with the year or other similar marker to differentiate the original and new works, as specified under the <i>Burra Charter</i> .	Construction
H_09	The method for removing concrete render would protect the remnant original finishes. Where original finishes are identified, these would be reflected in the final finish of the bridge above the water line.	Construction

Ref	Mitigation measures	When to implement
H_10	The location of the earth bunds and trench for the diversion pipe would be determined on site, in conjunction with the Project archaeologist. Preference should be to avoid impacts to potential archaeological deposits, but where these are unavoidable, the research questions would be directed towards gathering information that could be used in the future to implement the recommendation in the KAVHA HMP that the serpentine form of Watermill Creek be reinstated. Works within the restricted area would be supervised by an archaeologist.	Pre-construction/ Construction
H_11	All archaeological works would be conducted in accordance with the <i>Kingston and Arthur's Vale Historic Area (KAVHA) Archaeological Zoning and Management Plan</i> (Extent Heritage Pty Ltd, 2019).	Pre-construction/ Construction
H_12	Construction planning would include selection of plant and equipment with the aim of not exceeding the structural damage criteria (peak particle velocity) for structures that are particularly sensitive to vibration and have intrinsic value, as detailed in German standard DIN 4150-3: 1992-02 Vibration in Buildings – Part 3: Effects on Structures, at any heritage building/structure. Where plant and equipment is required to be used in proximity to a heritage building/structure and cannot satisfy structural damage criteria for vibration, additional site- and activity-specific mitigation and management measures would be developed and applied. This may include vibration monitoring, structural reinforcements, and/ or amelioration of structural damage.	Pre-construction/ Construction

6.2.4 Monitoring

The suggested monitoring actions for heritage management over the course of the project are described in Table 9.

Table 9 Cultural Heritage Monitoring Actions

Requirement	Method	Frequency
Protection of known heritage values	Designate no go zones, and restricted area on all site plans.	Pre-construction
	Heritage sites and fencing should be subject to monitoring inspections, and a dilapidation report of the structure before works commence should be undertaken.	Weekly
Prevention of accidental damage to heritage items	Observation.	Daily
Prevention of damage or loss of new archaeological items	Overseen by an Archaeologist.	During excavation works

6.3 Surface water, stormwater and marine water

6.3.1 Activities and Impacts

All discharge from the site would drain into Watermill Creek which eventually flows into the coastal waters of Emily Bay, part of the Norfolk Marine Park.

Incorporating preventative measures to minimise the risk of erosion, sediment mobilisation and contaminant discharge to Watermill Creek into the project design was required to minimise potential impact to Watermill Creek and the coastal waters of Emily Bay.

In the absence of management measures, key construction activities that could result in potential impacts to water quality of Watermill Creek, and Emily Bay include:

- Construction of the earth bunds (Figure 3) up and down stream of the bridge, dewatering and desilting for foundation works
- Removal of stream vegetation between the earth bunds
- Erosion and sedimentation from the earthworks and dewatering activities impacting water quality
- Potential release of acidic leachate from desludging and handling acid sulfate soils in Watermill Creek
- Temporary diversion of Town Creek outlet altering local stormwater flows which could cause local erosion and sedimentation
- In the unlikely event of unregulated pumping of surface water from the upstream earth bunds with discharge outlets below the lower earth bund altering hydrology and water quality of Watermill Creek downstream of the site. Release of polluted water may eventually discharge into Emily Bay
- Removal of the earth bunds, if undertaken in an uncontrolled manner, causing a surge of contaminated water (i.e. sediment) flowing down Watermill Creek adversely impacting the water quality including at Emily Bay.
- Reinstatement of Watermill Creek

It is important to note that the water quality of Watermill Creek and Emily Bay have been historically impacted by inadequately treated sewage discharged from residences in the upper catchment area of Watermill Creek. Water Quality monitoring conducted by NIRC have indicated high nitrate, phosphate, biochemical oxygen demand (a measure of organic pollution) and low pH (acidity) levels of the water quality of Watermill Creek which also has subsequently impacted the marine water quality of Emily Bay. The pollution with sewage includes the presence of microbiological contamination in the waters of Watermill Creek (i.e. with *Escherichia coli* bacteria, which is an indicator of potential presence of pathogens). Due to this safety and health control measures are warranted in the Contractor's Safety and Health Management Plan and/ or Safe Work Method Statement (SWMS) to safeguard the health of workers who may come into contact with water or sediment from Watermill Creek.

Sewage pollution has also been attributed to the historical impacts to the water quality at Emily Bay which has adversely impacted the fringing coral reefs along the shoreline as well as pose a health risk to swimmers in the bay. The removal of a 40m section of reeds from Watermill Creek (between the earth bunds) which act as a filter and sink for sewage pollution from upstream sources may result lower abatement of water pollution. This may be offset by water being retained in the upstream earth bund, and filtering capability of the retained vegetation downstream.

6.3.2 Objectives

- To minimise the sediment and contaminant load to Watermill Creek and Emily Bay during the works.
- To maintain the hydrology of Watermill Creek downstream of the site during the works.

6.3.3 Management Strategy and Actions

The management measures for the management of surface water are outlined in Table 10.

Table 10 Surface water mitigation measures

Ref	Mitigation Measures	When to Implement
S_01	Store chemicals/ fuel under shelter, with secondary containment and located away from waterways.	Pre-construction/ construction
S_02	Where possible and practical, Project works would be scheduled during the dry season and/ or periods of low water flow in Watermill Creek.	Pre-construction
S_03	Minimise the period that soil is left exposed to erosion where possible.	Construction
S_04	A detailed erosion and sedimentation control plan (ESCP) would be developed and applied consistent with the guidance in <i>Managing Urban Stormwater: Soils and Construction Volume 1</i> (Landcom, 2004)) prior to commencement of earthworks in consultation with the Norfolk Island Regional Council. The ESCP would include: <ul style="list-style-type: none"> • Sediment control measures for dewatering of the earth bunds • Erosion control measures at the dewatering pumps discharge outlets • Water quality treatment and monitoring requirements 	Pre-construction/ construction
S_05	Daily monitoring of the weather forecast and the water levels in the upstream earth bund.	Construction
S_06	Provide adequate pumps to cater for storm events and high flows in Watermill Creek. A minimum pump specification of 4" trash pump to up to 2,000 L per minute would be provided by the contractor.	Pre-construction/ construction
S_07	Retain stream vegetation downstream of the earth bund (to Emily Bay) to provide filtering. This only applies to the stream vegetation beyond the 40 m of vegetation which would be cleared between the earth bunds for the Project.	Construction
S_08	Detailed acid sulfate soil management measures would be developed and applied consistent with the guidance provided in <i>Acid Sulfate Soils: Assessment Guidelines</i> (NSW Acid Sulfate Soils Management Advisory Committee, 1998).	Pre-construction
S_09	The Project would be subject to water quality criteria developed consistent with the guidance in <i>Australian and New Zealand Guidelines for Fresh and Marine Water Quality</i> (ANZG, 2018) for the protection of 95% of species.	Pre-construction/ construction
S_10	A surface water monitoring program would be developed and applied, including baseline surface water quality monitoring prior to Project construction and water quality monitoring during the works. During works, daily visual, odour and pH inspections would occur and the primary control measure would be observations of change from the baseline conditions. Chemical samples would be obtained at the completion of works to compare against baseline and assess the efficacy of controls during works.	Pre-construction/ construction

6.3.4 Monitoring

The suggested monitoring actions for surface water and hydrology management and erosion control over the course of the project are described in Table 11. A water monitoring program would be developed to address the requirements.

Table 11 Surface Water, Stormwater and Marine Water Monitoring Actions

Requirement	Method	Frequency
Water levels in the upstream earth bund	Observation	Daily at the beginning and end of the workday After heavy rain events
Water quality of Watermill upstream and downstream of the site	The contractor would engage a suitably qualified or experienced person to undertake monitoring of turbidity and pH levels using a Turbidity Meter and pH Meter, upstream and downstream of the site (fortnightly).	Daily
Dewatering water quality	Turbidity and pH levels would be monitored using a Turbidity Meter and pH Meter (prior to pumping downstream)).	Prior to pumping downstream
Marine water quality at Emily Bay	Observation for visible sediment plume at final discharge point outlet	Weekly After heavy rain events

6.4 Biodiversity

6.4.1 Activities and Impacts

The Bounty Street Bridge is located on land vegetated with introduced species of pasture, i.e. Kikuyu grass, which is subject to cattle grazing or is maintained. The bridge is not located in the vicinity of native habitats and is readily accessible.

There are introduced reed species growing in Watermill Creek which would be removed from the stretch between the earth bunds within the project area prior to the works. Watermill Creek have been subject to periodic maintenance where reeds are removed during desilting works.

An EPBC Protected Matters Search Tool search results indicated that there are no known threatened ecological communities, flora or fauna within the construction boundary or immediate adjacent area.

Watermill Creek supports native eels and shrimp which is of local conservation importance. Precautionary and best management practices would be implemented to minimise impact on aquatic biota during construction. This would include installing a filter mesh on the pump intake and the diversion pipe to prevent mortality, rescuing and relocating eels and shrimp during dewatering works between the earth bunds.

All construction materials brought onto Norfolk Island would be subject to existing biosecurity control protocols. Considering that no machinery or equipment and only limited construction materials would be required to be brought into Norfolk Island for the Project, the Project would not specifically increase the biosecurity risk to biodiversity on Norfolk Island. The sourcing of uncontaminated soil to construct the earth bund for the coffer dam would avoid locations of known Argentine ant (*Linepithema humile*) infestation.

Local contractors would be engaged to undertake the work and would use local vehicles, machinery and plant from Norfolk Island. As such, the risk of introducing weeds, pathogens or pests (e.g. Argentine Ants) to the project site which is vegetated with exotic grasses warrants proper control procedures in accordance to the requirements of the Conservator of Reserves.

Watermill Creek discharges into Emily Bay which is a Commonwealth Marine Area. There are fringing coral reefs along the shoreline of Emily Bay and the beach is a popular tourist and community area. The water quality in Emily Bay and the coral reefs have been historically impacted by bacterial contamination including *E.coli* pollution from Watermill Creek. Uncontrolled sediment discharges from the project could potentially adversely impact the marine water quality at Emily Bay and smother the coral reefs, exacerbating marine pollution that is already occurring, particularly during wet events where heavy contaminate loads are flushed through the system into the catchment.

In the absence of management measures, potential impacts of the project on biodiversity include:

- Erosion and sedimentation causing silt laden and nutrient rich surface runoff to impact water quality and aquatic ecology of Watermill Creek and Emily Bay
- Mortality of fauna in the section of Watermill Creek that would be dried and excavated for the works (Figure 2)
- Mortality of aquatic fauna (eels, shrimp and fish) due to being sucked into the pumps used to dewater the upstream earth bund
- Temporary drying out of Watermill Creek downstream of the site if minimum flows are not maintained throughout construction causing mortality
- Temporary disturbance to fauna during the works
- Adverse impact to water quality (i.e. elevated sediment levels) which smother corals at Emily Bay
- Introduction or spread of weeds, pests or pathogens from contaminated materials and the potential to import new weed or pest species (e.g. Argentine Ants) into the site on machinery.

6.4.2 Objectives

- To minimise direct and indirect impacts to biodiversity during the course of the project.
- To minimise off site impact to Emily Bay Commonwealth marine area.

6.4.3 Management Strategy and Actions

The measures for the management of biodiversity are outlined in in Table 12.

Table 12 Biodiversity mitigation measures

Ref	Mitigation Measures	When to Implement
B_01	Stock proof fencing would be installed around the construction boundary, upstream of the bridge with a 20-metre buffer zone on either side of the Watermill Creek for desilting work.	Pre-construction
B_02	Stockpile and revegetate exposed areas upon completion of works.	Construction
B_03	Ensure equipment and other plant are washed down and inspected prior to entry to the site to avoid the spread of weeds, pests and other pathogens. No machinery to come from an Argentine Ant area unless treated and cleared.	Construction
B_04	Remove weeds immediately within the site and dispose without stockpiling.	Construction
B_05	Ensure that any material brought to site is free of weeds and pests (e.g. Argentine Ants) with evidence provided to the Project Manager.	Construction
B_06	Suitable protective filter mesh would be installed on suction lines and the diversion pipe to prevent native eel, shrimp and fish being sucked into the pipe intakes and causing mortality.	Construction
B_07	Any native eels, shrimp, fish of other aquatic fauna found in the dewatered section of Watermill Creek between the earth bunds would be immediately rescued and placed in a bucket filled with creek water, before being immediately released at a suitable location upstream of Watermill Creek.	Construction
B_08	Engage local volunteers to assist with the capture and relocation of native eels.	Construction
B_09	Dewatering of the upstream earth bund would be carried out using a diversion channel that maintains minimum flows in Watermill Creek downstream of the site to safeguard aquatic fauna.	Construction
B_10	No lights at night. Operate in accordance with the National Light Pollution Guidelines https://www.environment.gov.au/biodiversity/publications/national-light-pollution-guidelines-wildlife	Construction
B_11	Regularly train workers and contractors (such as at the site induction and toolbox talks) on the importance of safeguarding biodiversity in Watermill Creek and Emily Bay when the work is being carried out. The training would include awareness of the species present and actions to be taken if encountered.	Pre-construction/ construction
B_12	Reinstate Watermill Creek to its original condition upon completion of works	Post construction

Ref	Mitigation Measures	When to Implement
B_13	Parks Australia would be consulted on a relocation plan for aquatic fauna prior to dewatering.	Pre-construction/ construction

Mitigation measures relating to erosion/sediment control and noise are detailed in Section 6.3 and Section 6.10 respectively.

6.4.4 Monitoring

The suggested monitoring actions for biodiversity management over the course of the project are described in Table 13.

Table 13 Biodiversity Monitoring Actions

Requirement	Method	Frequency
Minimise impact to native eels, shrimp, fish and other aquatic fauna in Watermill Creek	Monitor during initial dewatering of Watermill Creek between the earth bunds	During the initial dewatering works
	Inspect the dewatering pump and diversion pipe intake mesh (i.e. for damage, etc)	Prior to dewatering works
Minimisation of weeds/pests	Monitor machinery and equipment brought onto the site.	Daily during works
	Monitor weeds and subsequent weed disposal.	

6.5 Waste Management

6.5.1 Activities and Impacts

Generation of waste materials on and off site can lead to environmental impacts and reduction in visual amenity.

In the absence of management measures, construction waste materials that would be generated include:

- Packaging waste such as plastic, cardboard, paper, wooden crates and metal straps
- Construction waste from fabrication and concreting works and temporary bracing structures such as fibre glass reinforcement rods off cuts, metal, wood, mortar and rocks
- Spoil from excavation of bridge footings and removal of coffer dam earth material
- Silt and biomass from desilting Watermill Creek
- Waste chemicals such as solvents, used oil and chemical containers
- Solid waste and sewage from workers on site.

Resource use and waste management would be controlled through the implementation of the Environmental Management Plan for the Project.

6.5.2 Objectives

- To minimise generation of waste materials on site and maximise (where possible) re-use of existing materials.

6.5.3 Management Strategy and Actions

The measures for the management of waste are outlined in Table 14.

Table 14 Waste management mitigation measures

Ref	Mitigation Measures	When to Implement
W_01	Wastes generated during construction would be collected in a central waste storage area, prior to offsite disposal at an appropriately permitted facility.	Pre-construction/ construction
W_02	Waste materials generated would be regularly removed from the worksite and disposed at a disposal site approved by DITRDCA. Waste that cannot be suitably recycled for use on site would be taken to the NIRC Waste Management Centre.	Construction
W_03	An emergency spill response procedure would be prepared to minimise the impact of any accidental spills, and include details on the requirements for managing spills, disposing of any contaminated waste, and reporting of any such incidents.	Pre-construction/ construction
W_04	The Waste Management Hierarchy of 'avoid-reduce-reuse-recycle-dispose' would be followed as the framework of waste management throughout the project.	Pre-construction/ construction
W_05	All waste would be reused or recycled to the greatest extent practicable (e.g. recycle/ reuse of oils where possible).	Construction

Ref	Mitigation Measures	When to Implement
W_06	All staff and subcontractors would undergo a site induction and ongoing toolbox talks that would detail waste minimisation and reuse management measures, including requirements of the waste management hierarchy. Waste minimisation training would include energy consumption awareness that promotes energy conservation methods including minimising energy use.	Pre-construction/ construction
W_07	Design and prefabricate structural elements (e.g. bridge concrete lining) to minimise waste generation on site as best practicable.	Pre-construction
W_08	Spoil from desilting and excavation of Watermill Creek would be managed to contain potential acidic leachate from Acid Sulfate Soils in accordance with <i>Acid Sulfate Soils: Assessment Guidelines</i> (NSW Acid Sulfate Soils Management Advisory Committee, 1998); and disposed at an approved site. In addition to this, a handheld pH meter would be used during construction, to assess the pH of the material against the Australian and New Zealand Guidelines for Fresh and Marine Water Quality criteria for 95% species protection (ANZG, 2018). The pH would be reviewed at the beginning and end of the construction shift, and reviewed 4-5 times per day.	Pre-construction
W_09	Manage and dispose of hazardous waste materials (e.g. oils, epoxy, adhesives and chemical containers) at the Waste Management Centre in accordance with legislative requirements and best management practices.	Construction
W_10	Consider using ready mixed concrete to minimise waste generation on site. Ready mixed trucks would be cleaned at the off-site batching plant.	Construction
W_11	Excavated earth from the earth bunds may be reused on-site to restore the original channel, and would be reused off-site as best practicable in consultation with DITRDCA.	Construction
W_12	Vehicles transporting waste/spoil/ silt to disposal sites would be properly covered.	Construction
W_13	Any materials spilled during transportation to or from the site would be immediately cleaned up.	Construction
W_14	Following completion of works, a formal clean up event would take place to remove any waste generated during the works.	Construction

6.5.4 Monitoring

The suggested monitoring actions for waste management over the course of the project are described in Table 15.

Table 15 Waste Management Monitoring Actions

Requirement	Method	Frequency
Maintain work area in clean condition and free of waste	Observation	Daily during fieldworks
Ensure haul routes are clean and free from spilled material	Observation	Daily during commute to/ from site

Requirement	Method	Frequency
Ensure work sites are left in clean condition upon completion of works and all waste is disposed at an approved disposal site	Observation	Final inspection
Dispose of HAZMAT (i.e. used oil, etc.) in accordance to legislative requirements.	Maintain records of disposal	Upon disposal

6.6 Traffic and Access

6.6.1 Activities and Impacts

In the absence of management measures, changes in traffic movement and movement of heavy machinery to the site has the potential to temporarily disrupt local traffic. Transportation of desilted material and waste to landfill and transportation of earth material for the earth bunds could result in spillage on roads if not properly controlled.

With appropriate management of construction vehicles, potential Project impacts to traffic and access are likely to be limited. These impacts would be temporary and short term.

The Project would have a positive impact on traffic and access by allowing the Bounty Street Bridge to be reopened to traffic.

6.6.2 Objectives

- To minimise disruption the traffic caused by haulage and transportation and ensure safe operation of vehicles at all times.

6.6.3 Management Strategy and Actions

The measures for the management of traffic are outlined in Table 16.

Table 16 Traffic and access mitigation measures

Ref	Mitigation Measures	When to Implement
T_01	Identify specific vehicle routes, including access to the site, temporary parking and laydown areas that avoids heritage structures, are safe and cause minimal disruption to the local community.	Pre-construction
T_02	Ongoing consultation with the Norfolk Island Regional Council and emergency services as appropriate.	Pre-construction/ construction
T_03	Induction for drivers working on the site to cover safety measures and heritage values.	Pre-construction/ construction
T_04	Maintain closure of the Bounty Street Bridge to traffic throughout the works and post proper road safety signage in accordance to authority requirements.	Construction
T_05	Prohibit vehicles and plant from driving close to the banks of Watermill Creek	Construction
T_06	Prohibit vehicles from parking on the verge of Bounty street bridge	Construction

Mitigation and measures for vehicles, trucks and machinery operating close to heritage structures are discussed in section 6.2.

6.6.4 Monitoring

None required unless non-conformance is observed.

6.7 Visual amenity

6.7.1 Activities and Impacts

Construction of the Project would have a temporary and short term impact on local landscape and visual amenity. Installation of earth bunds, traffic bollards and site perimeter fencing would cause a temporary impact to the visual landscape of the Bridge which sits in the open field of Kingston Commons which is visible from various viewpoints. Construction of earthen coffer dams and the presence of plant, equipment and workers would be visually intrusive over a limited visual catchment, and would be removed at the conclusion of the works. The site would be reinstated to its pre-disturbance condition following the works, and would returned to a visually indistinguishable state once vegetation has re-established.

The Bridge restoration works, and particularly the concrete supporting arch, would introduce a new physical element into the structure. As noted in the heritage impact assessment (refer to **Section 6.2**), the extent of work has been minimised and is generally limited to areas of the Bridge that are not visually prominent.

The Project would employ reinforcement below the Bridge arch set back 300 mm from the face of the Bridge, use similar construction materials (i.e. calcarenite, sandstone and lime mortar) and would remove Portland cement render to reveal the original Bridge fabric. Overall these works would contribute to a positive visual effect in some areas by removing materials that are not original.

6.7.2 Objectives

- Minimise the visual interruption of the landscape and visual impact as a result of the project.

6.7.3 Management Strategy and Actions

The measures for the management of visual amenity are outlined in Table 17.

Table 17 Visual amenity mitigation measures

Ref	Mitigation Measures	When to Implement
V_01	Plant, machinery and vehicle parking areas to be located as far as practicable from receivers	Pre-construction
V_02	Reinstate Watermill Creek and turf exposed areas to its original condition or better upon completion of works. The turf strips from on-site may be used to revegetate these areas.	Pre-construction

The mitigation measures related to finishing and colour of the heritage item are discussed in Section 6.2.

6.7.4 Monitoring

None required unless works result in complaints being received.

6.8 Odour Control

6.8.1 Activities and Impacts

Odours noticeable at the site boundary can cause nuisance to offsite sensitive receivers, and may be generated through exposure of odour-producing sediments.

Desilted material from Watermill Creek and exposure of the creek bed which has been historically polluted with high levels of bacterial contaminants, including *E.coli* and may including acid sulfate soil, both of which have the potential to release odours upon exposure.

Cutting, grinding and welding works as well as using chemicals such as solvents may cause localised odour, pose a health hazard to workers and cause nuisance to nearby receivers.

Overall, the potential generation of odours would be managed through application of good practice environmental management measures during the Project works. This would include maintaining soils in a moist condition, covering and/ or treating potential odorous materials, and careful selection of plant and equipment to minimise air pollution from fuel combustion.

6.8.2 Objectives

- To minimise odour impacts to nearby sensitive receivers.

6.8.3 Management Strategy and Actions

The measures for the management of odours are outlined in Table 18.

Table 18 Odour control management measures

Ref	Mitigation Measures	When to Implement
O_01	Plant and equipment would be maintained to minimise air emissions.	Pre-construction/ construction
O_02	All vehicles would be switched off when not in operation.	Construction.
O_03	Keep empty chemical containers (e.g. solvents, paints) closed and dispose of chemical waste and empty chemical containers as soon as practicable.	Construction
O_04	Remove odorous materials, dry and return, or cover with impermeable material.	Construction

6.8.4 Monitoring

None required unless works result in complaints being received or olfactory evidence indicates the potential for worker exposure. If either of these circumstances occurs, an odour management plan may be developed and would include a program of regular odour monitoring.

6.9 Dust Control

6.9.1 Activities and Impacts

Vehicle movement, transportation of materials and earthworks have the potential to generate dust during dry weather periods.

6.9.2 Objectives

To minimise dust issues during the material transportation, earthworks and after project completion.

6.9.3 Management Strategy and Actions

The measures for the management of dust are outlined in Table 19.

Table 19 Dust control mitigation measures

Ref	Mitigation Measures	When to Implement
D_01	Schedule activities taking into consideration seasonal weather conditions including time when prevailing winds are low.	Pre-construction/ construction
D_02	Cover and/or reinstate exposed areas as soon as practicable upon completion of works.	Construction
D_03	Minimise the area of exposed soil during works.	Construction
D_04	Obey speed limits.	Construction
D_05	Cover loads of soil during transport to or from the site.	Construction
D_06	Avoid site run-off of water or mud to reduce the potential for track-out dust emissions	Construction

6.9.4 Monitoring

None required unless works result in complaints being received or visible dust indicates the potential for worker exposure. If either of these circumstances occurs, a dust monitoring plan would be developed.

6.10 Noise and Vibration

The acoustic environment in and around the Project site experiences very low noise levels, contributed to mainly through non-anthropogenic noises sources (ie typically wind and fauna). Noise contributions are occasionally made by passing vehicles.

6.10.1 Activities and Impacts

The Project would generate temporary, short term noise impacts on the surrounding environment through:

- Truck movements
- Operation of plant and machinery, such as gen-sets, excavator, etc.
- Use of power tools such as for cutting and grinding
- Stonemasonry works

Noise is not anticipated to be an issue of concern at the site as the nearest receptor is 175 metres away. Construction activities would be carried out during the day time to avoid potential impacts during the quieter night time period.

6.10.2 Objectives

- To minimise potential noise impacts to nearby sensitive receivers.
- To minimize vibration impacts to the Bounty Bridge structure.

6.10.3 Management Strategy and Actions

The measures for the management of noise are outlined in Table 20.

Table 20 Noise mitigation measures

Ref	Mitigation Measures	When to implement
N_01	Plant and equipment would be selected and used to maximise the distance between noisy plant and sensitive receivers, direct noise-emitting plant away from receivers and be subject to regular inspection and maintenance.	Pre-construction/ construction
N_02	Regularly train workers and contractors (such as at the site induction and toolbox talks) on the importance of minimising noise emissions and how to use equipment in ways to minimise noise.	Pre-construction/ construction
N_03	Switch off any equipment when not in use for extended periods.	Construction
N_04	Works would generally be carried out during standard construction hours <ul style="list-style-type: none"> • Mondays to Fridays from 7:00am to 6:00pm • Saturdays from 8:00am to 1:00pm • At no time on Sundays or public holidays Any works outside these hours may be undertaken if approved by DITRDCA and the community is notified prior to these works occurring.	Construction

Ref	Mitigation Measures	When to implement
N_05	Construction planning would include selection of plant and equipment with the aim of not exceeding the structural damage criteria (peak particle velocity) for structures that are particularly sensitive to vibration and have intrinsic value, as detailed in German standard <i>DIN 4150-3: 1992-02 Vibration in Buildings – Part 3: Effects on Structures</i> , at any heritage building/structure. Where plant and equipment is required to be used in proximity to a heritage building/structure and cannot satisfy structural damage criteria for vibration, additional site- and activity-specific mitigation and management measures would be developed and applied. This may include vibration monitoring, structural reinforcements, and/ or amelioration of structural damage.	Construction

6.10.4 Monitoring

None required unless works result in complaints being received or excessive noise indicates the potential for worker exposure. If either of these circumstances occur, a noise management plan would be developed and would include a program of regular noise monitoring.

7.0 Communications and Consultation

7.1 Key contacts for the project

The key contacts for the project are presented in Table 21.

Table 21 Key contacts for the project

Name	Position	Number
TBD	Project Manager, Contractor	TBD
TBD	Site Manager, Contractor	TBD
TBD	Environmental Adviser, AECOM	TBD
TBD	Heritage Specialist, DITRDCA	TBD
TBD	Project Director DITRDCA (Canberra)	TBD
TBD	Planning Officer, Norfolk Island Regional Council	TBD

Note: TBD = To be determined

7.2 Consultation with Stakeholders

Consultation with all stakeholders regarding environmental issues would be conducted at regular stakeholder meetings and as required.

8.0 Emergency and Incident Management

8.1 Emergency Management

In the event of an emergency, the first priority would be the safety of all personnel and site workers in the immediate vicinity. Following this, all practical steps would be taken to minimise the risk of further damage as soon as possible after the event. The situation would be stabilised following the appropriate incident management or contingency plan procedures. The appropriate staff would be notified and emergency procedures enacted.

In general, the event of a serious emergency at the site, the following procedure would be followed:

1. Stop work
2. If safe to do so, make immediate arrangements to minimise further impact
3. All personnel would leave the work zone via established entry/exit routes
4. Leave the site and assemble at the designated emergency assembly area (to be specified during Site Induction)
5. Await further instructions from the Project Manager.

No project relevant personnel are to leave the assembly area unless advised to do so by the designated site manager.

The designated site manager would notify the relevant service as to the details regarding any emergency:

- Norfolk Island Fire Service
- Ambulance
- Norfolk Island Police
- Norfolk Island Regional Council.

Records would be kept of any incidents, accidents, hazardous situations, unusual events and unsafe health exposures and the corrective action taken. The incident would be investigated by determining the cause of any emergency so that necessary changes in work practices can be made to prevent the incident reoccurring.

Emergency procedures and contact telephone numbers would be displayed in a prominent position within each site working area.

8.2 Incident Management

In the event of an environmental incident, the first priority would be the safety of all personnel and site workers in the immediate vicinity. For this project environmental incidents include accidental damage to heritage items. Following this, all practical steps would be taken to minimise the risk of further environmental damage as soon as possible after the event. The situation would be stabilised following the appropriate incident management or contingency plan procedures. The appropriate staff would be notified and emergency procedures enacted.

In the event of a serious emergency at the site, the following procedure would be followed:

1. Stop work
2. If safe to do so, make immediate arrangements to minimise further environmental impact
3. All personnel would leave the work zone via established entry/exit routes
4. Leave the site and assemble at the designated emergency assembly area (to be specified during site induction)
5. Await further instructions from the Project Manager.

No project relevant personnel are to leave the assembly area unless advised to do so by the designated site manager. Records would be kept of any environmental incidents, accidents, hazardous situations, unusual events and unsafe health exposures and the corrective action taken. A representative of Contractor would investigate the root cause of any emergency so that necessary changes in work practices can be made to prevent the incident reoccurring.

8.2.1 Damage to Heritage Items

In the event of accidental damage to heritage items, the area would be cordoned off and photographs/video recorded of the extent of the damage. The designated Site Manager would notify the DITRDCA Archaeologist regarding any damage to heritage items:

Corrective action would be developed in consultation with the Archaeologist. The rectification works would be carried out under supervision of a Heritage Specialist and records would be maintained.

9.0 Environmental Audit, Corrective and Preventative Action

9.1 Environmental Audit

Environmental audits would be carried out periodically throughout the construction phase to independently verify that the recommended mitigation measures are being implemented effectively and the environmental receptors of concern are safeguarded. The Auditor would be competent on the basis of training, education and experience, and must be independent from the contractor.

The Auditor would prepare audit reports that document the compliance status against EMP requirements and any additional conditions of approval or requirements (if applicable) together with recommendations for continual improvement. Succinct audit reports would be submitted to DITRDCA within 7 days of conducting the audit. Audit findings would be communicated to key personnel and included in site training or toolbox talks. Audit records would be maintained.

9.2 Noncompliance, Corrective and Preventative Action

Noncompliance against environmental requirements can be raised through conducting audits, raised by the Project Manager or Consultant when non-compliances are observed or as a result of complaints received. When a noncompliance is raised, root cause analysis would be carried out and corrective action formulated and implemented without undue delay. The effectiveness of corrective actions taken would be verified to prevent recurrence.

Preventative action may be initiated from trends analysis, local environmental incidents on other sites, audit findings of other sites, changes in environmental risks due to changes in legislation or construction methods or opportunities for improvement. Preventative actions may be initiated by Project Manager or Consultant as required.

Records of corrective and preventative actions would be maintained.

SMITH, Alison

From: s 22(1)(a)(ii) @infrastructure.gov.au>
Sent: Wednesday, 6 May 2026 8:20 AM
To: s 22(1)(a)(ii)
Cc: s 22(1)(a)(ii)
Subject: Fw: 1941 drain docs
Attachments: EMA 2014 KAVHA 1941 drain SOHI A3C-0003.pdf; s 47F 2015 KAVHA 1941 channel addendum to 2014 SOHI A3C-0006.pdf; 65.3.3 1941 water channel condition.pdf; 66.3.03 insurance claim against collapsed 1941 water channel.pdf

OFFICIAL

From: s 47F
Sent: Friday, November 17, 2023 15:29
To: s 22(1)(a)(ii) @infrastructure.gov.au>; s 22(1)(a)(ii) @infrastructure.gov.au>
Cc: s 22(1)(a)(ii) @infrastructure.gov.au>
Subject: 1941 drain docs

Hi there,

Found some docs related to the 1941 drain (as she is known). Attached:

- Item 3.3 from the 65th KAVHA board meeting (May 2012), in which s 47F discusses the collapsing sides of the drain, and the proposed solution is to reconstruct 45 metres of the drain for a cost of up to \$70,000.
- Item 3.3 from the 66th KAVHA board meeting (July 2013), in which s 47F sends further information along. Apparently the tenders received for the proposed repairs ranged in cost from \$74,000 to \$104,000, and the KAVHA board had no provision in its 2011-2012 or 2012-2013 budgets to make the repairs. Apparently neither the Commonwealth or NI Administration had short-to-medium term funding available for the repairs, and so instead they began looking at whether they could make an insurance claim.

Note that this is the final KAVHA board meeting, and I'm not even actually sure it ended up happening as I've not been able to find minutes for it, unlike all the others! The dying gasp of a board here.

- Eric Martin and Associates: 2014 SOHI for filling the drain. Interestingly, the reason they give for filling it is that the sides are collapsing, and filling was thought to be a better option than repair.
- s 47F 2015 addendum to the SOHI: in here, the reasoning for filling it has now to do with the failure of the bridge, on top of the sides collapsing.

I'm not sending the full files as they're very large, but with regard to *why* the thing was made, here's the info from the annual reports for the island:

- **1937/1938:** "A very necessary deviation drain is under construction to divert Mill Creek at Kingston from its present course to a more direct one. This will avoid choking of the creek where at present it passes through a short tunnel, with its consequent periodical flooding of open grazing areas at Kingston, one-third of which has become swampy in nature, and is useless for grazing purposes."
- **1938/1939:** "An important work in hand, referred to in last year's annual report, is a new outlet to Emily Bay at Kingston for Mill Creek, involving a cutting 8 feet [2.4 metres] wide by an average depth of 8 feet [2.4 metres]

and 10 chains [201 metres] in length. When completed a large area of land now subject to flooding and consequent destruction of pasturage will again be available for grazing purposes.”

- **1939/1940:** “At Kingston work on the new outlet for the Town Creek, giving direct straight line access to Emily Bay has been further advanced during the year. Details were given in last year’s Annual Report.”
- **1940/1941:** “The main work in hand at present is the diversion of the town creek at Kingston, so that direct outlet to the sea may be provided and thereby facilitate the drainage of the Kingston Common. The length of the new channel is 10 ¼ chains [206 metres]. Work proceeds slowly owing to the present limited supply of labour, but will be completed in next financial year.”
- **1941/1942:** “The outfall diversion of Town Creek to Emily Bay, which work it was expected would be completed during the financial year just closed, still remains unfinished, as a result of shortage of labour.”

No mention is made of the works after that, and based on aerial photos from after the aerodrome was built, looks like they did indeed finish it in the 1942/1943 financial year. And if someone ever asks why any particular works at Kingston are slow, you can tell them that it took workmen nearly 5 years to dig just 200 metres of drain.

OFFICIAL

KAVHA 1941 DRAIN

Statement of Heritage Impact

Prepared by

Eric Martin and Associates

For

KAVHA

EMA

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**ISSUE 3
13029**

9 January 2014

1.0 INTRODUCTION

The concrete lined open walled drainage channel has collapsed in sections and remedial work is required. (Refer attached photograph)

The intention is to pipe the water along the channel from the Bay Street Bridge to the swamp and fill it in rather than reconstruct the channel. The other parts of the channel will remain open.

This advice discusses the heritage issues associated with the proposed actions.

2.0 SIGNIFICANCE AND CONSERVATION POLICIES

The drain is part of inventory item A3 Swamp Creek. The drain is inventory item A3C and was completed in 1941 to provide more effective means to drain the swamp and swamp creek. The following are details of existing documentation and Conservation and Management Plans.

1988 Conservation and Management Plan Volume 2

P92 The new channel is one of the now few elements of the place, which reflect in their fabric, notable aspects of the Pitcairn People's occupation pre-1945.

Policies 4.1.1 All Pre-1945 fabric should be conserved.

4.1.2 Reconstruct to the second settlement form subject to further investigation.

June 1994 The Swamp Creek and Serpentine Area Conservation Study and Interpretive Design by ACS.

The report references the 1988 CMP.

Clause 1.7.3 recommends reinstating lines of former roads to facilitate visitor access to the area and to aid interpretation.

P54-P55 provides details of a possible bridge.

The report recommends other works to the Serpentine Creek but these are outside the scope of the rectification of the concrete channel.

June 1995 The Swamp Creek And Serpentine Area Report and Recommendations Archaeological Report No 40 Part 2 by ACS.

No additional information on the open concrete channel is provided.

2008 Conservation and Management Plan

P79 Regular Clearing of weeds and no permit is necessary.

P125 Policy 11.0 Protect, conserve and manage the cultural landscape of KAVHA consistent with operational and community function.

Conserve fabric in accordance with their level of significance as per policy 23.

P135 Policy 23 Review and update the existing inventories.

P134 Policy 22 Maintain a Heritage Register to monitor and report on change to KAVHA.

2003 Conservation and Management Plan

- Inventory item A3C Twentieth Century Open Channel.

Statement of Significance indicating the continual need to drain the swampy lowland area of Kingston Common.

Significant Fabric - Alignment of the open drain-lesser
- Concrete lining to drain-neutral.

Conservation Policy - Archaeological assessment of impact or soil disturbance
- Archaeological monitoring
- Periodic maintenance to clean channel
- Continue to drain Kingston, in open channels.

- Inventory item A4 Bligh Street and bridges.

Statement of Significance indicating the development of the second penal settlement linking the first two major institutional complexes the Military Barracks and the Prisoner Barracks.

Significant Fabric - Reconstructed Gateway - considerable.
- Alignment and vestiges of bridges to Bligh Street - considerable.
- Modern road surface - neutral
- Recent Norfolk Island pine (post-1960) – intrusive.

Conservation Policy - Conserve the vestiges of the Bligh Street bridges
- Continue to drain Kingston, in open channels
- Archaeological assessment of any proposed disturbance
- Ensure vestiges of bridges are only used by pedestrians.

COMMENT

The 1988 CMP indicates that pre 1945 fabric should be conserved but makes no specific comment on the open drain.

The 2003 CMP indicates that the open drain is of low significance (alignment is of lesser significance and concrete lining of neutral significance) but the area should be drained in open channels.

The 2008 CMP offers no specific comment on the drain.

3.0 PROPOSAL

The proposal is to insert two 600mm diameter plastic stormwater pipes in the current open channel and then fill in the area and grass over.

4.0 COMMENT

The open channel is not the primary discharge from Swamp Creek which is through the Chimney Hill channel which was constructed in 1834 by Major Anderson. It appears that the 1941 channel was constructed to supplement discharge due to sand encroachment.

The Chimney Hill channel appears to manage the water flow without adverse impact on the existing fabric. We are advised that the two 600mm pipes will manage the overflow requirements for drainage of the area.

The open drain is of low significance and its importance as an aspect of Pitcairn people's occupation pre 1945 is minimal as it appears that its construction was one of practical need rather than any aspect of developing Pitcairn settlement.

The infill of the drain will return the area visually to as it existed in the second settlement and for 85 years of Pitcairn settlement and probably reinforces the significance of the area.

It will be important to continue to manage the area and ensure sand does not block the Chimney Hill discharge or impact on the proposed new piped drain.

5.0 CONCLUSION

The existing open channel is of low significance and its infill and installation of two 600mm diameter plastic stormwater pipes will have minimal impact on the heritage values of the area.



View of channel from Bay Street Bridge – January 2014

Released under the Freedom of Information Act 1982 by the Department of Infrastructure, Transport, Regional Development, Communications, Sport and the Arts

13029

7 January 2014

Building 11
Quality Row
Kingston
NORFOLK ISLAND NSW 2899

Attention: § 22(1)(a)
§ @admin.gov.nf
22(1)
(a)(ii)

Dear §
22(1)

KAVHA - INFILL OF 1941 OPEN CHANNEL

Please find attached our Statement of Heritage Impact for the proposed infill of the 1941 open channel.

This should be forwarded for approval to KAVHA Board and Department of Infrastructure and Regional Development who, as the funding authority, have responsibilities under the EPBC Act not to take an action that adversely affects the significance of the place.

There may also be local Norfolk Island Government approvals required as well.

Yours faithfully

§ 47F

§ 47F
Director

Registered Architect
ACT376 VIC5150 NSW5991
WA1663 QLD3391

Encl: SOHI



Kingston and Arthurs Vale Historic Area

Addendum to the 2014 Statement of Heritage Impact

for

1941 Channel

Prepared by the Commonwealth Heritage Manager

June 2015

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Addendum to the 2014 Statement of Heritage Impact for the 1941 Drain

1.0 Introduction

Following a roads and bridges assessment of Norfolk Island by Worely Parsons in April to June 2015, structural defects were identified in the bridge that spans the channel dug in 1941 (1941 Channel). These issues require a rebuilding or removal of the bridge in question.

2.0 Background

The 1941 Channel drains the area of the Kingston and Arthurs Vale Historic Area (KAVHA), that was, prior to European settlement, a standing swamp, with no egress to the sea, which later became known as The Serpentine.¹ From the late 18th Century, the swamp was drained via channels that were cut utilising convict labour, first around, and then through the calcarenite hill known as Dove Hill. This hill was later heavily quarried, with the land to the north west of the hill (the former swamp), utilised for decorative gardens, roads, bridges and recreation.

In 1941, a secondary channel (the 1941 Channel) was cut from the swamp directly to Emily Bay to attempt to assist in draining the valley. This secondary channel worked in concert with that constructed in the 1840's and the tunnel cut under Dove Hill in 1835. However, due to changes in the drain invert level in relation to sea level, this channel only flows after significant rainfall events. Consequently, wave action and high tides from Emily Bay, deposit sand in the 1941 Channel, which has effectively become little more than a spillway and suffering from degradation to its banks and structure.

In late May 2015, Worley Parsons engineers noted that the vehicular bridge across the 1941 Channel was suffering from concrete cancer and could be at risk of collapse. In order to protect the safety of the public, the bridge was closed on 2 June 2015 and options were investigated for its repair, replacement or removal.

While this bridge is closed, there is no vehicular access to Point Hunter and most of Emily Bay, which is the Island's principle scenic and beach recreation area. The community and the tourism industry will adjust to this restriction for a moderate period; however there will be considerable disruption to the Island's dominant industry and to use of the area by locals if this bridge closure extends into spring or summer. In 2014, studies into the water catchment of KAVHA identified high levels of contaminants related to stock and potentially human waste especially during and immediately following flood events. Recommendations from this report noted that waters flowing through KAVHA need to be retained for as long as practical to allow natural processes to lower the levels of contaminants within the system and that large flood events need to be retained for longer periods to allow settlement of sediment. These recommendations were two of several in a strategy aimed at improving water quality across the site and in particular the quality of waters flowing in to Emily Bay.

¹ Though the area is now referred to as the Serpentine, originally this meant only the decorative serpentine channel.

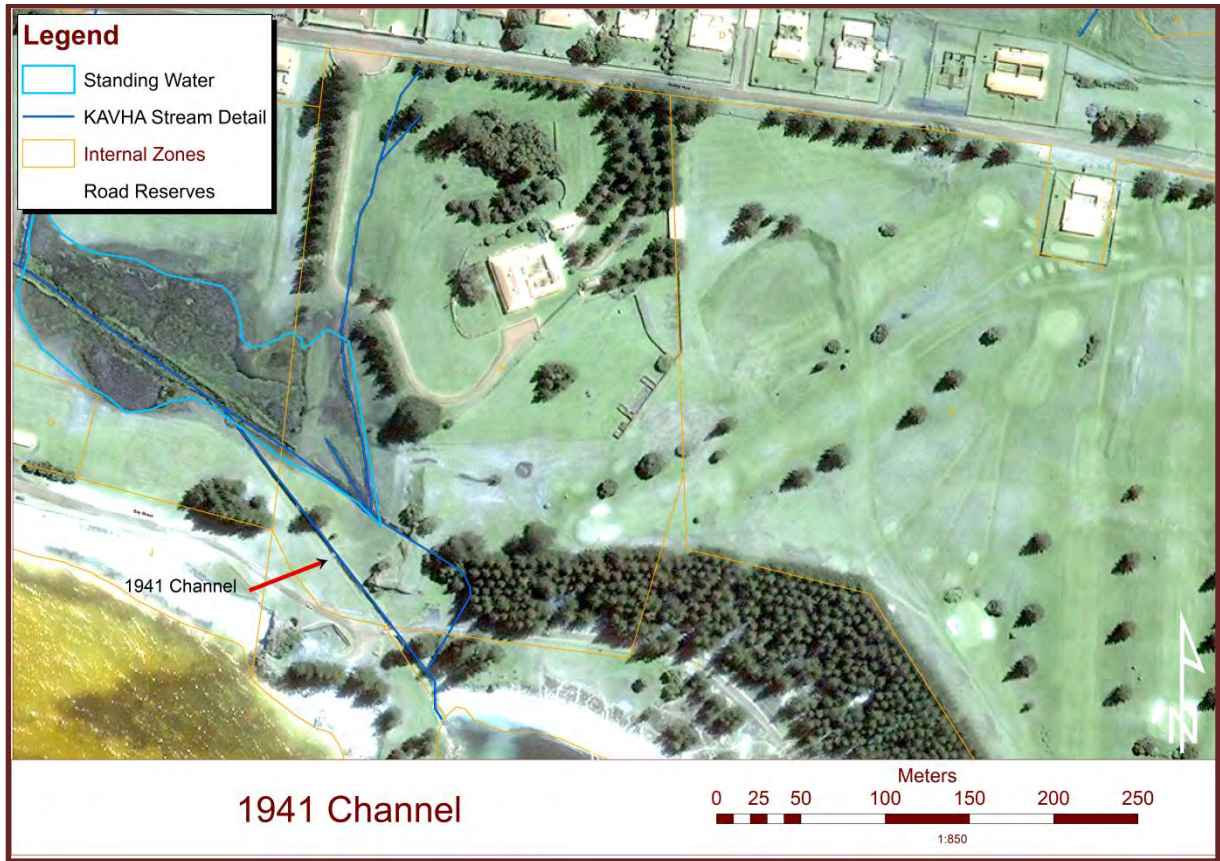


Figure 1: Location of 1941 Channel

3.0 Site Description

The 1941 Channel is a 2.5metre wide, up to 3 meter deep and approximately 200 metre long channel that connects the existing lowland swamp area of KAVHA to Emily Bay, in concert with the 1840's channel north east of it. Figure 2 and the photographs in the attachment provide details on the channel's structure. The channel cuts through former swamp and calcarenite bedrock before discharging to Emily Bay.

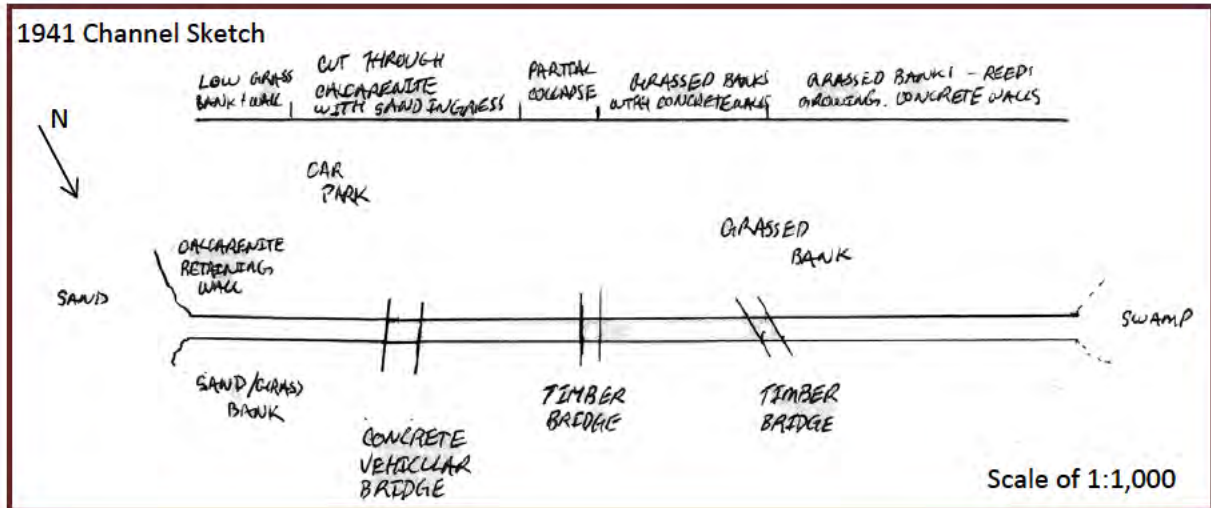


Figure 2: Structure of Channel

Released under the Freedom of Information Act 1982 by the Department of Infrastructure, Transport, Regional Development, Communications, Sport and the Arts

4.0 Significance

The 1941 Channel represents earthworks undertaken almost a century after major works on The Serpentine were previously undertaken by the then Colonial Administration. The impact of the construction of the 1941 Channel was the cutting of the historic route of Bligh Street and the division of an area of open space that had existed since the 1830's and the end of quarrying at Dove Hill.

The Significance of the 1941 Channel is assessed below against the Criteria of the listing currently in force for KAVHA.

Listing	Criteria	1941 Channel
Outstanding Universal Value (World Heritage)	IV - to be an outstanding example of a type of building, architectural or technological ensemble or landscape which illustrates (a) significant stage(s) in human history	Does not contribute
	VI - to be directly or tangibly associated with events or living traditions, with ideas, or with beliefs, with artistic and literary works of outstanding universal significance.	Does not contribute
National Heritage Values	the place has outstanding heritage value to the nation because of the place's importance in the course, or pattern, of Australia's natural or cultural history	Does not contribute
	the place has outstanding heritage value to the nation because of the place's possession of uncommon, rare or endangered aspects of Australia's natural or cultural history	Does not contribute
	the place has outstanding heritage value to the nation because of the place's potential to yield information that will contribute to an understanding of Australia's natural or cultural history	Does not contribute
	the place has outstanding heritage value to the nation because of the place's importance in demonstrating the principal characteristics of: <ul style="list-style-type: none"> i. a class of Australia's natural or cultural places; or ii. a class of Australia's natural or cultural environments; 	Does not contribute
	the place has outstanding heritage value to the nation because of the place's importance in exhibiting particular aesthetic characteristics valued by a community or cultural group	Does not contribute – Detracts from recognised values since its construction
	the place has outstanding heritage value to the nation because of the place's strong or special association with a	

Listing	Criteria	1941 Channel
	particular community or cultural group for social, cultural or spiritual reasons	
	the place has outstanding heritage value to the nation because of the place's special association with the life or works of a person, or group of persons, of importance in Australia's natural or cultural history	Does not contribute
	the place has outstanding heritage value to the nation because of the place's importance as part of Indigenous tradition.	Does not contribute
Norfolk Island Heritage Values	For the evolution of Norfolk Island's natural or cultural history.	Limited contribution via 3 rd Settlement Changes to KAVHA
	Because it demonstrates, rare or endangered aspects of Norfolk Island's natural or cultural heritage.	Does not contribute
	Because it provides information that will contribute to an understanding of Norfolk Island's natural or cultural history.	Does not contribute
	In demonstrating the principal characteristics of the range of landscapes, environments or ecosystems, the attributes of which identify them as being characteristic of their class.	Does not contribute
	By virtue of aesthetic characteristics or through technical, creative, design or artistic excellence, innovation or achievement valued by the Norfolk Island community.	Does not contribute
	Because it has a strong or special association with the Norfolk Island community for social, cultural or spiritual reasons.	Does not contribute
	Because it has a special association with the life or works of a person or group of persons that have been significant in Norfolk Island's natural or cultural history.	Does not contribute

5.0 Proposed Works

Initial work identified in 2014 focused on stabilisation of the western end of the 1941 Channel via a new concrete drain, proposed in response to the collapse of part of the concrete channel side wall. However, this concept did not take into account the potential for higher flows of water from the creek and swamp system into Emily Bay, where such flows would adversely impacted upon the reef ecosystem and public health.

The May 2015 determination that the bridge is structurally unsound has presented the opportunity to review the 1941 channel. Consideration of engineering advice for repairing the bridge, together with consideration of water quality management and heritage impacts has resulted in the following options:

1. Lay new slab over existing slab and raise road to meet;
2. Remove existing slab and construct new slab;
3. Remove existing slab, fill part of 1941 Channel and install pipes;
4. Remove existing slab and:
 - a. fill entire 1941 Channel and lay road over former bridge position; and
 - b. fill entire 1941 Channel and lay road over former bridge position in two stages.

Each option had the following benefits and issues.

Option	Issues	Strengths
1	<ul style="list-style-type: none"> • Future issues with lack of visibility to inspect integrity of new slab base; • Falling debris from deteriorated slab left <i>in situ</i>; • Closure of vehicular access to large part of site for tourists, tourism operators and the local community; • Retains non-historic 1941 Channel; • Allows supplementary high flow outfall to Emily Bay during large flood events; and. • Continued high adverse risk to public health and impact on reef ecosystem from pathogens, nutrients and sediment delivered into Emily Bay, especially during higher flow events. 	<ul style="list-style-type: none"> • Results in bridge similar to existing bridge • No planning of heritage approvals required
2	<ul style="list-style-type: none"> • Large scale cost and engineering requirements for new slab that cannot be met on island in the short term; • Closure of vehicular access to large part of site for tourists, tourism operators and the local 	<ul style="list-style-type: none"> • Replaces like for like

Option	Issues	Strengths
	<p>community;</p> <ul style="list-style-type: none"> • Allows supplementary high flow outfall to Emily Bay during large flood events; and • Continued high adverse risk to public health and impact on reef ecosystem from pathogens, nutrients and sediment delivered into Emily Bay, especially during higher flow events. 	
3	<ul style="list-style-type: none"> • Requires significant concrete headwalls and aprons; • Closure of vehicular access to large part of site for tourists, tourism operators and the local community; • Potential to increase regular outfalls of water into Emily Bay; • Allows supplementary high flow outfall to Emily Bay during large flood events; and • Continued high adverse risk to public health and impact on reef ecosystem from pathogens, nutrients and sediment delivered into Emily Bay. • 	<ul style="list-style-type: none"> • Partially restores historic landscape
4a	<ul style="list-style-type: none"> • Requires armouring for fill, with calcarenite stone wall at Emily Bay end: to match existing. 	<ul style="list-style-type: none"> • Restores historic landscape; • Significantly improves quality of waters delivered into Emily Bay, reducing adverse impacts on public health and reef ecosystem; and • Short period for works, allowing community access sooner.
4b	<ul style="list-style-type: none"> • Requires armouring for fill, with calcarenite stone wall at Emily Bay end: to match existing. 	<ul style="list-style-type: none"> • Restores historic landscape; • Significantly improves quality of waters delivered into Emily Bay, reducing adverse impacts on public

Option	Issues	Strengths
		<p>health and reef ecosystem; and</p> <ul style="list-style-type: none"> • Shortest period of disruption to community and tourism access to Emily Bay: bridge removed and access road restored in first stage, whole of channel filled and landscape restored (2nd Stage).

Following on site discussions with engineers, representatives of the Administration of Norfolk Island, the KAVHA Site Manager, Conservator of Public Reserves and the Commonwealth Heritage Manager, it was agreed that Option 4b would be the most appropriate, considering the engineering constraints, public access needs, water quality issues and heritage requirements of the site.

As such, Option 4b would consist of

- Stage 1 works:
 - remove existing concrete bridge deck;
 - remove sand from drain under bridge;
 - place and compact hardfill;
 - construct new road section in place of existing bridge; and
 - match to existing ground surface.
- Stage 2 works:
 - remove sand from drain downstream from road;
 - place and compact hardfill at both upstream and downstream ends of the drain;
 - fill full length of 1941 drain with clean fill material from roadworks at Ferny Lane;
 - compact as appropriate; and
 - cover with 200mm top-dressing to match to existing ground surface and grass.

The estimated total amount of fill material for both Stage 1 and Stage 2 works:

	Uncompacted	Compacted	Stage 1	Stage 2
Length	190m	190m		
Fill (m3)	900	1,200	225/300	675/900
Top-dressing (m3)	100	100	25/75	25/75

A calcarenite wall would be constructed at the Emily Bay end to match existing stone walls and utilise the wall materials that were installed to protect the eastern end of the 1941 Channel in the early 2000's and would be otherwise buried by works.

6.0 Impact Assessment

The impact of Option 4b against the contributory heritage values listed in Chapter 4 are:

Listing	Criteria	Impact
Outstanding Universal Value (World Heritage)	IV - to be an outstanding example of a type of building, architectural or technological ensemble or landscape which illustrates (a) significant stage(s) in human history	Positive impact in the restoration of previous landscape structure and reinstatement of convict era thoroughfares.
	VI - to be directly or tangibly associated with events or living traditions, with ideas, or with beliefs, with artistic and literary works of outstanding universal significance.	No effect
National Heritage Values	the place has outstanding heritage value to the nation because of the place's importance in the course, or pattern, of Australia's natural or cultural history	No effect
	the place has outstanding heritage value to the nation because of the place's possession of uncommon, rare or endangered aspects of Australia's natural or cultural history	No effect
	the place has outstanding heritage value to the nation because of the place's potential to yield information that will contribute to an understanding of Australia's natural or cultural history	No effect
	the place has outstanding heritage value to the nation because of the place's importance in demonstrating the principal characteristics of: <ul style="list-style-type: none"> i. a class of Australia's natural or cultural places; or ii. a class of Australia's natural or cultural environments; 	Positive impact through protection of the reef ecosystem (2 nd southernmost coral reef in the world) from high water outfalls and limiting salt water ingress into the upstream freshwater systems.
	the place has outstanding heritage value to the nation because of the place's importance in exhibiting particular aesthetic characteristics valued by a community or cultural group	Positive impact in the restoration of previous landscape structure and reinstatement of convict era thoroughfares.
	the place has outstanding heritage value to the nation because of the place's strong or special association with a particular community or cultural group for social, cultural or spiritual reasons	No effect
	the place has outstanding heritage value to the nation because of the place's	No effect

Listing	Criteria	Impact
	special association with the life or works of a person, or group of persons, of importance in Australia's natural or cultural history	
	the place has outstanding heritage value to the nation because of the place's importance as part of Indigenous tradition.	No effect
Norfolk Island Heritage Values	For the evolution of Norfolk Island's natural or cultural history.	Slight negative impact by removal of Third Settlement Works.
	Because it demonstrates, rare or endangered aspects of Norfolk Island's natural or cultural heritage.	Positive impact through protection of the reef ecosystem (2 nd southernmost coral reef in the world) from high water outfalls and limiting slat water ingress into the upstream freshwater systems.
	Because it provides information that will contribute to an understanding of Norfolk Island's natural or cultural history.	No effect
	In demonstrating the principal characteristics of the range of landscapes, environments or ecosystems, the attributes of which identify them as being characteristic of their class.	Positive impact via protection of the reef ecosystem (2 nd southernmost coral reef in the world) from high water outfalls and limiting slat water ingress into the upstream freshwater systems. Positive impact in the restoration of previous landscape structure and reinstatement of convict era thoroughfares.
	By virtue of aesthetic characteristics or through technical, creative, design or artistic excellence, innovation or achievement valued by the Norfolk Island community.	Positive impact in the restoration of previous landscape structure and reinstatement of convict era thoroughfares.
	Because it has a strong or special association with the Norfolk Island community for social, cultural or spiritual reasons.	No effect
	Because it has a special association with the life or works of a person or group of persons that have been significant in Norfolk Island's natural or cultural history.	No effect

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Overall impact for the project is assessed and being generally positive, however, a single slight negative impact remains, therefore this will require management.

7.0 Legislation

Several pieces of legislation are in effect within the project area and are assessed below:

Legislation	Trigger	Do Works Trigger Legislation	Notes
Environment Protection and Biodiversity Conservation Act 1999	Does the project cause “significant impact” to the recognised values of the site or elements of the site that contribute to those values	No	<ul style="list-style-type: none"> Due to landscape restoration and finishes, the works will positively enhance the sites aesthetic values
Norfolk Island Plan			
Government House Reserve Plan of Management			
Norfolk Island Heritage Act 2002	Works to a listed place or heritage item	Yes	<ul style="list-style-type: none"> Need for a Statement of Heritage Impact (SOHI) Need to assess impact to the satisfaction of the Minister

7.1 Environment Protection and Biodiversity Conservation Act 1999

The Environment Protection and Biodiversity Conservation Act 1999 requires that actions that have, will have or are likely to have a significant impact on a matter of national environmental significance require approval. NES matters include world heritage; national heritage; listed species and communities; listed migratory species; and the marine environment.

The NES matters relating to the proposed 1941 drain project are: world heritage; national heritage and the marine environment.

With regards to the World and National values, the assessment needs to determine if the project causes “significant impact” to the recognised values of the site or elements of the site that contribute to those values.

Based on the impact assessment above, it is not the view of the SOHI that significant impact will occur. Due to landscape restoration and finishes, the works will positively enhance the sites values.

It is likely that part of the habitat of the endemic Norfolk Island freshwater shrimp *Paratya norfolcensis* could be affected by filling the 1941 drain. This is not a listed EPBC species.

Given that at present the 1941 drain is dry for perhaps half its length and that provided it is filled from the dry end to the wet end, there should not be a direct effect on this species.

There will be some loss of habitat, however the filling of the drain can be expected to result in some increase of the wetland habitat: both in extent and duration, with net benefit to the shrimp. The project will also signal a change in management practices that are more conducive to freshwater habitat conservation.

7.2 2008 KAVHA CMP

The CMP recognises the environmental heritage significance of the wetland and also notes water quality and heritage structure issues. The CMP provides that The Norfolk Island Conservator of Public Reserves is responsible for the management of the KAVHA wetland.

The proposed works are not considered to be inconsistent with the policies and recommendations of the 2008 CMP, as noted below.

Policy 1.1 Retain, enhance and retrieve the cultural significance of the place as opportunities arise, taking into account operational requirements and funding sources;

The proposed works would enhance the heritage values of KAVHA

Policy 1.2 Assess all significant impacts on the place and avoid work that is likely to result in a change to the significance or integrity of any heritage fabric or result in a change to the capacity of the heritage fabric to represent the heritage values.

This report has assessed the impacts and works proposed

Policy 10.1 Protect and conserve the cultural landscape, the historic fabric, the setting, moveable objects and archaeological remains by maintaining the existing physical character of KAVHA, including:

- protect important views to KAVHA from public vantage points and vistas from within KAVHA.
- building fabric and settings of individual elements in the landscape;
- open, roughly grassed and grazed lowlands and the rustic and rural character of the setting avoiding additional fencing;
- formal town plan and spatial and building layout;
- the dominant non-commercial character of the place;
- undeveloped open grassed hillsides;
- significant trees and remnant natural vegetation;
- any night vistas revealed by further investigations.

The project improves the significant landscapes, views and vistas and restores elements of the former town plan via the reinstatement of Bligh Street and the Government House driveway.

Policy 12.1 Prepare a program of work to maintain and repair the significant elements and fabric of the place;

The project repairs earlier impact to the area

Policy 13.1 Programs of work for the protection, conservation, presentation and transmission of National, Commonwealth and potential World Heritage values will be designed to focus on the conservation, repair, maintenance, stabilisation and interpretation of the heritage values of the place.

This project assists in the transmission of values via the restoration of part of the historic landscape

Policy 13.2 Missing elements of original fabric will not be reconstructed unless there are well researched and sound conservation reasons to do so; and is consistent with this Conservation Management Plan

Research has clearly indicated that the 1941 channel is not of significant value

Policy 18.1 Heritage impact assessments should be prepared prior to undertaking works that could have adverse impacts on heritage values.

This SOHI addresses this policy.

7.3 Public Reserves Act 1997

The 1941 drain is within 3 public reserves:

- Kingston Recreation Reserve;
- Government House Grounds Reserve; and
- Point Hunter Reserve.

The bridge is within Point Hunter Reserve.

The objects of the Public Reserves Act 1997 are to protect and conserve public reserves so as to:

- promote the conservation of the natural environment and landscape beauty of Norfolk Island;
- promote the conservation of the heritage of Norfolk Island; and
- preserve the way of life and the quality of life of the people of Norfolk Island.

Further, the Public Reserves Act 1997 provides that a construction that would promote the objects of the Act shall be preferred to a construction that would not.

The Public Reserves Act 1997 provides that, subject to the Act, one of the functions of the Conservator of Public Reserves is to manage the reserves in accordance with the relevant plans of management. Section 21(1) of the Act provides that the Conservator of Public Reserves has the power to do all things necessary or convenient to be done in connection with the performance of his functions.

The Kingston Recreation Reserve and the Government House Grounds Reserve plans of management both include the following objective:

- Minimise the adverse impacts on water quality and the wetland ecosystem that may be associated with grounds and drainage maintenance, or public use.

The objectives of the Kingston Recreation Reserve Plan of Management also include:

- Maintain and protect wetland habitat; and
- Maximise the quality of waters flowing into Emily Bay.

The plans of management also provide that where there is any inconsistency between the intent of the plans and the intent of the approved KAVHA CMP, the intent of the approved KAVHA CMP shall prevail.

The Conservator has approved the removal of the bridge and the filling of the 1941 drain as previously outlined (Option 4b) and consider that this proposed action is consistent with the plans of management of the reserves and with the objects of the Public Reserves Act 1997; consistent with the CMP and within the powers of the Conservator of Public Reserves.

7.4 Norfolk Island Heritage Act 2002

The Norfolk Island Plan requires that works to a listed place or heritage item require a Statement of Heritage Impact (SOHI) and that the SOHI must assess impact to the satisfaction of the Minister.

This SOHI is intended to fulfil the requirements of the Act.

7.5 Norfolk Island Plan

The Norfolk Island Plan requires a development application for works beyond those to repair the bridge (i.e. for Stage 2):

34. (1) A development application shall be made to the Chief Executive Officer.
- (2) The application shall be accompanied by —
 - (a) any information or documents required by the Plan for the application; and
 - (b) any information or documents required under any other enactment; and
 - (c) if an environmental impact statement is required under section 45 for the use or development, the statement; and
 - (d) the prescribed fee (if any) for an application of that type.
- (3) The Chief Executive Officer may, if the Chief Executive Officer considers it reasonable in the circumstances —
 - (a) waive the requirement that an applicant provide any of the information referred to in subsection 34(2); or
 - (b) require an applicant to provide relevant information or documents alternative or additional to the information or documents referred to in paragraph 34(2)(a), by written notice to the applicant.
- (4) A requirement under paragraph 34(3)(b) shall be made within 14 days of receipt of the application.

This SOHI addresses the information requirements of the Norfolk Island Plan

8.0 Recommendations

In order to mitigate the minor negative impact, the following should be undertaken prior to works:

- The preparation of a Statement of Heritage Impact;
- Recording of the Channel photographically;
- Archiving of the SOHI with the KAVHA Research Centre; and
- Recording the area post-works for future reference.

9.0 Photos



Figure 3: East end of 1941 Channel from North



Figure 4: Centre of 1941 Channel from North



Figure 5: West end of 1941 Channel from North



Figure 6: 1941 channel from East



Figure 7: Looking West from bridge deck



Figure 8: Looking East from bridge deck



Figure 9: East end of 1941 channel from South

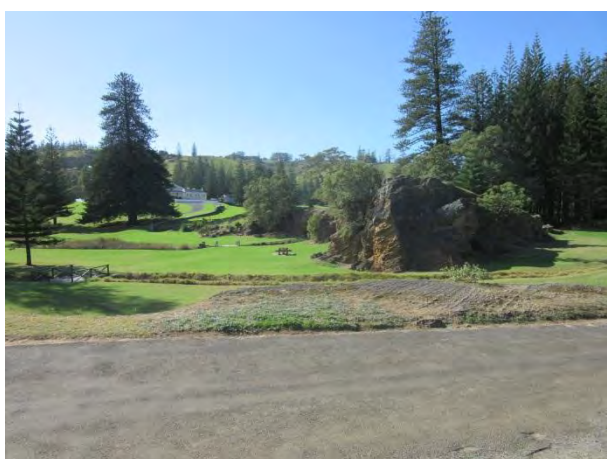


Figure 10: Centre of 1941 channel from South



Figure 11: West end of 1941 channel from South



Figure 12 looking East: 1941 channel



Figure 13: The Serpentine from the West end of the 1941 channel



Figure 14: View looking east from the West end of 1941 channel across the 1840s channel to Dove Hill



Figure 15: Concrete lining at West end of the 1941 channel



Figure 16: Looking North along the former route of Bligh Street

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Figure 17: Looking North along the former alignment of the Government House driveway

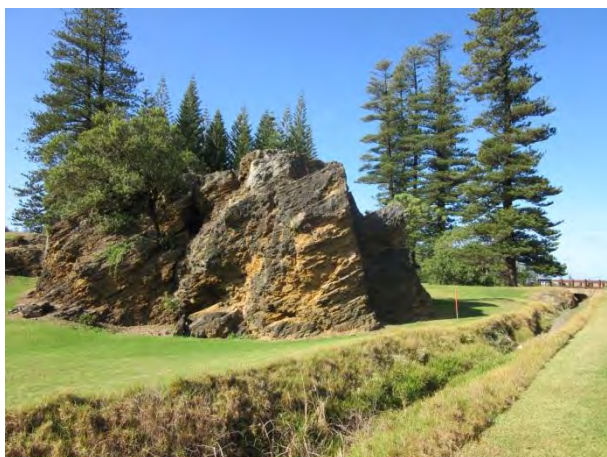


Figure 18: Part of the Dove Hill quarry area



Figure 19: Sand and vegetation in centre section of 1941 channel

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Figure 20: Bridge deck looking East



Figure 21: East end of the 1941 channel walls showing bedding



Figure 22: Bedding on South wall of 1941 channel near bridge



Figure 23: Bridge deck from 1941 channel



Figure 24: Bridge deck concrete cancer

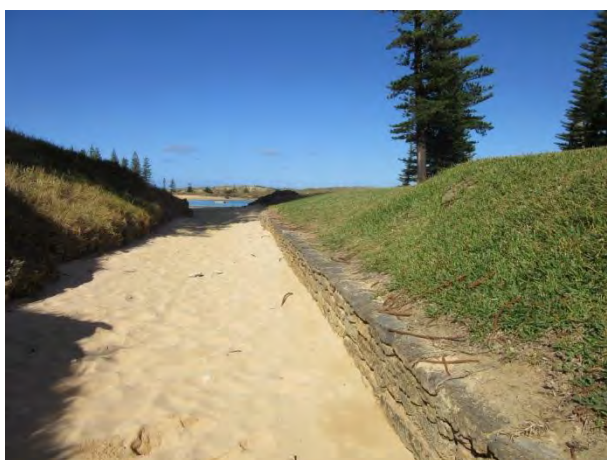


Figure 25: Looking east showing early 2000s calcarenite retaining wall



Figure 26: Waste calcarenite near surface, potentially from Dove Hill quarry. Such deposits are evident across KAVHA.

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MEMORANDUM

TO: KAVHA MANAGEMENT BOARD

DATE: 15TH MARCH 2012

RE: 1941 WATER CHANNEL

Background

As part of the 2010 annual inspection of the KAVHA site by the Heritage Architect, the Conservation and Maintenance supervisor conveyed concerns to the poor condition of the walls to the 1941 water channel.

The 1941 water channel is a man-made diversion channel (97 metres long) and was constructed to alleviate the previously constructed water channel through Chimney hill in 1835. The 1941 water channel is the main exit point for all run-off water that flows down from a major part of the island into Emily Bay.

In his 2010 report (refer Attachment A), the heritage architect recommended "At some stage the section of drain between the two timber bridges will need to be rebuilt"

Due to financial constraints and other priorities, no provision in the 2010-11 annual budget was made to rebuild or make safe the channel walls.

Again in the 2011-12 Works program report (refer Attachment B) by the Heritage Architect it was reported that "No work has occurred to date and the centre section between the timber bridges has become worse and stabilisation/rebuilding is required as it likely to collapse".

Due to financial constraints and other priorities, no provision in the 2011-12 annual budget was made to rebuild or make safe the channel walls.

On Tuesday 13th March 2012, 24 metres of the channel wall on the southern side collapsed. (refer Attachment C).

Consequences

Being the major diversion and exit point for a large percentage of runoff water on the Island there is a regular occurrence of large volumes of water flowing through this channel and any defect in the construction of the channel means there is a very high chance of serious erosion and further deterioration to the water channel. Temporary and reactionary repairs to the damaged wall have been made but will not protect the area in the event of significant rainfall. There is a urgent need for professional advice and to repair/rebuild this area.

Options.

1. **Plastic/concrete pipe work** - As there is deterioration to most of the 97 metres of wall there is an opportunity to lay plastic or concrete piping into the existing channel and then covering the pipe work with soil. This option would once again re-instate the seaward end to Bligh Street and would eliminate an OH&S hazard.

It would also be possible to stage the works so that only the most pressing area (45 metres) can be remediated and further works could be budgeted.

Initial prices from local suppliers indicate that to purchase 2 metre diameter HDPE pipe would be approximately \$2,000per metre (price subject to shipping costs and the New Zealand dollar exchange rate). There would also be additional labour and machinery costs to lay, backfill and concrete headwalls.

Limiting factors for this option would be the high cost of transportation of the pipes to the island. Estimated cost to complete 97 metres of channel - \$194k in pipe + machinery + materials + labour.

Estimated cost to complete 45 metres of channel - \$90K in pipe + machinery + materials + labour.

2. **Repair damaged section** – Repairs to the damaged section of the wall could be achieved by blocking the flow of water through the channel and then forming and pouring new concrete to make good the damaged area. This would rectify the immediate area however other sections of the channel are also in a precarious state and could also fall at any time. This option would be reactionary and would not be an overall fix to the problem.

Estimated cost to repair 24 metres of damaged area - \$10K in concrete + machinery + materials + labour

3. **Re-pour new concrete to whole or part of channel** - This option would be using what already exists as the foundation and re-form and pour new walls and base in situ and inside the existing channel. The collapsed area of the channel would obviously have to be double boxed to recreate the area and then backfilled.

With this option, the channel would remain open and not be covered over. The advantage of this option is the overall cost and the total use of local resources and suppliers. An additional advantage may mean this option would limit the need for environmental applications (EPBC) to be made as all works would re-create the original appearance.

Estimated cost to complete 97 metres of channel - \$31K in concrete + machinery + materials + labour.

Estimated cost to complete 45 metres of channel - \$23K in concrete + machinery + materials + labour.

Recommendation

- 45 metres of the 1941 water channel be reconstructed using option 3 as the preferred method.
- That an amount of \$70,000 be the maximum cap designated for this project and that more precise costings are developed subject to approval in principal.
- That suitable engineering design is sought and all relevant environmental obligations (EPBC referral) be completed as a matter of urgency.
- That works commence at the seaward end of the 1941 water channel and end 45 metres from that point.

s 47F



KAVHA Works Supervisor.

KAVHA Office

From: KAVHA Office <kavha@admin.gov.nf>
Sent: Tuesday, 17 July 2012 3:17 PM
To: § 47F
Cc: § 47F, KAVHA Site Manager'; § 47F, Administrator'; § 47F; 'Kavha Office'; § 47F Official Secretary'; § 47F; § 22(1)(a)(ii) @regional.gov.au
Subject: Board approval for Insurance claim against the 1941 water channel collapse
Follow Up Flag: Follow up
Due By: Thursday, 19 July 2012 8:00 AM
Flag Status: Flagged

Dear Board member,

At the May Board meeting you were briefed about the collapsed section of the 1941 water channel flowing into Emily Bay. A review of the collapse was conducted and a report prepared by the Heritage Architect. It was estimated around \$70,000 funding would be required to undertake the repairs. There was no provision in the 2011 or 2012 budgets to rebuild or make safe the channel walls. A business case was prepared for DRALGAS to seek funding from the Commonwealth in their procurement cycle and on this basis the Administration commenced a formal Tender process. Those Tenders have now been received and will be considered by the Tender Committee subject to available funding. At this time the quotes for repairs extend from \$74,000 to \$104,000. Advice has been provided to the CEO, DRALGAS and the applicants.

Currently there is potential for the collapse to enlarge increasing the eventual cost of repairs and creating a greater public safety risk.

There isn't available funding from either Government in the short to medium term.

DRALGAS and the NI Administration both hold insurance policies for their respective interests in Norfolk Island. KAVHA is not singled out. Advice indicates the DRAGLAS Policy includes cover for: General Liability \$100m, Professional Indemnity \$100m, Directors & Officers \$100m, Property – as per asset schedule, Fraud & Fidelity \$50k, Property in transit \$200k. NI Administration is insured through Statewide Mutual liability Scheme as a Local Government Authority having a \$100m limit of protection.

In addressing these risks I seek your approval to notify a claim against the appropriate (Commonwealth and/or Administrations) Insurance policies though natural peril storm damage and earth moving resulting in collapse.

In accordance with the Board functions to advise the Governments and the Administrator on measures for the care and control of KAVHA I seek your formal notification of the claim. Voting options are provided above for your ease of response.

Kind Regards

§ 22(1)(a)
 (ii) KAVHA Site Manager
 11 Quality Row
 Norfolk Island 2899

Department of Regional Australia, Local Government, Arts and Sport ph: + § 22(1)(a) e: § @admin.gov.nf
 (ii) 22(1)
 (a)(ii)

Timeline of events, findings, etc. leading to the filling of drain A3C.

23 July 2025

(EMA = Eric Martin and Associates)

Date	Information
1938-1942	Drain was constructed.
March 2010	Major issues discovered with drain. KAVHA Board told that drain would probably fail within 2 years and had to be rebuilt; Board opted not to do anything.
November 2011	Additional failures found in drain. KAVHA Board warned again; KAVHA Board opted to still do nothing.
March 2012	24 metres of the channel wall collapsed. Repairs were initially estimated at \$70,000; tenders were actually \$74-\$104,000. Due to collapsing budget of NI Government and failure KAVHA Board, no works done.
April-May 2013	Additional significant failures found at drain. Latest failures were actually completely damming the water from flowing into the Bay. As an alternative to repairing the drain, the feasibility of installing large pipes in the drain and then filling the drain with earth were investigated.
January 2014	Final recommendation given to install two 600 mm pipes in the drain and fill it with earth. These works were not done.
May-June 2015	<p>Vehicular bridge over the drain at Emily Bay was found to be severely damaged, about to fail and unsuitable for vehicular traffic. The bridge was so bad it could not be repaired, it had to be completely rebuilt.</p> <p>Partly due to how long it would take to repair it properly, partly due to cost, and partly due to trying for improvements in water quality in Emily Bay, the decision was made to fill the drain.</p>

Date	Detailed Information	Source
21-22 May 1936	9.5 inches (24 cm) of rain fell at Kingston in 7 hours.	1935-1936 annual report
7-8 April 1937	11 inches (28 cm) of rain fell at Kingston.	1936-1937 annual report
5 June 1937	5 inches (13 cm) of rain fell at Kingston in 3 hours.	1936-1937 annual report
1938-1939	Because of the three recent major storms (see above), construction began on a drainage channel that would allow the Kingston waterway to bypass the tunnel under Chimney Hill and flow directly into Emily Bay. The tunnel was regularly blocked by branches and debris, and bypassing it would provide for better drainage of the Kingston lowlands, which would allow the common to be more reliably used for pasturage.	1938-1939 annual report

Date	Detailed Information	Source
	The channel was designed to be 8 feet (2.4 metres) wide, 8 feet (2.4 metres) deep, and 10 chains long (201 metres)	
1939-1940	Work on the channel continued to be done.	1939-1940 annual report
1940-1941	Work on the channel continued to be done.	1940-1941 annual report
1941-1942	Work on the channel continued to be done.	1941-1942 annual report
1942	Although the completion of the channel's construction is not mentioned in any annual reports, it appears that the channel was finally completed as its full length is visible on an aerial photograph from the second half of 1942.	1942 aerial photos
September 2009	As part of works done to remove water weeds and silt from part of the waterway (between Pier Street bridge and Bounty Street bridge), the water level in the creek was lowered. This revealed structural issues both at Bounty Street bridge and A3C.	2009 Site manager's report #4
March 2010	<p>EMA undertook an inspection of the drain and documented major damage, including:</p> <ul style="list-style-type: none"> • The calcarenite on which the concrete had been poured was failing in many places. Some calcarenite had been destroyed (by unspecified forces), some had been eroded away, and some was damaged. • Failure and cracks were found along the entire length of the east wall, at intervals of roughly 3 metres. These failures were causing minor movement of the wall. • Additional failures and cracks were found along the length of the west wall. • Part of the drain had been carved out of calcarenite, rather than made out of poured concrete. This section was apparently only being held together by vegetation roots. <p>EMA concluded that there was a 100% of the drain failing in the near future, and stated that at the very least, parts of the drain had to be rebuilt within 2 years.</p> <p>The KAVHA Board did not think that the repairs proposed by EMA were as high priority as other works around site. As a result, partly for that reason and partly due to general funding constraints, no money was made available to rebuild or stabilise the channel walls.</p>	<p>2010 EMA inspection</p> <p>2012 works supervisor memo</p>
November 2011	<p>The KAVHA board was warned again about the impending failure of the channel walls. The site manager noted that there was additional cracking and buckling in the channel wall that pointed to a pressing need for repairs.</p> <p>Again, the KAVHA Board did not consider the repairs to be a high priority and set aside no funding for the rebuilding of the channel or the stabilisation of the walls.</p>	<p>2011 site manager's report #8</p> <p>2012 works supervisor memo</p>

Date	Detailed Information	Source
13 March 2012	24 metres of the channel wall collapsed.	2012 works supervisor memo
15 March 2012	<p>The KAVHA works supervisor sent a memo to the KAVHA board to inform them of the collapse. He reminded them that they had been warned repeatedly about the likely failure of the channel, and that they had not set aside funding for the necessary repairs.</p> <p>The supervisor also noted that while 24 metres of the wall had collapsed, there was evidence of deterioration and damage to almost every part of the drain, which was 97 metres long.</p> <p>The supervisor pointed out that any repairs to the drain would need to be comprehensive, rather than stop-gap, because of the quantities of water that flowed through the drain in major rainstorms. He noted that any defect that was not fixed (e.g., other cracks and buckling) would subsequently become the site of additional erosion and damage by major waterflows. In his opinion, minor or temporary repairs would only lead to additional failures and/or damage to the drain.</p> <p>The supervisor presented the KAVHA Board with three repair options (<i>note that the costings for each option do not include machinery, other materials or labour; they are just for the stated items</i>):</p> <ol style="list-style-type: none"> 1. (Option 1) Lay 2 metre diameter pipes into all or part of the drain and cover them with soil. This option could be done in segments, meaning the most pressing part of the drain could be repaired immediately and other parts could be repaired as funding became available. The costs for the pipes would be: <ol style="list-style-type: none"> a. \$194,000 for all 97 metres b. \$90,000 for a 45-metre section 2. (Option 2) Repair of the concrete section. This would involve fixing the concrete only in the area of the collapsed wall, ignoring all the other damage. The cost for the concrete would be \$10,000. 3. (Option 3) Pour new concrete for the entire channel. This option would entail using the existing channel as formwork, and pouring new concrete across it to form a new drain on top of the old one. The cost for the concrete would be: <ol style="list-style-type: none"> a. \$31,000 for all 97 metres b. \$23,000 for a 45-metre section <p>The supervisor recommended option 3 as the preferred solution. He calculated that the total cost including machinery, other materials and labour would be approximately \$70,000.</p>	2012 works supervisor memo
26 March 2012	EMA inspected the collapse and supported the works supervisor's recommendation of option 3 for repairs.	2012 EMA collapse inspections

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	EMA felt that the works could be considered "rebuilding" and routine maintenance work on the drain, and as a result it would not rise to the level of triggering EPBC Act compliance.	
May-July 2012	<p>The KAVHA board was briefed about the collapse at A3C during the May board meeting. Following that meeting, it was determined that the necessary repairs would cost about \$70,000, but there was not sufficient funding to do so.</p> <p>The board sought assistance from the Commonwealth to pay for the repairs as part of a procurement cycle, and as the first step the Commonwealth commenced a formal tender process. DRALGAS, the Commonwealth agency for KAVHA at the time, specifically designed the tender to be the absolute minimum required to manage the situation without triggering the need for referral under the EPBC Act.</p> <p>The quotes received as part of the tender process ranged from \$74,000 to \$104,000, and neither the Commonwealth nor NI Government had sufficient funding for such works.</p> <p>The KAVHA site manager informed the KAVHA board members about this via email and asked them if they would approve making an insurance claim against the damages to the drain against either the Commonwealth or NI Government insurance policies.</p> <p>However, there was never another KAVHA board meeting, and so no decision was made as to whether or not to make an insurance claim.</p>	<p>2012 insurance email</p> <p>2012 65th meeting draft minutes</p>
April 2013	<p>EMA undertook an inspection of the drain and documented additional major damage, including:</p> <ul style="list-style-type: none"> • One of the banks had collapsed, effectively damming water from flowing through the drain. • Erosion of the calcarenite was undermining the concrete of the drain in multiple locations. • A major crack had developed in one of the drain walls, and EMA suspected that part of the western wall had shifted. 	2013 EMA inspection
14 May 2013	EMA undertook an assessment to determine whether the drain could be converted to a set of covered water pipes, rather than an open drain. EMA concluded that the open drain was preferred, but that the creation of a covered drain would have a low impact on the heritage values at the site (however, it would require justification).	2013 EMA letter
9 January 2014	EMA wrote a SOHI to assess whether two 600 mm pipes could be installed in the open drain and it could be filled in. They concluded that the open channel was of low significance and could be replaced by buried pipelines.	2014 EMA SOHI
May-June 2015	During an assessment of the roads and bridges in KAVHA, Worley Parsons found significant structural issues with a vehicular bridge	2015 SOHI update

Date	Detailed Information	Source
	<p>over channel A3C. The issues were so major that the only options were to either completely rebuild the bridge or remove it.</p> <p>On 2 June 2015, the bridge was closed to vehicular access.</p> <p>In June, the KAVHA Heritage Manager § 47F wrote an addendum to the 2014 SOHI written by EMA to examine the possible options to fix the bridge, particularly because it was thought that the public would not react well to long-term closure of vehicular access to Emily Bay.</p> <p>The possible options that were assessed were:</p> <ol style="list-style-type: none"> 1. (Option 1) Laying a new slab over the top of the existing bridge and raising the road to meet it. This option would require no approvals, but several significant negatives would arise: <ol style="list-style-type: none"> a. It would potential result in future invisible issues with the old bridge under the new slab. b. It eliminated none of the risks from falling debris or collapse of the original bridge. c. It would result in long-term closure of vehicle access to Emily Bay. d. High flow outfall to Emily Bay during large flood events. e. Continued impacts to the reef caused by pathogens, nutrients and sediments flowing directly into the bay during high flow events. 2. (Option 2) Removal of the existing slab and construction of a new one. This one would require fewer approvals, as it was like-for-like. The negative outcomes were: <ol style="list-style-type: none"> a. High cost and major engineering requirements that could not be met on-island. b. Long-term closure of vehicular access to Emily Bay. c. Continued impacts to the reef caused by pathogens, nutrients and sediments flowing directly into the bay during high flow events. 3. (Option 3) Removal of slab, installation of pipes in the channel and filling of the channel with soil. This would require approvals, and the perceived negatives were: <ol style="list-style-type: none"> a. Required the construction of significant concrete headwalls and aprons. b. Medium-term closure of vehicular access to Emily Bay. c. Had potential to increase regular outfalls of water into Emily Bay. d. High flow outfall to Emily Bay during large flood events. e. Continued impacts to the reef caused by pathogens, nutrients and sediments flowing directly into the bay during high flow events. 	

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	<p>4. (Option 4A) Removal of bridge slab, filling of channel (without pipes) and laying of road over former bridge in one stage. This could be done in a fairly short period of time, and the only perceived negative was:</p> <ul style="list-style-type: none"> a. It would require armouring for fill with calcarenite stone <p>5. (Option 4B) Removal of bridge slab, filling of channel (without pipes) and laying of road over former bridge in two stages. This option would require the shortest amount of time, and the only perceived negative was:</p> <ul style="list-style-type: none"> a. It would require armouring for fill with calcarenite stone <p>Discussions about the possible repair options were held between engineers, the Commonwealth Heritage Manager, the KAVHA Site Manager, the Conservator of Public Reserves, and representatives from the NI Administrator, and as a result of these discussion option 4B was selected as the final outcome.</p> <p>In the impact assessment § 47F covered water quality issues in a manner that may have been beyond the scope of his expertise. § 47F was quite new in the role of Commonwealth Heritage Manager when he wrote this SOHI, and from the text it seems likely that he was heavily influenced by the Conservator of Public Reserves.</p> <p>His repeatedly noted that by filling the channel, they would achieve a positive result of <i>“protection of the reef ecosystem (2nd southernmost coral reef in the world) from high water outfalls and limiting [salt] water ingress into the upstream freshwater systems.”</i> He also noted that with regard to potential impacts on the habitat of a freshwater shrimp, <i>“the project will also signal a change in management practices that are more conducive to freshwater habitat conservation.”</i></p> <p>§ 47F noted that, per the Public Reserves Act, construction works that promote the objectives of the Public Reserves Act are preferred to works that do not, and that the Conservator has the power <i>“to do all things necessary or convenient to be done in connection with [the management of the reserves in accordance with their plans of management].”</i></p> <p>Section 7.3 is a discussion of the Public Reserves Act and how it relates to the assessment of impacts from the project, in which three objectives from the plans of management for Kingston Recreation Reserve and Government House Grounds Reserve are noted:</p> <ul style="list-style-type: none"> • <i>Minimise the adverse impacts on water quality and the wetland ecosystem that may be associated with grounds and drainage maintenance, or public use</i> • <i>Maintain and protect wetland habitat</i> • <i>Maximise the quality of waters flowing into Emily Bay</i> 	

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	<p>In his final assessment of the words against the Public Reserves Act, he wrote:</p> <p><i>The Conservator has approved the removal of the bridge and the filling of the 1941 drain as previously outlined (Option 4b) and consider that this proposed action is consistent with the plans of management of the reserves and with the objects of the Public Reserves Act 1997; consistent with the [KAVHA] CMP and within the powers of the Conservator of Public Reserves.</i></p> <p>The above appears to show that the Conservator wanted the drain filled as a water quality improvement measure, and that § 47F deferred to the Conservator’s decision, using text from the Public Reserves Act and several reserve plans of management as justification.</p> <p>§ 47F final conclusion regarding the impact of the proposed works was that the drain filling could go ahead, provided several minor mitigations were undertaken prior to and immediately following the works.</p>	

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