Sydney 46 Gale Road
Maroubra, NSW, 2035

Northern NSW 2 Queen St
Murwillumbah, NSW
P.O. Box 42 Condong, 2484

A.B.N. 83 082 211 498

General Inquiries +61 2 9568 5800
www.cosmosarch.com

Cosmos Archaeology Pty Ltd

Windsor
Bridge Replacement Project

Maritime Archaeological Testing Report
And
Detailed Salvage Strategy
For
Maritime Archaeological Excavation

Location

Windsor,

Hawkesbury River, NSW

March 2018

Windsor
Bridge Replacement Project

Maritime Archaeological Testing Report
And
Detailed Salvage Strategy
For
Maritime Archaeological Excavation

Prepared for:

Austral AHMS Joint Venture (AAJV)

By:

Cosmos Coroneos

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Professional Diving Services provided the dive support for this project. Their divers put in the long hours and overcame considerable logistical constraints to get the job done. Special thanks to the on-site crew of AAJV who smoothed the way for us to get our work done.

Cover Image: View of test trench locations on 30th August 2016, marked by white and orange buoys. Looking upstream from Public Wharf.

Executive Summary

This document outlines the conduct and findings of an underwater test excavation and associated surveys undertaken as part of the approvals process being prepared in response to the proposed Windsor Bridge Replacement Project. These surveys also make up part of the Historical Archaeological Report and Detailed Salvage Strategy required for the Minister's Conditions of Approval B3 and B4.

The test excavation within the footprint of the former Windsor Wharf found that archaeological remains associated with the earliest, if not original, versions of the wharf, ca. 1810s, are present. These remains are very likely to be reasonably well preserved under a cobble ballast mound which in places has been recently covered with larger quarried stones to serve as erosion protection. The artefacts recovered from the three test trenches reflect activities on and around Windsor Wharf and show that the area was used throughout the 19th and 20th centuries. The artefacts included discarded food and drink containers, discarded construction material and the possible presence of fastenings associated with small vessels. Those archaeological remains associated with the early 19th century remains of the wharf (Phases 1 and 2) are assessed as being of State Heritage significance.

The survey of the riverbank adjacent to the wharf site documented evidence of the 20th century version of the Windsor Wharf as well as more recent bank erosion protection measures. Dense vegetation on the river bank limited the amount of recording that could be undertaken. A diver survey downstream of the current public wharf in the area of a presumed second wharf did not find any structural remains.

This report re-assesses the impact to the heritage values of the former Windsor Wharf in response to changes in the scour protection measures along the southern bank. Instead of a concrete retaining wall, as proposed in the 2012 *Windsor Bridge replacement project: Environmental impact statement* (EIS), it is now proposed to install alternating layers of gravel, geotextile, rock filter and rock rip rap on the riverbank and riverbed which would cover most of the extent of the former Windsor Wharf site, including around the four proposed bridge piles that are located within the site.

The proposed scour protection will have a positive impact on the long term preservation of fabric and context, solidly aligning with best practice in underwater cultural heritage management. The proposed scour protection measures however will make parts of the site more difficult to access and during the operational life of the bridge the site would be realistically rendered inaccessible. To mitigate this negative impact, and the impact that piling will have on the site, a number of measures have been proposed which include a maritime archaeological research design and excavation strategy which details the manner and means with which to extract significant cultural information pertaining to the identified archaeological values of the former Windsor Wharf prior to the commencement of the bridge construction.

The maritime archaeological excavation will primarily focus on those parts of the riverbed which will be directly impacted by the four bridge piles closest to the southern riverbank and will be expanded around these localities for the purposes of discovering and recording former wharf remains. Investigations will also take place amongst the extant remains of the 20th century remains of the former Windsor Wharf adjacent to the riverbank and at the toe of the rock armour closer to the existing public wharf. The purpose of these investigations will be to define the extent of the earliest phases of the former Windsor Wharf. Details of the excavation are described in Section 12 of the report.

These measures constitute the maritime archaeological component of the Detailed Salvage Strategy requirement of Minister's Conditions of Approval B3.

The project has been approved as State Significant Infrastructure (SSI_4951) under Part 5.1 of the *Environmental Planning and Assessment Act 1979*. This document meets the Minister's Conditions of Approval as they relate to Heritage (B3) as follows:

Condition	**Location of Information**
The Applicant shall undertake an Archaeological Investigation Program comprising Aboriginal and non-Aboriginal Heritage in the project area on the southern side of the Hawkesbury River, prior to the commencement of preconstruction and construction activities in the southern area. The program shall be conducted to the satisfaction of the Director-General and in accordance with: (a) the Heritage Council's Archaeological Assessments Guideline (1996) using a methodology prepared, in consultation with the NSW Heritage Council for non- Aboriginal heritage; and (b) prepared in consultation with the OEH (Aboriginal heritage) and the Aboriginal stakeholders.	Contained in: Aboriginal Archaeological Research Design and Excavation Methodology (AAJV, July 2016) and Historical and Maritime Archaeological Research Design (AAJV, July 2016)
The Archaeological Investigation Program is to be undertaken by an archaeological heritage consultant approved by the Director-General in consultation with the NSW Heritage Council and by the OEH (Aboriginal heritage) and by an Excavation Director who shall demonstrate an ability to comply with the Heritage Council's Criteria for the Assessment of Excavation Directors (July 2011) and in particular must be able to demonstrate compliance with Criterion A.4 that: 'work under any approvals previously granted by the Heritage Council has been completed in accordance with the conditions of that consent and the final report has been submitted to the NSW Heritage Council.	The test excavation for Maritime Archaeology is presented in Sections 4 and 5 of this report. Also contained in Test Excavation Report – Historical Archaeology Section 1.6 (AAJV, May 2017), and Test Excavation Report – Aboriginal Heritage Section 1.4 (AAJV, May 2017)
The Archaeological Investigation Program shall include archaeological testing and geophysical investigation, as required for the significance assessment.	The significance assessment for Maritime Archaeology is presented in Section 7 of this report Also contained in Test Excavation Report – Historical Archaeology Sections 3,5 and 8 (AAJV, May 2017), and Test Excavation Report – Aboriginal Heritage Sections 4 and 7 (AAJV, May 2017)
The results of the Archaeological investigation Program are to be detailed in a Historic Archaeological Report and a Detailed Salvage Strategy comprising the non-Aboriginal and Aboriginal heritage findings. These are to be prepared in consultation with the OEH (Heritage Branch and Aboriginal heritage) and to the satisfaction of the Director-General, and shall include, but not necessarily be limited to:	Consultation is outlined in Section 13 of this report.
(a) detailed recommendations for further archaeological work	Recommendations for further archaeological fieldwork are presented in Section 10 of this report and a detailed maritime archaeological research design is presented in Sections 11 and 12.
(b) consideration of measures to avoid or minimise disturbance to archaeology sites, where archaeology of historical and Aboriginal heritage archaeological significance are found to be present	Measures to avoid or minimise the disturbance to the maritime archaeological sites are presented in Section 10 after re-evaluation of the impacts in Sections 8 and 9 of this report.
(c) where impacts cannot be avoided by construction of the SSI, recommend actions to salvage and interpret salvaged sites, conduct further research and archival recording of the historic heritage and Aboriginal heritage	Recommendations to salvage, interpret salvaged sites and archivally record maritime archaeological sites are presented in Section 10 and with a maritime archaeological research design forming part of the

value of each site, and to enhance and preserve the archaeology of historical non-Aboriginal and Aboriginal heritage significance	Detailed Salvage Strategy presented in Sections 11 and 12 of this report.
(d) consideration of providing visual evidence of heritage sites within the final landscape design of the SSI to preserve and acknowledge the heritage value of the Thompson Square Conservation Area and the site	An Interpretation Plan is being prepared by AAJV Suggestions for post-construction visual evidence and markers relating to the former Windsor Wharf site are presented in Section 10. Urban Design and Landscape Plan (SMM, September 2017)
(e) management and mitigation measures to minimise impacts due to preconstruction and construction activities	Measures to manage and mitigate impacts during preconstruction and construction activities are discussed in Section 10.
(f) preparation of a Hawkesbury Region Sand Bodies Study as detailed by Condition B3(f)	Contained in the Hawkesbury Region Sand Bodies Study (AAJV, November 2017)

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1.0 Introduction

The NSW Roads and Maritime Service (RMS) has engaged AAJV (a joint venture of Austral Archaeology and Extent Heritage (formerly AHMS)) to undertake an archaeological test excavation and associated surveys associated with the replacement of Windsor Bridge, Windsor, NSW, also known as the Windsor Bridge Replacement Project (WBRP).

RMS proposes to replace the existing Windsor bridge over the Hawkesbury River. The Windsor bridge replacement project would involve[1]:

- Construction of a new bridge over the Hawkesbury River at Windsor, around 35 metres downstream of the existing Windsor bridge.
- Construction of new approach roads and intersections to connect the new bridge to existing road network.
- Modifications to local roads and access arrangements, including changes to the access road to Macquarie Park and connection of The Terrace.
- Construction of pedestrian and cycling facilities, including a shared pedestrian/cycle pathway for access to and across the new bridge.
- Removal and backfilling of the existing bridge approach roads.
- Demolition of the existing Windsor bridge.
- Urban design and landscaping works, including within the parkland area of Thompson Square and adjacent to the northern intersection of Wilberforce Road, Freemans Reach Road and the access road to Macquarie Park.
- Ancillary works such as public utility adjustments, water management measures and scour protection works.

The project has been approved as State Significant Infrastructure (SSI_4951) under Part 5.1 of the *Environmental Planning and Assessment Act 1979*. The approval was issued on 20 December 2013 subject to the Minister's Conditions of Approval (MCoA). Part B – Pre-Construction Conditions of the MCoA includes a number of conditions (B1-B8) pertinent to the conservation of cultural heritage values of the project area. Conditions B3 and B4 require a range of geomorphological, Aboriginal, historical and maritime archaeological investigation works for both the southern and northern banks of the Hawkesbury River prior to commencement of pre-construction and construction works.

This document comprises the maritime component of both the “Historical Archaeological Report” and “Detailed Salvage Strategy” required by MCoA Conditions B3 and B4.

Cosmos Archaeology Pty Ltd has been engaged to undertake the maritime archaeological components of the field investigation. These components are:

- Test excavation on the riverbed within the footprint of the former Windsor Wharf ca. 1814 to 1950s;
- Survey of the riverbank above the former Windsor Wharf ca. 1814 to 1950s, and;
- Underwater survey of a potential second 19th century wharf downstream of the current Public Wharf.

[1] **Sinclair Knight Mertz November 2012** *Windsor Bridge replacement project: Environmental impact statement Volume 1 – main report*. Chapter 1 pg 1

2.0 Objective of the Test Excavation and Surveys

The objective of the test excavation and surveys were to:

> Obtain data that will better inform the management during and after the implementation of the detailed design of the new bridge. This management would aim to avoid and reduce impacts on the cultural heritage significance of the maritime infrastructure both above and below water and of other submerged archaeological remains of colonial period Windsor.

The purpose of this objective was to collect the necessary data from field investigations which would allow WBRP to comply with the conditions MCoA – SSI_4951 as they relate to the cultural heritage values of the site. Condition B3 is as follows:

*B3. The Applicant shall undertake an **Archaeological Investigation Program comprising Aboriginal and non-Aboriginal Heritage** in the project area on the southern side of the Hawkesbury River, prior to the commencement of pre-construction and construction activities in the southern area. The program shall be conducted to the satisfaction of the Director-General and in accordance with:*

a) the Heritage Council's Archaeological Assessments Guideline (1996) using a methodology prepared, in consultation with the NSW Heritage Council for non-Aboriginal heritage; and
b) prepared in consultation with the OEH (Aboriginal heritage) and the Aboriginal stakeholders.

The Archaeological Investigation Program is to be undertaken by an archaeological heritage consultant approved by the Director-General in consultation with the NSW Heritage Council and by the OEH (Aboriginal heritage) and by an Excavation Director who shall demonstrate an ability to comply with the Heritage Council's Criteria for the Assessment of Excavation Directors (July 2011) and in particular must be able to demonstrate compliance with Criterion A.4 that: 'work under any approvals previously granted by the Heritage Council has been completed in accordance with the conditions of that consent and the final report has been submitted to the NSW Heritage Council.

The Archaeological Investigation Program shall include archaeological testing and geophysical investigation, as required for the significance assessment.

*The results of the Archaeological Investigation Program are to be detailed in a **Historic Archaeological Report** and a **Detailed Salvage Strategy** comprising the non-Aboriginal and Aboriginal heritage findings. These are to be prepared in consultation with the OEH (Heritage Branch and Aboriginal heritage) and to the satisfaction of the Director-General, and shall include, but not necessarily be limited to:*

a) detailed recommendations for further archaeological work;
b) consideration of measures to avoid or minimise disturbance to archaeology sites, where archaeology of historical and Aboriginal heritage archaeological significance are found to be present;
c) where impacts cannot be avoided by construction of the SSI, recommend actions to salvage and interpret salvaged sites, conduct further research and archival recording of the historic heritage and Aboriginal heritage value of each site, and to enhance and preserve the archaeology of historical non-Aboriginal and Aboriginal heritage significance;
d) consideration of providing visual evidence of heritage sites within the final landscape design of the SSI to preserve and acknowledge the heritage value of the Thompson Square Conservation Area and the site;
e) management and mitigation measures to minimise impacts due to preconstruction and construction activities; and

f) preparation of a Hawkesbury Region Sand Bodies Study to the satisfaction of the Director-General and undertaken by suitably qualified and experienced persons whose appointment has been approved by the Director-General, in the event that any Pleistocene and/or early Holocene is encountered during the works referred to in condition B3. This study is required to be prepared in consultation with the Department, the OEH and Aboriginal stakeholders and is required to:

(i) be undertaken in accordance with a research design and action plan approved by the Director-General prior to the study commencing;

(ii) be directed towards locating and evaluating sand bodies likely to contain evidence of early Aboriginal habitation in the Hawkesbury River area, in the project location in areas disturbed by construction of the project, including the existing Windsor Bridge and new bridge locations;

(iii) findings are to be made publicly available; and

(iv) make recommendations concerning the preservation and future management of any finds.

In the event that any Pleistocene and/or early Holocene is encountered, the recommendations of the Hawkesbury Region Sand Bodies Study are to be fully complied with.

This report details how the findings of the test excavation and surveys address the relevant conditions listed in MCoA – SSI_4951.

The land based reports related to heritage are listed below and were approved on 1st December 2017:

AAJV, May 2017	Test Excavation Report – Historical Archaeology
AAJV, May 2017	Test Excavation Report – Aboriginal Heritage Section
AAJV, November 2017	Detailed Salvage Strategy for Aboriginal and Historical Archaeological Heritage

3.0 Archaeological Research Design for the Test Excavation

The direction and conduct of the test excavation was shaped through the preparation of a Historical and Maritime Archaeological Research Design (ARD) by AAJV for this Project.[2] The research design, as it relates to maritime archaeology, is provided in two parts in the ARD. The first part, presented in **Section 4.2.3**, focuses on specific site formation questions, the answers to which would be used to formulate a more informed salvage excavation methodology that would answer the wider site related research questions posed in **Section 4.8.2.4** of the report. The two parts to the research design for the maritime archaeology test excavation are presented below:

3.1 Archaeological Research Design – Part 1: Site formation questions

The following research design is based on the findings of site surveys and historical research undertaken since 2008 for the former Windsor Wharf site.[3] The initial dive inspection in late 2008 documented an expanse of hand-sized cobbles in the area where the former Windsor Wharf was thought to be located. The size of the cobbles were interpreted as being consistent with 19th century ship's ballast which was often discarded around/under maritime infrastructure. Also such sized rocks were used to weigh down and protect bedlogs from scouring/marine borer attack; bedlogs being the foundations for piles used to support the deck of wharves and jetties.

It was thought that the cobble ballast was associated with the earliest phases of maritime infrastructure at Windsor and that further investigation was required to confirm this interpretation and to better understand the nature of the site. At the time of the preparation of this research design it was thought that the original 1795 to ca. 1806 Wharf and Store was located in the same area. Research undertaken for the *Thompson Square and Windsor Bridge Replacement Program Project Area Windsor, NSW: Strategic Conservation Management Plan* (SCMP), currently under preparation, has put forward a strong argument to place the location of the earliest wharf at Windsor adjacent to and upstream of the present Bridge (see **Section 6.1**).

To formulate suitable management options for the site of the former Windsor Wharf ca. 1814 to 1950s, the following information was required:

- *What is the exact extent of the site?* Knowing the extent of the site is important for determining the extent of impact and informed management protocols and processes.
- *How compact is the ballast mound?* The degree of compactness of this feature assists in assessing whether the site is sufficiently robust to withstand long term impacts of any predicted scouring or the overlaying of scour protection.[4]
- *What archaeological remains are within and under the ballast mound?* Understanding the cultural heritage significance of artefacts and structure currently protected by the ballast mound allows the development of more informed management protocols and processes.

The test excavation attempted to answer the above questions by:

[2] **AAJV, 18th July 2016,** *Windsor Bridge Replacement Project – Historical and Maritime Archaeological Research Design*. Prepared on behalf of NSW Roads and Maritime Services.

[3] **Cosmos Archaeology, February 2009** *Windsor Bridge: Punt and Wharf sites : maritime Archaeology Inspection.* **Cosmos Archaeology, October 2012** *Proposed Windsor Bridge Replacement – maritime Archaeological Statement of Heritage Impact : Final Working Paper Report.* **Cosmos Archaeology, October 2013** *Windsor Bridge Replacement; Archaeological Research Design Excavation/Recording Methodology*. Prepared for the Windsor Bridge Alliance.

[4] Since the formulation of the ARD and the completion of the test excavation in September 2016, scour protection designs have been produced which includes covering the former Windsor Wharf site with rock armour. The objectives and findings of the test excavation are applicable for the understanding of the impacts of the proposed scour protection on the ballast mound.

- Determining the depth and compact nature of the rubble ballast that is present on the site;
- Determining the nature of the strata present immediately below the ballast deposit, and subsequent strata on site;
- Determining the compactness of the site and potential to be impacted from long term indirect impacts, such as from increased water velocity, and the potential for scouring or deflation to occur;
- Further understanding the archaeological potential within the ballast deposit; and,
- Further understanding the archaeological potential within the strata below the ballast layer.

The archaeological potential considered in the context of this test excavation related to the potential quantum and date range of the artefacts present within the matrices. This is the maritime archaeological equivalent of a terrestrial underfloor deposit where, in this case, artefacts have fallen through gaps in the deck planks or off boats. It is possible that this ballast layer provides a *terminus ante quem*[5] by having sealed off earlier archaeological deposits. At the time of the preparation of the research design it was not known if the ballast layer was placed in the 1790s, 1810s or later.

It followed that, if the interpretation of the rounded cobble formation as ballast is found to be correct, then it would be apparent that the foundations of the wharves, which may be piles and/or bed logs, would be present. This is akin to a mound created by the collapsing walls of a building where it would be obvious that the footings of the building would be buried. Such structural features would not be used as a primary guide for archaeological potential. In this case, archaeological potential would be assessed on the greater or lesser likelihood of underfloor deposits between the footings and the predicted depth of deposits. This was the approach undertaken for the test excavation.

To clarify, the maritime test excavation was not designed as a salvage excavation aimed at recovering large volumes of artefactual material for detailed study or display/interpretation, nor was a large volume of artefactual material anticipated given the relatively small area being tested (three locations of approximately 0.5 by 0.5 m in area). Furthermore, as it was the intention to demonstrate that there were artefacts or the potential for artefacts to be present in the ballast mound, it was not seen as necessary for this test excavation to excavate with higher resolution; that is, in arbitrary spits.

It was not the aim to locate the footings of the substructure of the wharf. In the process of undertaking the test excavation, if archaeological remains of former wharf structures were identified, these would be documented and included in the site plan.

3.2 Archaeological Research Design – Part 2: Site specific questions

The second part to the research design dealt with the riverine elements of the Windsor site. The ARD noted that the current archaeological program involved targeted, small scale testing only, hence the evidence for all research questions would not be found during works and may result in different or expanded research questions for future archaeological works as a part of the WBRP or beyond.[6] The riverine related research questions were as follows:

- *How was the first jetty constructed?*
- *Is there any evidence of early ship construction?*

[5] "limit before which" In this context refers to the artefacts under the ballast mound which would have been deposited prior to the laying of the ballast mound, not after.

[6] **AAJV, July 2016 p45**

- *What can it tell us about the engineering skills available to the colony within the first five years of settlement?*
- *Was ballast used to stabilise the jetty, and which jetty phase was the ballast used for?*
- *How was the risk of flooding managed?*
- *What was the quality of the materials used in the jetty? (I.e. was copper sheathing used? Spacing of piles, size and standard of fastenings). Does this say something about the availability of materials or the level of importance placed on the jetty by the authorities, through comparison with other contemporary jetty sites?*
- *Was the jetty constructed on bed logs or piled directly into the riverbed?*
- *How was the 1814/15 (second) jetty constructed and how was it modified and altered throughout the 19th century?*
- *What do the river artefacts tell us about the use of the Windsor Wharf and the commercial contacts over time?*
- *Is there any evidence for the operations of the ferry on either side of the river?*
- *Are there new facilities for the punt (cable tie etc.) where the new road meets the water?*

The questions above have been addressed in **Section 6** of this report. It should be noted that when the above research questions were devised the historic maritime infrastructure at Windsor was referred to as a 'jetty'. For this report the correct term 'wharf' is applied for these structures. A jetty is a linear structure that projects from shore and a wharf runs along the shore. The maritime structures at Windsor were wharves and historically were referred to as such. Furthermore it was initially thought that the second 'jetty' was constructed very close to or over the top of the first and as such excavations in one area could reveal he remains of both. However historical research undertaken for the SCMP demonstrated that the two structures were built some distance apart. This is further discussed in **Section 6.1**.

4.0 Conduct of Test Excavation and Surveys

4.1 Test Excavation and Survey – former wharf site

The field investigation took place over five days from the 29th August to 2nd September, 2016. All diving was carried out from a dedicated dive platform using Surface Supplied Breathing Apparatus (for dive times see Annex A). Water visibility was less than 0.2 m.

Prior to the commencement of test excavation, nine underwater diver transects were swum over two days for the purpose of mapping the site and locating optimum positions for the three test trenches (Figure 1). Selecting the optimum locations for the trenches was paramount as the initial transects revealed that much of survey area along the shoreward side was covered in large basalt-type rock recently deposited as rock armour. This rock armour overlies the earlier cobble based ballast and could not be moved manually without much time being lost. Therefore, locating the trenches where there was no rock armour would ensure that the objectives of the test excavation would be met within the time made available. Underwater Test Trenches (UWTT) 01 and 03 were positioned whilst undertaking Transects 5 and 7. Transect 6 was undertaken for the purposes of siting UWTT02, however, no suitable location was found. The diver then swum downstream, following the edge of the cobble mass.

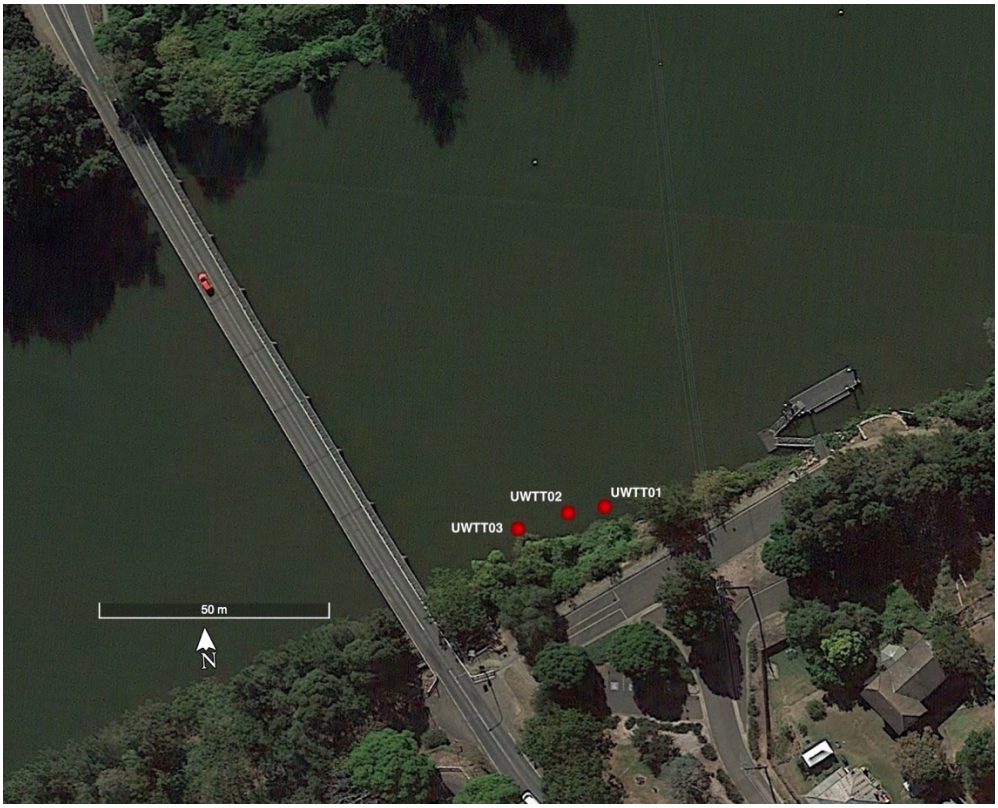


Figure 1: Location of underwater test trenches. (source: Google Earth)

Weighted 20 m lines were run out from the base of the riverbank towards the centre of the river for seven of the nine transects. Attempts were made to make the lines straight but it was not always possible as they caught on branches and protruding rocks on the riverbed. A diver carrying a staff with a prism proceeded along each transect recording the riverbed composition at two metre intervals (where weights were located) while a team positioned on the public wharf located the diver's position using a Total Station. When the riverbed consisted of sand, probing was carried out using a 50 mm diameter PVC tube. The diver was assisted by a team member swimming on the surface who held the staff and prism upright.

Two long transects were run parallel to the shore, one as close to the river bank as possible (with vegetation hampering access and movement) and the other towards the middle of the river following the edge of the rock armour/ballast were it became covered with sand.

Three test trenches were excavated over three days from the 31st August to 2nd September 2016 (Figure 2). Details of the conduct of excavation for each trench are discussed below but the general methodology included manoeuvring the dive punt into position close to the trench and anchoring and/or tying it to the river bank. As required by Roads and Maritime Services, a double silt curtain– a 2 m by 2 m boxed curtain set inside a 3 m by 3 m boxed curtain – was deployed and tied off to the punt and the river bank. The 1 m by 1 m sieve with a mesh size of 3.5 mm was swung over the internal boxed curtain. The water dredge was then manoeuvred into position; the inlet located at the trench and the outlet over the sieve. For UWTT02 and UWTT03 where water visibility permitted, video footage was able to be obtained.

At the completion of dredging, sufficient time was allowed for water clarity within the silt curtains to improve. This did not take long as only sand and gravel was dredged in all the trenches. Often the water clarity was better inside the curtains than in the surrounding river.

The artefacts recovered were recorded the same day and photographed that day or overnight. The purpose of the photography was to obtain sufficient detail of the artefact so that it could be further described and analysed at a later date. On the final day of excavation, the artefacts recovered were placed in mesh bags with a plastic tag marked with the trench ID and Unit number. The bagged artefacts were placed within their respective trenches after the bottom of each trench was lined with shade cloth. Each trench was then filled in with the cobbles and other rock that had been removed during the excavation.

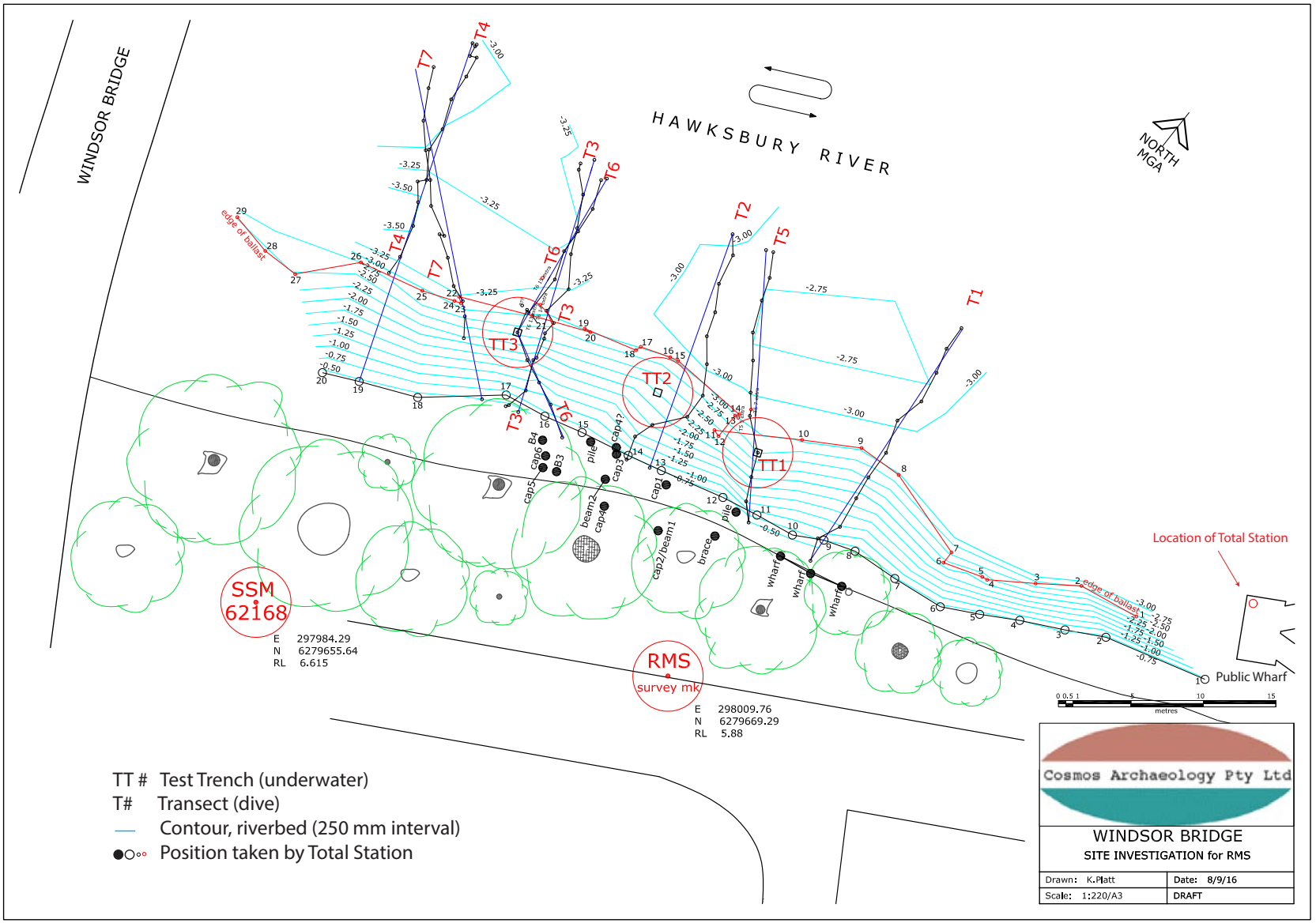


Figure 2: Location of underwater dive transects, test trenches and above water wharf features.

4.2 Survey – Riverbank

The main survey of the riverbank was undertaken between the 29th and 31st August 2016 during spring tides. This survey was confined to the immediate water's edge as the riverbank was overgrown with dense vegetation. Cultural features that were visible and accessible were positioned using a Total Station (see Figure 2) and were photographed. The survey was conducted during the ebbing tide over those three days (Table 1).

Further examination of the riverbank took place on the 20th and 21st September 2016 as part of archaeological monitoring of gabion wall investigations being conducted by the WBRP geotechnical team. The investigations were also carried during spring tide but as the lowest tide of the day peaked mid-morning it was possible to discern additional features on or adjacent to the river bank to what was observed two weeks previously (see Table 1). These features were photographed and described, however, their locations could only be approximated as a Total Station was not available.

Table 1: Tide ranges at Windsor during field investigations around the river bank.

Date	Time of low tide and height (mAHD)	Time of high tide and height (mAHD)	Time of low tide and height (mAHD)
29th August 2016	0550 – 0.37	1113 – 1.31	1730 – 0.46
30th August 2016	0639 – 0.31	1202 – 1.37	1822 – 0.42
31st August 2016	0759 – 0.27	1327 – 1.46	1551 – 0.38
20th September 2016	0330 – 1.68	1014 – 0.22	1558 – 1.75
21st September 2016	0424 – 1.55	1102 – 0.31	1649 – 1.72

4.3 Survey – Potential second wharf

The 2012 heritage assessment undertaken for the WBRP identified the potential for the presence of a wharf directly below the Government House site.[7] The area identified in the assessment was covered by two diver based transects run parallel to the river bank using weighted lines (Figure 3). The first transect was 80 m in length and set approximately 15 m from shore while the second transect was 20 m in length and approximately 5 m from shore (Table 2). The coordinates of the end points of the transects were recorded using GPS which varied in accuracy from 5 to 11 m.

For Transect 1, measurements were taken every 4 m while for Transect 2 measurements were taken every 2 m. Water visibility ranged from between 0.1 to 0.5 m.

Table 2: End coordinates of diver transects undertaken in search of potential second wharf.

Transect	Western end	Eastern end
1	298091 m E 6279725 m S	298149 m E 6279747 m S
2	298105 m E 6279718 m S	298124 m E 6279726 m S

[7] **Biosis, 2012**, *Windsor Bridge Replacement Project Historic Heritage Assessment and Statement of Heritage Impact*: Table 1, Figure 4, Plate 23 and pp 18 and 54.

Figure 3: Location of survey transects for potential second government wharf site.

5.0 Findings

5.1 Riverbed Topography

As part of the archaeological investigation, a stretch of riverbed was surveyed along the southern bank for the Hawkesbury River between the existing bridge and the public wharf downstream. The area surveyed measures approximately 70 m along the shore and 30 m out towards the centre of the river (Figure 4).

The site plan has been created from measurements and observations made by nine transects run across the survey area (Figures 5 and 6 and see Figure 2). It should be kept in mind when viewing the plan that water visibility was 0.2 m and therefore the demarcation of the cobble/ballast boundary has been extrapolated.

Three broad zones were identified in the survey:

1) Rock armour close to the river bank. Characterised by a relatively steep gradient from the base of the riverbank towards the river composed of large, predominantly basalt-like rock, 300 mm to 600 mm across.

There were also the occasional large chunks of concrete as well as concentrations of sandstone kerbing up to 750 mm in length. A worker from the Council informed us during the survey that the kerbing originated from the main road through the Windsor Township and was deposited by the local Council in the late 20th century to retard bank erosion.

The rock armour itself was also deposited for this reason but it is not clear when this took place and whether it pre-dates the installation of the gabion baskets. The size of the rocks indicate that they were most likely deposited by a machine such as a mechanical excavator. This would suggest that the deposit was formed, or at least commenced being formed, in the 20th century, most likely the last quarter.

Lying atop of the rock armour, particularly close to the river bank, were logs and branches while thick vegetation in part precluded easy access to the bank. A small vegetated 'island' closer to the bridge appears to have been attached to the river bank but broke away due to a combination of the weight of vegetation and evident erosion that is undermining the bank at this location.

2) Ballast. This is characterised by predominantly cobbles, consisting of rounded stones up to 300 mm across, and sub angular rock of around the same size. The gradient downwards towards the centre of the river is slighter than that of the rock armour. This deposit is believed to have been the ballast laid over the bed logs for the late 18th to early 19th century wharves. This formation would have extended towards the river bank and is likely to have been covered by the rock armour. The cobble ballast was covered with sand along the riverward edge. It is likely that the northern boundary of the ballast extends for a few metres further northward than shown on the plan. Lying atop of this exposed expanse of ballast is the occasional larger angular rock and sandstone kerbing.

3) Sand. The majority of the survey area is composed of coarse loose sand. The looseness and coarseness of the sand suggests a mobile riverbed. Towards the bridge there was evidence of scouring where an underlying substrate of gravelly sand was exposed.

Probing met refusal for the most part at around 150 mm depth where it was thought that the compactness of the sand prevented further penetration. A shopping trolley lying on its side was observed at one location towards the northern end of the survey area. Only one corner was exposed indicating that somewhere between 0.5 m and 0.75 m of the object was buried. This means that the deposit of sand at this location is least 0.5 m thick.

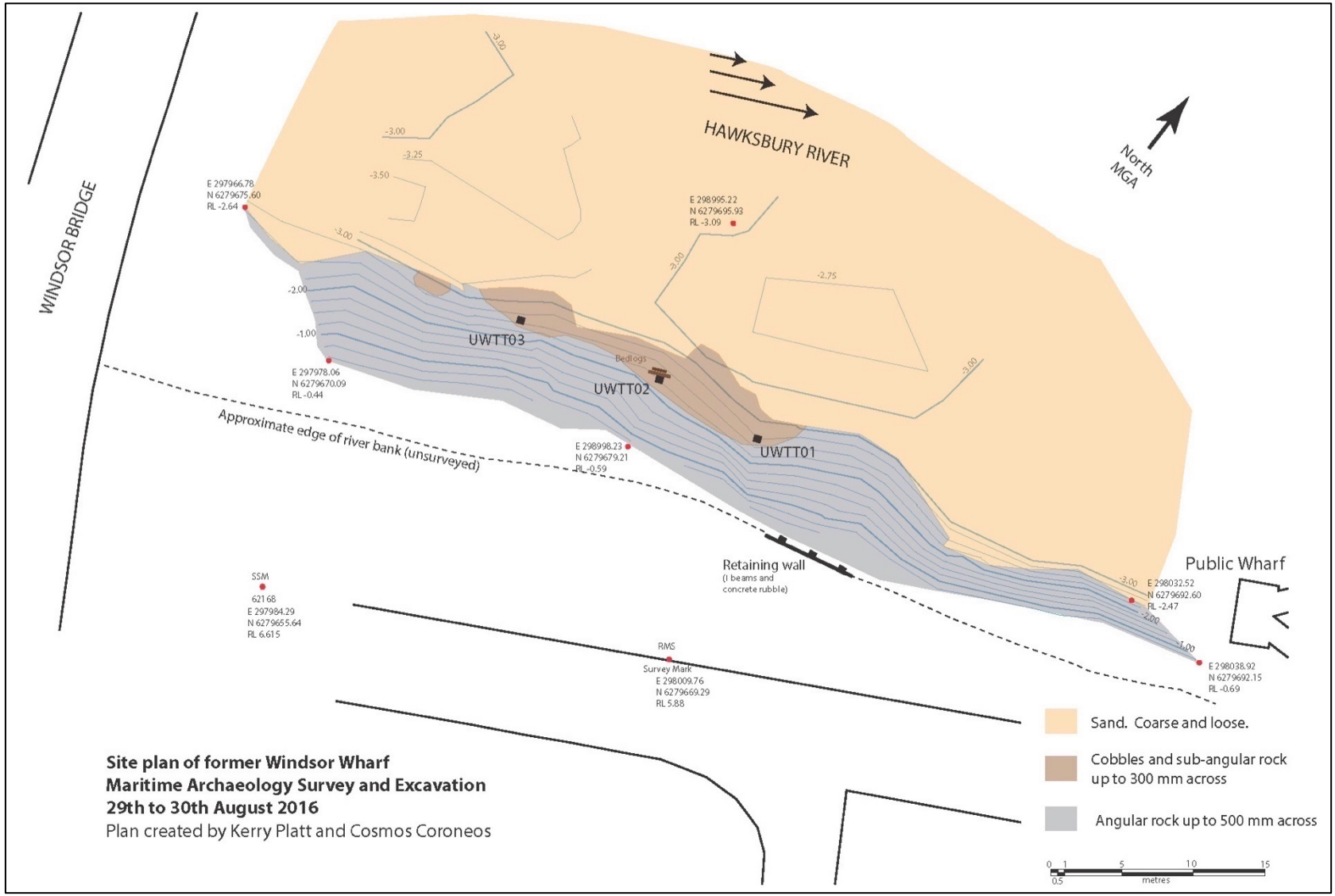


Figure 4: Location of test trenches and bed logs.

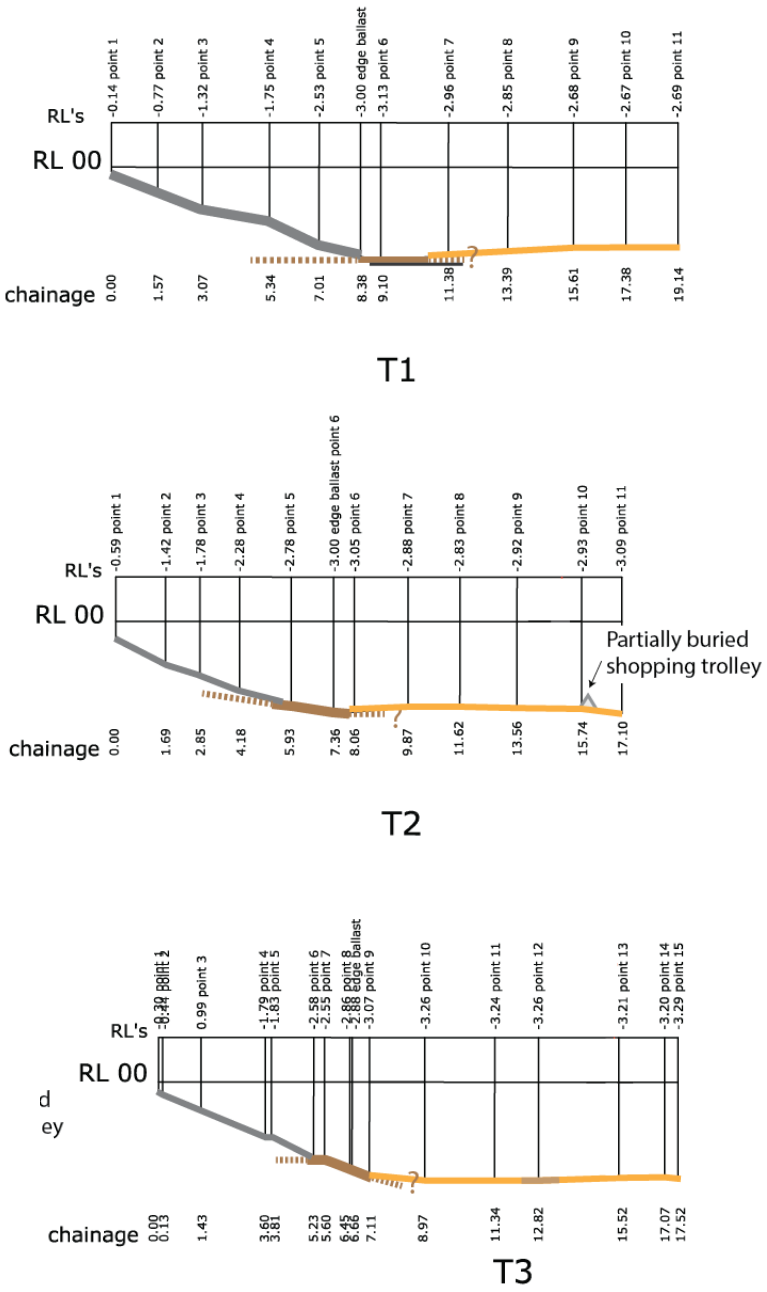


Figure 5: Diver transect profiles 1, 2 and 3 showing riverbed composition.

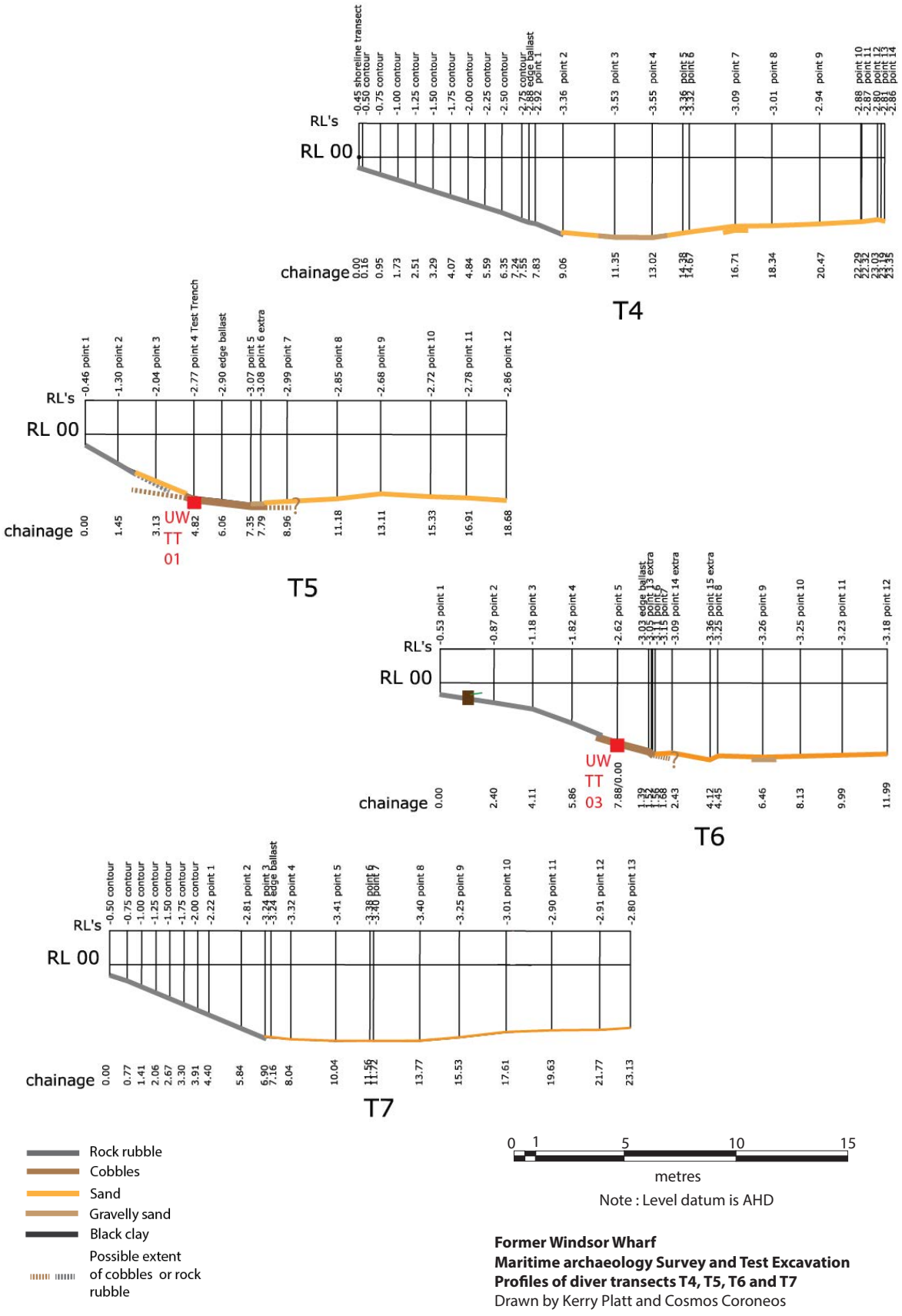


Figure 6: Diver transect profiles 4, 5, 6 and 7 showing riverbed composition.

5.2 Riverbank Descriptions

The survey of the riverbank identified eight separate maritime infrastructure features and a ninth feature which is composed of sandstone kerbing that had been deposited on the riverbed to prevent erosion of the bank (Figure 7). These features are described below in Table 3.

Table 3: Maritime infrastructure features observed along the riverbank

Feature Id	Type	Description	Figure ref.
1	Wall, pile and pipe	The closest recorded feature to the existing bridge, comprised of a hand-stacked irregular-coursed retaining wall composed of squared sandstone blocks up to 300 mm across. This wall was in poor condition. Set into the remains of this wall was a broken stone ware pipe up to 300 mm in diameter which serviced as a storm water or sewer outlet. A timber pile was partially exposed within the river bank. This feature was located adjacent to the end of the line of gabion baskets that run along the river edge at the low water level.	8
2	Timber planks	Exposed at a very low water mark, which are most likely decking from the 20th century version of the wharf, as well as modern bricks which were visible in an undercut section of the bank. There was around 2 m of sloping ground above the feature before the gabion baskets became visible.	9
Features 3 to 7 were located close together and present the most exposed and intact section of the 20th century version of the wharf.			
3	Waler	Western most exposed timber waler – consisting of 2 m exposed length with a diameter of approximately 300 mm	
4	Pile	Timber pile stump 300 mm in diameter.	10
5	2 Piles	Timber pile stumps 250 mm in diameter. Cut off close to the riverbed and are only exposed at very low tide. They were approximately 1 m apart. Adjacent to those piles was a collapsed squared timber girder which had a copper alloy bolt and nut protruding	10, 11, 12
6	Walers	Two timber walers, approximately 300 mm in diameter and 6 m long, joined by a bolt to the west side and a single timber waler, approximately 300 mm diameter and 6 m long, to the east. A squared timber beam – possibly a capwale – approximately 300 mm across and 6 m long connected the two walers and was parallel to the shoreline.	13,
7	Pile	Timber pile stump 300 mm in diameter.	10
Downstream of the remains of the 20th century wharf there was a relatively recent retaining wall			
8	Wall	Formed of three vertical steel I-beams, 300 mm by 200 mm, backed by a squared timber beam, 200 mm across and approximately 4 m long, with a fill of sandstone, brick and concrete fragments	14
9	Kerbing	Downstream and adjacent to the retaining wall was a collection of sandstone kerbing up to 750 mm in length (Figure 15). During the field investigation a worker from the Council explained that the kerbing originated from the main road through the Windsor Township and was deposited by the local Council in the late 20th century to retard bank erosion	15

In summary, the observed wharf features were associated with the 20th century version of the Windsor Wharf with the possible exception of the hand stacked rubble retaining wall from Feature 5 which could date to the second half of the 19th century.

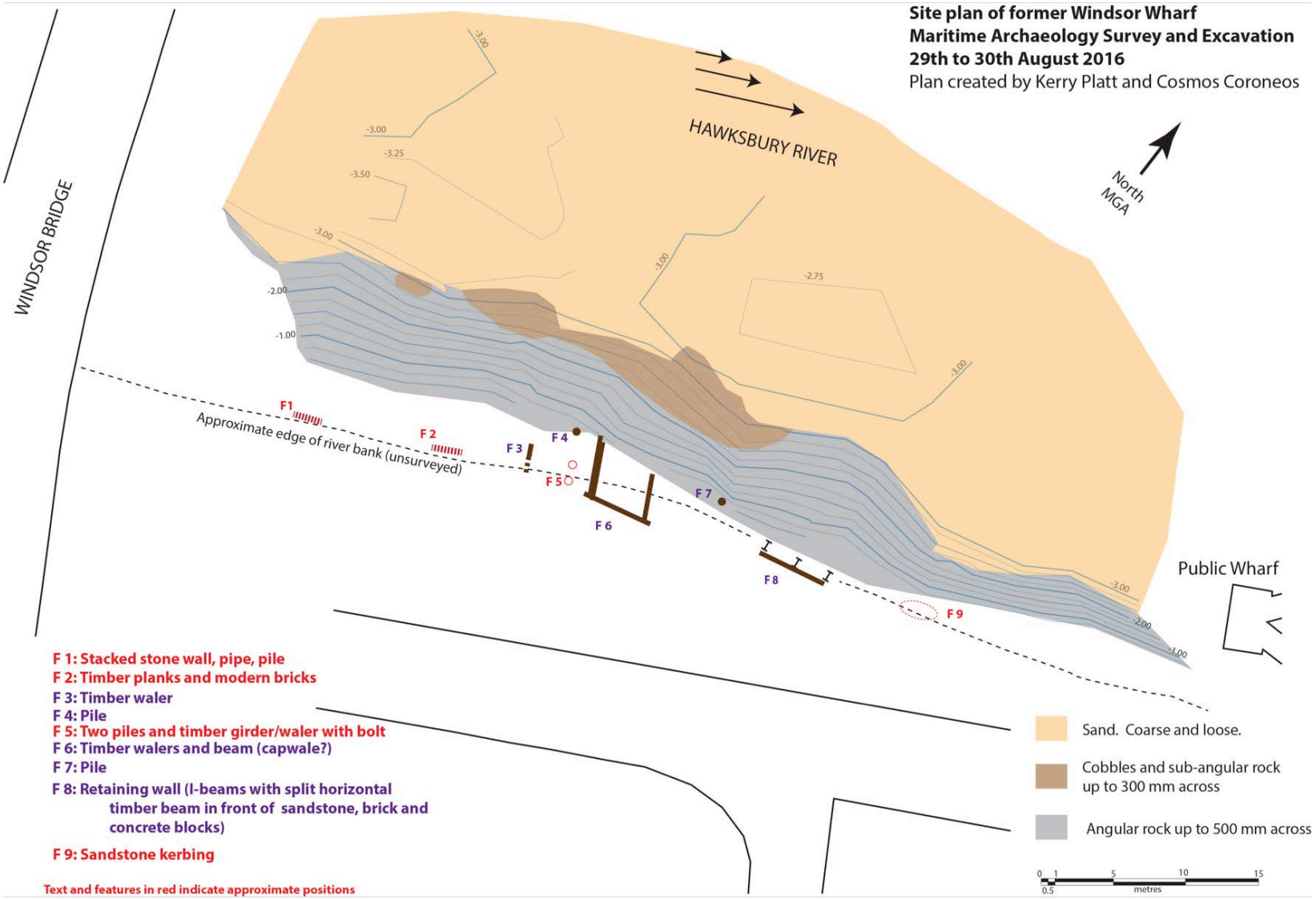


Figure 7: Riverbank features related to maritime infrastructure.

Figure 8: Feature 1 is composed of a timber pile, broken stone ware pipe and irregular coursed roughly squared stone retaining wall. Exposed at spring low tide. Scale in 50 mm increments.

Figure 9: Timber planking (Feature 2) associated with the 20th century version of the Windsor wharf. Scale in 50 mm increments.

Figure 10: Timber pile (Feature 7). Scale in 200 mm increments.

Figure 11: Timber pile (Feature 5). Scale in 50 mm increments.

Figure 12: Copper alloy bolt and nut protruding from timber girder (Feature 5). Scale in 50 mm increments.

Figure 13: Wharf timbers (Feature 6). Scale in 200 mm increments.

Figure 14: Retaining wall (Feature 8). Scale in 50 mm increments.

Figure 15: Sandstone kerbing (Feature 9).

5.3 Test Trench Descriptions

5.3.1 Underwater Test Trench 1 (UWTT01)

Easting	298005	**Northing**	6279685	**Reduced level (mAHD)**	-2.77
Dimensions	500 mm diameter excavated to depth of approximately 500 mm.				

Riverbed description:

The riverbed surface in the immediate vicinity of UWTT01 sloped down relatively gently towards the centre of the river and was composed of a thin (20 mm) layer of loose silt which overlaid loosely compacted cobbles ranging in size from 100 mm to 200 mm across. What appeared to be an engine block was located approximately one metre upstream of the test trench.

Conduct of excavation:

Water visibility at the time of the excavation was 0.1 m to 0.2 m. The excavation commenced with the removal of the loosely packed cobbles, which ranged in size from 50 mm to 300 mm across, to a depth of approximately 200 mm. This consisted Unit 1. Artefacts recovered from this stratum were kept separate.

Under the loosely packed cobbles was Unit 2 – a matrix of similar cobbles tightly packed with gravel and sand. This deposit was largely anaerobic. The water dredge was put into operation at this point, being used to break up the matrix and remove the sand/gravel onto the sieve on the punt while the cobbles were set aside. Some cobbles were retained as samples. Dredging continued for a depth of 150 mm until stiff clay was encountered on the downstream side of the trench. Within this matrix was the occasional sub-angular stone of up to 150 mm across.

Excavation continued for another 50 mm on the upstream part of the trench before encountering a layer of sand and coarse gravel forming Unit 3. The northern edge of this trench was bounded by what appeared to be a large sandstone block. This layer was approximately 100 mm thick and lay on stiff black clay. The relative thinness of the sand layer between compacted cobble/gravel matrix and the clay did not readily allow for the isolation of artefacts coming from that layer. Therefore, for the purposes of this test excavation, there was no differentiation recorded between artefacts coming from the cobble/gravel and sand layers.

Stratigraphy:

The stratigraphy of Underwater Test Trench 1 is presented in the table below:

Table 4: Stratigraphical contexts of Underwater Test Trench 1

Depth (mAHD)	Unit	Matrix	Description	Artefacts	Interpretation
-2.77	N/A	Silt	Silt, fine.	0	Natural sedimentation.
-2.77.5	1	Cobbles	Round stone from 50 mm to 300 mm across. Loosely packed.	Two fragments of ceramic and glass, modern.	Ballast, pre-20th century.
-2.97	2	Cobbles, sand, gravel	Round stone from 150 mm to 300 with some sub-angular stone up to 150 mm across. Tightly packed with sand and gravel.	Fragments of glass, aluminium, ferrous and rubber. Likely all modern.	Ballast, pre-20th century.
-3.12 to -3.17	3	Sand, coarse gravel	Sand and coarse gravel.		Natural.
-3.22 to -3.27	N/A	Clay	Stiff black clay	N/A	Natural.

Artefacts:

Six artefacts were recovered within this test trench (see Annex B). Those that could be identified (four) are modern, that is, post mid-20th century. These four artefacts, recovered from Unit 1 and 2/3, are objects associated with food and beverage functions (Figure 16). They are consistent with what would be found in the vicinity of a wharf and would be most likely linked to recreational activities on and around the structure. The two unidentified objects are a fragment of metal, possibly ferrous, with evidence of paint, and a plastic or rubber cap. Both these items very likely date to the 20th century.

The stones recovered from Unit 1 were mostly rounded and appeared to be types of sandstone and mudstone (Figure 17).

Figure 16: Fragment of mid to late 20th century cereal bowl.

Figure 17: Sample of ballast from Unit 1. Dark staining of stones signifies anaerobic conditions.

Interpretation:

The predominantly cobble matrix, Units 1 and 2, was a cultural deposit. The size of the cobbles and other sub-angular stones, being up to 300 mm across, suggested that they were deposited prior to mechanisation, that is, they were deposited by hand such as by shovel or basket either from a cart or boat. This suggestion is based on the observation that 20th century marine/riverine structures created as breakwaters and other forms of erosion control tend to be composed of large, > 500 mm, angular stone and that rounded smaller rocks would not be as effective.

Most of the stones recovered appeared similar to that known to occur in the area and are associated with Quaternary fluvial deposits (see discussion on site formation below). It is very likely that the cobbles were deposited as ballast to secure the bed logs for the late 18th to early 19th century wharves.

The differing levels of compactness of the cobble matrix can be explained in part by the shape of the stone used and the time elapsed since deposition. Round stone does not compact/compress as much as smaller angular and flatter stone. When the cobbles were deposited there would have been voids between the stones. Over time, water-borne sediments of various grades, depending on changing current velocities, would have percolated through the deposited cobbles filling the voids. Such a process would see the voids lowest down in the ballast being filled by sand and gravel first. Over time the voids would be progressively filled thereby compacting the cobble ballast. The absence of sand/gravel amongst the stones in the upper 200 mm of the matrix could be explained by the effects of scouring at times of high current flows. The dusting of silt over the stones denotes slow water movement at the time of the test excavation and its relative thinness possibly indicates that conditions at this part of the site are rarely calm long enough to allow greater silt deposits to build up.

Artefacts deposited onto the cobble matrix would behave in a similar way to sediments, in that those small enough would travel down through the voids until they stop at the sand and clay substrates or at points where the sand/gravel has already filled the voids. This process suggests that older artefacts could be expected to be found lower down in the ballast. However, the random nature of the distribution and size of the voids would indicate that this process would be not be consistent. Also, the penetration of any artefact into the ballast would be determined in part by its size and shape. Small artefacts with minimal surface area, being flat or narrow, would be expected to travel deeper into the ballast than larger rounder objects. The cobble ballast provides very good scour protection at times of high water flows and artefacts deposited onto it are more likely to work their way downwards into the matrix than be swept away downstream during flood events.

The discernible layer of sand and gravel (Unit 3) underneath the cobble ballast (Units 1 and 2) and above the stiff black clay is very likely a natural deposit. The riverbed beyond the ballast is characteristically sandy. Artefacts deposited onto the sandy riverbed prior to the deposition of the ballast would be effectively sealed from the effects of flooding and scour. Knowing when the ballast mound was formed would establish a *terminus ante quem* for the riverbed deposits which it has sealed.

The stiff black clay at which the excavation ceased was also observed in some of the terrestrial test trenches for this project.

5.3.2 Underwater Test Trench 2 (UWTT02)

Easting	297997	**Northing**	6279684	**Reduced level (mAHD)**	-2.29
Dimensions	Semi-circular, 500 mm diameter, 250 wide with the riverward side bounded by a timber log. Excavated to depth of approximately 250 mm.				

Riverbed description:

The riverbed surface in the immediate vicinity of UWTT02 sloped down relatively gently towards the centre of the river and was composed of a thin (20 mm) layer of loose silt which overlaid loosely compacted cobbles ranging in size of up to 300 mm across. On the riverward side of the trench was a partially buried timber log, approximately 400 mm in diameter, which lay approximately parallel with the river bank (Figures 18 and 19). Approximately 1.5 m of the log was exposed and this exposed section was greatly degraded from marine borer damage. Adjacent to, and lying alongside, was another log which was mostly buried and had an apparent smaller diameter of around 300 mm. Approximately 0.5 m of this smaller log was exposed and displayed little evidence of marine borer damage.

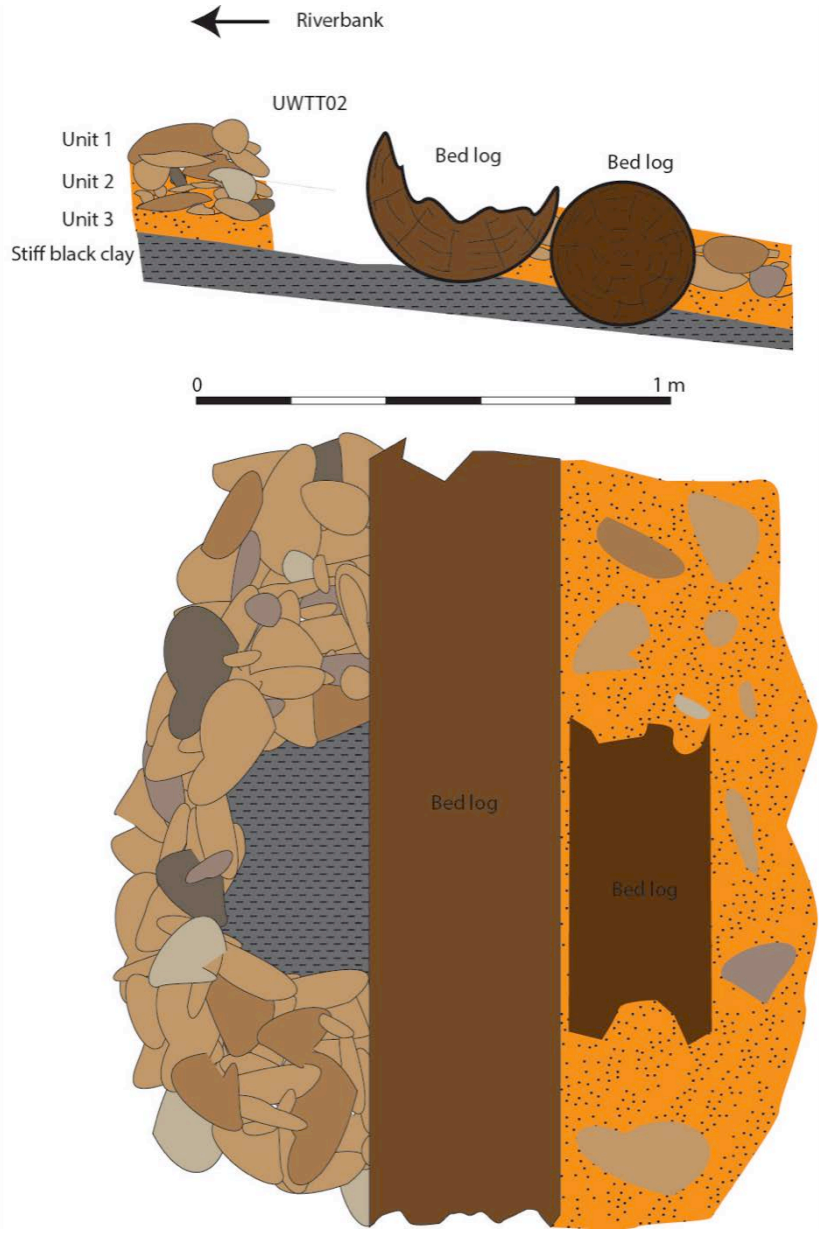


Figure 18: Trench plan and profile of UWTT02 and adjacent bed logs.

Conduct of excavation:

Water visibility at the time of the excavation was 0.1 to 0.2 m. The excavation commenced with the removal of the loosely packed cobbles, which ranged in size from 150 mm to 300 mm across, to a depth of approximately 100 mm and formed Unit 1. Within Unit 1 there were round and angular pebbles up to 50 mm across. Artefacts recovered from this stratum were kept separate.

Under the loosely packed cobbles was a matrix of similar cobbles, tightly packed with pebbles, gravel and sand, forming Unit 2. Some of the stone within this matrix was angular and relatively flat (Figure 20). This deposit was packed up against the timber log. The water dredge was put into operation at this point, being used to break up the matrix and remove the sand/gravel onto the sieve on the punt while the cobbles were set aside. Some cobbles were retained as samples. There appeared to be a higher ratio of gravel/sand to cobbles than what was observed in Unit 2 of UWTT01.

Dredging continued for 100 mm until a gravelly sand layer was observed, being Unit 3. This layer was approximately 50 mm thick and lay on stiff black clay. The relative thinness of the sand layer between compacted cobble/gravel matrix and the clay did not readily allow for the isolation of artefacts coming from that layer. Therefore, for the purposes of this test excavation, there was no differentiation recorded between artefacts coming from the cobble/gravel and sand layers.

Figure 19: Video screen grab of timber log which abuts UWTT02.

Figure 20: Video screen grab of west face of UWTT02.

Stratigraphy:

The stratigraphy of Underwater Test Trench 2 is presented in the table below:

Table 5: Stratigraphical contexts of Underwater Test Trench 2

Depth (mAHD)	Unit	Matrix	Description	Artefacts	Interpretation
-2.29	N/A	Silt	Silt, fine.	0	Natural sedimentation
-2.29.2	1	Cobbles	Rounded stones from 150 mm to 300 mm across. Loosely packed. Also angular and round pebbles up to 50 mm across.	A fragment of lead flashing.	Ballast, pre-20th century.

-2.39	2	Cobbles, sand, gravel	Rounded stones up to 300 mm across. Tightly packed with pebbles (up to 50 mm across), sand and gravel.	18 objects mostly glass and ferrous fragments including a 1952 penny and what appears to be a copper alloy clench ring.	Ballast, pre-20th century.
-2.49	3	Sand, coarse gravel	Sand and coarse gravel.		Natural
-2.54	N/A	Clay	Stiff black clay	N/A	Natural

Artefacts:

Nineteen artefacts were recovered within this test trench (see Annex B). Some of these were liberated from within select ferrous concretions that were recovered. The date range for these artefacts spanned between the late 18th and late 19th century.

All artefacts, apart from a fragment of lead flashing in the upper part of the ballast (Unit 1), were recovered from Units 2 and 3. Four of these artefacts were associated with glass bottles from the 20th century. A fragment of a very thin aluminium coil appears to be the residue from the opening of tinned food. A fragment of bovine long bone, possibly butchered, was the only food item recovered.

A number of artefacts (seven) were related to an industrial or construction type function. Two fragments of what appeared to be window glass are dated to having been manufactured prior to the 1880s due to their thinness.[8] A concreted ferrous, seemingly wire, nail with what appears to be a rhomboid head suggests a date of manufacture in the second half of the 19th century or possibly early 20th century. A small piece of hardened steel slag was recorded and the fragmentary remains (three) of hand tools were also recovered. The remains of discarded or accidentally dropped tools are common under wharf sites.

Two artefacts related to construction functions but with a possible maritime application were an offcut of a copper alloy sheet, which may have been used as vessel sheathing or a wear plate, and a copper alloy washer which had the appearance of a clench ring (Figure 21). Such objects are commonly found on littoral sites such as wharves and where shipbuilding has taken place.

A copper alloy 1952 penny was the only identifiable 'personal' item recovered (Figure 22). A fragment of what was thought to be ceramic with enamel blue paint or glaze could not be further identified or dated. The function of a fragment of worked wood could also not be determined.

The stones recovered from the Unit 1 were mostly rounded and sub angular and generally flatter than spherical in shape. There appeared to be types of sandstone as well as coarser-grained harder rock which may be metamorphic or igneous in nature.

[8] For changes in thickness of flat glass In Australia see **Boow, J. 1991** *Early Australian Commercial Glass: Manufacturing Processes* pg 111 Table 6. A RMS reviewer asked "Is it possible that the glass thinness could have occurred over time from being exposed to erosive forces from sand and water?" Glass that is exposed to abrasion from sand and other particles propelled by water becomes pitted from the impacts on its surface. Over time such artefacts become opaque and pitted with worn smooth edges. They can appear as white smooth flat pebbles. The fragments of window glass found in this test trench have not been exposed to sand and water abrasion suggesting they were protected from such actions soon after deposition.

Figure 21: Copper alloy washer which may have been a clench ring.

Figure 22: 1952 penny from Unit 2.

Interpretation:

The predominantly cobble matrix – Units 1 and 2 – was a cultural deposit. The size of the cobbles, being up to 300 mm across, suggests that they were deposited prior to mechanization, that is, they were deposited by hand such as by shovel or basket either from a cart or boat. Most of the stones recovered appeared similar to that known to occur in the area and are associated with Quaternary fluvial deposits (see discussion on site formation below). It is very likely that the cobbles were deposited as ballast to secure the bed logs for the late 18th to early 19th century wharves.

The differing levels of compactness of the cobble matrix can be explained in part by the shape of the stone used and the time elapsed since deposition. Rounded stone does not compact/compress as much as smaller angular and flatter stone. The fact that some of the stone recovered for examination was flat and angular rather than spheroid perhaps suggests that some consideration was given to the choice of stone used as ballast.

When the cobbles were deposited there would have been voids between the stones. Over time water-borne sediments of various grades depending on changing current velocities, would have percolated through the deposited cobbles filling the voids. Such a process would see the voids lowest down in the ballast being filled by sand and gravel first. Over time the voids would be progressively filled thereby compacting the cobble ballast. The absence of sand/gravel less than 50 mm across amongst the stones in the upper 200 mm of the matrix could be explained by the effects of scouring at times of high current flows. The dusting of silt over the stones denotes slow water movement at the time of the test excavation and its relative thinness possibly indicates that conditions at this part of the site are rarely calm long enough to allow greater silt deposits to build up.

Artefacts deposited onto the cobble matrix would behave in a similar way to sediments, in that those small enough would travel down through the voids until they stop at the sand and clay substrates or at points where the sand/gravel has already filled the voids. This process suggests that older artefacts could be expected to be found lower down in the ballast. However, the random nature of the distribution and size of the voids would indicate that this process would be not be consistent. Also, the penetration of any artefact into the ballast would be determined in part by its size and shape. Small artefacts with minimal surface area, being flat or narrow, would be expected to travel deeper into the ballast than larger rounder objects. The cobble ballast provides very good scour protection at times of high

water flows and artefacts deposited onto it are more likely to work their way downwards into the matrix than be swept away downstream during flood events.

The discernible layer of sand and gravel (Unit 3) between the cobble ballast (Units 1 and 2) and the stiff black clay is very likely a natural deposit. The riverbed beyond the ballast is characteristically sandy. Artefacts deposited onto the sandy riverbed prior to the deposition of the ballast would be effectively sealed from the effects of flooding and scour. Knowing when the ballast mound was formed would establish a *terminus ante quem* for the riverbed deposits which it has sealed.

The stiff black clay at which the excavation ceased was also observed in some of the terrestrial test trenches for this project.

The timber logs observed adjacent to the trench are the right size, location and size for bed logs which wharf piles were checked into. This was the prevailing technology for wharf construction in the late 18th and early 19th century. The smaller diameter log is more buried and appears set lower down into the clay substrate. It is possible that what has been observed are the wharf bed logs for two different phases of wharf construction from the 1810s (see Section 6.2).

5.3.3 Underwater Test Trench 3 (UWTT03)

Easting	298005	**Northing**	6279685	**Reduced level (mAHD)**	-2.77
Dimensions	1.5 m across and 0.5 m wide. Excavated to depth of up to 1 m.				

Riverbed description:

The riverbed surface in the immediate vicinity of UWTT03 sloped down relatively gently towards the centre of the river. Exposed on the surface were cobbles ranging in size from 100 mm to 300 mm with the occasional larger stone of up to 400 mm. There was no silt covering the cobbles.

Conduct of excavation:

Water visibility at the time of the excavation was 0.1 m to 0.2 m. The excavation commenced with the removal of the loosely packed cobbles, which ranged in size of up to 300 mm across, to a depth of approximately 150 mm forming Unit 1. Under this layer of cobbles there was discerned a layer of coarse sand approximately 100 mm thick forming Unit 2. No artefacts were recovered from these two units.

The sand layer separated the loose cobbles above from a matrix of similar cobbles compacted with sand and gravel below. The water dredge was put into operation at this point, being used to break up the matrix and remove the sand/gravel onto the sieve on the punt while the cobbles were set aside. Some cobbles were retained as samples. Dredging continued for approximately 750 mm with a lessening of gravel between the rocks. The excavation was impeded by a large rock 600 mm across which necessitated extending the trench upstream to allow the deepening of the trench. The depth of the trench, up to 1 m, also necessitated its widening to allow for ease of excavation.

Excavation ceased when a concreted matrix of rock and stone was encountered. This matrix could not be penetrated without hammering or chiselling.

Stratigraphy:

The stratigraphy of Underwater Test Trench 3 is presented in the table below:

Table 6: Stratigraphical contexts of Underwater Test Trench 3

Depth (mAHD)	Unit	Matrix	Description	Artefacts	Interpretation
-2.77	1	Cobbles	Rounded stone up to 300 mm across. Loosely packed.	0	Rock armour, recent or Ballast, pre-20th century.
-2.92	2	Sand, coarse gravel	Sand and coarse gravel.	0	Natural accumulation
-3.02	3	Cobbles, sand, gravel	Tightly packed cobbles with sand and gravel though with depth the presence of gravel decreases	20 objects related mostly to food/beverage uses and functions associated with construction.	Ballast, pre-20th century.

-3.77	n/a	Rock and sand	Concreted. Would need hammer/chisel to break up.	n/a	Most likely continuation of pre-20th century ballast

Artefacts:

Twenty artefacts were recovered within this test trench (see Annex B). The date range for these artefacts spanned between the late 18th and late 19th century and were mostly associated with food/beverage and construction related functions. All artefacts were recovered from Unit 3.

Eight artefacts were associated with food and beverage functions with the majority (seven) being bottle or drinking glass fragments manufactured in the 20th century. There was one ceramic plate fragment decorated with blue transfer print which could not be dated with any certainty other than it was manufactured in the 19th or 20th centuries.

A number of artefacts (10) were related to an industrial or construction type function. There were two fragments of bitumen. Apart from being used on the surrounding roads in the 20th century, the timber deck of the wharf may have been bituminised at one time. A small fragment of slate was recovered. Slate is sometimes found associated with wharf and shipwreck sites as they were used like scratch paper for tallying up cargoes or recording soundings. However, slate was mostly used for roofing from the 1840s and its presence in this context may be due to building materials being dropped by accident during cargo transfer or being deliberately dumped off the wharf as part of a demolished building.

Other objects related to building construction included a worn fragment of sand stock brick, two ferrous wire nails, a tack and a nut. A fragment of lead could have been used as flashing or as a form or water proofing on a roof or on a vessel. A fragment of copper plate or sheeting was most likely used in a marine application such as sheathing to protect timber hulls or piling from marine borers. A square shanked copper alloy nail is of a type commonly used in small timber boat construction or in the upper works or internal fittings for larger craft (Figure 22).

A small rounded wrought iron object, 20 mm across, has fine gouged lines across one surface suggesting it may be the fragmentary remains of a machinery component.

The stones recovered from Unit 3 were mostly rounded, sub-angular and generally flatter rather than spherical in shape. There appeared to be types of sandstone as well as coarser grained harder rock which may be metamorphic or igneous in nature (Figure 24). One dark fragment appeared to be basalt.

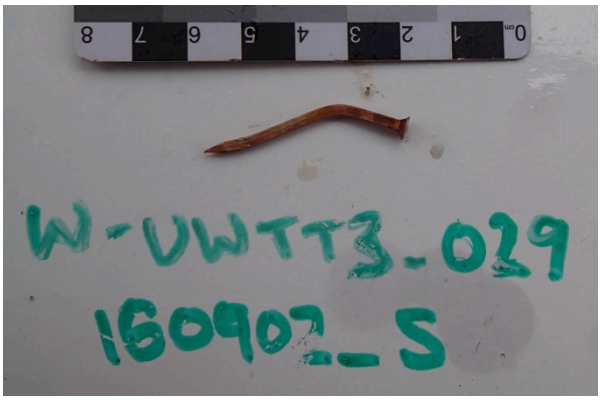


Figure 23: Copper alloy nail from Unit 2.

Figure 24: Sample of stone recovered from Unit 3.

Interpretation:

The predominantly cobble matrices, Units 1 and 3, were cultural deposits. It is most likely that the concreted stone and sand exposed at approximately 1 m depth is a continuation of Unit 3, however, time and physical constraints did not allow for the excavation of this trench to continue. The depth deposit in this trench differs markedly from that observed in the other trenches where natural clay beds were uncovered at 0.5 m and 0.25 m below the top of the ballast. In this trench the clay bed is over 1 m below the surface of the ballast and could indicate the sharp dipping away of the riverbed towards the centre of the river or a localised scour hole that was filled in.

The relatively thin layer of sand (Unit 2) between the cobble deposits suggests that there was a period of time between the deposition of the lower (Unit 3) and upper (Unit 1) matrices. The presence of 20th century artefacts in Unit 3 suggest that the upper most deposit of loose cobbles was possibly laid relatively recently, perhaps as part of bank stabilisation works in the late 19th century. The presence of larger angular stones, 400 mm across, in the vicinity of the trench support this possibility.

The lower matrix is similar to what was observed in UWTT01 and UWTT02 and likely deposited prior to mechanization, that is, they were deposited by hand such as by shovel or basket either from a cart or boat. Most of the stones recovered appear similar to that known to occur in the area and are associated with Quaternary fluvial deposits (see discussion on site formation below). It is very likely that the cobbles were deposited as ballast to secure the bed logs for the late 18th to early 19th century wharves.

The differing levels of compactness of the cobble matrix can be explained in part by the shape of the stone used and the time elapsed since deposition. Rounded stone does not compact/compress as much as smaller angular and flatter stone. The fact that some of the stone recovered for examination was flat rather than spheroid perhaps suggests that some consideration was given to the choice of stone used as ballast.

When the cobbles were deposited there would have been voids between the stones. Over time water-borne sediments of various grades depending on changing current velocities, would have percolated through the deposited cobbles filling the voids. Such a process would see the voids lowest down in the ballast being filled by sand and gravel first. Over time the voids would be progressively filled thereby compacting the cobble ballast. With time it could also be expected that the sand and stone lower down in the stratigraphy would become cemented as a result of lack of water movement and weight of deposits above. The absence of sand amongst the stones in the upper cobble matrix (Unit 1) could be explained by the effects of scouring at times of high current flows.

Artefacts deposited onto the cobble matrix would behave in a similar way to sediments, in that those small enough would travel down through the voids until they stop at the sand and clay substrates or at points where the sand/gravel has already filled the voids. This process suggests that older artefacts could be expected to be found lower down in the ballast. However, the random nature of the distribution and size of the voids would indicate that this process would be not be consistent. Also, the penetration of any artefact into the ballast would be determined in part by its size and shape. Small artefacts with minimal surface area, being flat or narrow, would be expected to travel deeper into the ballast than larger rounder objects. The cobble ballast provides very good scour protection at times of high water flows and artefacts deposited onto it are more likely to work their way downwards into the matrix than be swept away downstream during flood events.

5.4 Potential Second Wharf Site

The riverbed at this location was composed of sandy silt and a diver was able to thrust his arm easily into the seabed up to his elbow. No cultural material of heritage significance was found. If there was a wharf in this area, any remains would be completely buried at present.

The description of the riverbed for each transect is described below:

Table 7: Transect 1 description

Distance from upstream end (m)	Riverbed description	Distance from upstream end (m)	Riverbed description
0	Silty sand, loose	32	Silty sand, loose
4	Silty sand, loose	36	Silty sand, loose with small branches
8	Silty sand, loose	40	Silty sand, loose
12	Silty sand, loose	44	Silty sand, very loose
16	Silty sand, loose	48	Silty sand, very loose
20	Silty sand, loose	52	Silty sand, loose
24	Silty sand, loose	56	Silty, loose with branches
28	Silty sand, loose	60	Silty, loose with branches

Table 8: Transect 2 description

Distance from upstream end (m)	Riverbed description	Distance from upstream end (m)	Riverbed description
0	Silty sand	12	Sandy silt, loose
2	Sandy silt	14	Sandy silt, loose with some twigs
4	Silty sand and weed	16	Sandy silt, loose with some weed
6	Silty sand, 50% weed	18	Sandy silt, loose with 80% weed
8	Sandy silt	20	Sandy silt, loose with some twigs
10	Sandy silt, loose		

6.0 Addressing the Research Design

6.1 Historical Development of the Windsor Wharf

An overview of the development of the Windsor Wharf is provided below to assist in the analysis of the finds and the answering of the research questions. The historical outline draws upon the history presented in the SCMP.[9]

Phase 1	1795 - ca. 1806	Wharf and Store	The wharf and store were built in 1795 and destroyed in 1799. The wharf was rebuilt but was washed away in 1800-01 or in 1806. Based on historical analysis it is thought to have been constructed on the north-western side of Thompson Square, adjacent and up stream of the current bridge.[10] The presumed site of the wharf store is outside the impact area of the proposed new bridge.
Phase 2	1814 - 1860s	Windsor Wharf, early	Initial wharf was built in 1814/15, and was extended or in the process of being extended in 1815/16 when it was destroyed in 1816. A third wharf was built between 1816 and 1820 with interruptions due to flooding.
	Phase 2a 1814 - 1815	*1st Howe and McGrath Wharf*	*In August 1814 contract issued for a wharf 50 ft (15 m) in length, projecting 18 ft (6 m) into the River. Piles 16" (41 cm) to 18" (46 cm) thick. In June 1815 wharf was described as projecting 20 ft (6 m) into River, 6 ft (2 m) high and 65 ft long (20 m).*
	Phase 2b 1815 - 1816	*2nd Howe and McGrath Wharf*	*Wharf was, or was in the process of being extended by an additional 226 ft (69 m) and 33 ft (10 m) wide. There were at least 3 rows of piles, two of which were forward of the edge of the apron of the first wharf. Planking was to be 2" (5 cm) thick and 6 " (15 cm) wide fastened with 5" (13 cm) spikes with capwales and land ties. It is unclear whether this wharf was completed.*
	Phase 2c 1820 - 1860s	*Greenway wharf*	*No contemporary records of the dimensions and manner of construction of the wharf. 1835 plan of Windsor showing the wharf depicts it being ca. 26 m (85 ft) long and ca. 8 m (26 ft) wide. This was larger than Howe and McGrath's first wharf but substantially smaller than their second wharf (Figure 25).*
Phase 3	1874 - 1934	Windsor Wharf, mid	The wharf was rebuilt in 1874. There are no contemporary records of the dimensions and manner of construction of the wharf. Given the date of construction, it very likely involved new screw piling technology or piles driven into the riverbed by steam powered hammers. A plan from 1894 shows the wharf as being ca. 30 m long at the riverward edge and ca. 6 m wide (Figure 26). It was presumably built from timber.
Phase 4	1934 - 1950s	Windsor Wharf, late	The wharf was rebuilt in 1935. There are no contemporary records of the dimensions and manner of construction of the wharf. It was presumably built from timber with possible steel and concrete elements. The remains of this wharf are those that are visible protruding from the riverbank and riverbed at low tide.
Phase 5	1950s – present	Bank Stabilisation	Attempts at bank stabilisation involved a steel girder and concrete retaining wall, rock armour composed of basalt boulders and occasional sandstone street kerbing. Latest attempts at bank stabilisation included the installation of gabion baskets.

[9] **AAJV, January 2018,** *Thompson Square and Windsor Bridge Replacement Program Project Area Windsor, NSW: Strategic Conservation Management Plan – Volume 1: Site identification, Historical Background and Heritage Status*.
[10] **Op. Cit., AAJV, January 2018**, pp 49

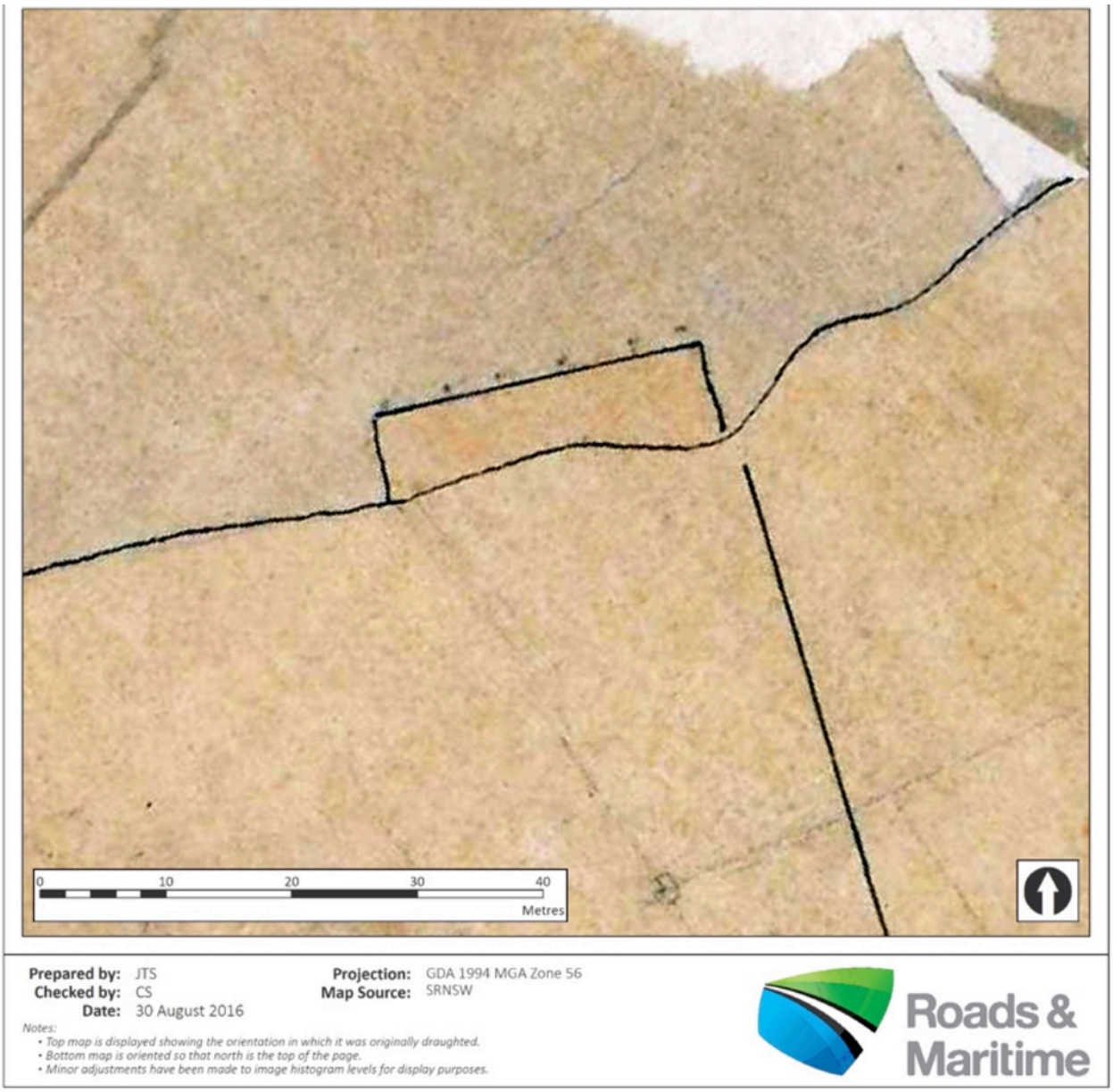


Figure 25: Greenway's wharf surveyed in 1835 (Source: G. B. White, plan of Windsor, 1835, SRNSW, Map 5968).[11]

[11] **AAJV, December 2016,** Figure 63

Figure 26: The wharf surveyed in 1894 (Source: C. Scrivener, plan of Thompson Square, 1894, LPI, Road Plan, R 1009.3000).[12]

6.2 Answering the Research Design – Part 1: Site formation questions

The test excavation and the accompanying survey provided important information on the nature of the archaeological resource at the site of the former Windsor Wharf ca. 1814 to 1950s. The observations made are as follows:

1) The extent of the ballast could not be determined because it was covered by recently deposited rock armour and its northern extremity was covered with sand. What was exposed was an approximately 20 m by 5 m strip in the centre of the survey area, approximately 7 m to 9 m from the riverbank, where the rock armour had not reached. It is almost certain that the ballast mound extended to the river bank and would be present under the rock armour.

Comparing the exposed extent of the ballast mound with overlays of historical maps of the Windsor Wharf does not provide obvious correlations. Figure 27 shows the outlines of the Phase 2c of the Windsor Wharf in 1835 and 1841 and Phase 3 in 1894. The ballast mound and the bedlogs are to the north west of the Phase 2c wharf and to the north of the Phase 2 wharf. The timber piles and beams from Phase 4 and possibly Phase 3 of the wharf align well with the 1894 plan of the site.

Assuming the 1835 and 1841 maps are reasonably accurate then the bedlogs found in UWTT02 could be part of the north west corner of the Phase 2c wharf. Alternatively, the ballast mound and bedlogs could be part of the short lived Phase 2b wharf which was a substantially longer wharf. However, it is however unclear whether the construction of the Phase 2b wharf had been completed before it was destroyed by floods.

[12] **AAJV, December 2016**, Figure 64

Alternatively it is possible that the location of the Phase 2c wharf in the two available maps is inaccurate. Generally 19th century survey maps which focus on cadastral boundaries and terrestrial features tend to position maritime structures, such as jetties and wharves, less accurately. Sometimes they are not shown at all.[13] Riverbanks and shorelines can change relatively quickly due to storm and flood events and so very rarely do they overlay well between historic maps. The Phase 3 wharf is built on what looks like a promontory. This promontory may have been created by the presence of the cobble ballast associated with the early phases of the wharf, as it retarded the erosion of the riverbank at that particular spot, and probably accelerated riverbank erosion on either side of it. If this assumption is correct then the Phase 2c wharf would have been located 10 m upstream from what is shown in the 1835 and 1841 maps which places it broadly in line with the Phase 3 wharf. Support for this argument could be found in the depiction of what appears to be riverbank erosion already appearing immediately downstream of the 1835 and 1841 depiction of the Phase 2c wharf. Furthermore, the underwater survey in 2016 did not identify any cobbles in the vicinity of the downstream edge of the historical drawings for Phase 2c of the wharf though it is possible that they would be covered with rock armour and sand. If this assumption is correct then there is a good correlation with the exposed extent of the ballast with the Phase 2b wharf extent and that one of the exposed bedlogs could be associated with the outermost row of piles which formed the edge of the apron of the Phase 2c wharf.

[13] **see AAJV, 18th July 2016** *Appendix A – Historical Map Overlays which shows maps of Windsor post dating 1829 which do not show the Windsor Wharf.*

Figure 27: Results of the 2016 maritime archaeology survey and test excavation with overlays of historic maps of Windsor Wharf.

Based on the historical maps, the bed logs at UWTT02 could have formed the northern extremity of the wharf structure but, given the uncertainties of the historical mapping and the changing riverbank, this cannot be certain at present. As bed logs were set to receive piles, it can be expected that the wharf would have had many such bed logs, each log representing a bent or row of piles. It is also likely that the ballast mound would have extended beyond the wharf apron for a short distance so as to protect the basal elements of the structure from scouring. However, it can be expected that the ballast continues under the sand riverwards for at least another 1 m to 2 m.

Regarding the total length of the ballast mound, it can be expected to match at least the known maximum length of Phase 2c of the Windsor Wharf which, based on the only known historic maps (1835 and 1841), would be approximately 26 m (85 ft) long. If the larger second Howe and McGrath (Phase 2b) wharf was built then the ballast mound should be approximately 84 m in length. Though there is some doubt as to whether this structure was completed before it was destroyed by flood, the watercolour of the ruins of the wharf in 1816 show that there were piles already in place when disaster struck. This would indicate that bedlogs and ballast were also already in place. It is unknown at present whether these early wharves were constructed with all the foundations (ballast and bedlogs) being laid down first or they were constructed one section at a time. The exposed length of the cobble ballast is around 20 m and based on the above two scenarios it is possible that only relatively short sections are covered by the rock armour both downstream and upstream of the exposed section if the second Howe and McGrath (Phase 2b) wharf was not completed. If the Phase 2b wharf was completed, or at least the bedlogs and ballast for the nominated 276 ft (85 m) of the proposed length were laid, then what has been recorded is approximately 25% of the total length of the Phase 2b wharf.

2) The compactness of the ballast varies. The upper portions are not compacted and are easily removed by hand. The ballast matrix below the loose stone is compacted with sand and gravel but can be broken down by hand with the aid of a water dredge or hand tool. In UWTT03 it would appear that the ballast mound has become concreted at depths greater than 1 m.

It is difficult to predict how robust this cobble ballast mound would be in sustained higher water velocity conditions without water flow modelling arising from changed conditions from the construction of the new bridge. Presently it appears that scouring does occur as shown by the poor condition of the exposed bed log and the absence of sand within the upper parts of the cobble mound. It can be stated with some certainty that the exposed cobble ballast would be less stable in response to accelerated scouring than the rock armour which overlies it.

3) The archaeological remains within the ballast mound were more plentiful than anticipated for such a small area excavated, especially in UWTT02. As expected there were artefacts from a wide date range within the matrix, from early 19th to late 20th centuries. The presence of only 20th century artefacts in UWTT01 is most likely due to the relatively small area excavated – 0.5 m diameter – and possibly indicates a relatively higher level of activity in and around this part of the wharf site in the 20th than the 19th century. The manner of excavation did not allow obtaining a refined understanding of the chronological deposition of artefacts, or internal stratigraphy, within the ballast mound. Any future excavation will attempt to excavate the mound in spits.

As expected, the artefacts recovered were relatively small, representing an underwater version of what would be expected in the underfloor deposit of a building. It is likely that ballast has completely covered larger artefacts, such as bed logs, thereby partially preserving them from marine borer damage. Larger objects may also be present in the relatively thin sand layer that was perceived in UWTT01 and UWTT02 lying above the natural clay. If this interpretation is correct then artefacts associated with the settlement of

Windsor and pre-dating the construction of the wharf(s) could be present. Of relevance would be artefacts associated with shipbuilding that took place between the wharf site and current bridge in the first decade of the 19th century.

With regards to the cobbles that comprise the ballast mound, it was originally thought that they may have been transported in by vessels under ballast from elsewhere on the river or beyond. The June 2013 SKM geotechnical report for this project describes a Quaternary stratum composed of "*sandy gravel with some cobbles. Typically fine to coarse grained, sub-angular to rounded, dense to compact … some igneous origin gravels/cobbles, alluvial*".[14] This description fits most of the samples obtained during the test excavation. It is very likely that much of the stone in the ballast mound was locally sourced though stone from elsewhere on the river and the east coast of Australia, and were then added to the mound by vessels moored alongside the wharf.

6.3 Answering the Research Design – Part 2: Site specific questions

As noted in **Section 3.2**, the test excavation was not designed to answer site specific questions, however, the results of the test excavation can at this stage contribute towards answering some of them. What can be answered of the wider site specific questions is presented in Table 9 below.

Also noted in Section 3.2 was that the use of the term 'jetty' for the research questions has been replaced in this report by the correct term 'wharf'. Furthermore research has shown that the first and second 'jetty' were constructed some distance apart with the site of the first 'jetty' very likely being outside the impact area for the new bridge. The changes to maritime infrastructure nomenclature and phasing is discussed in Section 6.1, presented in square brackets in Table 9 and is summarised as follows:

- 'first jetty' equates to Phase 1 – Wharf and Store (1795 to ca. 1806)
- 'second jetty' equates to Phases 2 to 4 – Windsor Wharf (1814 to1950s)

Table 9: Response to site specific questions.

Site specific research question	Results of test excavation
How was the first jetty [Phase 1 - Wharf and Store] *constructed?*	The test excavation was carried out where the 2012 EIS identified areas of potential impact from the construction of the new bridge. When the 2012 EIS was prepared it was thought that the Wharf and Store (Phase 1) was situated at the same location or very close to the Windsor Wharf (Phases 2 to 4). Historical research and analysis undertaken for the SCMP points to the location of the Wharf and Store (Phase 1) being adjacent and upstream of the current bridge.[15] As such the test excavation did not take place where the wharf/store is now thought to be located. The dive transects conducted in the general area did not find any evidence that could be attributed to the Wharf and Store (Phase 1).
Is there any evidence of early ship construction?	Some artefacts possibly associated with the construction of water craft were recovered from the test trenches, however, these could not be confidently attributed to having an association with early shipbuilding.

[14] **SKM, June 2013,** *Windsor Bridge Replacement – Detailed Design: Geotechnical Investigation Report.* Prepared for Windsor Bridge Alliance: pg. 32, Unit 3D, Appendix A and Figure B1

[15] *Op. Cit.,* **AAJV, January 2018 :** pg 49.

What can it tell us about the engineering skills available to the colony within the first five years of settlement?	Information recovered from the three test trenches could not contribute towards answering this question.
Was ballast used to stabilise the jetty [Phase 1 - Wharf and Store]*, and which jetty phase* [Phases 2 to 4 – Windsor Wharf] *was the ballast used for?*	The test excavation did not take place in the vicinity of where the Wharf and Store (Phase 1) is thought to have been located (see above). Two sets of bedlogs associated with early phases of the Windsor Wharf were partially covered in ballast.
How was the risk of flooding managed?	Information recovered from the three test trenches could not contribute towards answering this question. The use of ballast to weigh down bedlogs which supported timber piles was a standard practice. This is because newly submerged logs (varies according to timber species and length of curing) are buoyant and that such structures were in locations where there was water movement in the form of wave surge, current and/or steady flow. So ballast was required to prevent lift as well as lateral movement of the logs. There was no indication from the three test trenches that there were additional measures in place to protect the structure from flood events. On the contrary there was a less than expected coverage of ballast over the bedlogs at UWTT02.
What was the quality of the materials used in the jetty [Phase 1 - Wharf and Store]*? (I.e. was copper sheathing used? Spacing of piles, size and standard of fastenings). Does this say something about the availability of materials or the level of importance placed on the wharf/store by the authorities, through comparison with other contemporary wharf sites?*	The test excavation did not take place in the vicinity of where the Wharf and Store (Phase 1) is thought to have been located (see above). Information recovered from the three test trenches could not contribute towards answering this question.
Was the jetty [Phase 1 - Wharf and Store] *constructed on bed logs or piled directly into the riverbed?*	The test excavation did not take place in the vicinity of where the Wharf and Store (Phase 1) is thought to have been located (see above). Information recovered from the three test trenches could not contribute towards answering this question.
How was the 1814/15 (second) jetty [Phases 2 to 4 – Windsor Wharf] *constructed and how was it modified and altered throughout the 19th century?*	The earliest phases (Phase 2) of the former Windsor Wharf was constructed on bed logs while the later 20th century version was piled directly into the riverbed. The bed logs found at UWTT02 are very likely associated with the former Windsor Wharf. They were not sufficiently exposed for any statements to be made about the quality of the structures. One log, presumably the earlier one as it was more buried, appeared to be of a smaller diameter than the other. No timber samples were obtained.
What do the river artefacts tell us about the use of the wharf and the commercial contacts over time?	The artefacts recovered from the three test trenches show the area was used throughout the 19th and 20th centuries. The artefacts reflect the activities on and around the former Windsor Wharf and include discarded food and drink containers, discarded construction material as well as the possible presence of fastenings associated with small vessels.
Is there any evidence for the operations of the ferry on either side of the river?	The test excavation did not take place in the vicinity of where the ferry operated. Information recovered from the three test trenches could not contribute towards answering this question.
Are there new facilities for the punt (cable tie etc.) where the new road meets the water?	The test excavation did not take place in the vicinity of where the ferry operated. Information recovered from the three test trenches could not contribute towards answering this question.

7.0 Revised Statement of Cultural Heritage Significance

7.1 Introduction

An assessment of cultural significance or heritage significance seeks to understand and establish the importance or value that a place, site or item may have to select communities and the general community at large. The Australian ICOMOS Charter for the Conservation of Places of Cultural Significance (the Burra Charter 1979, most recently revised in 2013), is the standard adopted by most heritage practitioners in Australia when assessing significance. It defines cultural significance as:

"*Aesthetic, historic, scientific or social value for past, present or future generations*."[16]

This value may be contained in the fabric of the item, its setting and relationship to other items, the response that the item stimulates in those who value it now, or the meaning of that item to contemporary society.

Accurate assessment of the cultural significance of sites, places and items is an essential component of the NSW heritage assessment and planning process. A clear determination of a site's significance allows informed planning decisions to be made for place, in addition to ensuring that their heritage values are maintained, enhanced, or at least minimally affected by development. Assessments of significance are made by applying standard evaluation criteria:

European Cultural Heritage Significance Criteria (NSW Heritage Office Guidelines)

a. An item is important in the course or pattern of NSW's cultural or natural history (or the cultural or natural history of the local area);
b. An item has strong or special associations with the life or works of a person, or group of persons, of importance in NSW' cultural or natural history (or the cultural or natural history of the local area);
c. An item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW (or the local area);
d. An item has strong or special associations with a particular community or cultural group in NSW (or the local area) for social, cultural or spiritual reasons;
e. An item has potential to yield information that will contribute to an understanding of NSW's cultural or natural history (or the cultural or natural history of the local area);
f. An item possesses uncommon, rare or endangered aspects of NSW's cultural or natural history (or the cultural or natural history of the local area);
g. An item is important in demonstrating the principal characteristics of a class of NSW's cultural or natural places; or cultural and natural environments.[17]

[16] **Australia ICOMOS Inc. 1999** *The Burra Charter: The Australia ICOMOS Charter for Places of Cultural Significance*. Article 1.2.

[17] **NSW Heritage Office & Department of Urban Affairs & Planning 2001** *NSW Heritage Manual – Assessing Heritage Significance*

7.2 Evaluation of Maritime Infrastructure at Windsor

Based on the findings of the test excavation and survey of the former Windsor Wharf site and utilising the historical research obtained for the SCMP, the statement of cultural heritage significance, assessed against NSW Heritage Council criteria, is as follows:

Wharf and Store (1795-ca.1806) and Windsor Wharf (ca.1814-ca.1950s)

Criterion a) An item is important in the course or pattern of NSW's cultural or natural history (or the cultural or natural history of the local area)

The construction of a wharf at Windsor was an integral part of the establishment and development of dispersed frontier farming and then the township. The first maritime structure was a wharf and associated store constructed in 1795 to supply the military garrison. By this time the surrounding area was being used for farming purposes and the wharf/store was likely used to convey crops out to the settlement in Sydney. This mode of transport was likely faster than the overland route that was not formally established until 1816.

The second structure was built at another site downstream of the wharf/store and was a more substantial wharf, first constructed in 1814. Referred to as the Windsor Wharf it was expanded then destroyed by floods and rebuilt by 1820. It served as the nexus between land and water for the transfer of goods, produce and people to and from the 'mosquito fleet'[18] that plied the Hawkesbury River and beyond. Such was the importance and volume of the water borne trade that an additional temporary wharf was constructed in 1855.

The construction of the rail line to Windsor in 1864 actually increased the wharf's importance as vessels brought produce from properties along the river to the rail head. This is why the wharf was again rebuilt in 1874 after floods in the 1860s and the construction of the current bridge appears to have altered the shape of the riverbank. However, by this stage the river trade had begun to decline as siltation reduced the size of vessels that could access the wharf. This decline was accelerated by the construction of the rail line at Brooklyn in 1887 at the entrance to the Hawkesbury River which diverted away the cargo trade. The introduction of the motor vehicle accelerated this decline and, though the wharf was again refurbished in 1934, the function of this structure had become more focused on recreational activities rather than trade. By the middle of the 20th century this wharf had fallen into disrepair.

Since the 1950s there have been a number of attempts at stabilising the riverbank including the construction of a short section of concrete and steel girder retaining wall, deposition on the river bed of basalt rubble as well as sandstone kerbing discarded from the refurbishment of Windsor's streets. The latest form of bank stabilisation has been the installation of gabion baskets sometime in the 2000s.

The construction of both wharves at Windsor are associated with the survival of the early colony, providing a means of transporting agricultural crops out of the greater Windsor area back to the main settlement at Port Jackson.

The historical significance of the various phases and manifestations of the wharfage at Windsor is assessed as follows:

[18] 'mosquito fleet' is a term used for the collection of small shallow draft vessels used to service those busy ports which could not accommodate large tonnage vessels.

Table 10: Historical significance of the different phases of maritime infrastructure at Windsor.

Phase	Period	Name	Assessment	Significance
1	1790 to ca. 1806	Windsor Wharf and Stores	A critically important outport within the intra-colony trade network.	**State**
2	1814 to 1860s	Windsor Wharf, early	An important (one of a few in the early 19th century) port within the intra-colony trade network.	**State**
	a) 1814 to 1815	*1st Howe and McGrath wharf*		
	b) 1815 to 1816	*2nd Howe and McGrath wharf*		
	c) 1820 to 1860s	*Greenway wharf*		
3	1874 to 1934	Windsor Wharf, mid	One of many riverine ports within the colony of NSW which were revitalised or expanded due to changes piling technology and good economic times. The port initially stimulated by the rail line passing by Windsor but declined in importance as a trade centre as rail networks and later motor vehicle transport expanded across the Sydney basin.	Local
4	1934 to 1950s	Windsor Wharf, late	River borne trade had all but ceased by the time the last version of the wharf was constructed. It's role was primarily one for recreation uses which reflected the main use of the Hawkesbury River as the 20th century wore on.	Local
5	1950s to present	Bank Stabilisation	The attempts at bank stabilisation do not merit any significant historical associations.	Does not meet criterion threshold.

The first wharf (Wharf and Store 1795-ca.1806) and the earliest phases of the Windsor Wharf (ca.1814-ca.1860s) are considered to be State significant under this criterion on the basis they formed part of critical transport and trade infrastructure for one of the earliest European settlements in Australia, a settlement which was important for the survival of Sydney as a viable colony.

Criterion b) *An item has strong or special associations with the life or works of a person, or group of persons, of importance in NSW' cultural or natural history (or the cultural or natural history of the local area);*

The earliest version of the former Windsor Wharf in ca.1814 was associated with two important personages in the early colony – Governor Macquarie who commissioned its construction in 1814, and Francis Greenway who oversaw its final construction in 1820. Three years earlier Macquarie had developed a plan for the formation of a township at

Windsor, as well as four other townships on the Hawkesbury River. While it was not in the original plan for the establishment of a formal town, the need for adequate loading facilities on the river was later identified and endorsed by Governor Macquarie.

The wharf was built by John Howe and James McGrath, both early land grantees at Mulgrave (Windsor), who also improved the road from Parramatta to Windsor and searched for an overland route to the Hunter River. After the wharf was damaged in a flood in 1816, Macquarie ensured the survival of the wharf by granting further funding to complete the wharf. Oversight of the construction was entrusted to Francis Greenway who completed the structure in 1820. Well known for his flamboyant and sound design principles, it is not currently known whether his flair was translated into the construction of this structure. The enlarged 276 ft wharf, proposed and commenced in 1815, was ambitious but may have been designed prior to Greenway's involvement in the project. That the wharf constructed under his supervision appears to have lasted for fifty years before a major refurbishment is possibly testament to his skills as both an architect and a builder.

The association of the various phases and manifestations of the wharfage at Windsor with a person or persons of importance in NSW is assessed as follows:

Table 11: Association of the different phases of maritime infrastructure at Windsor with important persons.

Phase	Period	Name	Assessment	Significance
1	1790 to ca. 1806	Windsor Wharf and Stores	No known association with person or persons of importance in NSW	Local
2	1814 to 1860s	Windsor Wharf, early		**State**
	a) 1814 to 1815	*1st Howe and McGrath wharf*	Associated with John Howe and James McGrath who contributed to the early development of the area.	
	b) 1815 to 1816	*2nd Howe and McGrath wharf*		
	c) 1820 to 1860s	*Greenway wharf*	The third rebuild of the wharf, sub-period c), is associated with Lachlan Macquarie and Francis Greenway. It is the only known wharf to have been constructed, and possibly designed, under Greenway's supervision.	
3	1874 to 1934	Windsor Wharf, mid	No known association with person or persons of importance in NSW	Does not meet criterion threshold.
4	1934 to 1950s	Windsor Wharf, late	No known association with person or persons of importance in NSW	Does not meet criterion threshold.
5	1950s to present	Bank Stabilisation	No known association with person or persons of importance in NSW	Does not meet criterion threshold.

The earliest phase of the former Windsor Wharf ca.1814-ca.1950s, has a strong association with both Governor Macquarie and Francis Greenway, who are both important figures in the

history of NSW, and as such the wharves built at Windsor are considered to be State significant under this criterion.

Criterion c) *An item is important in demonstrating aesthetic characteristics and / or a high degree of creative or technical achievement in NSW (or the local area);*

Limited archaeological remains associated with the ca.1814-ca.1950s wharf are visible from the current road bridge or via boat. These remains are limited to the 20th century phase of construction and consist of the lower support components of the wharf, such as bracing and deck beams, and as such are not considered to be aesthetic characteristics or show a creative or technical achievement. The former wharf site, particularly the 19th century manifestations, are likely only to exist within the archaeological record, including on and below the riverbed, and as such the former wharves are not considered to meet the requirements of this criterion.

Criterion d) *An item has strong or special associations with a particular community or cultural group in NSW (or the local area) for social, cultural or spiritual reasons;*

The presence of maritime infrastructure at Windsor, a wharf/store in 1795 and later a wharf from ca.1814 to ca.1950ss, was used for the supply of the early land grants and later formal settlement at Windsor as well as to assist in transporting agricultural crops out to the settlement at Parramatta and Sydney. The evolution of the wharf from a major transportation hub for cargo and passengers continued until the early twentieth century. Although the wharf was used by the larger community for transportation needs, there were no single particular community or cultural groups who can be associated with either of the wharves built at Windsor. As such, the wharves built at Windsor are not considered to meet the requirements of this criterion.

Criterion e) *An item has potential to yield information that will contribute to an understanding of NSW's cultural or natural history (or the cultural or natural history of the local area);*

Archaeological investigations in 2008 and 2016 have shown that there is considerable archaeological potential regarding the remains of the ca.1814-ca.1950s wharf and possibly 1795-ca.1806 wharf/store. There is very little historical information on the wharf/store and that which is available for the Windsor Wharf indicate broad dimensions but little in the way of detail for the various designs and rebuilds that occurred in the 1810s. The 2016 investigation took place in the footprint of the former Windsor Wharf and found what appeared to be two adjacent bed logs of differing diameters. They probably relate to two different wharf building phases in the early 19th and possibly late 18th century.

Physical evidence that has survived in the archaeological record has the potential to provide new information relating to construction techniques and material that were used, specifically in relation to types of wood used, fastenings, bracing and pile information as well as quality of workmanship and materials. Information relating to repair work to the wharf can also be determined from the remains in the archaeological record of wharf sites, such as from the driving in of repair "sister" piles or the addition of extra bracing or fastenings.

Artefacts discarded, accidentally or deliberately, from the wharf and vessels moored alongside can contribute towards knowledge of the variety of traffic and goods that passed through this portal between Windsor and Sydney over time.

The potential of the archaeological remains of the various phases and manifestations of the wharfage at Windsor to yield information of importance to NSW is assessed as follows:

Table 12: Potential of the different phases of maritime infrastructure at Windsor to yield important information.

Phase	Period	Name	Assessment	Significance
1	1790 to ca. 1806	Windsor Wharf and Stores	Nothing is known of the size and manner of construction of this important piece of maritime infrastructure. Through the examination of the physical remains, an understanding of the intent behind its construction as well as the technical ability of its builders could be inferred. The artefacts associated with activities on and around the wharf/store could provide much information on the usage of the structure and on the cargoes that passed over it. Archaeological remains associated with this structure have not been identified. It is thought to have been sited adjacent and upstream of current bridge and as such the archaeological remains of the wharf/store and associated artefacts are possibly poorly preserved because of the impact associated with the construction of the bridge.	**State**
2	1814 to 1860s	Windsor Wharf, early	The dimensions of the wharf for the three sub-periods are broadly known, however there is less detail known on the manner and quality of construction of such an important piece of public maritime infrastructure. There is also some doubt as to whether the large, 276 ft long, wharf (Phase 2b) was completed before it was destroyed. As with Phase 1, the artefacts associated with activities on and around the wharf could provide much information the usage of the structure and on the cargoes that passed over it.	**State**
	a) 1814 to 1815	*1st Howe and McGrath wharf*		
	b) 1815 to 1816	*2nd Howe and McGrath wharf*		
	c) 1820 to 1860s	*Greenway wharf*		
3	1874 to 1934	Windsor Wharf, mid	The wharf was rebuilt at a time of changing technology in maritime infrastructure construction. The piles would have been screwed or pounded into the riverbed by a steam driven hammer. This form of construction became ubiquitous from the 1860s to the present day. As the importance of the port as a trade centre declined there would have a been a change of the activities that took place on and around the wharf. Artefacts recovered from the site could provide some indication of the type and intensity of those activities.	Local

4	1934 to 1950s	Windsor Wharf, late	The materials and techniques used in the construction of the wharf in this phase would have been commonplace throughout NSW at this time. The artefacts from this phase recovered from the site could provide some indication of how the wharf was used.	Local
5	1950s to present	Bank Stabilisation	Further examination of the forms of bank stabilisation used on the site in this phase would not yield any new information on this type of civil engineering.	Does not meet criterion threshold.

The archaeological remains associated with the wharf/store (first) and Windsor Wharf (second), both above and below the low water line, have the potential to contribute to a greater understanding of settlement before and during the Macquarie era. As such, the earliest phases of archaeological site associated with both former structures built at Windsor are considered to be State significant under this criterion.

Criterion f) *An item possesses uncommon, rare or endangered aspects of NSW's cultural or natural history (or the cultural or natural history of the local area);*

The archaeological remains associated with the former Windsor wharves are considered to be a rare and endangered archaeological resource. Wharf redevelopment within major ports and harbours has occurred continuously as required to maintain the function of the port area. Through this process, infrastructure is updated and wharves are demolished and rebuilt. Wharf sites along major rivers and secondary ports are likely to exist, both intact and as an archaeological resource, as redevelopment of these sites is less likely to occur over the development of other transportation advances, such as rail or road infrastructure. However in major centres, such as Sydney, early shorelines with their associated maritime infrastructure are often buried under reclamation and as such are relatively inaccessible.

Aspects of the wharf that are present in and behind the riverbank at Windsor are likely to be intact, and relate to design and construction techniques that are directly associated with the early settlement of NSW that has since evolved.

The 1820 reconstruction of the wharf was supervised by renowned architect Francis Greenway. As far as is known, this is the only in-water construction of maritime infrastructure within his repertoire of public works.

Table 13: Rarity of the different phases of maritime infrastructure at Windsor.

Phase	Period	Name	Assessment	Significance
1	1790 to ca. 1806	Windsor Wharf and Stores	A wharf such as that built at Windsor in the late 18th century would have been a relatively rare type of government infrastructure at the time. However, remains of such structures, and associated archaeological deposits, are relatively rare and/or are inaccessible under reclamation.	**State**
2	1814 to 1860s	Windsor Wharf, early	Wharves of the type constructed at Windsor in the early 19th century	**State**

	a) 1814 to 1815	*1st Howe and McGrath wharf*	would have become more commonplace around NSW towards the middle of the century. However, remains of such structures, and associated archaeological deposits, are relatively rare and/or are inaccessible under reclamation. The wharf constructed in sub-period c) was done so under the direction of Francis Greenway and is possibly the only structure of this type that he is associated with.	
	b) 1815 to 1816	*2nd Howe and McGrath wharf*		
	c) 1820 to 1860s	*Greenway wharf*		
3	1874 to 1934	Windsor Wharf, mid	Wharves constructed in the second half of the 19th century were commonplace forms of maritime infrastructure. The archaeological remains of such structures are largely accessible in areas where ports have declined and inaccessible in places which saw a lot of foreshore development in the late 19th and 20th centuries, such as Sydney Harbour.	Local
4	1934 to 1950s	Windsor Wharf, late	Wharves constructed in the first half of the 20th century were commonplace forms of maritime infrastructure. The archaeological remains of such structures are largely accessible across the State.	Local
5	1950s to present	Bank Stabilisation	The use of retaining walls, rock armour and more recently Gabion baskets is ubiquitous across the State. The use of former 19th century sandstone kerbing as rock armour, however, is unusual.	Local

The physical and archaeological remains of the former wharves built at Windsor are considered to be State significant under this criterion.

Criterion g) *An item is important in demonstrating the principal characteristics of a class of NSW's cultural or natural places; or cultural and natural environments.*

The sites of the former wharves at Windsor are represented by fragmentary remains that can be seen from certain vantage points, such as on the river, and the primary remains of the wharves likely to be present within the archaeological record. As such, the sites are not considered to retain the principal characteristics of its type or design. The maritime infrastructure at Windsor are not considered to meet the standards of this criterion.

Statement of cultural significance

The presence of wharves at Windsor was an important infrastructure development that was part of the early settlement and development of the township. The construction of the first wharf in 1795 allowed for supplies to be unloaded safely at the early store and military garrison while allowing for farm crops to be exported out. The construction of a more

substantial second wharf, which commenced in ca.1814 as part of the formalisation and development of the Macquarie town, reinforced the importance of the settlement and the need for maritime infrastructure as part of that plan. This wharf was rebuilt soon after – it was commissioned by Governor Macquarie and its construction was overseen by Francis Greenway.

The wharf was an integral part of the Windsor Township until the expansion of rail to Brooklyn at the entrance to the Hawkesbury River diverted away the cargo trade and the motor vehicle decreased the importance of water borne transport. The archaeological resource present on the site is considered to be a rare and endangered resource that can provide new information into the design and construction types of wharves in the early settlement of NSW and Australia. The late 18th century wharf/store and early to mid-19th century version of the wharf at Windsor are assessed to be of State significance.

8.0 Proposed Erosion Protection Design and Bridge Pile Locations – Southern Bank

The bridge design presented in the 2012 EIS included a scour protection system on the southern bank that would have consisted of a concrete panel retaining wall between the existing bridge and current public wharf with rock scour protection along the base of the wall.[19] The purpose of the retaining wall was to protect the bridge abutments and piers from the erosive impacts of high river flows. Its construction would have required excavation along the riverbank and the riverbed. As such, these works would have a considerable impact on the archaeological remains of the former Windsor Wharf.[20]

The scour protection system for the southern bank has been re-designed (see **Annex C**). The primary reason for this re-design was to avoid and minimise impacts to the archaeological remains associated with the former Windsor Wharf.

The scour protection works on the southern bank involves covering the riverbank and the riverbed up to 20 m from the bank with rock armour. The rock armour will also cover the base of the four bridge piles (Figure 28).

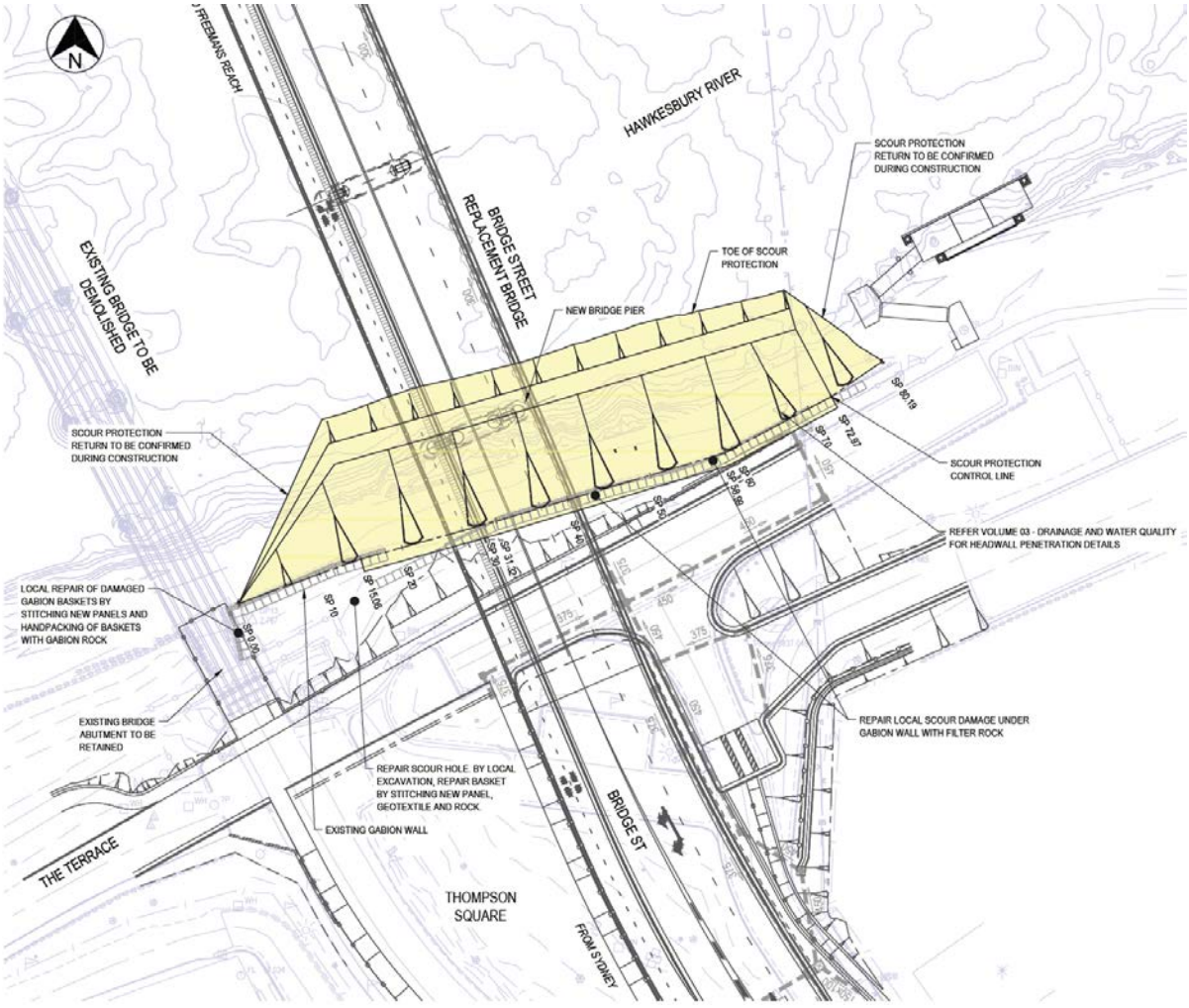


Figure 28: Proposed extent of scour protection on the southern bank and location of southern most bridge piles. [21]

[19] **Sinclair Knight Mertz November 2012** Volume 2 Maritime heritage working paper, pg 85
[20] **Sinclair Knight Mertz November 2012** Volume 2 Maritime heritage working paper, pg 89
[21] **Jacobs & Royal Haskoning DHV 13 April 2017** Hawkesbury City Council Area, MR82 – Bridge Street, Windsor. Windsor Bridge Replacement from Macquarie Street to Wilberforce Road – Detailed Design Volume 09 Scour Protection. **RMS** Registration no. DS2012/000289 Revision 4 : General Arrangement Plan Southern Bank Drawing number NB98005-ECC-DG-0921

Extant structures associated with the former Windsor Wharf site – such as the retaining wall (Phase 5), piles and timber decking (Phase 4) – that are not recovered as part of the archaeological works, will be covered in granular fill to form a smooth surface prior to placing geotextile and rock rip rap.[22] The granular fill shall be a well-graded cohesiveness material (gravel) ranging in size from between 5 and 150 mm.

The rip rap will be composed of igneous metamorphic rock less than 2.5 m across which will be wedged and locked together so that they are not free to move. The rock is not to be dropped or rolled into position.[23] Vegetation on the southern riverbank is to be cleared but there will be no grubbing carried out.

The combined thickness of the granular fill, filter and rip rap rock over the existing bank and riverbed will vary from 1.3 to 2.1 m (Figure 29). There will be no excavation of the riverbank or riverbed for the purposes of installing the proposed scour protection.

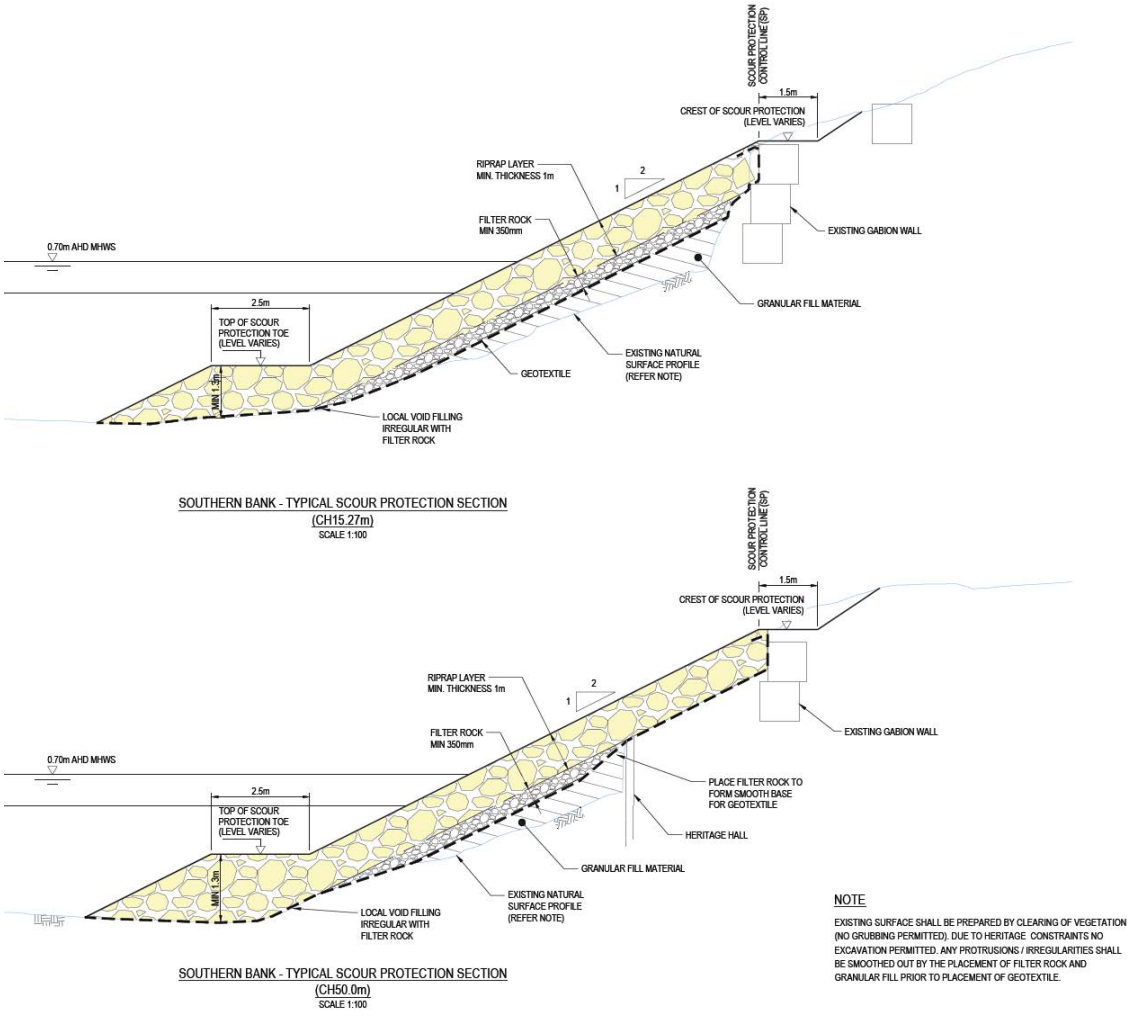


Figure 29: Typical scour protection sections on the southern bank. [24]

The southernmost proposed bridge piles remain in generally the same location as was described in the 2012 EIS (see Figure 28 for pile locations). There will be four piles arranged in two pairs. The distance between the pairs will be 3 m while the distance between each set of piles will be 1.5 m. The piles will be permanently cased cast-in-place reinforced concrete piles, 1.562 m in diameter including the casing (Figure 30).

[22] **Jacobs & Royal Haskoning DHV 13 April 2017** : General notes Sheet 1
[23] **Jacobs & Royal Haskoning DHV 13 April 2017** : General notes Sheet 1
[24] **Jacobs & Royal Haskoning DHV 13 April 2017** : Typical sections Sheet 1

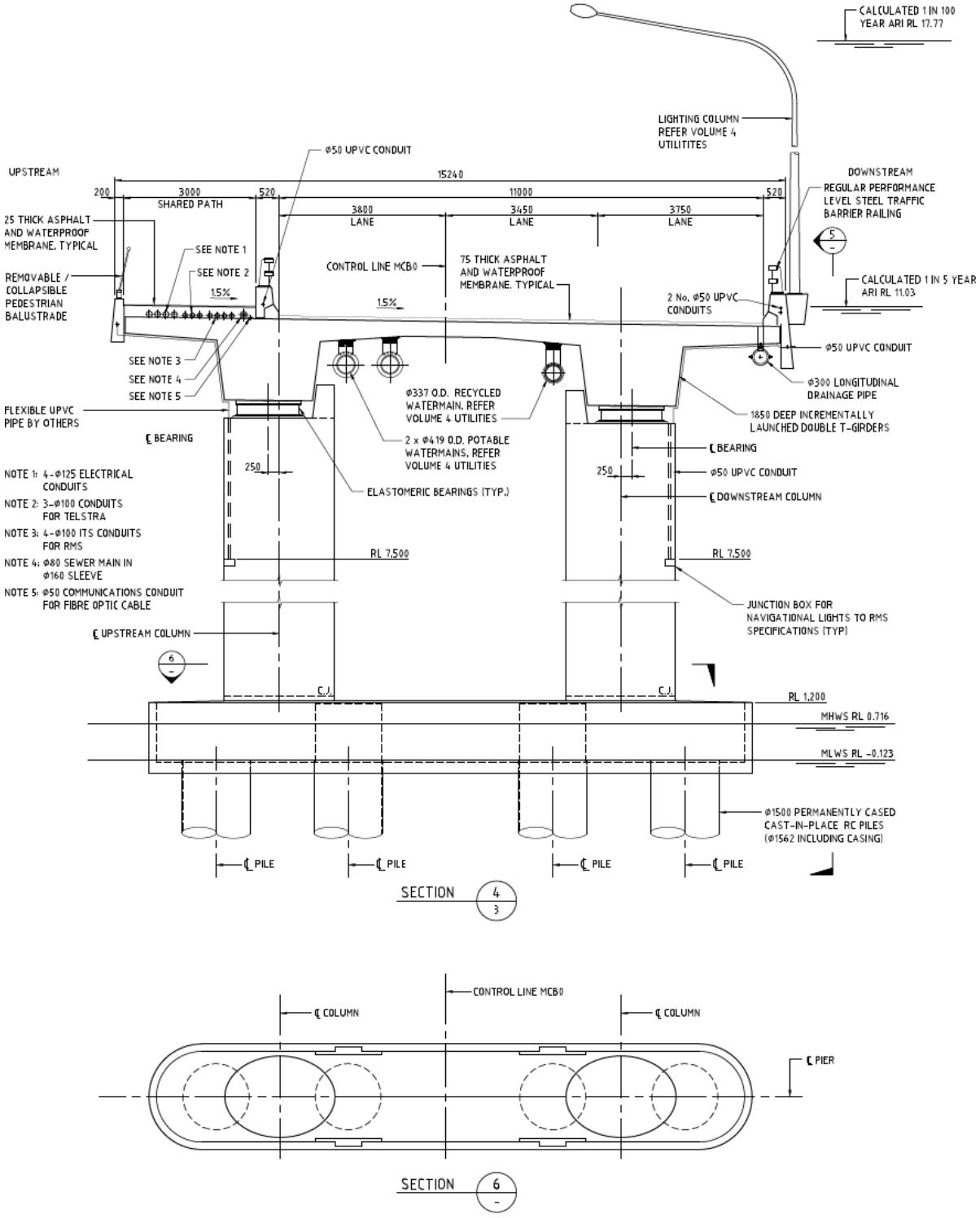


Figure 30: Cross section of the proposed bridge piles that proposed . [25]

[25] **Jacobs 21st October 2016** Bridge over Hawkesbury River at Windsor. Registrations no. of plans DS2012/000155 : General Arrangement Sheet C

9.0 Revised Impact Assessment

As the proposed method of scour protection on the southern bank has changed from that presented in the 2012 EIS, it is necessary to re-assess the impact of the proposed works on the archaeological remains of the former Windsor Wharf. The impact of the proposed piles also requires re-assessment in light of the findings of the test excavation and survey.

The following assessment attempts to quantify the scale of potential impacts to the identified archaeological remains. The following relative scale table will be used:

Table 14: Scale of potential impacts on cultural heritage values.

Negligible	Minor	Moderate	Major	Extreme
No measurable alterations on additions to the existing natural and human processes already impacting on the cultural heritage site.	Low level physical impact to the cultural heritage values of the site but with heritage values remaining largely intact.	Moderate physical impact to the cultural heritage values of the site but with a partial reduction to the heritage values of the site.	Moderate to high level of physical impact to the cultural heritage site resulting in substantial reduction in heritage values of the site.	High level impact resulting in substantial or complete loss of cultural heritage values of the site

9.1 Bridge Piles

How will the piling impact the archaeological remains associated with the former Windsor Wharf?

The four piles are to be placed within the area where cobble ballast has been recorded (Figure 31). One pile will intersect the bedlogs recorded in UWTTT02. The 1.562 m diameter piles will destroy the context and fabric of any archaeological material within the footprint of each pile. The piles are to be bored which means that the impact to the surrounding riverbed will be confined to the dislocation of artefacts and structural elements within their contexts.

What will be the scale of impact of the piling on the archaeological remains associated with the former Windsor Wharf?

An area approximately 6 m in diameter. This would amount to approximately 15% of the exposed cobble ballast. The only bedlogs associated with Phase 2 of the former Windsor Wharf will be severely impacted. At present, it is not known how much of this phase of the former Winsor Wharf survives. It has been assessed that there is potential for the cobble ballast to extend under the Phase 5 rock armour but its condition cannot be determined based on available information. Likewise, there is likely to be more bedlogs associated with this phase present. However, this is not certain and the bedlogs near UWTT02 are the only structural features identified to date that are associated with Phase 2 of the former Windsor Wharf.

Based on this understanding of the proposed works relating to piling and the archaeological potential of the former Windsor Wharf site, it is assessed that the impact of the piling to cultural heritage values of the site – particularly as it relates to the potential to yield information that will contribute to an understanding of NSW's cultural history – are as follows:

Table 15: Impact of piling on cultural heritage values of the different phases of maritime infrastructure at Windsor

Phase	Period/sub-phase	Name	Scale of Impact (without mitigation)
Phase 1	1795 to ca. 1806	Wharf and Store	No impact
Phase 2	1814 to 1860s	Windsor Wharf, early	
	Phase 2a 1814 to 1815	*1st Howe and McGrath wharf*	Major
	Phase 2b 1815 to 1816	*2nd Howe and McGrath wharf*	Potentially Major
	Phase 2c 1820 to 1860s	*Greenway wharf*	Major
Phase 3	1874 to 1934	Windsor Wharf, mid	Negligible
Phase 4	1934 to 1950s	Windsor Wharf, late	Negligible
Phase 5	1950s to present	Bank Stabilisation	Negligible

Have other options been considered?

In 2013 an option was assessed which had the bridge piles moved 10 m towards the centre of the Hawkesbury River.[26] The relocation of the piles to this location would have avoided the impact to structural remains of the former Windsor Wharf site though there may have been a limited impact to archaeological deposits associated with the functioning of the wharf. The relocation of the proposed bridge piles has been re-examined and the project team confirmed that it is not feasible due to other cumulative design impacts.

9.2 Scour Protection

How will the scour protection impact the archaeological remains associated with the former Windsor Wharf?

The covering of the site with rock of various grades and geo-textile, in the manner proposed, will have a positive impact on the heritage values of the site. This is because the site will be protected from the gradual degradation of its heritage values through mechanical (sand abrasion, floating objects, etc.) and biological (marine borers damage) processes which reduce site cohesion and scrambles the information it contains.

The covering of the site is a form of *in-situ* preservation. This conforms with Rule 1 of the Annex to the UNESCO Convention for Protection of Underwater Cultural Heritage which states in part that the '*...protection of underwater cultural heritage through* in situ *preservation shall be considered as the first option.*'[27] However, the Convention is '*Convinced of the importance of research, information and education to the protection and preservation of underwater cultural heritage*' and it is also '*Convinced of the public's right to enjoy the educational and recreational benefits of responsible non-intrusive access to* in situ *underwater cultural heritage, and of the value of public education to contribute to awareness, appreciation and protection of that heritage*'.

[26] **Cosmos Archaeology, October 2013** *Windsor Bridge Replacement; Archaeological Research Design Excavation/Recording Methodology.* Section 3

[27] **United Nations Educational, Scientific and Cultural Organisation, 2001** *Convention on the Protection of the Underwater Cultural Heritage*

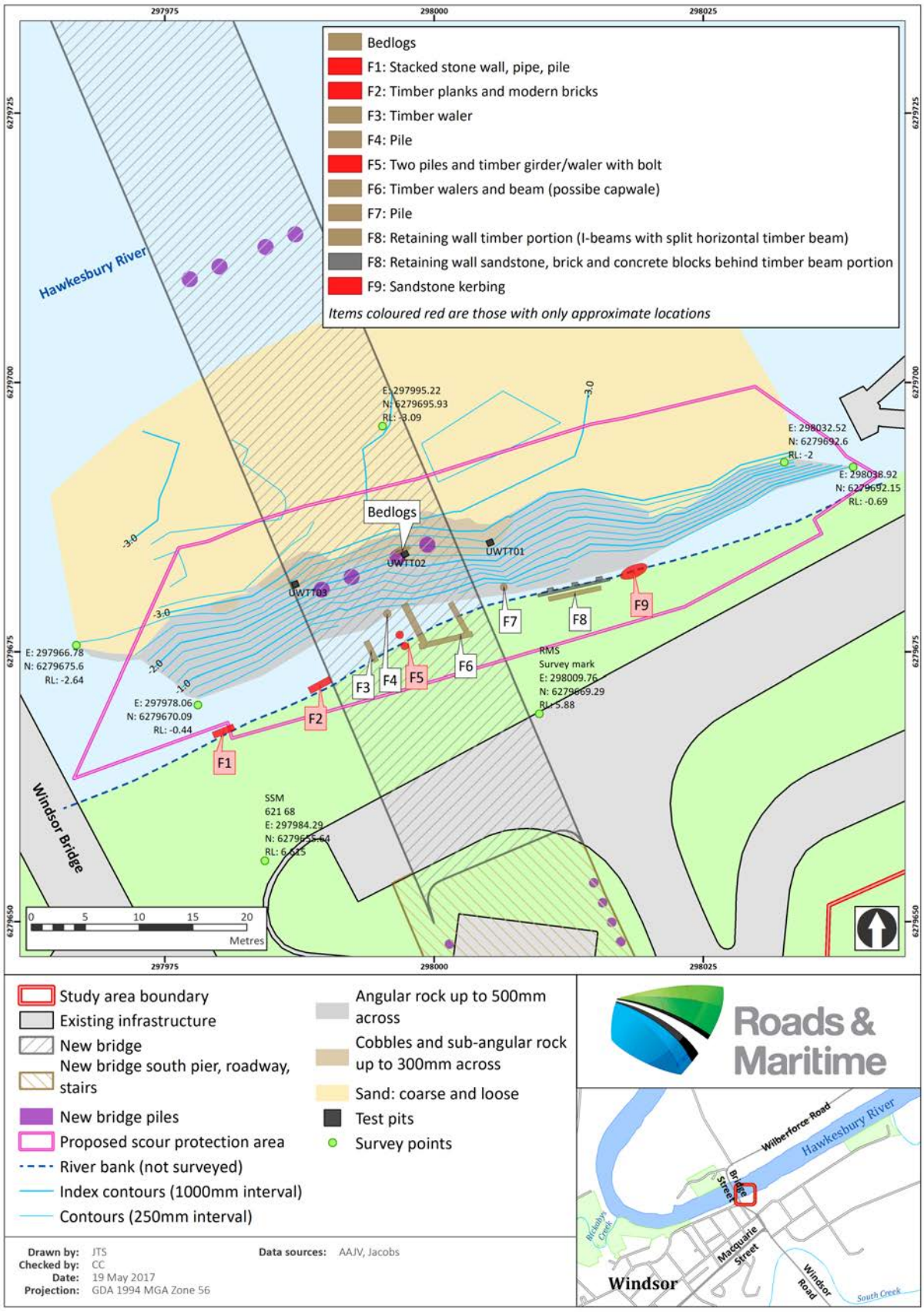


Figure 31: Overlay of the proposed works on the recorded remains of the former Windsor Wharf site.

In situ preservation of underwater cultural sites is standard practice in Australia; the wrecks of the *Clarence*[28], *William Salthouse*[29] and *Solway*[30] are just a few examples. The site protection methods in these examples involved the manual installation of sand bags or ce-grass. As such they could also be manually removed at select locations if the site was to be investigated in the future. The methods employed were in effect reversible, which conforms with Article 15.2 of the Burra Charter – *Changes which reduce cultural significance should be reversible, and reversed when circumstances permit*.[31]

For the examples provided above archaeological excavation had taken place prior to their covering. For the *Solway* and the *Clarence* (2012 season) the excavations were specifically carried out to answer research questions before the sites were covered over.

The proposed scour protection works will make the archaeological remains of the former Windsor Wharf very difficult to access and realistically would render the buried remains inaccessible at least during the life of the new proposed bridge. This can be viewed as a negative impact to the site. Even though the exposed cobble ballast of the Phase 2 of the wharf is a heritage item which is difficult to access by the general public, obtrusive research in the form of archaeological excavation can be used to educate the public about this rare and significant cultural aspect of NSW historical development.

Another potential impact may be scouring around the toe of the riverward edge of the scour protection. Such scouring could result in the exposure of archaeological remains associated with the former Windsor Wharf and result in accelerated degradation.

What will be the scale of impact of the installation and presence of the proposed scour protection on the archaeological remains associated with the former Windsor Wharf?

The proposed scour protection will very likely cover the overwater extent of the former Windsor Wharf, though there is a possibility that, if the Phase 2b wharf was constructed, the downstream and upstream extremities of that structure would not be covered. In any event, the working life of the Phase 2b structure would have been short lived (ca. one year) and the majority of the archaeological deposits which would have formed during the functioning life of the wharf would also be covered by the proposed scour works.

Based on the understanding of the proposed works relating to the scour protection works and the archaeological potential of the former Windsor Wharf site, it is assessed that the impact of these works to cultural heritage values of the site – particularly as it relates to the potential to yield information that will contribute to an understanding of NSW's cultural history – are as follows:

Table 16: Impact of scour protection on cultural heritage values of the of maritime infrastructure at Windsor

Phase	Period/sub-phase	Name	Scale of Impact (without mitigation)
Phase 1	1795 to ca. 1806	Wharf and Store	No impact
Phase 2	1814 to 1860s	Windsor Wharf, early	
	Phase 2a 1814 to 1815	*1st Howe and McGrath wharf*	Major
	Phase 2b 1815 to 1816	*2nd Howe and McGrath wharf*	Potentially Moderate

[28] Australian Historic Shipwreck Preservation Project http://www.ahspp.org.au

[29] **Staniforth, Mark 2006 'in Situ Site Stabilization: The William Salthouse Case Study' In Underwater Cultural Heritage at Risk: Managing Natural and Human Impacts. Heritage at Risk Special Edition. ICOMOS.**

[30] **Coroneos, Cosmos 2006** 'A Cheap and Effective Method of Protecting Underwater Cultural Heritage'. In *Underwater Cultural Heritage at Risk: Managing Natural and Human Impacts. Heritage at Risk Special Edition.* ICOMOS.

[31] **Australia ICOMOS 2013**

	Phase 2c 1820 to 1860s	*Greenway wharf*	Major
Phase 3	1874 to 1934	Windsor Wharf, mid	Minor
Phase 4	1934 to 1950s	Windsor Wharf, late	Minor
Phase 5	1950s to present	Bank Stabilisation	Minor

The minor impact of the scour protection on Phase 5 identifies the burial of the sandstone kerbing which could be recovered for re-use on road repairs where sandstone kerbing is still in place with the Local Government Area.

Have other options been considered?

The 2012 EIS had proposed the installation of a concrete retaining wall along the river bank. This option would have required extensive excavation which would have had a substantial impact on the archaeological remains of the former Windsor Wharf. In addition, there was no rock armour proposed to be laid down around the bridge piles and the river bed between the piles and the concrete retaining wall. The absence of such scour protection would have likely accelerated the rate of erosion of the archaeological remains by destabilising the cobble ballast mound associated with Phase 2 of the Wharf. The option assessed in 2013 had no scour protection or bank stabilisation works proposed.[32] As with the option presented in the 2012 EIS, the absence of such protection would have had considerable long term negative impact to the heritage values of the site.

The present option is considered to be the best for the long term preservation of archaeological remains of the former Windsor Wharf site.

[32] Op. Cit., **Cosmos Archaeology, October 2013** - Section 3

10.0 Proposed Mitigation Measures

A number of mitigation measures are proposed below to alleviate the assessed potential impacts of the proposed scour protection and southernmost bridge piles on the heritage values of the former Windsor Wharf, as discussed in **Section 9**.

Archival recording

Covering of the riverbank will conceal the extant remains of the latter phases of the former Windsor Wharf. An archival recording of the site has commenced however. It could not be satisfactorily completed on account of thick vegetation on the riverbank. This archival recording should be completed once vegetation has been cleared and prior to the installation of the scour protection.

Archival recording of the site would reduce the severity of the impact to the heritage values of Phase 3, 4 and 5 of the former Windsor Wharf arising from the installation and coverage of the scour protection from *Minor* to *Negligible*.

Maritime Archaeological Excavation

Article 28.1 of the Burra Charter states:

> *Disturbance of significant fabric for study, or to obtain evidence, should be minimised. Study of a place by any disturbance of the fabric, including archaeological excavation, should only be undertaken to provide data essential for decision on the conservation of the place, or to obtain important evidence about to be lost or made inaccessible.*

The excavation would address the relevant research questions posed in the ARD, these being modified to specifically address the former Windsor Wharf ca.1814 to 1950s:

- *How was the former Windsor Wharf ca. 1814 to 1950s constructed and how was it modified and altered throughout the 19th century?*
- *Is there any evidence of early ship construction?*
- *What can it tell us about the engineering skills available to the colony within the first five years of settlement*
- *Was ballast used to stabilise the wharf, and which wharf phase was the ballast used for?*
- *How was the risk of flooding managed?*
- *What was the quality of the materials used in the wharf? (I.e. was copper sheathing used? Spacing of piles, size and standard of fastenings). Does this say something about the availability of materials or the level of importance placed on the wharf by the authorities, through comparison with other contemporary wharf sites?*
- *Was the wharf constructed on bed logs or piled directly into the riverbed?*
- *What do the river artefacts tell us about the use of the wharf and the commercial contacts over time?*

To answer these questions, the excavation approach would focus on the exposed bed logs adjacent to UWTT02 with the objective of exposing the whole of these bed logs and ascertaining whether they are fastened together, end on end. The excavation would determine whether there are any further bed logs shoreward and riverward of the aforementioned logs. In addition, further excavation would take place within the footprint of the four bridge pylons. As part of the excavation, all artefacts exposed will be recovered to provide a better understanding of the activities that took place on and around the wharf.

The detailed maritime archaeological research design for this excavation is presented in **Sections 11** and **12**.

Archaeological excavation of the site would reduce the severity of the impact to the heritage values of Phase 2 of the former Windsor Wharf arising from the installation and coverage of the scour protection as well as the piling from *Major* to *Moderate*.

The installation of the scour protection on the southern bank will make the archaeological remains of the former Windsor Wharf relatively inaccessible or, at the very least, important physical evidence from the site will be lost to future generations until such time that the working life of the proposed bridge expires. However, as the physical remains and associated contexts of the site will be protected under the gravel/filter rock/rip rap there is a lessening of an imperative to excavate the site in its entirety to preserve its significance. What is proposed is a balance between minimising the disturbance to the fabric of the site and extracting the important information it contains for the purposes of making it available to the public.

Post Construction management of in situ *maritime archaeological remains*

To ensure that archaeological remains associated with the former Windsor Wharf are not compromised by scouring around the toe of the scour protection after the completion of the bridge construction a monitoring protocol is to be established. Detailed and comprehensive management procedures for maritime archaeological remains will be included in final heritage report required under condition C5. Though these procedures can only be finalised after the installation of the scour protection a broad outline of the likely monitoring protocols is presented below:

1. Baseline survey. Dive inspection of the perimeter of the scour protection, within one month of installation. The inspection would include video survey (if visibility allows) and annotated descriptions of the scour protection and river bed interface on a surveyed plan which shows the extent of the scour protection.
2. First dive inspection. To be carried out six months after the baseline survey.
3. Second dive inspection. To be carried out six months after first dive inspection.

The inspections are to be carried out under the supervision of a maritime archaeologist. The objective of the inspections would be document the extent of scouring, if any observed, and record any cultural features that are exposed. The assessment of the cultural heritage significance of any finds will guide any further mitigation. Depending on the condition of the finds and the level of threat to the find a number of mitigation options could be implemented such as recording the exposed remains *in situ* and covering with rock armour, recovering of artefacts, to limited archaeological excavation. For example If early 19th century phases of the former Windsor Wharf are exposed the appropriate mitigation would be to cover the remains with scour protection or rock armour. Artefacts of cultural heritage significance that would be recovered for examination would be re-buried in the underwater repository established for the artefacts recovered from the maritime archaeological excavation (see **Section 12.7**).

The monitoring protocols will also outline steps to take with regards to inspections to be undertaken in the unforeseen event of erosion occurring up and downstream of the bridge site resulting from the changed conditions on the river bed.

Interpretive signage

The proposed scour protection will cover all remaining visible traces of the former Windsor Wharf. The bridge will pass directly over the site mimicking in part the function of the wharf, that of a transport conduit between water and land. The proposed pedestrian easement under the bridge on the southern bank will provide an excellent opportunity to display historical and archaeological information relating to the wharf and its uses. This could take

the form of signage along the easement and possibly even installing timber planking as the walking surface in the easement spanning the length of the former Windsor Wharf. Artefacts recovered during the excavation such as bricks, glass, ceramic could be jammed between the planking to emulate, in part, the site formation process for archaeological deposits associated with maritime infrastructure such as wharves.

The above mitigation measures replace Recommendation 1 of the maritime archaeological statement of heritage impact in the 2012 EIS.[33] Recommendation 2 is still applicable, which is:

> *Archaeological monitoring works should be undertaken as part of the early site works on the northern side of the existing bridge in the general location of the northern punt landing. This archaeological monitoring should occur during early site preparation works to record any remaining archaeological remains, relics or landscape features that remain of the former crossing.*
>
> *This work should be done by a qualified archaeologist and an archaeological monitoring report should be prepared at the end of the monitoring works and submitted to the Office of Environment and Heritage for their records.*

[33] **Sinclair Knight Mertz November 2012** Volume 2 Maritime heritage working paper, pg 99

11.0 Research Design

11.1 Previous Maritime Archaeological Excavations of Wharf Sites in Australia

The research design and methodology for the maritime archaeological work has been prepared in the following manner:

- An appraisal of previous maritime archaeological excavation work that has been undertaken in Australia on wharf or jetty sites;
- Appraisal of the research questions and methodologies that were asked on these projects and if the methodology was sufficiently robust to answer the research questions;
- Research questions that should be asked for the former Windsor Wharf site.

11.1.1 Long Jetty, Western Australia

The Western Australian Maritime Museum (now the Department of Maritime Archaeology, Western Australian Museum) undertook a maritime archaeological excavation at the location of the former Long Jetty, Bathers Bay, Western Australia.[34] The jetty was Fremantle's first sea jetty built in 1831, and was the focal point for trade and communications for the Western Australian Colony. A maritime archaeological excavation was conducted as the site was to be redeveloped for a new Marina. The archaeological excavation had the opportunity to examine Fremantle's early economic and social development.

The excavation had three objectives:

- Map the remaining jetty structure, ascertain the spread of material and gauge the extent to which it would be covered or disturbed by the development;
- Raise, catalogue, conserve and display a representative sample of material from the threatened area for research and educational purposes; and,
- Verify the heritage value of the Long Jetty with a view to gaining protection for the site, possibly under the Western Australian *Maritime Archaeology Act 1973*.

The excavation was initially conducted with a water dredge, but this was considered too slow considering the area and depth to be excavated. Propeller wash was used instead to expose large areas in a short time. Holes were excavated at 5 m intervals, with divers monitoring the holes and relaying instructions on strength and direction to the boat skipper. An airlift was used in areas too shallow for propeller wash and in areas inaccessible for the boat. Seventy holes were excavated in total. The locations of the trenches were recorded by triangulating their location from the remaining extant piles from the original jetty that were already mapped. Only a sample of the site was excavated, approximately 7,500 m^2 out of 50,000m^2, (ca. 14%) however over 1,140 artefacts were recovered, recorded, catalogued and conserved for display.

The Western Australian Maritime Museum was limited by time constraints, previous looting of the site and low visibility conditions, all of which did not allow for stratigraphic analysis of the sediment and archaeological deposits or slower controlled method of excavation. However, the excavation work and artefacts recovered were sufficient to assess the various economic, social and cultural activities associated with the site. The vast majority of material relates to ships and shipping activities, with a prevalence of alcoholic bottles. There were also artefacts relating to bay whaling, personal belongings, coins, and spent ammunition.

[34] **Garratt, Dena, 1994,** *The Long Jetty Excavation, 14 July to 20 Aug, 1984 – A Report on the Long Jetty Excavation.*

As a site, it consisted of a collection of randomly located material over a vast area, lost over a 90 year time span. Stratigraphy was less evident and had been dramatically altered by environmental and human activities. Despite this, a pattern emerged showing greater concentrations of artefacts under and in the area 0-10 m either side of the jetty and again in the area 15-25 m either side of the jetty. This indicates that the material was either dropped from the side of moored vessels or from the jetty itself, wit those in the outer corridor having a greater association with shipping and less with the jetty.

11.1.2 Albany Jetty, Western Australia

The Western Australian Maritime Museum (now the Department of Maritime Archaeology, Western Australian Museum) also undertook an underwater excavation on the site of the former Albany Town Jetty.[35] The jetty formed Western Australia's international port and was used extensively from the mid-19th century until the 1880s. The site was under threat from a proposed marine upgrade, and the Western Australian Maritime Museum were engaged to undertake a salvage maritime archaeological excavation and recording of the former jetty site.

The project was to assess the impact that the proposed new marina would have on the archaeological remains of the former jetty. The aims of the investigations were to determine if artefacts were present in and around the location of the previous jetty, if there was horizontal patterning of the artefacts in and around the different locations of the jetty, and whether there was evidence for stratigraphic deposits at the site. The information collected could then be used to suggest strategies for minimising the impact of the proposed marina development.

The excavation was conducted with the use of an underwater dredge with divers working using surface supplied breathing equipment. A series of 2 m by 2 m test trenches were excavated using a premade metal square grid frame to mark the boundaries of the excavation area. The resulting excavation area was a conical pit roughly 1.5 to 2 m deep.

In total, 125 artefacts were recovered from the excavation work, with a horizontal distribution of the artefacts present underneath and immediately adjacent to the jetty and another deposit present 10 m away from the edge of the jetty. The lack of personal and alcoholic drinking containers that were recovered from the site suggested the jetty was not used for recreational purposes like other jetties were. The excavation methodology also allowed for the recording of stratigraphic sediment deposits, though the presence of a shell deposit layer across the site below the seabed suggested surge and wave turbulence constantly resorted the accumulated deposits according to density, shape and surface area rather than by chronological deposition.

11.1.3 Holdfast Bay Jetty, South Australia

The Society for Underwater Historical Research (now the South Australian Archaeological Society) in South Australia undertook a maritime archaeological excavation in several locations directly under and immediately around the location of the former jetty built at Holdfast Bay.[36] The project was funded by a research grant for the excavation and a permanent interpretation display at the Glenelg Museum.

The project targeted excavation to beneath former activity areas associated with the former jetty, including underneath the café and aquarium built on the jetty itself. Ten metre by two m trenches were gridded out on the site with smaller 2 m units marked out with star pickets

[35] **Garratt, D. et al., 1995,** An Assessment of the Submerged Archaeological Remains at the Albany Town Jetty.
[36] **Lewczak, Chris and Richards, Nathan, 2007,** Artefact patterning at the Holdfast Bay jetty: Part 1, a consideration of non-cultural site formation factors, in *AIMA 2001 Vol.31*. **Lewczak, Chris and Richards, Nathan, 2007,** Artefact patterning at the Holdfast bay jetty: Part 2, an interpretation of the archaeological deposit, in *AIMA 2001 Vol.31*. **Lewczak, Chris, 2000,** *Where Things May Lie: An Investigation into Artefact Patterning from Within a Coastal Marine Deposit.* Honours thesis, Flinders University, South Australia.

within each trench. The location of these trenches were surveyed with the use of a Total Station. The excavation aimed to answer several research questions, including:

- Where artefacts were distributed on the seabed;
- Whether the artefact distribution was similar to that recorded at Long Jetty and Albany Bay Jetty;
- Whether there was evidence of artefact stratification within the archaeological deposits; and,
- Whether there was evidence for the vertical movement and patterning of artefacts within the archaeological deposits.

The excavation was conducted with the use of a water dredge with divers working systematically through each 2 x 2 m trench. Visibility ranged from one to five metres and allowed for the divers to stop excavating when artefacts were uncovered. It also allowed for recording the location of the artefacts through triangulation, using four measuring tapes to record the location of the artefact in three dimensions.

All artefacts collected were catalogued, recorded and photographed, along with their location information. This allowed for the artefacts to be mapped to their three dimensional location within each trench, enabling analysis of their distribution including factors such as material type, weight and density. The archaeological excavation was able the answer the research questions asked of the site due to accurate, three dimensional recording. It found that the distribution of artefacts underneath and immediately below the jetty matched the predictive modelling that was seen on the Long Jetty and Albany Bay Jetty projects for the location of artefacts located immediately below the jetty structure, and that there is potential for the movement of artefacts within marine sediment deposits based on the density, surface area and/or shape of the artefact.

11.1.4 Heart of the River excavations, Bremer River, Ipswich, Queensland

A cultural heritage study along the Bremer River in Ipswich, Queensland, identified a number of mid-19th century wharves and associated storehouses on the banks of the river within the boundary of the project area. The site continued to be used for commercial shipping and ferry activities well into the 20th century. Three wharves were located within the study area including the J and G Harris wharf, the Australian Steam Navigation Company's wharf and the Railway wharf.

A maritime archaeological survey was carried out in January 2006 by Oceania Maritime Consultants in the vicinity of the three former wharves. The results of the preliminary survey found that there were archaeological remains present on the site of the former wharves that were considered to yield information relating to the understanding of Queensland's history, particularly the early development of Ipswich, the Darling Downs and Brisbane Valley".[37]

Cosmos Archaeology was commissioned to undertake a maritime archaeological investigation in April 2006 for a proposed riverbank redevelopment along the Bremer River in Ipswich, Queensland,[38] including an underwater survey in the location of the proposed pile locations. This survey identified rubble sandstone across the riverbed, as well as artefact remains. The rubble sandstone was located below a shallow deposit of silt across the site, extending out from the base of the bank. The original function of the rock rubble on the site was unknown however, it was speculated that the source could have been from a formal retaining wall or fill material that had collapsed and deflated across the site, or it could have been deliberately cast into the river and used as ballast between the piles. The size of the

[37] **Oceanic Maritime Consultants, January 2006** *A Preliminary Survey of Three Historic Wharf Sites at Town Reach, Bremer River, Ipswich*.:16
[38] **Cosmos Archaeology June 2006**, River Heart Phase 1: Maritime Archaeological Investigation.

rocks are such that they can be lifted by one or two individuals. The assessment argues the rock is likely to be associated with ballasting for former wharves as similar material was not observed along the riverbank in the vicinity of the more recent wharf sites.

Hand fanning was employed on the site to remove silt that had accumulated on top and within the sandstone rubble layer. Artefacts were recorded as being present on the site, including items ranging from copper alloy buttons to iron tie rods, as well as personal and structural remains. There was a large number of smaller artefacts present in concretions present on the rock ballast; including personal items such as a copper alloy zipper tag and a copper alloy broach pin. These items were found at one pile location; however, the results of the underwater survey stipulated that further personal material may be located in the study area if more accurate excavation techniques are employed.

Heavier structural material recorded on the site included handmade and machine pressed bricks, lead flashing, roofing slate and square shanked nails. This material was attributed to either dropped cargo, remains of demolished nearby buildings or mixed fill. Two wrought iron rods, on large with an eyelet and the other smaller, were also recovered and believed to have been structural remains of the former wharf.

The artefacts recovered from the site were not associated with a specific date range – analysis identified a range from prior to 1850 through to the present. No stratification was found within the deposits on the site, and the investigation could not identify if material was directly deposited onto the site, was redeposited by wave action from further upstream or originated from land.[39]

Analysis of the site formation processes for the study area attributed the collection of artefacts to the presence of the rock rubble field. The Bremer River has flooded in its history and is known to be become a fast flowing river. Artefacts were able to fall between the rocks and be held in place, even during times of floods or during other strong currents. The archaeological investigation also assumed that, with the presence of artefacts on the surface between the rock rubble, there is the potential for artefacts to be present within the rock rubble matrix.

The archaeological investigation also considered the date that the rock rubble was deposited on site as this had bearing on the archaeological potential for the site. If the rubble was deposited during the time of the earliest wharf on site, artefacts from that early period were considered likely to be present and include artefacts from vessels docked at the wharf as well as items dropped from the wharf. If the rubble was deposited at a later date, such as from the collapse of a retaining wall, then only artefacts relating from that time, or later, would be captured by the rubble.[40]

11.1.5 Summary of the conduct and findings of maritime excavations of wharf sites in Australia

The excavations undertaken by the Western Australian Maritime Museum (now the Department of Maritime Archaeology, Western Australian Museum) at Long Jetty and Albany Bay Jetty revealed the artefact patterning that is present in and around sites such as wharves and jetties. The excavations show that concentrations of artefacts are present immediately underneath and adjacent to the structure, as well as 10 m out and away from the structure. The distance that artefacts are present further out from the structure is representative of the width of the vessels docking at the jetties, as this represents deposition from the side of the vessels.

Methodologies employed on both excavations was quite different. The Long Jetty excavation used propeller wash from a boat. The propeller wash excavation method would not be suited to the excavation at Windsor as sediments and any artefacts within them would be

[39] *Op. Cit.,* **Cosmos Archaeology, 2006**: 31.
[40] *Ibid.*

scattered. Low to zero visibility diving conditions at Windsor would not enable the collection of scattered artefacts, as was conducted at Long Jetty, and the artefacts would be lost. The excavation methodology used at Albany Bay Jetty employed a 2 x 2 m gridded system and excavation through the use of a water dredge. This excavation was able to record artefacts when they were uncovered, as well as accurately recording the change in sediment profiles. This was successful, in part, to more favourable visibility conditions that were present on the site, as well as to controlled excavation method used.

The excavation undertaken at Holdfast Bay set out a grid system over the activity areas underneath and immediately adjacent to the jetty. The excavation took advantage of better underwater visibility that was present to record artefacts and sediment deposits as they were excavated. This allowed for three dimensional recording techniques to be used on the site. Gridding of the site allowed for more accurate understanding of where artefacts were uncovered and the context of activities they were likely associated with. Use of the water dredge as a means for excavation allowed for a more controlled excavation. This technique would be well suited for use on the site at Windsor as gridding of the trenches and controlled excavation would allow for very specific spatial information to be recorded, including depth and location, despite the zero visibility diving conditions. However, it would not be possible to use the same three dimensional recording techniques for each artefact on this site due to the limited visibility expected in the Hawkesbury River.

The survey and limited excavation at Bremer River in Ipswich was conducted on an archaeological site similar to that at Windsor. The excavation used hand fanning to assess the potential for maritime archaeological remains, including artefacts, on top and within the sandstone rubble remains. The techniques were successful in determining the presence of smaller personal artefacts as well as larger structural remains; however, this technique would be too slow to be used on a large site such as at Windsor. Hand fanning with use of an induction dredge would allow for the faster excavation of the deposits. However, at Windsor, artefacts themselves will only be able to be recorded if they were brought up to the surface, due to the anticipated visibility conditions.

11.2 Maritime archaeological research questions

The following are maritime archaeological research design questions to be asked for the Windsor Wharf site. The archaeological questions can be broken down into three categories.

- The former Windsor Wharf as part of a local and greater regional trade network;
- The former Windsor Wharf as the nexus between river transportation and the settlement at Windsor, and;
- The construction of the various forms of the former Windsor Wharf.

11.2.1 Maritime infrastructure sites as part of a local and greater regional trade network

The construction of maritime infrastructure, initially a jetty and later a wharf, at Windsor was important for the transport of goods and people between the settlement and Port Jackson. This is evidenced by how quickly the jetty was constructed – within one year of the establishment of the formal settlement in 1795. Vessels coming into Windsor were carrying cargo for the satellite settlement as well as for exporting goods. The ballast that is present in the location of the Windsor Wharf site may provide evidence to Windsor's position within a larger regional trade network. This is because some of the rock may have been deposited by vessels under ballast so as to free up space and weight for cargo. An analysis of the ballast present at Windsor, specifically the type of stone used and where it originates, could provide information as to where the vessels were coming from when they arrived at Windsor.

Research Questions

1. *Is there any ballast present which is not of local origin?*
2. *Can non-local ballast be provenanced?*
3. *What can the provenance of the ballast tell us about the trade networks of the port of Windsor?*

How These Questions Can Be Answered

The research questions can be answered by collecting samples of the rock that has been used as ballast and undertaking petrographic analysis. The sample should be taken from different locations and depths in the ballast matrix to determine a relative chronology of when the rock was deposited and the variety of locations where the rock originated.

11.2.2 The former Windsor Wharf as a nexus between the river transport route and the settlement at Windsor

Many activities occur through the use life of a wharf. The wharves at Windsor were used both to import goods to the farming settlement as well as to export goods back to the settlement at Port Jackson and later around the mouth of the Hawkesbury River. The presence and importance of this maritime infrastructure is directly linked to the settlement, growth and development at Windsor. Other activities also take advantage of the presence of a wharf in the local area, such as recreational uses including fishing on a more local level. Activities around a wharf also change as the primary role of the wharf changes or ceases.

Research Questions

4. *What types of activities were occurring at the site of the former Windsor Wharf?*
5. *Was there a change in the types of activities that were being undertaken on the former Windsor Wharf over time?*

How These Questions Can Be Answered

Excavation of the archaeological deposits across different contexts will contribute to answering of these research questions. For this to occur, the excavation must be conducted in a way to be able to identify the different contexts at this site, including within and below the ballast deposits. Excavation will also aid in developing an understanding of the site formation processes, including the construction phases associated with the construction of the wharf. Particular attention should also be paid to any pre-1810s deposits that may be present below the ballast layer and may relate to the shipbuilding activities that took place in the area.

11.2.3 The construction of the former Windsor Wharf ca. 1814 to 1950s

There is limited information available relating to the construction methods of maritime infrastructure in the early settlement of Australia. Information that can be found is incomplete and relies on descriptions or, in the case of Windsor, tender documents, which mention the presence of a wharf or jetty. Information relating to how the structure was built, including technique, material, fastenings and piling works, is not known. The archaeological record has the potential to provide answers to these questions. Evidence of repairs and possible additions may also be found from investigating remains associated with the wharves built at Windsor.

The findings of the test excavation revealed the partially exposed remains of two timber logs which where the right size and location to be bed logs, such as those which wharf piles were checked into. This was the prevailing technology for wharf construction in the late 18th and early 19th century. The smaller diameter log is more buried and appears set lower down into the clay substrate. It is possible that these are the wharf bed logs for two different phases of

wharf construction from the 1810s but are very unlikely to be from as early as the 1790s. It is very likely that other bed logs are present on the site which are buried and/or partially exposed within the ballast zone.

The presence of structural remains of the early 19th century wharf demonstrate a considerable archaeological potential to show how the earliest versions of the second wharf were constructed. Contemporary archaeological evidence of similar maritime structures from NSW and Tasmania, such as Squires Jetty at Putney,[41] Brick Point at Port Arthur,[42] and the teamer jetty at Saltwater River on the Tasman Peninsula,[43] are of jetties. Such linear structures projected out from the bank/shore and their width was dictated by the uniform length of the bed logs.

In the case of a wharf, the structure runs along the bank and it could be assumed that the bed logs would be laid perpendicular to the bank and the width of the wharf essentially influenced by the length of the available bed logs. The discovery during the 2016 investigations of bed logs laid parallel to the bank suggests a more complicated structure as it is very unlikely that a single log could span the length of the early wharf, which was reportedly from 20 m to 23 m long. Was the early wharf constructed from bed logs fastened together end on end or were they free standing with regular spacing between them? Could any inferences be drawn from comparing the manner of construction with how the structures fared when subjected to flooding events? Was there any substantial difference between the Francis Greenway construction (1820) and the 1814, 1815 versions, and could this be attributed to the longevity of the structure compared to these short-lived earlier builds?

Research Questions

6. *How was the former Windsor Wharf ca. 1814 to 1950s constructed and how was it modified and altered throughout the 19th century?*
7. *What is the extent of the remains of the earlier phases of the former Windsor Wharf?*
8. *What was the quality of the materials used in the wharf? Was copper sheathing used? What were the spacing of piles and the size and standard of fastenings? Does this say something about the availability of materials or the level of importance placed on the wharf by the authorities, through comparison with other contemporary wharf sites?*
9. *What can it tell us about the engineering skills available to the colony within the first few decades of European settlement?*
10. *Is there any evidence of early ship construction?*
11. *What do the artefacts associated with the site tell us about the use of the wharf and commercial contacts over time?*

How These Questions Can Be Answered

Excavation within the ballast zone of the site will contribute to answering these questions. The excavation would need to be able to distinguish between the various phases of construction for the wharf. This could be done through a combination of stratigraphical excavation, examination of the materials used and through mapping the location of the bedlogs to determine possible different alignments of the various versions of the wharf. Timbers would need to be exposed and examined for physical evidence of joinery or fastenings and/or repair work. Timber samples would also need be taken.

[41] **Cosmos Archaeology, March 2015, Halvorsen's Boat Building Complex. Maritime Archaeological Assessment.**
[42] **Coroneos, Cosmos 2004,** 'The Maritime History and Archaeology of Port Arthur'. In *A Harbour Large To Admit a Whole Fleet*: 92 and **Cosmos Archaeology June 2000** *Port Arthur Maritime Archaeological Survey: Report on the 2000 field season*: 109 and Figure 33
[43] **Jackman, Greg, 2004** 'Foetal Shore: The sea as critical medium in the past and future of the Tasman Peninsula convict system'. In *A Harbour Large To Admit a Whole Fleet*. : 29

12.0 Excavation Methodology

12.1 Considerations

The excavation approach for this investigation has been shaped by taking the following critical factors into account:

1) From experience, the water visibility on the site of the former Windsor Wharf can vary from 200 mm to zero mm. Water clarity depends on rainfall in the previous days, tide and possible seasonal factors. The turbidity of the water at this location on the Hawkesbury River can provide the diver with the sensation of light (indicating which way is up) and nothing else if visibility is zero. Though the test excavation had 200 mm of visibility, this level of visibility cannot be relied on for a comprehensive excavation. It is possible that the excavation may be conducted solely by touch. This of course limits what can be achieved when compared to a terrestrial excavation. It also means only one diver at a time can effectively work in a trench to avoid confusion and disturbance. Crucial to the success of the excavation programme is the use of trained, experienced and well-briefed divers as well as constant communication between the diver and the surface using hard wire communications.
2) The water depth, of less than 6 m, is shallow enough to avoid concerns of nitrogen build-up and the need for excessive decompression stops, meaning that a diver can stay underwater for a whole day with only short breaks. Such a regimen over a period of weeks would be fatiguing and, in any case, the threat of hyperthermia would limit a diver to working underwater for between 2 to 4 hours a day. This means that a trench will have more than one diver working in separate shifts on it each day. Further to what was stated above, having divers well briefed as to the objectives and methods of the excavation, as well as being briefed by the preceding diver before commencing their shift, will be crucial.
3) From the test excavation it appears that there maybe chronological cultural contexts present that are associated with the late 18th century. This is not commonly encountered in a submerged environment within an Australian context with respect to archaeological excavations. The excavation methodology has been developed to attempt to isolate these contexts in what is a relatively rare opportunity.
4) As the excavation will take place in zero visibility, the diver will have limited ability to recover artefacts on the riverbed. As such, all material, including archaeological material, will be brought up to the working platform via the induction dredge and will be sieved. This is not a common maritime archaeological method as excavations in zero visibility are uncommon within Australia, however, it is thought the best method for the conditions.
5) The rock armour placed over the site in recent years presents a challenge for any underwater archaeological investigation of the site. Potentially up to 2 m thick close to the river bank and comprising of boulders up to 750 mm across, exposing the remains of the former Windsor Wharf would be a laborious task. This is because the boulders would need to be manually moved or individually slung to be lifted by a mechanical excavator or small crane. The requirement for such care is because the depth of the former wharf remains under the rock armour can only be conjectured and as such any attempts at bulk excavation would very likely severely impact the archaeological remains. Furthermore the projected depths of the former wharf remains closer to the riverbank would mean that battering or benching of the rock armour around the area to be investigated would be required. Some form of shoring system may also be needed. Therefore the closer to the riverbank an archaeological investigation takes place, the longer it will take to remove the overlaying rock armour and make the area safe for divers.

12.2 Excavation approach

In general, the excavation will be conducted by divers on Surface Supplied Breathing Apparatus (SSBA). As such, the diver will be tethered to the working platform and able to communicate via communication lines with the crew on the working platform at all times.

The excavation will be carried out with a diver-operated water induction dredge. The sediments will be hand-fanned into the dredge, with the material that is collected by the dredge taken onto the working platform (see **Section 12.5** for more detail on vessels).

At this stage, the working platform is expected to be a dumb barge of 9 m x 4 m with a small container from which dive operations will be conducted (Figures 32 and 33). The working platform has a collection well on board, whereby the sediments and other material can be sent to and passed through sieves on board the working platform. Artefacts can then be collected and sorted. With the sieve well in the centre of the working platform, it is possible to attach a silt screen all the way around the hull forming a skirt.

Figure 32 – Proposed barge for use as a dive and work platform.

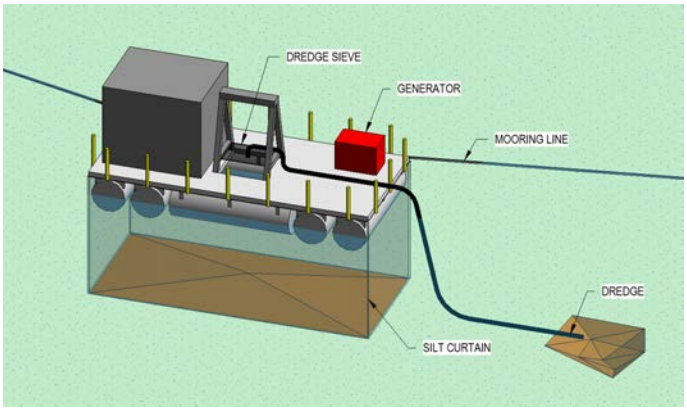


Figure 33 – Proposed configuration of the barge. Container is where diver operations will be based and generator (electric) will power the water induction dredge.

Larger materials, such as ballast, larger artefacts and selected structural remains associated with a wharf, will be excavated first and then removed by hand (if possible) into crates that are then brought to the surface using a suitably rated derrick affixed to the deck.

Underwater recording will be done on a combination of SSBA and SCUBA.

The excavation approach is undertaken in the following phases:

Phase 1 – Site setup.

Phase 2 – Excavation around location of the proposed bridge piers.

Phase 3 – Excavation to locate further wharf bedlogs.

Phase 4 – Mapping of excavated area and exposed structural features.

Phase 5 – Backfilling and site clean up.

Phase 1

The maritime archaeological excavation will commence with an initial site setup that will include setting up moorings for the work platform, establishing datum points on the site both in the water and on the bank, recording the location of all above water features accurately and preparing the location for the first excavation trench.

Phase 2

This phase involves excavating where the four piers will be placed. As the piers will destroy any archaeological information within the footprint of each pier, the aim of the excavation will focus on recovering artefacts within stratigraphic contexts. In addition, exposed sections of bedlogs and other wharf features will be recorded.

The two downstream piers will be covered by a 2 x 6 m long trench – DT1 (Figure 34). This trench will be configured so as to incorporate the exposed bedlogs recorded during the test excavation. The length of the trench may be sufficient so as to expose one or possibly both ends of the bedlogs. The two upstream pier locations will each be covered by a 2 m x 2m sized trench - DT2 and DT3.

These trenches are to be excavated stratigraphically and in spits where possible. They will be excavated down to natural clay. For the purposes of this methodology, these three trenches, which amount to 20 square metres, will be referred to as the 'deep' trenches so as to differentiate those shallower trenches described in the four sub-phases of Phase 3. The depth of the 'deep' trenches is expected to range from between 250 to 1000 mm.

DT2 and DT3 are located within the rock armour and as such the rock armour within a 3 m wide and 9 m long strip will be removed prior to the commencement of excavation (see ST4 in Figure 34).

Phase 3

The aim of the archaeological works in this phase is to learn more about the wharf structure. This investigation can be separated into two sub-phases:

a) Exposure of the bedlogs encountered during the test excavation so as to find the ends of the two logs, and;

b) Uncovering parallel rows of bedlogs towards the riverbank and possibly towards the centre of the river.

c) Investigate the landward extent of the earlier phases of the former Windsor Wharf.

d) Investigate the downstream extent of the earlier phases of the former Windsor Wharf.

Phase 3a would be undertaken if the excavations in Phase 2 do not expose the ends of the bedlogs. Based on what was observed during the test excavation, it is expected that there would be minimal removal of ballast covering these logs, though there may be some removal of the rock armour above the cobbles. The removal of the cobbles and rock armour will be done manually and should not result in the recovery of artefacts. It is not the intention to remove the cobbles down to earlier strata or natural clay. It is proposed that, if required, this 'shallower' form of excavation will continue up to five metres (ST1) downstream of DT1 with a width of 3 m.

The removal of rock armour within a 3 m x 9 m strip that encompasses DT2, DT3 and the upstream portion of DT1 will in essence be a shallow trench (see ST4 in Figure 34).

Phases 3b to 3d will involve the search for additional bedlogs and ballast. This would address the research questions dealing with the construction of the wharf such as the different phases of construction, the spacing of the bedlogs and how solidly the structures were built.

To achieve Phase 3b a shallow trench, 3 m wide, (ST3) is proposed to extend towards the riverbank for at least three metres from the edge of DT1. This would involve the removal of larger rock armour. It is not intended to extend the trench further towards the riverbank as this would require increased effort to remove the increasingly thicker layer of rock armour closer to the bank. Another shallow trench (ST2) is to extend from the deep trench located

over the currently exposed bedlogs towards the river centre for up to four metres or where the ballast ceases, whichever comes first. The purpose of this trench is to determine, and confirm, that the presently exposed bedlogs form the edge of the apron for the former wharf. This shallow trench will also require the removal of sand covering the ballast by water dredge. It is anticipated that the riverward edge of the ballast would signify that the wharf did not extend beyond that point.

Phase 3c will be represented by a 2 m x 2 m trench located between the extant timber piles and waler F3 and F4 (see ST5 in Figure 34). The purpose of this trench is to determine the presence or absence of the early 19th century phases of the former Windsor Wharf. This is also the area where the 1815/16 brick barrel drain may have emptied into the river.[44] Archaeological excavations carried on land in January 2018 discovered the drain and were able to determine its alignment and where it would exit the river bank.

Excavation of ST5 would be achieved by exposing either ballast or bedlogs. It is anticipated that rock armour has not been placed in the immediate vicinity of these extant piles. Should such rock armour however be encountered and after excavation is still present 500 mm below the starting levels of the trench, the excavation will cease. In addition overhead vegetation will need to be cut away and as ST5 is located in an intertidal area excavation will only be carried out at high tide when divers will be able to access the area.

To investigate whether there are remains of the former Windsor Wharf further downstream – Phase 3d - a 3 m x 3 m shallow trench will be excavated at a point midway between the proposed bridge piles and the current public wharf (see ST6 in Figure 34). This location was chosen as 19th century plans of the study area show the wharf was present in this approximate location.[45] In this area the rock armour does not appear to extend far from the river bank and it may be possible with the excavation of the sandy seabed and limited removal of rock armour to find the remains – ballast and/or bedlogs - of the former Windsor Wharf.

Phase 4

This phase focuses on the recording of structures exposed in Phases 2 and 3. The expected zero to poor visibility provides challenges for mapping the excavation area. It is proposed to use a multibeam array that could be mounted on a small boat or even a canoe to map the excavation area at high resolution. Divers could then augment the map with detailed and specific measurements. Key points, such as the ends of the bedlogs will be surveyed using a Total Station. If visibility permits some photography and video would be obtained.

During this phase samples will be taken from the bedlogs to determine timber species. This requires sawing off solid pieces of timber no greater than the size of a matchbox.

Phase 5

This last phase will involve the re-burial of artefacts not selected for conservation or further analysis. It will also involve backfilling the trenches with the ballast recovered during the excavation (see **Section 12.7** for further discussion).

Timings

The excavation will occur before construction works commence and should take approximately 2 months to complete.

[44] *Op. Cit.,* **AAJV, January 2018 :** pg 89
[45] *Op. Cit.,* **Cosmos Archaeology, November 2017 *:*** Figure 27

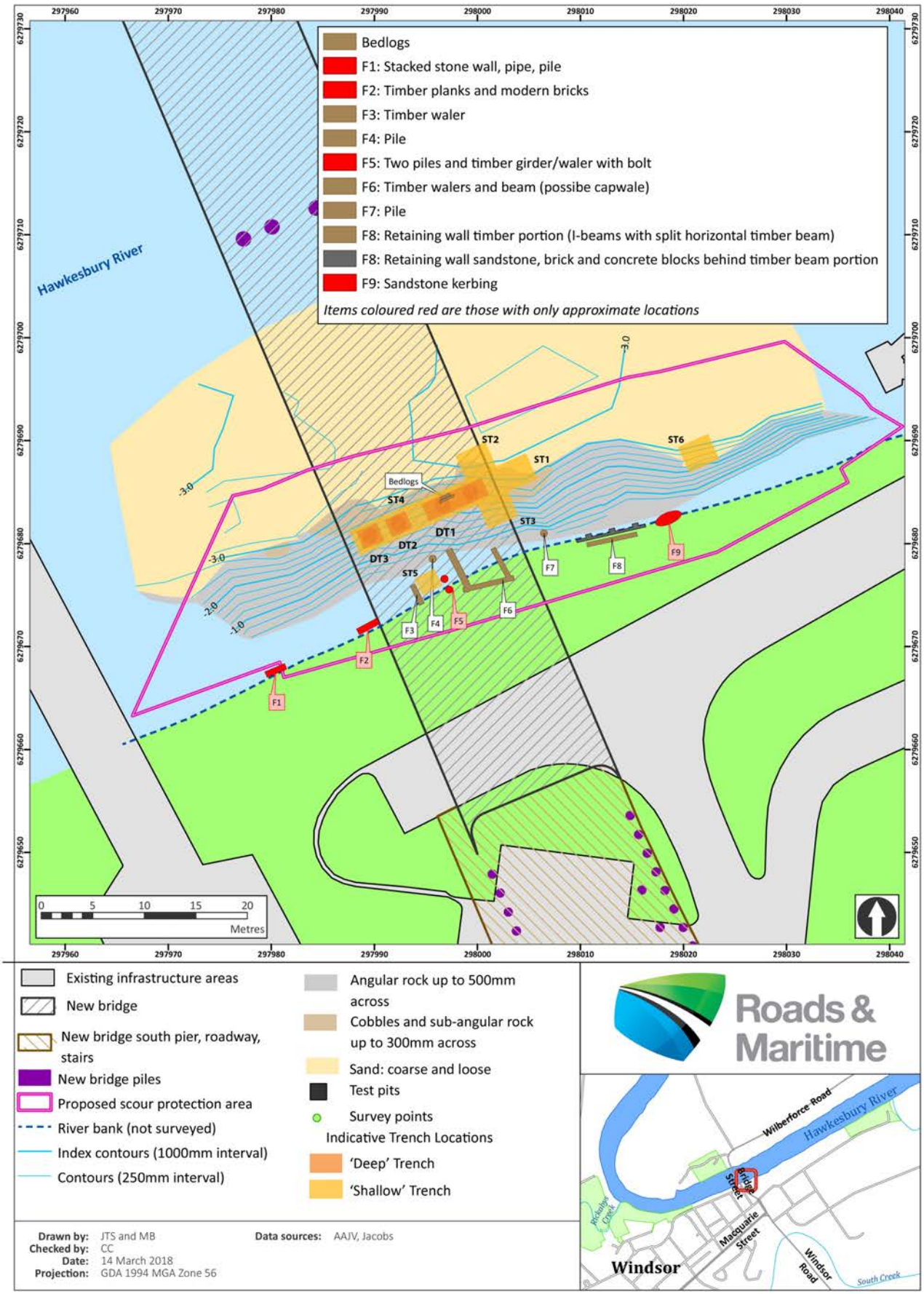
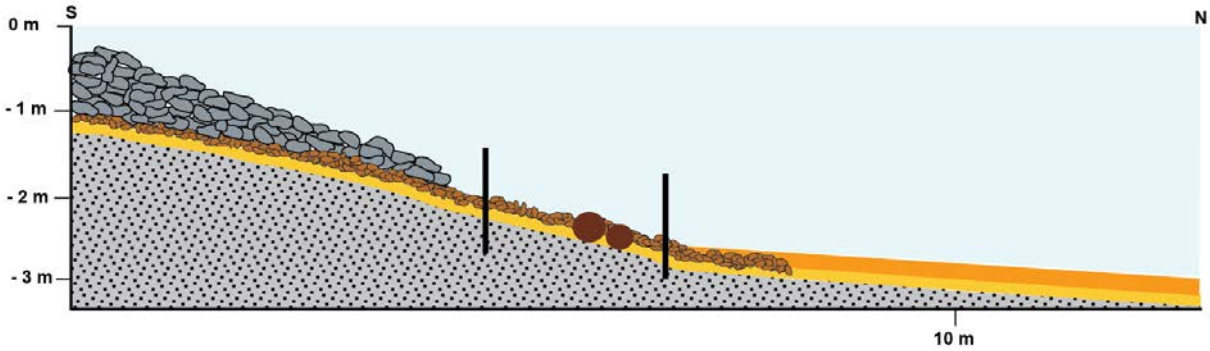
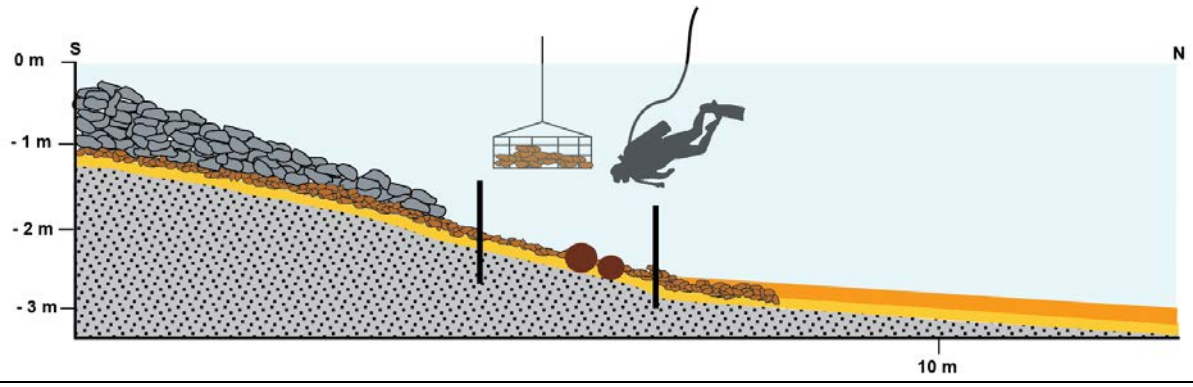
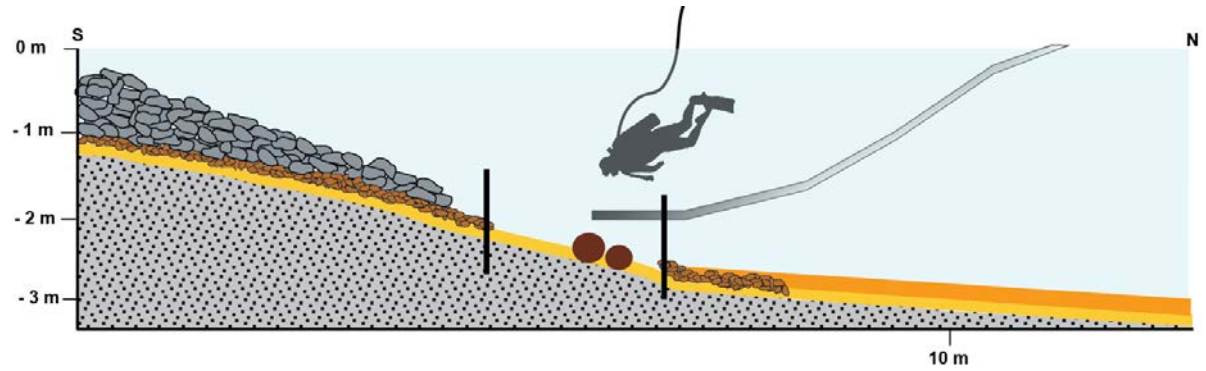
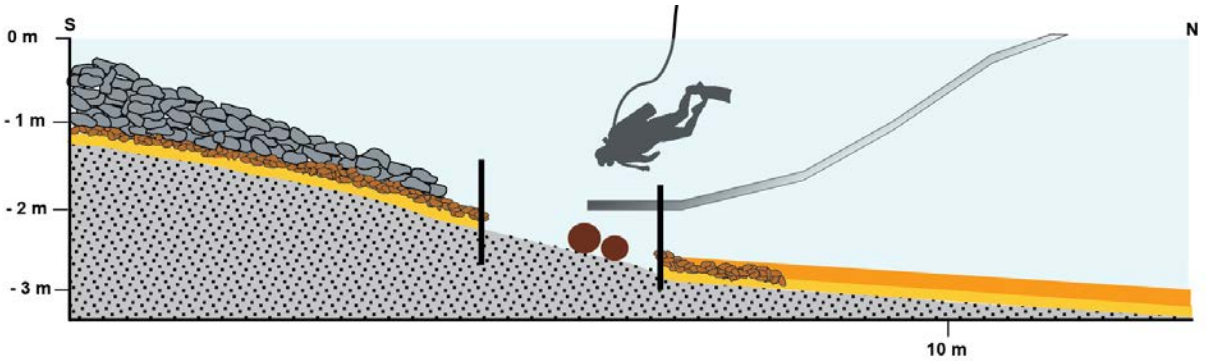


Figure 34 – Location of the proposed archaeological trenches.

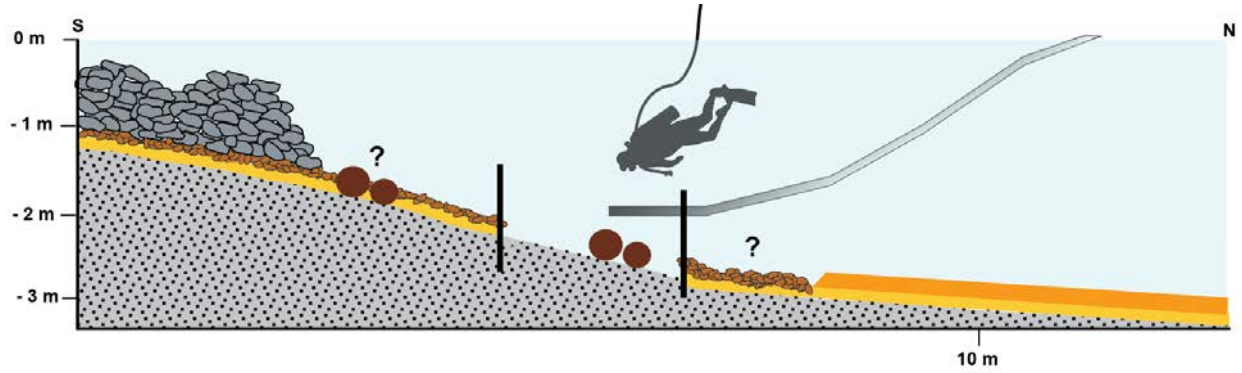
12.3 Excavation techniques

The excavation techniques to be used for this investigation are presented below. They are illustrated so as to assist in the description of the proposed activities. These illustrations are not to scale and are indicative as to what may be present on the site.

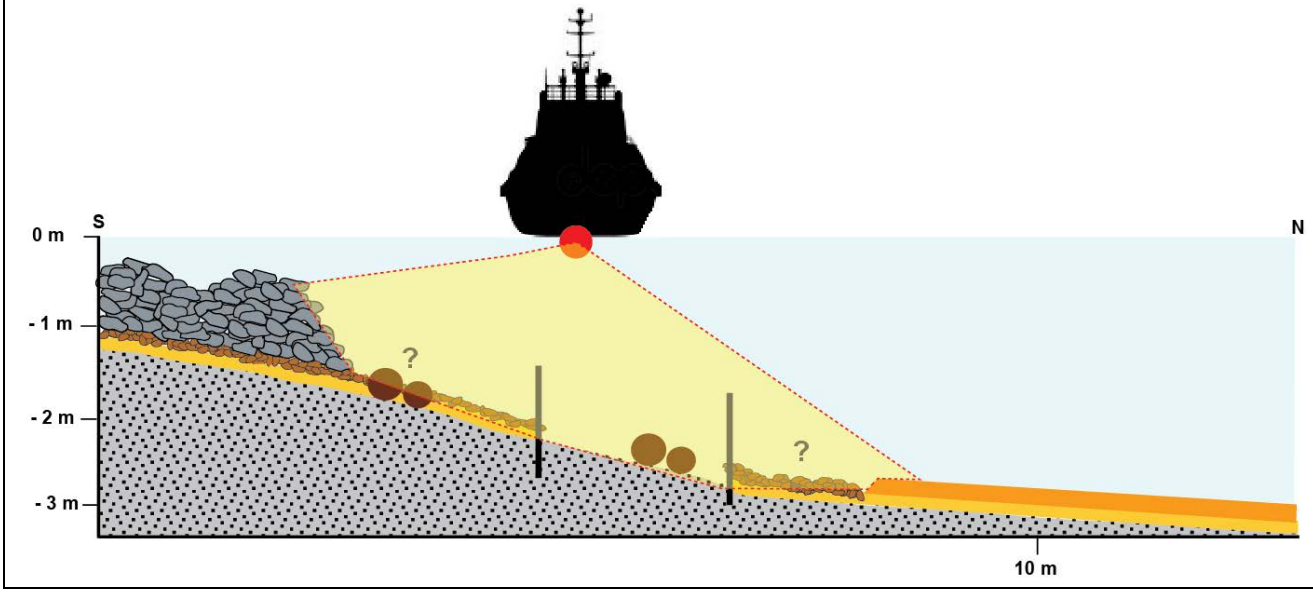
Phase 1 – set up				
Task	**Description**	**Reason for this method**	**Possible Problems**	**Possible Solutions**
Marking out trench boundaries.	The four corners of the trench will be marked out with star pickets, or similar material, as the corner posts.	Controlling the excavation area will allow for accurate recording of materials and artefacts excavated from each trench.	Cannot place star pickets (or similar) through the stone ballast area.	In the event that star pickets cannot be placed into the site, the ballast will be removed within the trench area to define a soft edge of the trench for the diver to work within.
				
Phase 2 – excavation at bridge pier locations (deep trench)				
Removal of loose cobbles.	The upper layer of loose cobble ballast will be removed by hand. Rock armour in vicinity of upstream bridge pier locations will moved aside manually or by diver operated lift bags. Those cobbles with adhered concretions will be recovered. Artefacts encountered within this layer will be recovered and assigned to unique context number.	This upper layer of cobbles appears to be periodically scoured and is frequently disturbed by cultural activities. Therefore, the artefacts in this layer are expected to be a mix of modern and older items and should be separated from the artefacts recovered from within the compacted ballast.	Loose cobble layer is not consistent in its thickness or looseness.	Manual removal of cobbles to stop when hand tools are needed to dislodge the cobbles. Excavation with water dredge to commence at change of context.
				

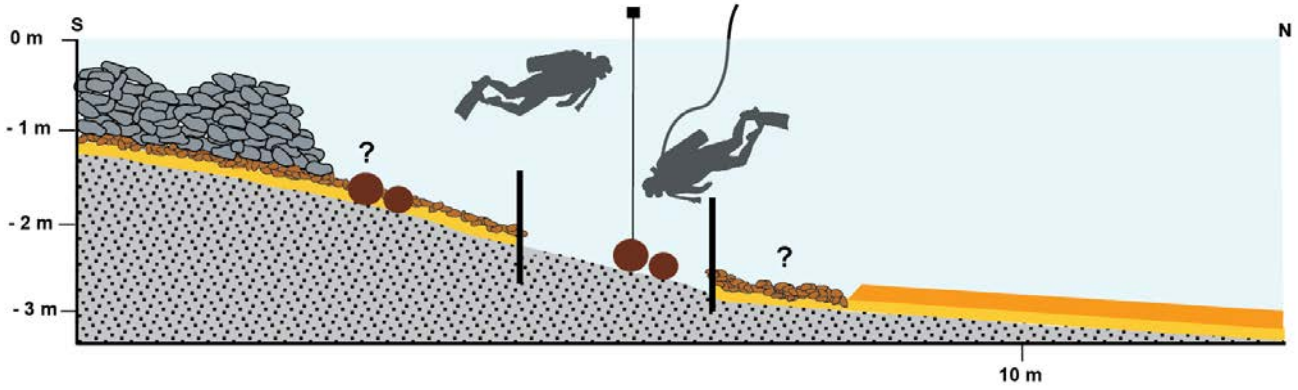
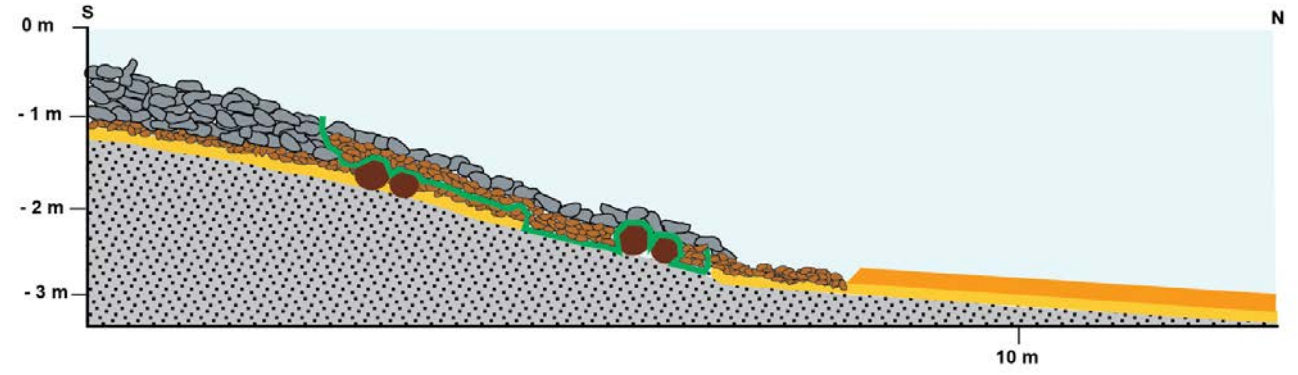
Excavation of compact cobbles.	The compact cobble layer to be excavated using a water induction dredge in 200 mm spits. Those cobbles with adhered concretions will be recovered. The sediment will be sieved on the working platform and artefacts will be catalogued according to context and spit.	Excavating by spits within the compact cobble layer will provide the opportunity to possibly capture changes in activities on the site over time.	The thickness of the compact cobble layer may be less than 200 mm in places.	Excavate as a single spit only. Note on trench plan area where there is more than one spit.
				
Excavation of sand stratum between cobble layer and compact clay substrate.	This sand context will be excavated as a single spit using a water induction dredge. The sediment will be sieved on the working platform and artefacts will be catalogued according to context and spit if deposit is thicker than 200 mm.	This sand context may contain artefacts which were deposited prior to the construction of the wharf in the early 19th century.	The thickness of the sand layer may be more than 200 mm in places. Very unlikely.	Start second spit. Note on trench plan where spits are located.
				
Phase 3 - Excavation to locate further wharf bedlogs ('shallow' trenches)				
Removal of loose cobbles and rock armour.	Cobbles shoreward and riverward of the deep trench at the proposed downstream bridge piers will be manually removed. Rock armour closer to riverbank will moved aside manually or by diver operated lift bags. Overlying sand deposits towards the centre of the river will be excavated using a water induction dredge. The sediment will be sieved on the working platform and artefacts will be catalogued according to context.	The aim of the removal of the rock is to expose more of the bedlogs discovered during the test excavation and any additional bedlogs towards the riverbank. The removal of the sand is required to expose the edge of the ballast. There will be no spits when excavating into the overlying sand as this sand is considered highly mobile and would not contain any meaningful	1. Ends of known bedlogs are not located. 2. Bedlogs not found closer to bank. 3. Sand deposit overlying ballast exceeds 1 m.	1. Continue shallow trench downstream from 'deep' trench until ends of both logs found. Logs should be no longer than 10 m. 2. Assess thickness of rock armour overlying cobbles. If can still be moved manually or by lift bag, continue removal until bedlogs are found. 3/ Continue sand removal until edge of ballast is found.

		chronological stratigraphy.		



Phase 4 - Mapping of excavated area and exposed structural features				
Multibeam survey of excavated area	To be surveyed at high resolution – 100 mm. Trenches are not to be backfilled until the multi-beam survey has been completed.	The purpose of this, apart from providing a general picture of the excavated area, will be to see whether any structural material has been missed by the divers. It will also provide a guide as to what needs to be surveyed in detail using the Total Station	Water too shallow for vessel to pass over the site.	Conduct survey at spring high tide or use kayak with hull mounted multibeam.



Map and record structural features	Key features of the structural remains will be positioned using Total Station operated by a surveyor. Divers will record details such as notches and fastenings. Timber samples are to be taken at this time.	The purpose of this is provide essential information that will contribute to understanding the construction of the wharf.	Structural remains may dislodge during the excavation phase.	Structural remains are to be surveyed as soon as practicable. If remains are dislodged during excavation then the diver will stop and the approximate location of the pile will be surveyed in prior to excavation continuing in that trench.
				
Phase 5 - Backfilling and site clean up				
Backfilling of trenches	Each trench will be lined with geo-tech material and filled with cobbles.	The purpose of this is to demarcate where the archaeological excavation has taken place and to protect archaeological remains left *in situ*. This is standard site management practice.		
				
Relocation of artefacts	Those artefacts not retained for conservation are to be relocated near the site after they have been recorded and catalogued.	The purpose of this is to conserve the artefacts in an environment similar to where they were recovered and be accessible for future study. As such, they cannot be buried within the excavated trenches as they will become inaccessible.	Difficulty finding suitable location for relocation of artefacts.	Excavate hole into clay substrate up or downstream of the site and bury. Alternatively, bury in the upper part of scour rock mound between bank and bridge piers.

12.4 Unexpected finds during the course of excavation

During the course of the maritime archaeological excavation if an unexpected find is made, RMS will be provided with a cultural heritage significance assessment. This assessment will include information describing the find, the cultural heritage significance assessment and advice on how to proceed. This will be undertaken by the Excavation Director. An unexpected find for the purposes of this excavation is defined as, an archaeological structure, feature or deposit which was not identified in the Research Design (See Section 11).If the find is assessed to be of Local heritage significance it will remain in place until RMS provides approval to remove. If the find is assessed to be of State heritage significance then OEH will be consulted on how the find will be managed.

If the unexpected find continues beyond the limits of the proposed trenches then the trench could be extended so far as to better identify and assess the significance of the unexpected find. If an unexpected find is assessed to be of State heritage significance, one recommendation could be to expose the find beyond the limits of the proposed trenches to allow for suitable recording and investigation to take place.

12.5 Proposed work vessels

The following discussion on work vessels takes into consideration the following opportunities and constraints associated with a maritime archaeological excavation at Windsor:

- Transport to and from the work site and the time taken to set up and shut down each day;
- Work space for recording of artefacts;
- Storage space for dive equipment, work gear and artefacts;
- Accommodation;
- Movement on land between excavation area and work compound, and;
- Siting and setting up of work compound.

The proposal for a three vessel solution for the comprehensive excavation is aimed to simplify logistics with respect to movement between land and the site as well as the cost and time required to set up a work compound on land. The three vessels proposed are:

- Work dumb barge (diving, dredging and sieving platform);
- Tender (communication between vessels and shore, moves the dumb barge); and,
- Houseboat (artefact cataloguing, storage, security, accommodation).

Work dumb barge

It is intended that this vessel be moored at the work area for the duration of the excavation (Figure 35). It will need to be transported to the Hawkesbury River on a semi-trailer and craned into the river. The best location for entry onto the River is being investigated and the process will need to be reviewed and approved by RMS.

Once on the River, the tender will push it to the work site and fixed in place with a four point mooring system. Two lines will connect to fixed points on shore while two moorings (twin train wheels) will be placed on the riverbed. The moorings and lines will be set up so that the barge can be manoeuvred short distances by hand.

As discussed in **Section 12.2**, the sieve will be set up over a well in the centre of the barge to allow any silt plume to be contained by a silt curtain attached to the exterior hull.

The use of a work barge that stays on station for the duration of the project will eliminate the time that would otherwise be taken each day in launching/retrieving the work boat and setting up/dismantling the silt curtains.

Tender

The tender will be required to have sufficient power to move the barge to and from the launch site as well as manoeuvring the vessel should it part its moorings. The tender will also have the role of transporting personnel and equipment from the work barge to the houseboat and to shore. It would be used to assist with the excavation such as the raising of artefacts and ballast.

Houseboat

The primary purpose of the houseboat is to serve as the 'dig house' where artefacts recovered from the excavation are stored, recorded, analysed and catalogued. Also stored on the houseboat will be dive and survey gear as well as other stores and tools for the excavation. The tender will be moored at the houseboat each night.

The houseboat will have overnight accommodation for at least four personnel. The crew, who will be rotated during the course of the excavation, will have the role of monitoring the work barge overnight and to take remedial action with the tender should the barge come loose from its moorings. To perform this role effectively, the houseboat would need to be moored within visual distance of the work barge.

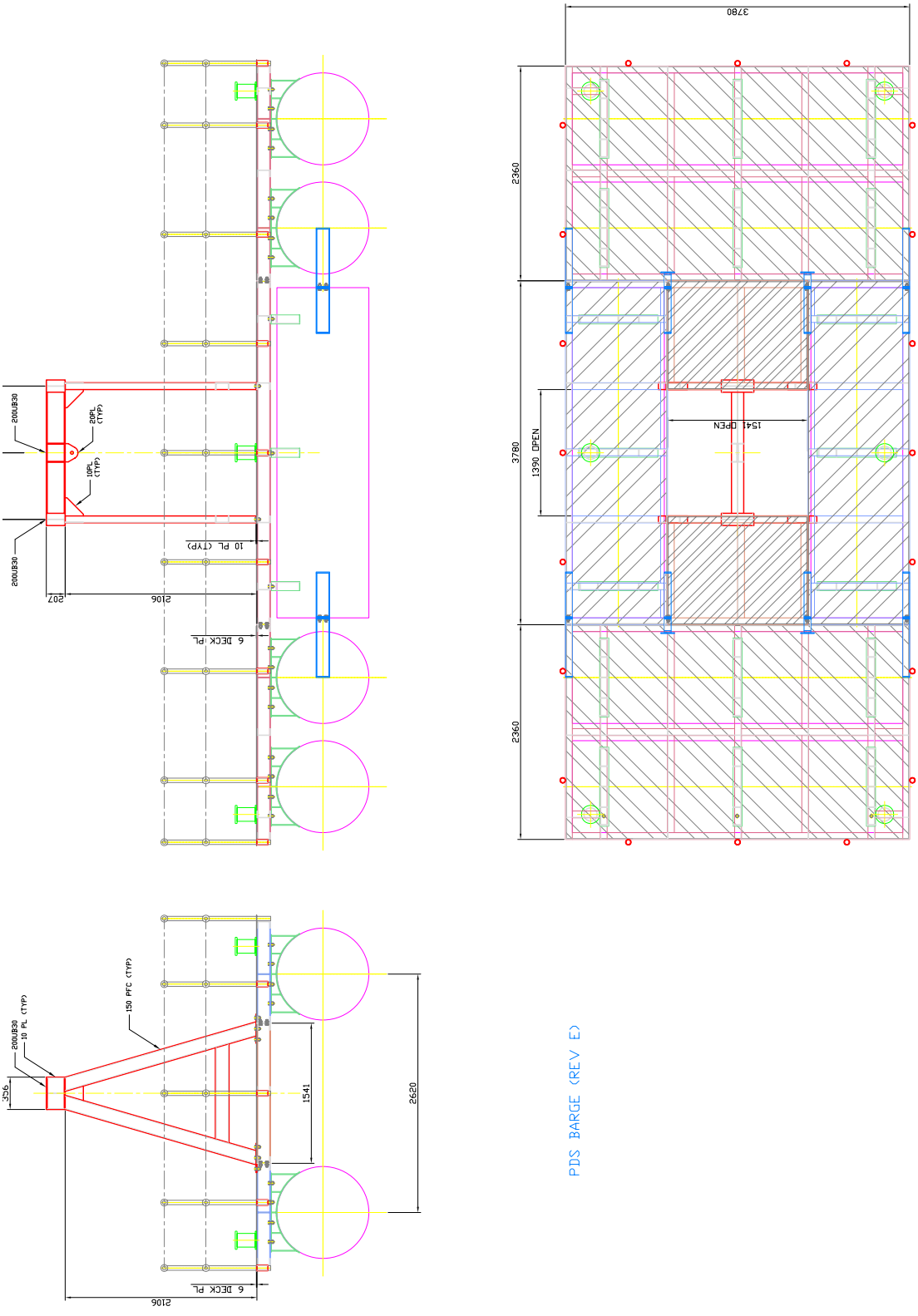


Figure 35 – Schematics of the proposed work dumb barge.

12.6 Personnel

The maritime archaeology excavation will be carried out by Cosmos Archaeology with Cosmos Coroneos as the Excavation Director. The Excavation Director (ED) will be responsible or organising the maritime archaeological divers, coordinating the work and liaising with AAJV and RMS. The ED will also be responsible for ensuring the excavation methodology is being maintained and data is collected at the highest possible standard.

Three maritime archaeologists will be engaged to assist the underwater dredging and recording work. The archaeologists will have a minimum certification of ADAS Part II. They will be working off of the platform moored on the site, with one diver in each trench at a time.

One of the three maritime archaeologists will have the role of Maritime Archaeological Team Leader (MATL). The MATL will be responsible for maintaining standards concerned with the operation and recording of the site underwater.

An additional archaeologist will have the role of Artefact Registrar (AR). It will be the AR's responsibility to coordinate the sieving of the dredge spoil that is brought up onto the working platform. The AR will be responsible for ensuring the artefacts are bagged and catalogued as they are excavated from each spit or context.

A commercial dive team will be engaged to provide all the equipment required for the project. This includes the work barge, tender, SSBA equipment and a three member dive team including dive supervisor. They will also maintain the equipment over the course of the excavation as well as operate the three vessels.

12.7 Artefact recording and curation

It is anticipated that working conditions on the site will be near zero visibility. As this is the case, all artefacts that are encountered during the excavation will be raised; either by the dredge and collected at the sieves on the working platform, or by raising them in crates after the artefacts are placed inside by the diver underwater. All of the artefacts from the same spit will be catalogued as being in the same context.

On the working platform, archaeologists will sieve through the material that is brought up in the dredge. Artefacts that are collected in the sieves will be labelled in the same context and the spit from which they are excavated.

A conservator will be engaged at the commencement of the excavation to detail how to temporarily conserve material that is raised from the river. This will include details regarding temporary storage needs as well as requirements regarding water, filling and changing, light and humidity. Generally the artefacts will be stored in river water on the houseboat as a temporary form of conservation.

All artefacts will be catalogued and numbered for the trench and context that they were retrieved from, as well as if they were retrieved by the diver or from the sieve. They will also be measured, photographed in detail and described.

Prior to the commencement of the excavation, an artefact retention and discard policy will be prepared to guide the excavation team. The policy will detail what class/type of artefacts will be discarded at the completion of recording, which are to be retained for re-burial and which will be nominated for conservation. Generally, State significant artefacts which are rare and/or emblematic of the former Windsor Wharf would be recommended for conservation while modern materials such as plastics, stainless steel and concrete would be discarded.

Artefacts retained for re-burial on site will be placed in plastic bags with their context identification written on tags placed in the bags. The bagged artefacts will be placed in a specially excavated hole on the riverbed away from the footprint of the scour protection. This repository would be covered with rock and its position accurately recorded using a Total Station. This cache of artefacts could later be moved into a specially selected location within the scour protection area for added protection.

The purpose of re-burying a select number of the artefacts is to provide a cost effective long term storage option for these objects. There is a nationwide move by agencies responsible for the management of underwater cultural heritage to create underwater repositories for artefacts recovered from underwater environments. The recently completed Australian Historic Shipwreck Protection Project examined ways in which recovered organic artefacts from the wreck of the *Clarence* (1841-50) could be recovered, recorded and reburied with minimal impact to the integrity of the object.[46] Recent maritime archaeological work in Darwin Harbour saw over 500 artefacts recovered prior to the commencement of dredging, recorded on board work vessels and reburied.[47]

For artefacts to be reburied successfully they require to be returned to a similar environment from which they were recovered. For example, if recovered from a sandy seabed at 10 m of water where there is little current, a similar environment should be sought. This usually means that they should not be re-buried far from where they were found. The artefacts should also be buried at a depth to effect anaerobic conditions, which can dramatically slow down fabric degradation.

Artefact analysis will commence at the completion of the maritime archaeological excavation work. Most of the artefacts that are likely to be excavated will be similar to those recovered on the terrestrial historical archaeological site. Therefore, it is proposed that the photographs and the catalogue of the artefacts obtained from the underwater excavation be provided to the terrestrial team for analysis.

For maritime related artefacts, including maritime infrastructure, recovered from both terrestrial and underwater contexts, it is proposed that there be specialist input from the maritime archaeological team. The advantage of the proposal is that there will be a consistency to the way the artefacts are examined and interpreted. If this proposal is agreed to then a copy of the fields used for cataloguing will need to be supplied by the terrestrial team prior to the commencement of the maritime excavation.

12.8 Reporting

At the completion of the excavation, a report will be prepared detailing the conduct and findings. This report will also answer the archaeological research questions that have been asked of the site. The maritime archaeological excavation report will include the following sections:

- Introduction and executive summary;
- Rationale and planning framework;
- Site history;
- Archaeological background and collated research;
- Archaeological investigation methodology, results and site recordings;
- Conduct;
- Findings;
- Interpretation;
- Addressing research questions;
- Re-assessment of cultural heritage significance;
- Monitoring procedures for the long term management of the site;

[46] **Australian Historic Shipwreck Preservation Project,** available http://www.ahspp.org.au
[47] **Cosmos Archaeology Pty Ltd, February 2014,** *INPEX Ichthys LNG Project: Nearshore Development – Dredging. East Arm Darwin Harbour, Northern Territory. Relocation of Heritage Objects & Removal of Debris.*

- Annex – Artefact catalogue; and,
- CD/DVD of all digital data including artefact photography as well as any video and/or survey data.

In addition to the technical maritime archaeological report, a plain English report (shortened version) will be produced that will summarise the findings presented in the excavation report.

12.9 Workplace Health Safety and Environmental Requirements

A Diving Project Plan and Hazard Identification Risk Assessment will be prepared for the excavation as well as Safety Work Methods Statement (SWMS) for activities not directly related to on-water tasks. All diving will be carried out according to AS2299 Occupational Diving standards.

12.10 Public information and interpretation

Public information on the archaeological program will be managed in accordance with the RMS Community and Stakeholder Engagement Plan for the WBRP. It is proposed at this stage that, as a minimum, signage be placed at the public wharf adjacent to the site and nearby public boat ramps that will contain the following information:

- History of the former Windsor Wharf;
- The rationale and objectives of the excavation; and,
- Safety information such where diving works are taking place and to be aware of dive flags.

13.0 Consultation with Office of Environment and Heritage

This testing report and detailed salvage strategy has been prepared based on the findings of the 2016 test excavation programs for the maritime archaeology, the known and predicted impacts of the Windsor Bridge Replacement Project and relevant stakeholder feedback. The Archaeological Testing Reports were lodged with DPE in May 2017. Comments from OEH were received on 24 July 2017. Issues raised were primarily related to the recommended heritage mitigation and proposed archaeological salvage works.

The Detailed Salvage Strategy was provided to DPE and OEH on 17 August 2017. A meeting in the lead up was held with OEH on 11 August 2017, attended by Dr Siobhan Lavelle (historical archaeology) and Mr Brad Duncan (maritime archaeology). Comments on the strategy were received from OEH on 6 November 2017 and discussed at a meeting held on 20 December 2017, attended by Dr Siobhan Lavelle (historical archaeology) and Mr Stirling Smith (maritime archaeology). Further comments were received from OEH on 15 January 2018 and from DPE on 31 January 2018.

Where appropriate, the document has been amended in line with those comments and to the satisfaction of DPE and OEH.

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Annex A – Dive Log

Date	Diver name	Max depth (m)	Left surface	Left bottom	Total bottom time (min)
29th August 2016	Coroneos	5	1320	1422	54
29th August 2016	Venturoni	5	1520	1613	53
30th August 2016	Coroneos	5	1036	1305	149
30th August 2016	Venturoni	5	1420	1530	70
31st August 2016	Coroneos	5	1036	1136	60
31st August 2016	Venturoni	5	1404	1630	146
1st September 2016	Venturoni	5	1048	1120	50
1st September 2016	Venturoni	5	1205	1240	35
1st September 2016	Coroneos	5	1259	1425	86
2nd September 2016	Forture	5	1035	1100	25
2nd September 2016	Forture	5	1140	1210	30
2nd September 2016	Venturoni	5	1230	1345	45
Total dives	**12**		**Total bottom time**		**803**

Annex B – Artefact Catalogue

Trench	Artefact number	Date	Context	Material	Integrity	Detailed description	Dimensions	Other	Use	Category	Date range
W_UWTT1	001	160831	Unit 1 - Ballast/ upper	Ceramic	Two fragments forming approximately 2/3 of whole bowl	Two fragments of curved ceramic which cleanly join together to form 2/3 of a small cereal bowl. The ceramic is a light white/crème with small dark grey inclusions. The base of the bowl has the makers mark "Johnson of Australia" in a grey-coloured script. The larger section has all surviving elements of the base with walls and rim, while the smaller fragment has cleanly broken from the side of the larger and is just wall and rim. All cracks are clean and show the profile shape of the bowl.	The larger fragment is approximately 140 mm in diameter with all surviving elements of the base and approximately 1/3 of the original walls and rim. The base has a diameter of approximately 60 mm and the original diameter of the rim would have been approximately 170 mm. The height of the bowl is approximately 45 mm with a thickness of about 5 mm at the base and 3 mm on the walls. The smaller fragment has cleanly cracked from the side of the larger, being a part of the walls and rim. It is approximately 80 mm long and 40 mm wide.	Johnson of Australia', also known as 'Johnson Brothers, Australia', was an English-based firm. The Australian branch ran through a firm known as 'Soveriegn Pottery Ltd'. The company produced earthenware crockery with transfer designs in Australia from the early 1950s. Since 1968 Johnson Brothers has operated as part of the Wedgwood Group. Johnson Brothers transfered to China in 2003.	Food bowl	Food and beverage	1950+

W_UWTT1	002	160831	Unit 1 - Ballast/ upper	Glass	Base only	Clear glass base of a bottle. The base has a crescent-shaped stipple and a suction scar. The surviving fragments of the bottle body have "NOT TO … RECYCLE …" embossed. The broken edges of the bottle are jaggered.	900 mm diameter base. Surviving remnants of body are a maximum of 20 mm high.	Stippling was introduced on machine made bottles in the mid to late 20th century to aid in movement on a conveyor belt. The crescent shaped pattern is common on modern beer bottles. The colour of the glass indicates it may have been used for soda.	Soda bottle	Food and beverage	1940+
W_UWTT1	003	160831	Unit 2 - Ballast/ lower	Glass	1/3 of neck and finish	Fragment of amber glass bottle neck and finish. Bottle has an external screw thread. Neck seem is visible. Broken edges are jaggered.	Original diameter would have been approximately 16 mm. Surviving length is 32 mm long and 18 mm wide.	Machine made indicating post 1920s. External screw thread popular from late 1920s onwards. Likely a beer or alcohol bottle.	Beer bottle	Food and beverage	1920+

W_UWTT1	004	160831	Unit 2 - Ballast/ lower	Aluminium	Fragment	Fragment of aluminium which is torn and worn on every side. Slightly curved. One face is decorated with two red horizontal stripes either side of a central white stripe. The red stripes have "ISLAND", possibly the end of "QUEENSLAND", and "WULKURAKA" in italicised upper-case lettering. The back is silver.	Surviving length is 23 mm by 10 mm wide. Original shape unknown. Aluminium is 1/10 mm thick.	Wulkuraka is a suburb of Ipswich in Queensland, an hour from Brisbane. It was the location of a factory for the iconic and widely known McMahon's Soft Drinks from 1977. This item is probably from an aluminium can for a soft drink, however, the specific type of drink could not be determined. Red or maroon is the Queensland state colour and used frequently for Queensland based companies. It is possible that McMahon's Soft Drinks had national circulation.	Soda can	Food and beverage	1977+

W_UWTT1	005	160831	Unit 2 - Ballast/ lower	Ferrous (steel)	Fragment	Metal fragment, possibly ferrous, with one flat side and ragged edges. The flat side is painted white with a black line or partial lettering. Reverse side shows the dark metal. Purpose unknown. Condition of metal and quality of paint indicate a kind of industrial purpose.	Surviving length is 30 mm by 8 mm wide.	Could be the remains of a sign.	UNK	Industrial	UNK
W_UWTT1	006	160831	Unit 2 - Ballast/ lower	Rubber	UNK	Small unidentified plastic or rubber circular cap. Black with white dot on op. Inside has an unknown, possibly natural, white substance embedded inside. From the size of the item, it appears to have been part of an object which may have been a personal item.	Approximately 8 mm in diameter and perfectly semi-circular in profile. Thickness approximately 2 mm.		UNK	Personal	UNK

W_UWTT2	001	160901	Unit 1 - Ballast/ upper	Lead	UNK	Fragment of lead flashing which has been folded roughly in half. All sides are uneven although two may represent the original edges of the item. All surfaces are battered and uneven.	The fragment is approximately 135 mm long by 73 mm wide and the flashing is approximately 2 mm thick.	Lead flashing is commonly used in the construction industry for use on roofs and walls. It was also used in timber vessels as water proofing and as localised sheathing in bow and stern areas. Used heavily in the 19th century although less so today due to environmental impact.	Flashing	Constructio n	1800s+

W_UWTT2	002	160901	Unit 2 - Ballast/ lower	Ferrous	Whole	Single nail in poor condition with concretion obscuring surface and original size. Head is rounded and though concreted, it appears to have had a rhomboid type head. The nail is slightly bent towards the head with a tapered point at the opposite end. The shaft appears to be circular and may have tapered along its length.	Nail is approximately 75 mm long. Surviving concreted thickness of shaft varies from 8 mm to 4 mm, appearing round in profile. The head is 10 mm in diameter.	If the shaft is circular in profile, this nail was likely a wire nail. Wire nails were used in Australia largely from the 1860s and included rose and rhomboid headed nails.	Nail	Construction	1860s to early 20th century

W_UWTT2	003	160901	Unit 2 - Ballast/ lower	Copper alloy	Complete	An Australian penny dated to 1952. The face reads "GEORGIVS VI D:G:BR:OMN:REX:FIDE I:DEF." embossed with the face of King George, and the reverse "AUSTRALIA / PENNY / 1952" and an embossed kangaroo and seven-pointed star. The coin is stained on both sides with brown streaks.	The coin is 30 mm in diameter.		Penny	Currency	1952
W_UWTT2	004	160901	Unit 2 - Ballast/ lower	Plastic	Complete	Likely a plastic ring used for backing a steel bottle cap for a glass bottle. It is thin and flexible with a raised rim. Some fixed concretion attached and the plastic is coloured yellow and black, possibly from the marine environment.	26 mm in diameter.	In the mid-20th century, plastic replaced cork as the compressible liner used with crown caps. Crown caps were used from the 1890s but are common on beer and soda bottles today.	Crown cap liner	Food and beverage	1950s+

W_UWTT2	005	160901	Unit 2 - Ballast/ lower	Glass	Fragment	Fragment of green glass with broken edges. The curve and slight tapering of th glass indicates this is from the body of a tapering bottle. The green colour indictes an alcoholic beverage. The quality of the glass, with uniform thickness and no marks or bubbles in the glass, appears modern.	Approximately 70 mm long by 55 mm wide. Original diamter would have been approximately 100 mm. Glass thickness approximately 3 mm.	Machine made glass bottles with glass of this quality, lacking bubbles, were produced from the 1930s.	Bottle	Food and beverage	1930s+

W_UWTT2	006	160901	Unit 2 - Ballast/ lower	Timber	Fragment	Fragment of timber, possibly shaped as it has one smooth flat side. Heavily damaged with marine borer damage throughout.	Approximately 110 mm long by 65 mm wide and 55 mm deep.	This fragment could have been part of a marine structure or any kind of discarded timber material. The extent of marine borer damage to timber varies greatly in different types of marine conditions and so cannot be used to indicate a time frame that this timber has been in marine conditions. There are no diagnostic features to indicate its original function.	UNK	UNK	UNK

W_UWTT2	007	160901	Unit 2 - Ballast/ lower	Copper alloy	Almost complete	Metal ring, possibly a clench ring. The ring is cast with a solid form, a thick depth and smooth interior and exterior surfaces, although the exterior has feint grooves running around the circumference - perhaps to give it traction. One face has been badly damaged with the result that the surface is 'stepped' along its length.	Approximately 24 mm external diameter and 13 mm internal diameter. It is approximately 6 mm thick.	Clench rings were commonly used for ship building and fitting, however, were typically thinner than this item. Copper alloys were used as fastenings from the late 18th century, originally only in areas where the seawater would otherwise cause a galvanic action with vessels sheathed in copper.	Clench ring	Ship constructio n	1780s+
W_UWTT2	008	160901	Unit 2 - Ballast/ lower	Ferrous (steel)	Complete	Appears to be a small fragment of hardened steel slag, globular and irregular in form. Does not appear to be part of a larger item.	Approximately 23 mm long, 12 mm wide and less than 10 mm thick.	Steel was being made from the late 19th century.	Slag	Constructio n	1870s+

W_UWTT2	009	160901	Unit 2 - Ballast/ lower	Ferrous (wrought iron)	UNK	Small thin wrought iron bar of circular profile which is rounded on one end but defiling on the other revealing the hard, pointed metal of the interior. Possibly the shaft from a small hand tool.	Approximately 90 mm long and 5 mm in diameter along its length with the interior metal measuring approximately 2 mm in diameter at widest and narrowing to a point.		Small hand tool	Constructio n	UNK
W_UWTT2	010	160901	Unit 2 - Ballast/ lower	Aluminiu m	UNK	A coil formed of a thin aluminium strip with ragged edges. The coils are irregular and do not seem to be functional. Likely that this is from a can of food, such as spam, that requried a key to lift a strip of aluminium around the circumference of the can to open.	Coil is approximately 23 mm long. The width of the coiled strip is 2.5 mm and paper thin.	This style of can opening was patented in 1866 in the US by J. Osterhoudt and still used today.	Coil from can	Food and beverage	late 1900s

W_UWTT2	011	160901	Unit 2 - Ballast/ lower	Glass	Fragment	Fragment of clear thin window glass. This fragment is triangular in shape. The thinness of the glass indicates it is crown window glass.	30 mm maximum length, 23 mm maximum width and 2 mm thickness.	Window glass was first imported to Australia from England until the mid-20th c. The thinner crown glass was not suited for Australian weather and so, by the 1870s, the thicker broad glass gained preference. Crown window glass can range from 1 mm to 2.5 mm, with an end date of 1880s.	Windo w glass	Constructio n	to 1880s
W_UWTT2	012	160901	Unit 2 - Ballast/ lower	Glass	Fragment	Fragment of amber glass. Exibits a slight curve indicating it is from a bottle. This fragment is trapezoidal in shape.	17 mm maximum length, 12 mm maximum width and 1 mm thickness.	Amber colour indicates a beer or alcohol bottle. Machine made glass post-dates the 1920s.	Bottle	Food and beverage	1920s+
W_UWTT2	013	160901	Unit 2 - Ballast/ lower	Glass	Fragment	Fragment of very dark olive green glass. Longitudinal curve indicates it is from a bottle. Relatively thick.	23 mm maximum length, 10 mm maximum width and 3 mm thickness.	Dark olive collour and thickness indicates a wine or champagne bottle. Machine made glass post-dates the 1920s.	Bottle	Food and beverage	1920s+

W_UWTT2	014	160901	Unit 2 - Ballast/ lower	Glass	Fragment	Two fragments of very light apple green glass. Both vary in thickness throughout length but are shaped to be flat. Both broken on all sides. Second may have flaked to result in varying thickness.	1) 35 mm maximum length, 10 mm maximum width and varying from 1 mm to 2 mm thick. 2) 20 mm maximum length, 10 mm maximum width and varying from 1 mm to 2 mm thick.	Although not good examples, these are likely crown glass used for windows and mirrors until the 1880s.	Windo w glass	Constructio n	to 1880s
W_UWTT2	015	160901	Unit 2 - Ballast/ lower	Copper alloy	Fragment	Small fragment of copper alloy roughly shaped like a right-angled triangle with a slightly curved, concave, hypotenuse. One corner has also been cut at a diagonal. Short straight edge may be original while the rest appear broken. Slightly curved along length.	12 mm length, 8 mm width and 2 mm thick with a curved height of approximately 5 mm.	Possibly sheathing offcut, flashing or wear plate	Sheathi ng, flashing or guard	Ship or marine constructio n	1780s+

W_UWTT2	016	160901	Unit 2 - Ballast/ lower	Ceramic	Fragment	Fragment of blue-painted ceramic. Thickness varies throughout diameter with thickest part in centre. Roughly round in shape with broken edges. One face is flat while the other is slightly rounded. Painted a light blue on both sides with crème ceramic beneath. Profile of ceramic shows fine composition with dark inclusions.	Approximately 19 mm maximum diameter. Thickness in centre is 1 mm tapering to a pointed edge on circumference.	The size of this item does not appear to be functional on its own. The painted colour indicates it was likely part of a larger ceramic decorative item from which this fragment has become broken off or dislodged.	Decoration	Decoration	1800s+
W_UWTT2	017	160901	Unit 2 - Ballast/ lower	Ferrous	UNK	A flat fragment of concreted ferrous in the shape of an elongated triangle, with one long side more at a right angle to the base than the other. A circular hole is in the centre of the wide end. Surviving metal is flaking apart	Approximately 107 mm long with a maximum width of 30 mm tapering to 7 mm and approximately 2 mm thick. The hole has a maximum diameter of approximately 7 mm.	Possible piece of a hand tool, such as large scissors, or a piece off ferrous offcut.	Small hand tool	Construction	UNK

W_UWTT2	018	160901	Unit 2 - Ballast/ lower	Ferrous	Complete	A long tapering fragment of thick ferrous material with a square cross section at the narrow end and rectangular cross section a the wider end. All visible edges appear shaped with the profile of remaining concretion indicating an undamaged continuation of this shaping. it appears that one long edge of the item is flat with the handle while the other edge tapers away.	Approximately 240 mm long with a minimum exposed width of 30 mm and a maximum concreted width of 60 mm at the opposite end. The narrow end has a square cross section of 30 mm diameter and the larger end has a concreted rectangular cross section of approximately 20 mm by 60 mm.	It is likely that the square end fitted into a wooden handle and that this item was part of a hand tool for shaping material. It may have been similar to a rasp, chisel etc.	Hand tool	Constructio n	UNK
W_UWTT2	019	160901	Unit 2 - Ballast/ lower	Bone	Fragment	Fragment of bone, from a large mammal. One face has a smooth exterior while the interior is porous.	Fragment is approximately 40 mm long with a maximum width of 20 mm tapering to 12 mm with broken edges on all sides.	Appears to bepart of a long bone shaft most likely cattle with possible butchery marks.	Cattle bone	Food and beverage	1788+

W_UWTT3	020	160902	Unit 3 - Ballast /lower	Bitumen	Fragments	Two fragments of bitumen. Both are dark in colour with rough surfaces.	1) Maximum diameter of approximately 45 mm. 2) Maximum diameter of approximately 25 mm.	Bitumen originally used from the 1920s-1930s in Australia, becoming the standard road surface by the 1960s.	Road surfacing	Construction	1920s+
W_UWTT3	021	160902	Unit 3 - Ballast/ lower	Bitumen	Fragment	A fragment of bitumen. Dark in colour with rough texture. One surface is flat indicating a possible road surface.	Maximum diameter of approximately 60 mm.	Bitumen originally used from the 1920s-1930s in Australia, becoming the standard road surface by the 1960s.	Road surfacing	Construction	1920s+
W_UWTT3	022	160902	Unit 3 - Ballast/ lower	Glass	Fragment	Two fragments of clear glass. Curved shape indicate bottle glass. Glass is relatively quite thick. One has green/black adhesive remains of a label. The glass is very good quality.	1) Length 70 mm, width 35 mm, thickness 5 mm. 2) Length 35 mm, width 30 mm, thickness 5 mm.	Machine made glass post-dates the 1920s. Condition of glass, lack of any colour and evidence of label all indicate it is more modern. Likely used as a beverage bottle.	Bottle	Food and beverage	1950s+

W_UWTT3	023	160902	Unit 3 - Ballast/ lower	Brick	Fragment	A sample of red-brown brick with black inclusions. All surfaces are uneven indicating no original surface. Composed of low fired red/brown clay with black stone grog. Sandstock.	60 mm long, 45 mm wide and 40 mm thick.	Brickmaking has occurred in Australia since 1788, with manual 'sandstock' methods used until the 1840s and mechanical methods beginning in the late 1870s. The clay material, fine texture, impurities and variations indicate that this brick was of the earlier sandstock kind.	Brick	Construction	<1840s
W_UWTT3	024	160902	Unit 3 - Ballast/ lower	Glass	Fragment	Fragment of amber glass. Exibits a slight curve indicating it is from a bottle.	17 mm maximum length, 12 mm maximum width and 3 mm thickness.	Amber colour indicates a beer or alcohol bottle. Machine made glass post-dates the 1920s.	Bottle	Food and beverage	1920s+
W_UWTT3	025	160902	Unit 3 - Ballast/ lower	Glass	Fragment	Fragment of apple green glass, slightly rounded indicating it is from a bottle.	20 mm maximum length, 15 mm maximum height and 7 mm thick.	Apple-green colour and thickness indicates a wine bottle. Machine made glass post-dates the 1920s.	Bottle	Food and beverage	1920s+

W_UWTT3	026	160902	Unit 3 - Ballast/ lower	Glass	Fragment	Fragment of clear glass, twisted in shape with two curves on different angles. Not from a bottle but possibly from a drinking glass.	25 mm maximum length, 20 mm maximum width, approximately 5 mm thick.	Machine made glass post-dates the 1920s. Condition of glass, lack of any colour indicates it is more modern.	Drinking glass	Food and beverage	1920s+
W_UWTT3	027	160902	Unit 3 - Ballast/ lower	Ferrous	Fragment	Tack in very poor condition. Heavily corroded so that the original shape is almost indistinguishable. Has a bulbous end indicating that it has a round head. The shaftapperas to be round and tapering to a point.	35 mm in length, head maximum diameter 15 mm, head length approximately 8 mm, shaft diameter approximately 7 mm, shaft length approximately 28 mm. Shaft has a possible round profile.	The shortness of the shaft suggests that this is a tack rather than a nail.	Tack	Construction	1800s+
W_UWTT3	028	160902	Unit 3 - Ballast/ lower	Ferrous	Complete	Nail in good condition. It has a round profile shaft with a hexagonal head. The base end of the nail is shaped into a point. Exibits some evidence of corrosion along its length.	60 mm in length, head diameter 6 mm and shaft diameter 4 mm.	As the shaft is circular in profile, this nail was likely a wire nail. Wide nails were used in Australia largely from the 1870s and included rose and rhomboid headed nails.	Nail	Construction	1870+

W_UWTT3	029	160902	Unit 3 - Ballast/ lower	Copper alloy	Complete	Copper nail in excellent condition. It has a square profile and round head. The nail is bent approximately 1/3 of the length down from the head creating an angle of approximately 135 degrees. The base end tapers to a fine point.	40 mm in length, round head of 4 mm diameter and square profile shaft diameter 2 mm.	Copper alloy fastenings are generally used in marine environments as they do not corrode readily. Such material was almost exclsuively used in the 19th century before galvnised iron and aluminium. This type of nail is commonly used in small timber boat construction or in the upper works or internal fittings for larger craft.	Nail	Ship or marine constructio n	1815+
W_UWTT3	030	160902	Unit 3 - Ballast/ lower	Glass	Fragment	Fragment of clear glass. Exhibits a slight curve indicating it is from a bottle.	33 mm in length, 20 mm width, approximately 3 mm thick.	Machine made glass post-dates the 1920s. Condition of glass, lack of any colour indicates it is more modern.	Bottle	Food and beverage	1920s+

W_UWTT3	031	160902	Unit 3 - Ballast/ lower	Copper	Fragment	Fragment of very thin copper plating. Small in size with irregular edges and rough, dented surface.	22 mm in length, 12 mm width, thickness is approximately 0.1 mm	Copper plating was regularly used as sheathing on timber vessels. Becoming popular in the late 18th century to early 19th century, it is still used today on classical built vessels.	Sheathing	Ship construction	1780+
W_UWTT3	032	160902	Unit 3 - Ballast/ lower	Glass	Fragment	Fragment of amber glass. Curved in shape as if for a bottle with a large circumference. Has the writing "E.REFILL'" finely embossed down one side indicating that this fragment is from the lower body of the bottle. Surviving fragment is roughly square in shape.	20 mm in length, 18 mm width, thickness 3 mm.	Amber colour indicates a beer or alcohol bottle. Machine made glass post-dates the 1920s.	Bottle	Food and beverage	1920s+

W_UWTT3	033	160902	Unit 3 - Ballast/ lower	Glass	Fragment	Large fragment of clear glass, curved in shape indicating a bottle.	80 mm in length, 40 mm width, 5 mm thickness.	Machine made glass post-dates the 1920s. Condition of glass, lack of any colour indicates it is more modern. Thickness of glass and degree of curve indicates a single-serve beverage.	Bottle	Food and beverage	1920s+
W_UWTT3	034	160902	Unit 3 - Ballast/ lower	Lead	Fragment	Fragment of lead plating or flashing with some rounded edges and some ragged. Both surfaces are rough. One side appears to have long parallel scratches.	75 mm in length, 45 mm width, thickness varies from approximately 0.5 mm to 1.5 mm.	Lead flashing is commonly used in the construction industry for use on roofs and walls. It was also used in timber vessels as water proofing and as localised sheathing in bow and stern areas. Used heavily in the 19th century although less so today due to environmental impact.	Flashing	Construction or ship construction.	1800s+

W_UWTT3	035	160902	Unit 3 - Ballast/ lower	Ferrous	Complete	A large hexagonal ferrous nut. All surfaces exhibit thin concretion or growth. The nut has a circular interior for a shaft although any evidence of a thread is obscured. The object is weighty indicating a high proportion of integrity.	60 mm maximum exterior diameter, 33 mm width, 33 mm length of one side, 30 mm internal diameter	Currently used for heavy construction. May be associated with the constructon of one of the later phases of the wharf.	Nut	Constructio n	UNK
W_UWTT3	036	160902	Unit 3 - Ballast/ lower	Ceramic	Fragment	Fragment of white ceramic with blue transfer print. Mostly flat but slightly shaped ridge around one corner indicating part of a round rim or base footing for plate. Cross section is crème with black staining that may be a result of marine or chemical reactions.	20 mm in length, 20 mm width, 4 mm thickness	Ceramic with blue and white transfer print was common in Australia in the earlier part of the 19th century and continues to today.	Plate	Food and beverage	1800s+

W_UWTT3	037	160902	Unit 3 - Ballast/ lower	Ferrous (wrought iron)	UNK	Ferrous item, possibly wrought iron. Appears to have a circular profile with a similar width to diameter. It is concreted which conceals the surface of the item but there is slight evidence of some kind of fine gouged lines running up the sides, parralel with the 'shaft' of the item.	20 mm diameter, 17 mm width	UNK	UNK	Machinery	UNK
W_UWTT3	038	160902	Unit 3 - Ballast/ lower	Ferrous	Almost complete	Nail with a round profile and rhomboid head. The head and most of the shaft is intact with only the tip (and possibly the end of the shaft) missing. This end appears to have been snapped off.	45 mm in length, 8 mm head diameter, 4 mm shaft diameter.	As the shaft is circular in profile, this nail was likely a wire nail. Wide nails were used in Australia largely from the 1870s and included rose and rhomboid headed nails.	Nail	Construction	1860s to early 20th century

W_UWTT3	039	160902	Unit 3 - Ballast/ lower	Slate	Fragment	Fragment of slate. Rounded but irregular edges with an even thickness and finely rough surfaces.	53 mm in length, 20 mm width, 1.5 mm thickness	Slate has been used for roofing in Australia since the second half of the 19th century and is still available today for the restoration of historic buildings. Slate is also curretly used for flooring and decorative walls. Slate was also used in maritime contexts to temporarily note calculations for cargoes or soundings.	Roofing or 'note pad'	Construction/maritime	1780s+

Annex C – Proposed Scour Protection

HAWKESBURY CITY COUNCIL AREA

MR182 - BRIDGE STREET, WINDSOR

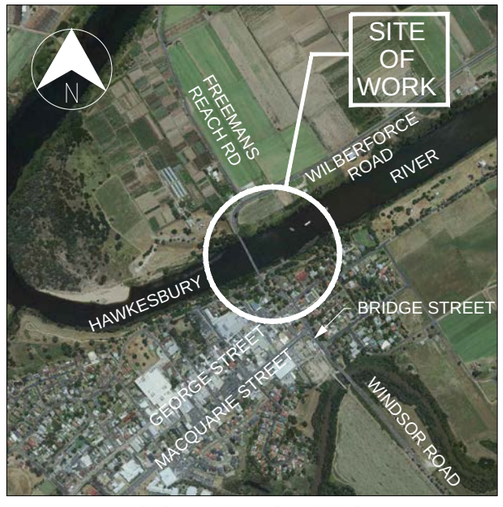
WINDSOR BRIDGE REPLACEMENT

FROM MACQUARIE STREET TO WILBERFORCE ROAD

DETAILED DESIGN
VOLUME 09
SCOUR PROTECTION

DRAWING DOCUMENTATION

VOLUME	DISCIPLINE DESCRIPTION
01	GENERAL
02	ROADWORKS
03	DRAINAGE & WATER QUALITY
04	UTILITIES
05	PAVEMENT & KERBS
06	PAVEMENT MARKING, SIGNS, BARRIERS AND STREET FURNITURE
07	PROPERTY WORKS
08	GEOTECHNICAL
09	SCOUR PROTECTION
10	MINOR STRUCTURES
11	MAJOR STRUCTURES
12	LANDSCAPE DESIGN
13	SUPPLEMENTARY DRAWINGS



LOCALITY SKETCH
NOT TO SCALE

NOT FOR CONSTRUCTION

THIS DRAWING MAY BE PREPARED IN COLOUR AND MAY BE INCOMPLETE IF COPIED
0 5 10 15 20 25 30 35 40 45 50mm ON A3 SIZE ORIGINAL

DRAWING FILE LOCATION / NAME
C:\Users\parishj\AppData\Local\projectwise\rms_projects\dms02688\NB98005-ECC-DG-0901.dwg

LINEAR REFERENCING
START: 000182,1010,A1,0.02 FINISH: 000182,1030,A1,0.0208

PLOT DATE / TIME 4/7/2017 8:40:00 AM PLOT BY shail

PREPARED BY

JACOBS
177 Pacific Highway
North Sydney, SYDNEY, NSW 2060
AUSTRALIA
Tel: (02) 9928 2100 Fax (02) 9928 2500
Web: www.jacobs.com

A COMPANY OF Royal HaskoningDHV Enhancing Society Together

HASKONING AUSTRALIA PTY LTD
SYDNEY
Suite 5, Level 5
100 Walker Street
North Sydney NSW 2060
+61 2 8854 5000 Telephone
+61 2 99290960 Fax
www.royalhaskoning.com Internet

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RMS PROJECT MANAGER
NAME GURJIT SINGH
TITLE PROJECT MANAGER

VALIDATION AND ACCEPTANCE OF THESE DRAWINGS AND THE DESIGN SHOWN THEREON IS TO BE CARRIED OUT UNDER SEPARATE PROCESS

CLIENT
Transport Roads & Maritime Services

PREPARED FOR
GREATER SYDNEY PROJECT OFFICE
SYDNEY OUTER

HAWKESBURY CITY COUNCIL AREA
MR182 - BRIDGE STREET, WINDSOR
WINDSOR BRIDGE REPLACEMENT
SCOUR PROTECTION COVER SHEET

A3

RMS PROJECT No. P.0011444
DESIGN PROJECT No. NB98005
RMS REGISTRATION No. DS2012 / 000289
VOL. 09
ISSUE STATUS DETAILED DESIGN - TENDER ISSUE
EDMS No.
SHEET No. 0901
ISSUE 4

SCOUR PROTECTION - DRAWING INDEX

DRAWING NUMBER	DRAWING TITLE
	GENERAL
NB98005-ECC-DG-0901	SCOUR PROTECTION COVER SHEET
NB98005-ECC-DG-0902	SCOUR PROTECTION DRAWING INDEX
NB98005-ECC-DG-0903	SCOUR PROTECTION GENERAL NOTES SHEET 1
NB98005-ECC-DG-0904	SCOUR PROTECTION GENERAL NOTES SHEET 2
NB98005-ECC-DG-0911	SCOUR PROTECTION TYPICAL SECTIONS SHEET 1
NB98005-ECC-DG-0912	SCOUR PROTECTION TYPICAL SECTIONS SHEET 2
NB98005-ECC-DG-0921	SCOUR PROTECTION GENERAL ARRANGEMENT PLAN SOUTHERN EMBANKMENT
NB98005-ECC-DG-0931	SCOUR PROTECTION CROSS SECTIONS SOUTHERN EMBANKMENT SHEET 1
NB98005-ECC-DG-0932	SCOUR PROTECTION CROSS SECTIONS SOUTHERN EMBANKMENT SHEET 2
NB98005-ECC-DG-0933	SCOUR PROTECTION CROSS SECTIONS SOUTHERN EMBANKMENT SHEET 3
NB98005-ECC-DG-0934	SCOUR PROTECTION CROSS SECTIONS SOUTHERN EMBANKMENT SHEET 4
NB98005-ECC-DG-0941	SCOUR PROTECTION GENERAL ARRANGEMENT PLAN NORTHERN EMBANKMENT
NB98005-ECC-DG-0951	SCOUR PROTECTION CROSS SECTIONS NORTHERN EMBANKMENT SHEET 1
NB98005-ECC-DG-0952	SCOUR PROTECTION CROSS SECTIONS NORTHERN EMBANKMENT SHEET 2
NB98005-ECC-DG-0953	SCOUR PROTECTION CROSS SECTIONS NORTHERN EMBANKMENT SHEET 3
NB98005-ECC-DG-0954	SCOUR PROTECTION CROSS SECTIONS NORTHERN EMBANKMENT SHEET 4
NB98005-ECC-DG-0955	SCOUR PROTECTION CROSS SECTIONS NORTHERN EMBANKMENT SHEET 5

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TITLE	INITIAL	DATE
DRAFTSPERSON	RMD	
DRAFTING CHECK	SH	
DESIGNER	RMD	
DESIGN CHECK	SR	
PROJECT MANAGER	TR	

ORIGINAL DRAWING AT A3 SIZE

CO-ORDINATE SYSTEM: MGA Zone 56 | HEIGHT DATUM: A.H.D.

DRAWINGS / DESIGN PREPARED BY
JACOBS
177 Pacific Highway
North Sydney, SYDNEY, NSW 2060
AUSTRALIA
Tel: (02) 9928 2100 Fax (02) 9928 2500
Web: www.jacobs.com

CLIENT
NSW GOVERNMENT Transport Roads & Maritime Services

PREPARED FOR
GREATER SYDNEY PROJECT OFFICE
SYDNEY OUTER

PROJECT
HAWKESBURY CITY COUNCIL AREA
MR182 - BRIDGE STREET, WINDSOR
WINDSOR BRIDGE REPLACEMENT
SCOUR PROTECTION
DRAWING INDEX

STATUS
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1 GENERAL

ALL LEVELS AND CHAINAGES ARE MEASURED IN METRES UNLESS SHOWN OTHERWISE.

ALL WORKS ARE TO BE CARRIED OUT IN ACCORDANCE WITH RMS LATEST STANDARDS, CURRENT APPLICABLE AUSTRALIAN STANDARD OR AS OTHERWISE SPECIFIED RELATING TO THEIR APPLICATIONS AS LISTED BELOW.

ALL WORKS ARE TO BE UNDERTAKEN IN ACCORDANCE WITH THE DETAILS SHOWN ON THE DRAWINGS, AND IN ACCORDANCE WITH THIS SPECIFICATION.

THE CONTRACTORS SHALL IDENTIFY AND MARK THE LOCATION OF ALL ACTIVE SERVICES IN THE AREA OF THE WORKS.

IT IS THE CONTRACTORS RESPONSIBILITY TO ASCERTAIN IN THE FIELD THE ACTUAL LOCATION AND LEVELS OF UNDERGROUND SERVICES OR ANY OTHER FEATURES THAT MAY BE AFFECTED BY THE WORKS.

THE CONTRACTOR SHALL CONTACT 'DIAL BEFORE YOU DIG', LIAISE WITH RELEVANT AUTHORITIES AND SATISFY THEMSELVES TO THE ACTUAL LOCATIONS OF EXISTING SERVICES BY PHYSICAL LOCATION 'POTHOLING' WHETHER INDICATED OR NOT ON THE DRAWINGS.

EXISTING SERVICES ARE TO BE MARKED AND PROTECTED AT ALL TIMES.

CARE IS TO BE TAKEN WHEN EXCAVATING NEAR EXISTING SERVICES.

ALL ACTIVE SERVICES ARE TO BE RETAINED.

ANY OPERATING SERVICES AND FACILITIES THAT ARE MOVED, DAMAGED OR ALTERED DURING ANY SITE WORKS OTHER THAN THOSE APPROVED IN WRITING BY THE SUPERINTENDENT SHALL BE RESTORED OR REPLACED AT THE EXPENSE OF THE CONTRACTOR.

ALL EXISTING STORMWATER OUTLETS MUST BE RETAINED AND FUNCTIONING BOTH DURING THE WORKS AND AFTER COMPLETION OF THE WORKS.

TEMPORARY DIVERSIONS MAY BE MADE WITH THE APPROVAL OF THE PRINCIPAL.

MEASURES TAKEN TO DIVERT AND REINSTATE THESE OUTLETS MUST BE APPROVED IN WRITING BY THE PRINCIPAL PRIOR TO THESE MEASURES BEING IMPLEMENTED.

ON COMPLETION OF WORKS, ALL AREAS ARE TO BE RESTORED TO ORIGINAL CONDITION.

DURING CONSTRUCTION THE STRUCTURE SHALL BE MAINTAINED IN A STABLE CONDITION AND NO PART SHALL BE OVERSTRESSED. TEMPORARY BRACING AND BATTERS SHALL BE PROVIDED BY THE CONTRACTOR TO KEEP THE WORKS AND EXCAVATIONS STABLE AT ALL TIMES.

2 CONTAMINATION REFERENCE INFORMATION AND MANAGEMENT REQUIREMENTS

2.1 EXCAVATION OF ACID SULFATE SOILS (ASS)

AN ACID SULFATE SOILS MANAGEMENT PLAN (ASSMP) MUST BE PREPARED IN ACCORDANCE WITH THE RMS GUIDELINES FOR THE MANAGEMENT OF ACID SULFATE MATERIALS TO DEFINE MEASURES TO DEAL WITH THE RISKS OF EXPOSING/EXCAVATING ASS AND APPROPRIATE OFF-SITE DISPOSAL.

TREATMENT AND MANAGEMENT OF ASS (IF REQUIRED) SHALL BE UNDERTAKEN IN ACCORDANCE WITH THE ASSMP.

2.2 WASTE CHARACTERISATION AND OFF SITE DISPOSAL

ALL MATERIAL REQUIRING OFF-SITE DISPOSAL MUST BE CLASSIFIED IN ACCORDANCE WITH THE NSW DECCW (2009) WASTE CLASSIFICATION GUIDELINES.

THE DISPOSAL OF EXCAVATED SOIL MUST BE UNDERTAKEN UNDER STRICT PROTOCOLS IN LINE WITH THE NSW WASTE REGULATIONS AS DETAILED IN THE PROTECTION OF THE ENVIRONMENT OPERATIONS ACT (1997).

RECORDS MUST BE MAINTAINED OF THE LOCATION, AREAS AND VOLUMES OF SOIL EXCAVATED FOR DISPOSAL, INCLUDING DETAILS OF THE DATE AND TIME OF TRANSPORT AND THE LANDFILL TO WHICH THE MATERIAL WAS TAKEN.

COPIES OF RELEVANT WASTE TRANSFER LICENCES AND WEIGHBRIDGE DOCKETS MUST BE KEPT AND MADE AVAILABLE ON REQUEST TO THE PRINCIPAL.

2.3 IMPORTATION OF MATERIAL

ANY MATERIAL IMPORTED TO THE SITE FOR CONSTRUCTION OF THE REVETMENT MUST BE CLASSIFIED AS ONE OF THE FOLLOWING:

- VIRGIN EXCAVATED NATURAL MATERIAL (VENM) OR EXCAVATED NATURAL MATERIAL (ENM), AS DEFINED IN THE NSW PROTECTION OF THE ENVIRONMENT OPERATIONS ACT (1997);
- MATERIAL COVERED BY AN EXEMPTION IN LINE WITH THE PROTECTION OF THE ENVIRONMENT OPERATIONS (WASTE) REGULATION 2005 - GENERAL EXEMPTION UNDER PART 6, CLAUSE 51 AND 51A

LABORATORY TESTING SHALL BE UNDERTAKEN PRIOR TO THE IMPORTATION OF INTENDED CLEAN FILL TO DEMONSTRATE THAT THE SOURCE MEETS THE REQUIREMENTS OF THE VENM OR ENM CLASSIFICATION OR THE REQUIREMENTS WITHIN THE RELEVANT SOIL EXEMPTION. A MINIMUM TESTING FREQUENCY OF 1 TEST PER EACH SOURCE IS TO BE ADOPTED.

3 SURVEY

LEVELS ARE TO AUSTRALIAN HEIGHT DATUM .

HORIZON GRID TO MGA GRID SYSTEM.

THE FOLLOWING SURVEY STAGES ARE REQUIRED:

- INITIAL SURVEY (4.1)
- INTERMEDIATE SURVEY (4.2)
- FINAL SURVEY (4.3)

3.1 INITIAL SURVEY

BEFORE COMMENCEMENT OF EXCAVATION WORK ON THE SITE, A CONFIRMATION SURVEY SHALL BE CARRIED OUT TO ALLOW REVIEW OF THE PROPOSED DESIGN AND FOR VOLUME ESTIMATES TO BE CONFIRMED, SPECIFICALLY THE TOE AREA OF THE SLOPE AND LEVELS BELOW WATER LEVEL IN THE RIVER IMMEDIATELY IN FRONT OF THE WORKS.

THE CONTRACTOR SHALL UNDERTAKE SURVEYED CROSS-SECTIONS AND PLANS AT 10 M INTERVALS FOR THE ENTIRE LENGTH OF THE RECONSTRUCTION WORKS.

THEY SHALL BE PROVIDED TO THE PRINCIPAL IN ELECTRONIC FORMAT IN GENIO FORMAT.

THE CROSS-SECTIONS SHALL EXTEND A MINIMUM OF 5 M FROM THE TOP AND BASE OF THE PROPOSED ROCK ARMOUR.

COPIES OF THE SURVEY SHALL BE PROVIDED TO THE PRINCIPAL ONE WEEK BEFORE THE PROPOSED COMMENCEMENT OF EXCAVATION WORKS.

ANY MODIFICATIONS TO THE PROPOSED DESIGN WILL BE RE-ISSUED TO THE CONTRACTOR PRIOR TO WORK COMMENCING. NO EXCAVATION WORK SHALL COMMENCE WITHOUT THE WRITTEN APPROVAL OF THE PRINCIPAL.

3.2 INTERMEDIATE SURVEY

DURING EXCAVATION AND REGRADING OF THE SLOPES (REFER SECTION REVETMENT PLACEMENT), SURVEYS SHALL BE CARRIED OUT TO DEMONSTRATE THAT THE SLOPE MEETS THE DESIGN SPECIFICATION.

THE CONTRACTOR SHALL PROVIDE SUFFICIENT SURVEY INFORMATION TO CONFIRM THAT THE REQUIRED SLOPE GRADES HAVE BEEN ACHIEVED.

THE CONTRACTOR SHALL NOT PROCEED WITH THE LAYING OF THE FOUNDATION LAYERS WITHOUT PRIOR WRITTEN APPROVAL OF THE PRINCIPAL.

3.3 FINAL SURVEY

AFTER COMPLETION OF THE REVETMENT WORKS, A DETAILED FINAL SURVEY (AS SPECIFIED FOR THE DETAILED INITIAL SURVEY) IS REQUIRED AT THE SAME SECTION LOCATIONS AS THE INITIAL SURVEY, TO CONFIRM THAT THE WORKS HAVE BEEN CARRIED OUT IN ACCORDANCE WITH THE SPECIFICATION AND DRAWINGS.

THE CONTRACTOR SHALL BE RESPONSIBLE FOR ANY FURTHER SURVEY WORK REQUIRED DUE TO ANY OF THE WORK BEING INCOMPLETE OR NOT COMPLYING WITH THE SPECIFICATION AND DRAWINGS.

4 EXCAVATION AND EARTHWORKS

ALL EXCAVATIONS AND EARTHWORKS SHALL BE CARRIED OUT IN ACCORDANCE WITH RMS R44.

4.1 CLEAR AND GRUB

CLEARING AND GRUBBING ON THE NORTHERN EMBANKMENT SHALL BE CARRIED OUT IN ACCORDANCE WITH RMS G40.

CLEARING ON THE SOUTHERN EMBANKMENT SHALL BE CARRIED OUT IN ACCORDANCE WITH RMS G40. GRUBBING SHALL NOT BE CARRIED OUT.

5 REVETMENT CONSTRUCTION AND PLACEMENT

5.1 GENERAL

AREAS OF EXPOSED BANK SHALL BE COVERED WITH GEOTEXTILE AT THE END OF EACH DAY, WITH NO MORE THAN 25 METER LENGTH OF REVETMENT TO BE DISTURBED PRIOR TO PLACEMENT OF GEOTEXTILE, AND ROCK REVETMENT.

ALL DISTURBED AREAS SHALL BE COVERED WITH GEOTEXTILE AND PROTECTED FROM WASH AND RIVER CURRENT AS SOON AS PRACTICALLY POSSIBLE AFTER DISTURBING THE SLOPE AND NOT LEFT UNDISTURBED WITHIN THE TIDE AND WASH ZONE OVER NIGHT.

5.2 REGRADING OF SLOPE

5.2.1 NORTHERN BANK

ALL SLOPES SHALL BE EXCAVATED AND TRIMMED TO ACHIEVE THE DESIGN BATTER SLOPES AS SHOWN ON THE DRAWINGS.

EXCAVATION SHALL BE CARRIED OUT TO THE LEVELS AND EXTENTS AS NOMINATED ON THE DRAWINGS.

REGRADING AND PREPARATION WORKS SHALL BE CARRIED OUT TO THE SATISFACTION OF THE PRINCIPAL, WITH INTERMEDIATE SURVEYS CARRIED OUT TO CONFIRM THE DESIGN BATTER SLOPE IS BEING ACHIEVED. (REFER NOTE 3.2)

5.2.1 SOUTHERN BANK

EXISTING STRUCTURES (OLD RETAINING WALLS, PILES, TIMBER DECKING) THAT ARE NOT SALVAGED AS PART OF THE WORKS, SHALL BE COVERED WITH GRANULAR FILL TO FORM A SMOOTH SURFACE PRIOR TO PLACING GEOTEXTILE AND ROCK RIP RAP. NOTE THAT NO EXCAVATION PERMITTED ON THE SOUTHERN RIVERBANK.

5.3 FOUNDATION PREPARATION

FOLLOWING THE SLOPE TRIMMING AND REGRADING WORKS, THE SURFACE OF THE SLOPE SHALL BE MADE CONTINUOUS AND FREE OF VOIDS BY PLACING A FOUNDATION LAYER OF GRANULAR FILL TO PROVIDE A SMOOTH BEDDING LAYER IN PREPARATION FOR SUBSEQUENT WORKS.

THE SURFACE OF THE FOUNDATION LAYER SHALL BE FREE OF SHARP OBJECTS AND PROTRUSIONS TO PREVENT TEARING OF THE GEOTEXTILE LAYER.

THE FOUNDATION PREPARATION WILL BE INSPECTED BY THE PRINCIPAL IN ACCORDANCE WITH RMS G1.

5.4 GEOTEXTILE SEPARATION LAYER

THE GEOTEXTILE SHALL BE 'TEXCEL 600R' OR APPROVED EQUIVALENT PRODUCT.

THE GEOTEXTILE SHALL BE PLACED ON A CONTINUOUS BED FREE OF VOIDS AND SHARP OBJECTS TO PREVENT TEARING.

QUALITY CONTROL CERTIFICATES DEMONSTRATING THE SUPPLIED MATERIALS CONFORM TO THE MANUFACTURERS TESTING SPECIFICATION SHALL BE PROVIDED TO THE SUPERINTENDENT PRIOR TO PLACEMENT.

DETAILS OF THE POSITIONING OF THE GEOTEXTILE ARE GIVEN ON DRAWINGS.

GEOTEXTILE ELEMENTS MAY BE JOINED BY OVERLAPPING A MIN 1000 MM IN ACCORDANCE WITH THE MANUFACTURERS INSTALLATION GUIDELINES.

GEOTEXTILE PLACED IN WATER SHALL REQUIRE BALLASTING TO SECURE IT IN POSITION PRIOR TO PLACEMENT OF THE FULL ROCK ARMOUR LAYER.

5.4.1 RIP RAP AND FILTER LAYER ROCK MATERIAL REQUIREMENTS

THE RIP RAP AND FILTER ROCK USED FOR THE REVETMENT CONSTRUCTION SHALL CONSIST OF IMPORTED MATERIAL WHICH COMPLIES WITH THE CRITERIA OUTLINED IN THE TABLE 1.

5.4.2 SUPPLY OF ROCK FOR RIP RAP AND FILTER LAYER ROCK

PRIOR TO PLACEMENT OF THE ROCK, CERTIFICATION SHALL BE PROVIDED TO THE PRINCIPAL TO SHOW COMPLIANCE WITH THE SPECIFICATION.

THE CERTIFICATION SHALL BE PROVIDED AT LEAST 7 DAYS PRIOR TO IMPORTATION AND APPROVAL MUST BE RECEIVED IN WRITING, FROM THE PRINCIPAL PRIOR TO PLACEMENT OF THE ROCK ARMOUR LAYER.

THE PRINCIPAL SHALL INSPECT THE QUARRY (AND ROCK MATERIAL) AND PREPARED ROCK PRIOR TO DELIVERY TO CONFIRM ABOVE MATERIAL REQUIREMENTS (QUALITY AND SIZE) ARE MET.

5.4.3 SUPPLY OF GRANULAR FILL

GRANULAR FILL SHALL BE A WELL GRADED COHESIONLESS MATERIAL (GRAVEL) WITH MAXIMUM 5% (BY WEIGHT) PASSING 4.75MM SIEVE AND A MAXIMUM STONE (PARTICLE SIZE OF 150MM)

5.4.4 PLACEMENT OF RIP RAP AND FILTER ROCK

THE RIP RAP LAYER SHALL BE PLACED SUCH THAT THE FINISHED BATTER SLOPE, CREST AND TOE LEVELS, AND LAYER THICKNESS ARE SATISFIED.

IN ADDITION, ROCKS SHALL BE WEDGED AND LOCKED TOGETHER SUCH THAT THEY ARE NOT FREE TO MOVE, TO THE SATISFACTION OF THE SUPERINTENDENT.

ROCK SHALL NOT BE ROLLED OR DROPPED INTO POSITION.

THE METHOD OF PLACEMENT SHALL BE SUCH AS TO:

- MINIMISE ROCK BREAKDOWN ON HANDLING AND THE RESULTING PRODUCTION OF SMALLER ROCK;
- MINIMISE THE SEGREGATION OF VARIOUS GRADES OF ROCK; AND
- PREVENT DAMAGE TO THE GEOTEXTILE LAYER.

5.4.5 FINISHED LEVELS REVETMENT

THE CONSTRUCTION TOLERANCES FOR FINISHED LEVELS SHALL BE + 100 MM ROCK REVETMENT AND PROVIDED MINIMUM THICKNESS OF ROCK REVETMENT AND CAPPING AS SHOWN ON THE DRAWINGS IS ACHIEVED.

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TITLE	INITIAL	DATE
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DRAFTING CHECK	SH	
DESIGNER	RMD	
DESIGN CHECK	SR	
PROJECT MANAGER	TR	

ORIGINAL DRAWING AT A3 SIZE

CO-ORDINATE SYSTEM: MGA Zone 56 | HEIGHT DATUM: A.H.D.

DRAWINGS / DESIGN PREPARED BY: JACOBS; Royal HaskoningDHV

CLIENT: NSW Government Transport Roads & Maritime Services

PREPARED FOR: GREATER SYDNEY PROJECT OFFICE SYDNEY OUTER

PROJECT: HAWKESBURY CITY COUNCIL AREA
MR182 - BRIDGE STREET, WINDSOR
WINDSOR BRIDGE REPLACEMENT
SCOUR PROTECTION
GENERAL NOTES
SHEET 1

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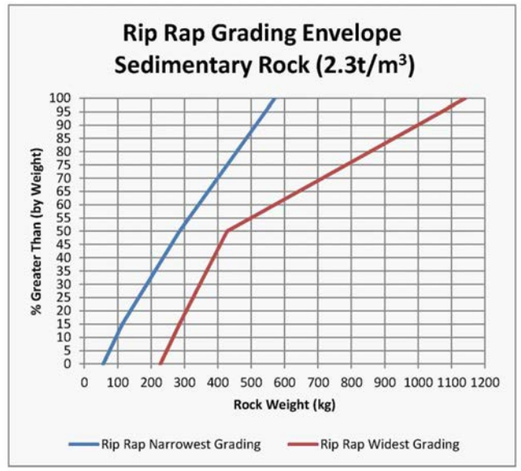
TABLE 1 ROCK PROPERTIES RIP RAP AND FILTER ROCK

PROPERTY	TEST METHOD	UNIT	CRITERIA	FREQUENCY
GENERAL ROCK TYPE AND PROPERTIES	PETROGRAPHIC AND VISUAL EXAMINATION		INDIVIDUAL ROCKS ARE TO BE FREE FROM CRACKS, CLEAVAGE PLANES, SEAMS AND DEFECTS, WHICH WOULD RESULT IN THE BREAKDOWN OF THE ROCK IN A MARINE ENVIRONMENT. FINE GRAINED SEDIMENTARY ROCKS SUCH AS SHALE, SILTSTONE AND MUDSTONES ARE NOT SUITABLE DUE TO PHYSICAL WEATHERING (SLAKING) WHICH CAUSES BREAKDOWN ON REPEATED WETTING AND DRYING	MINIMUM ONE PER SOURCE OF ROCK
STRENGTH	USC (WET)	MPa	>20 (SEDIMENTARY) > 60 (IGNEOUS METAMORPHIC)	MINIMUM THREE TESTS (1 PER 200 m^3)
	IS(50) POINT LOAD (WET)(T223)	MPa	> 1.5 (SEDIMENTARY) > 5 (IGNEOUS METAMORPHIC)	MINIMUM THREE TESTS (1 PER 200 m^3)
	WET/DRY STRENGTH RATIO (T215)	%	< 25 %	MINIMUM THREE TESTS (1 PER 200 m^3)
DENSITY	DRY UNIT WEIGHT	TONNE/m^3	>2.3 (SEDIMENTARY) >2.6 (IGNEOUS)	MINIMUM THREE TESTS (1 PER 200 m^3)
DURABILITY	SODIUM SULPHATE SOUNDNESS (5 CYCLES)	%	< 9%	MINIMUM THREE TESTS PER SOURCE OF ROCK
MAX/MIN DIMENSION	VISUAL INSPECTION	-	< 2.5	DAILY ONE PER SOURCE
DIMENSION/WEIGHT BLOCKS	VISUAL INSPECTION AND MEASUREMENTS	kg/BLOCK	REFER TO GRADING ENVELOPES	DAILY ONE PER SOURCE WEEKLY BRIDGE AND MEASUREMENT EACH BLOCK

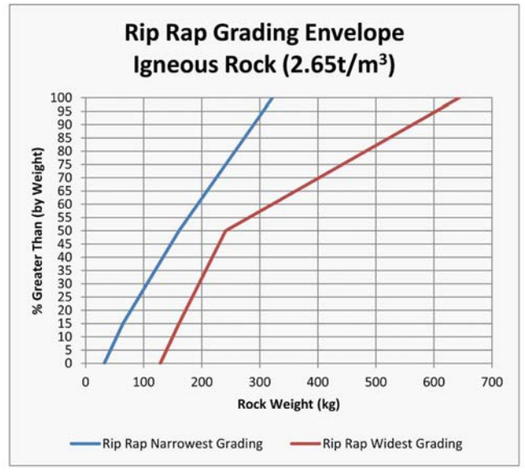
SEDIMENTARY ROCK AS PLACED SHALL COMPLY WITH THE FOLLOWING RIP RAP GRADING ENVELOPE (ASSUMED DENSITY = 2.3 t/m^3):

ROCK PERCENTILE	WEIGHT (kg)	EQUIVALENT NOMINAL DIAMETER DN (mm)	EQUIVALENT SIEVE SIZE DIAMETER (mm)
LOWER W_{MIN}	57	292	347
UPPER W_{MIN}	228	463	551
LOWER W_{15}	114	368	438
UPPER W_{15}	285	499	594
LOWER W_{50}	285	499	594
UPPER W_{50}	428	571	680
LOWER W_{100}	571	628	748
UPPER W_{100}	1142	792	943



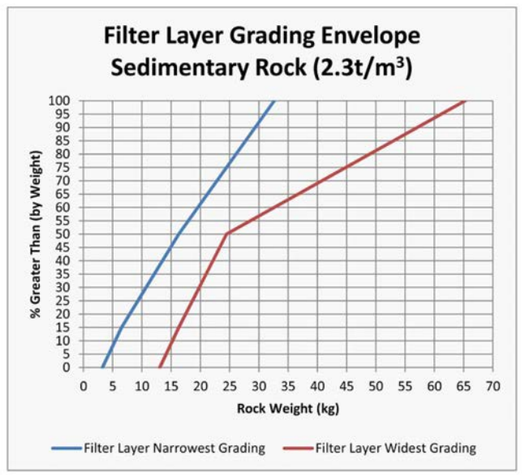
IGNEOUS ROCK AS PLACED SHALL COMPLY WITH THE FOLLOWING FILTER LAYER GRADING ENVELOPE (ASSUMED DENSITY = 2.65 t/m^3):

ROCK PERCENTILE	WEIGHT (kg)	EQUIVALENT NOMINAL DIAMETER DN (mm)	EQUIVALENT SIEVE SIZE DIAMETER (mm)
LOWER W_{MIN}	2	89	105
UPPER W_{MIN}	7	141	167
LOWER W_{15}	4	112	133
UPPER W_{15}	9	151	180
LOWER W_{50}	9	151	180
UPPER W_{50}	14	173	206
LOWER W_{100}	18	191	227
UPPER W_{100}	37	240	286



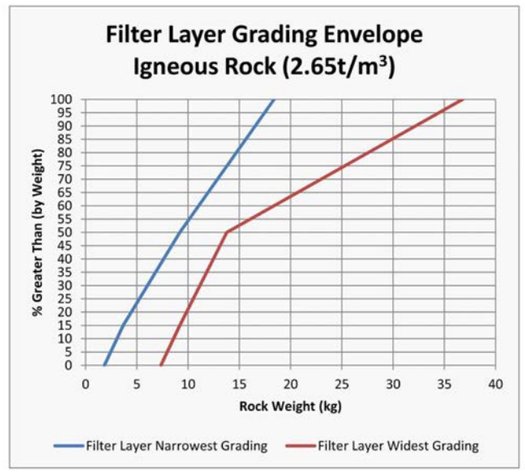
IGNEOUS ROCK AS PLACED SHALL COMPLY WITH THE FOLLOWING RIP RAP GRADING ENVELOPE (ASSUMED DENSITY = 2.65 t/m^3):

ROCK PERCENTILE	WEIGHT (kg)	EQUIVALENT NOMINAL DIAMETER DN (mm)	EQUIVALENT SIEVE SIZE DIAMETER (mm)
LOWER W_{MIN}	32	230	274
UPPER W_{MIN}	129	365	434
LOWER W_{15}	64	290	345
UPPER W_{15}	161	393	468
LOWER W_{50}	161	393	468
UPPER W_{50}	241	450	536
LOWER W_{100}	322	495	589
UPPER W_{100}	643	624	743



SEDIMENTARY ROCK AS PLACED SHALL COMPLY WITH THE FOLLOWING FILTER LAYER GRADING ENVELOPE (ASSUMED DENSITY = 2.3 t/m^3):

ROCK PERCENTILE	WEIGHT (kg)	EQUIVALENT NOMINAL DIAMETER DN (mm)	EQUIVALENT SIEVE SIZE DIAMETER (mm)
LOWER W_{MIN}	3	112	134
UPPER W_{MIN}	13	178	212
LOWER W_{15}	7	142	169
UPPER W_{15}	16	192	229
LOWER W_{50}	16	192	229
UPPER W_{50}	24	220	262
LOWER W_{100}	33	242	288
UPPER W_{100}	65	305	363



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DRAFTING CHECK	SH	
DESIGNER	RMD	
DESIGN CHECK	SR	
PROJECT MANAGER	TR	

ORIGINAL DRAWING AT A3 SIZE
CO-ORDINATE SYSTEM: MGA Zone 56 HEIGHT DATUM: A.H.D.

DRAWINGS / DESIGN PREPARED BY
JACOBS
Royal HaskoningDHV Enhancing Society Together

CLIENT
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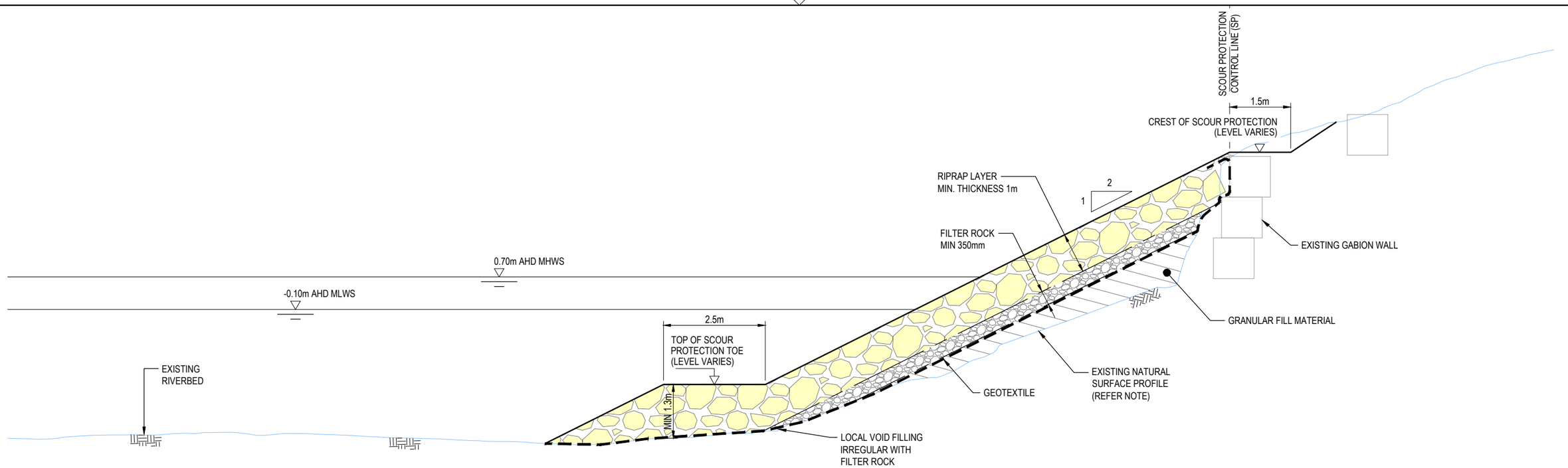

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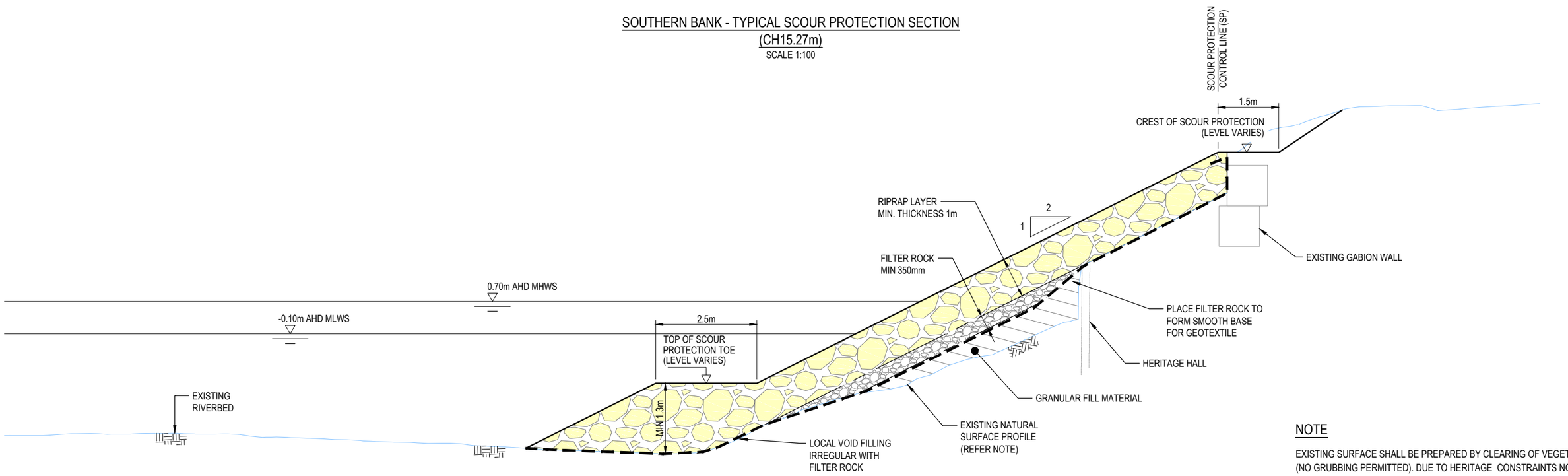

SOUTHERN BANK - TYPICAL SCOUR PROTECTION SECTION
(CH50.0m)
SCALE 1:100

NOTE

EXISTING SURFACE SHALL BE PREPARED BY CLEARING OF VEGETATION (NO GRUBBING PERMITTED). DUE TO HERITAGE CONSTRAINTS NO EXCAVATION PERMITTED. ANY PROTRUSIONS / IRREGULARITIES SHALL BE SMOOTHED OUT BY THE PLACEMENT OF FILTER ROCK AND GRANULAR FILL PRIOR TO PLACEMENT OF GEOTEXTILE.

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DRAWINGS / DESIGN PREPARED BY
JACOBS
177 Pacific Highway
North Sydney, SYDNEY, NSW 2060
AUSTRALIA
Tel: (02) 9928 2100 Fax (02) 9928 2500
Web: www.jacobs.com

CLIENT
NSW GOVERNMENT Transport Roads & Maritime Services

PREPARED FOR
GREATER SYDNEY PROJECT OFFICE
SYDNEY OUTER

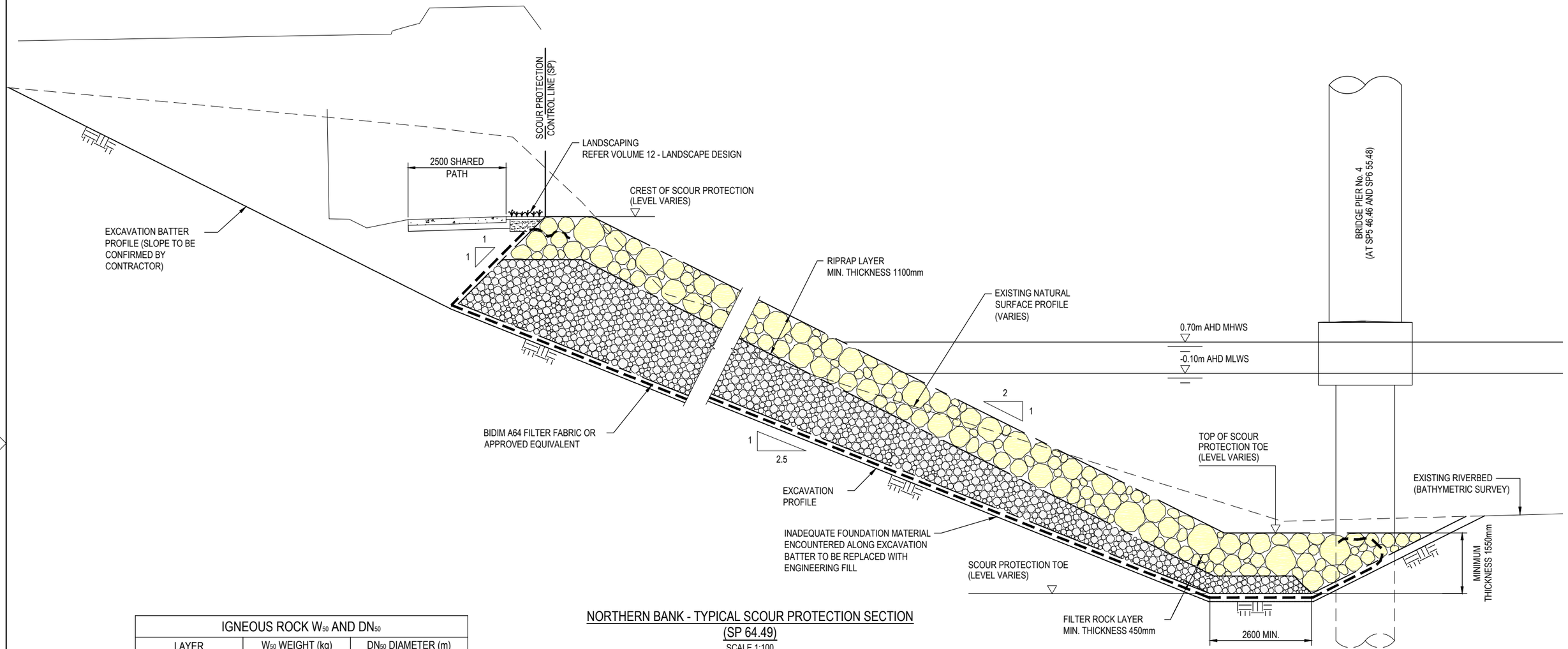
PROJECT
HAWKESBURY CITY COUNCIL AREA
MR182 - BRIDGE STREET, WINDSOR
WINDSOR BRIDGE REPLACEMENT
SCOUR PROTECTION
TYPICAL SECTIONS
SHEET 1

STATUS
NOT FOR CONSTRUCTION

VOLUME	RMS REGISTRATION No	
09	DS2012/000289	
PHASE	DRAWING No	REV
100%	NB98005-ECC-DG-0911	4

DATE: 12/04/2017 9:26:19 AM LOGIN NAME: PARISH, JORDAN
LOCATION: C:\Users\parishj\AppData\Local\Projectwise\rms_projects\dms02688\NB98005-ECC-DG-0911.dwg

0 | 5 | 10 | 15 | 20 | 25 mm ON A3 ORIGINAL



NORTHERN BANK - TYPICAL SCOUR PROTECTION SECTION (SP 64.49)

SCALE 1:100

IGNEOUS ROCK W_{50} AND DN_{50}		
LAYER	W_{50} WEIGHT (kg)	DN_{50} DIAMETER (m)
RIPRAP	161 - 241	0.39 - 0.45
FILTER ROCK	9 - 14	0.15 - 0.17

SEDIMENTARY ROCK W_{50} AND DN_{50}		
LAYER	W_{50} WEIGHT (kg)	DN_{50} DIAMETER (m)
RIPRAP	285 - 428	0.50 - 0.57
FILTER ROCK	16 - 24	0.19 - 0.22

NOTE:
DN DENOTES NOMINAL DIAMETER

NOTES:
1. EXISTING SURFACE AND RIVER PROFILES PROVIDED BY JACOBS AND BASED ON SURVEY MANAGED BY RMS BETWEEN NOV 2011 AND JAN 2013.
2. ALL DIMENSIONS ARE IN MILLIMETRES AND ALL LEVELS ARE IN METRES (UNLESS NOTED OTHERWISE).
3. ALL LEVELS REDUCED TO AUSTRALIAN HEIGHT DATUM (AHD).

REV	DATE	DESCRIPTION	DRAWN	REVIEWED	APPROVAL
4	13.04.17	ISSUED FOR 100% DETAILED DESIGN	RMD	BDP	TR
3	-	NOT USED	-	-	-
2	-	NOT USED	-	-	-
1	-	NOT USED	-	-	-
A	14.05.13	ISSUED FOR 80% DETAILED DESIGN (8A136/MA/0015)	ADS	BM	GB

0 5 10 15 20 25 mm ON A3 ORIGINAL

TITLE	INITIAL	DATE
DRAFTSPERSON	RMD	
DRAFTING CHECK	SB	
DESIGNER	BAM	
DESIGN CHECK	SB	
PROJECT MANAGER	GB	

ORIGINAL DRAWING AT A3 SIZE
SCALE 1:100 1 0 1 2 AT A3

CO-ORDINATE SYSTEM: MGA Zone 56 | HEIGHT DATUM: A.H.D.

DRAWINGS / DESIGN PREPARED BY
JACOBS
Royal HaskoningDHV
Enhancing Society Together

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SYDNEY OUTER

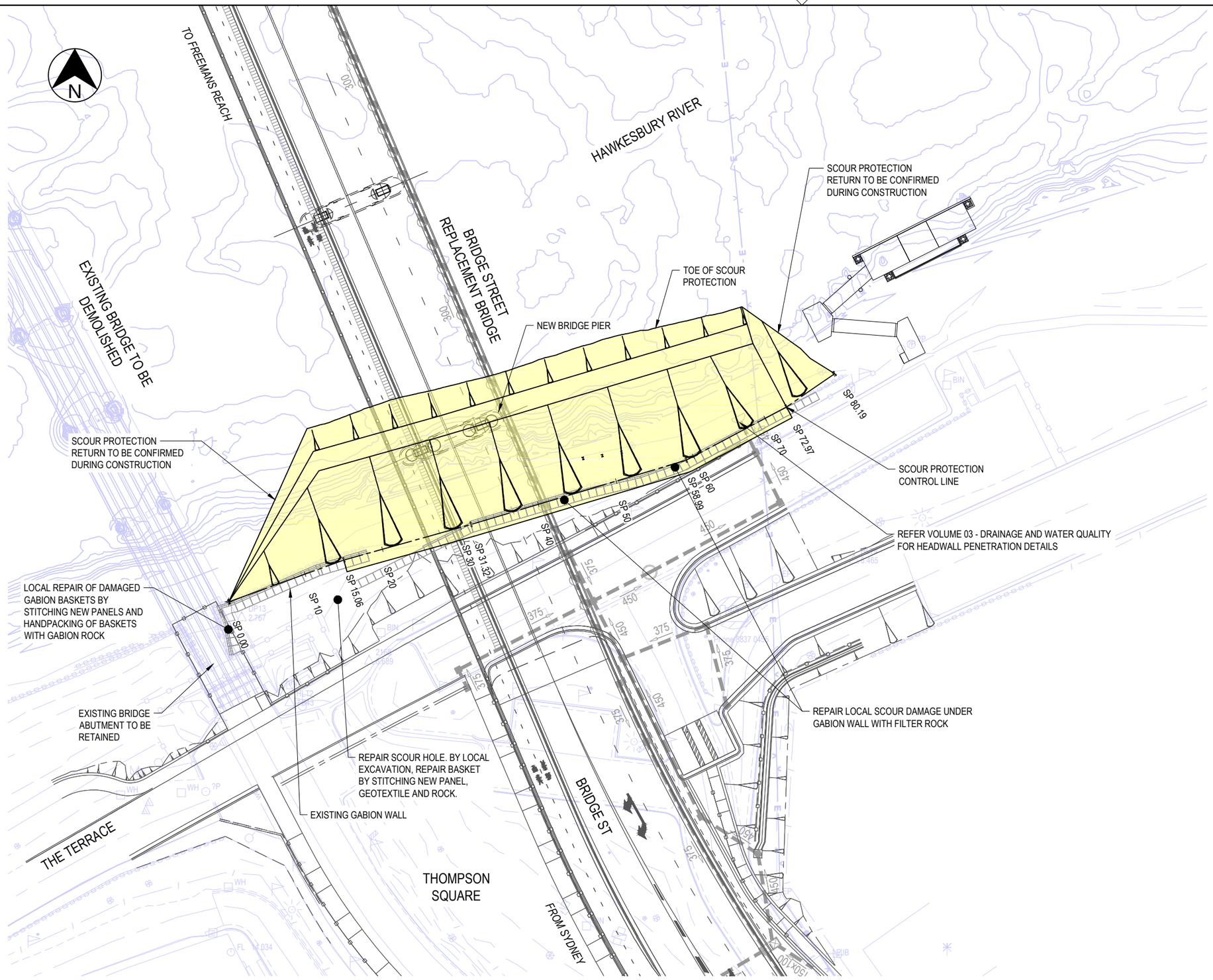
PROJECT
HAWKESBURY CITY COUNCIL AREA
MR182 - BRIDGE STREET, WINDSOR
WINDSOR BRIDGE REPLACEMENT
SCOUR PROTECTION
TYPICAL SECTIONS
SHEET 2

STATUS
NOT FOR CONSTRUCTION

VOLUME	RMS REGISTRATION No	
09	DS2012/000289	
PHASE	DRAWING No	REV
100%	NB98005-ECC-DG-0912	4

DATE: 12/04/2017 9:26:25 AM LOGIN NAME: PARISH, JORDAN
LOCATION: C:\Users\parishj\AppData\Local\projectwise\rms_projects\dms02688\NB98005-ECC-DG-0912.dwg

SETOUT TABLE		
POINTS (SP)	EASTING	NORTHING
SP 0.00	297967.026	6279667.840
SP2 15.06	297981.185	6279672.227
SP 31.32	297996.840	6279680.132
SP 58.99	298023.357	6279686.684
SP 72.97	298035.710	6279690.784
SP6 80.19	298041.645	6279690.784



PLAN
SCALE 1:500

REV	DATE	DESCRIPTION	DRAWN	REVIEWED	APPROVAL
4	13.04.17	ISSUED FOR 100% DETAILED DESIGN	RMD	BDP	TR
3	-	NOT USED	-	-	-
2	-	NOT USED	-	-	-
1	-	NOT USED	-	-	-
0	-	NOT USED	-	-	-

TITLE	INITIAL	DATE
DRAFTSPERSON	RMD	
DRAFTING CHECK	SH	
DESIGNER	RMD	
DESIGN CHECK	SR	
PROJECT MANAGER	TR	

ORIGINAL DRAWING AT A3 SIZE
SCALE 1:500 5 0 5 10 AT A3
CO-ORDINATE SYSTEM: MGA Zone 56
HEIGHT DATUM: A.H.D.

DRAWINGS / DESIGN PREPARED BY
JACOBS
177 Pacific Highway
North Sydney, SYDNEY, NSW 2060
AUSTRALIA
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SYDNEY OUTER

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HAWKESBURY CITY COUNCIL AREA
MR182 - BRIDGE STREET, WINDSOR
WINDSOR BRIDGE REPLACEMENT
SCOUR PROTECTION
GENERAL ARRANGEMENT PLAN
SOUTHERN EMBANKMENT

STATUS
NOT FOR CONSTRUCTION

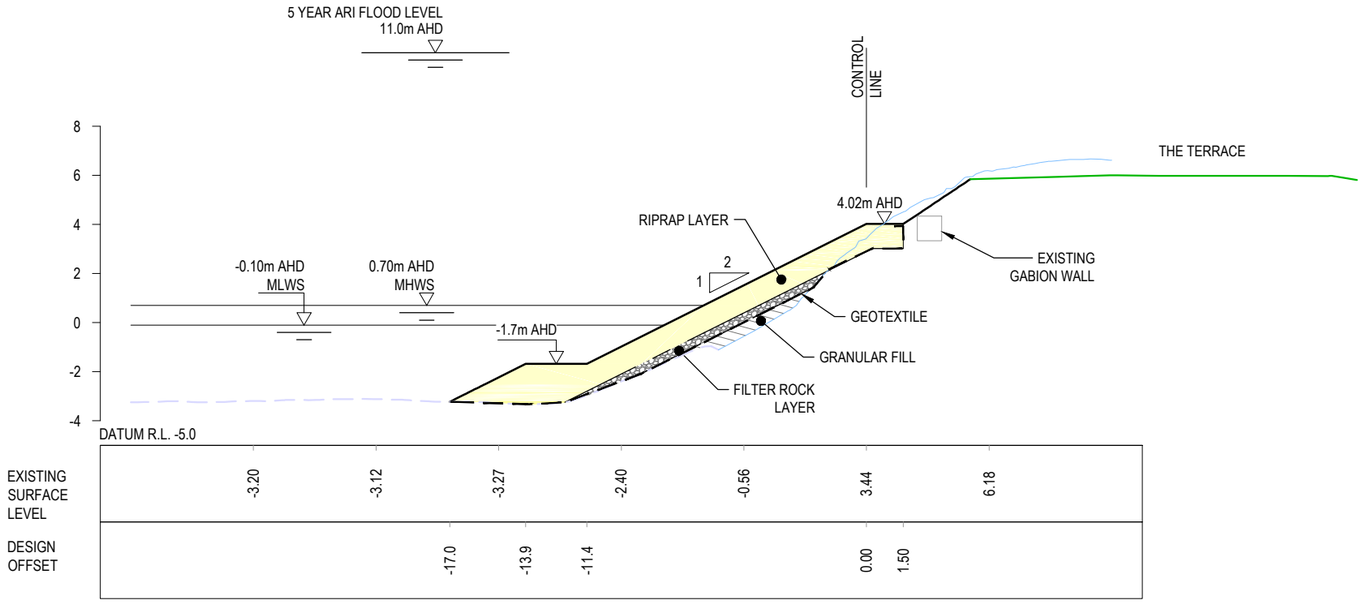
VOLUME	RMS REGISTRATION No	
09	DS2012/000289	
PHASE	DRAWING No	REV
100%	NB98005-ECC-DG-0921	4

DATE: 12/04/2017 9:26:32 AM LOGIN NAME: PARISH, JORDAN
LOCATION: C:\Users\parish\AppData\Local\projectwise\ims_projects\dms02688\NB98005-ECC-DG-0921.dwg

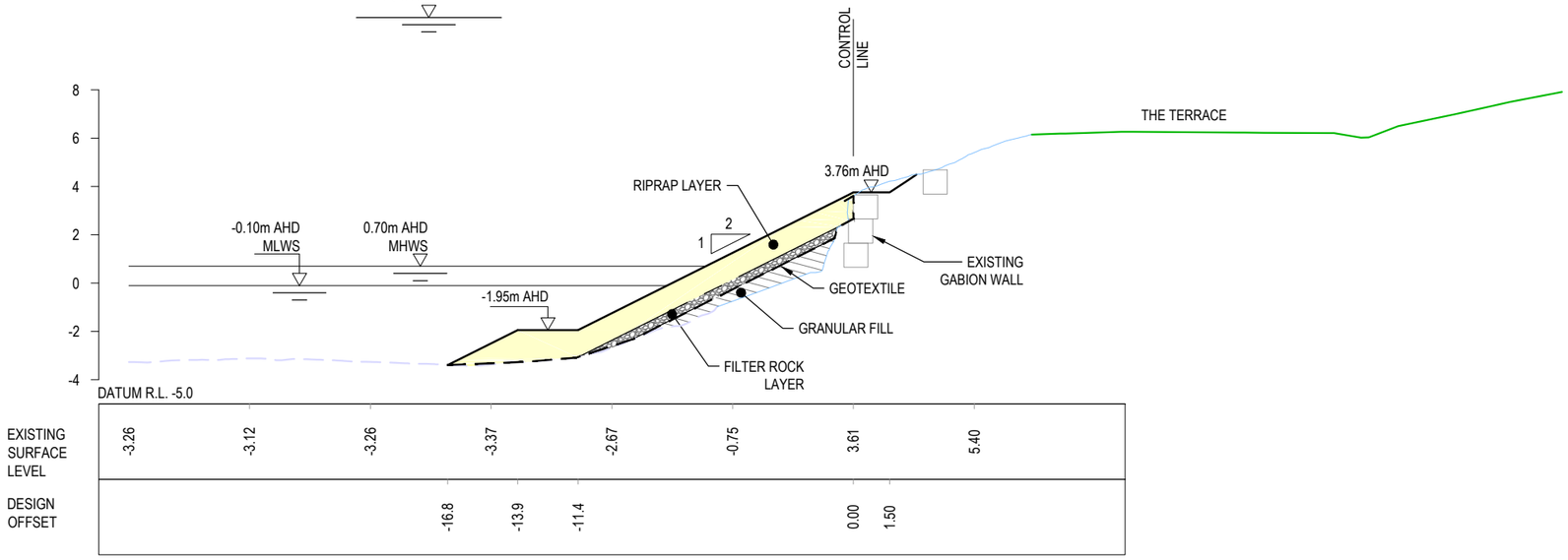
0 5 10 15 20 25 mm ON A3 ORIGINAL

LEGEND:

- EXISTING NATURAL SURFACE (TOPOGRAPHIC SURVEY)
- EXISTING RIVER BED (BATHYMETRIC SURVEY)
- PROPOSED ROAD DESIGN



CH 20.0



CH 15.27

REV	DATE	DESCRIPTION	DRAWN	REVIEWED	APPROVAL
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2	-	NOT USED	-	-	-
1	-	NOT USED	-	-	-
0	-	NOT USED	-	-	-

0 | 5 | 10 | 15 | 20 | 25 mm ON A3 ORIGINAL

TITLE	INITIAL	DATE
DRAFTSPERSON	RMD	
DRAFTING CHECK	SH	
DESIGNER	RMD	
DESIGN CHECK	SR	
PROJECT MANAGER	TR	

ORIGINAL DRAWING AT A3 SIZE
SCALE 1:250 2.5 0 2.5 5 AT A3

CO-ORDINATE SYSTEM: MGA Zone 56
HEIGHT DATUM: A.H.D.

DRAWINGS / DESIGN PREPARED BY
JACOBS
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MR182 - BRIDGE STREET, WINDSOR
WINDSOR BRIDGE REPLACEMENT
SCOUR PROTECTION
CROSS SECTIONS
SOUTHERN EMBANKMENT SHEET 1

STATUS
NOT FOR CONSTRUCTION

VOLUME	RMS REGISTRATION No	
09	DS2012/000289	
PHASE	DRAWING No	REV
100%	NB98005-ECC-DG-0931	4

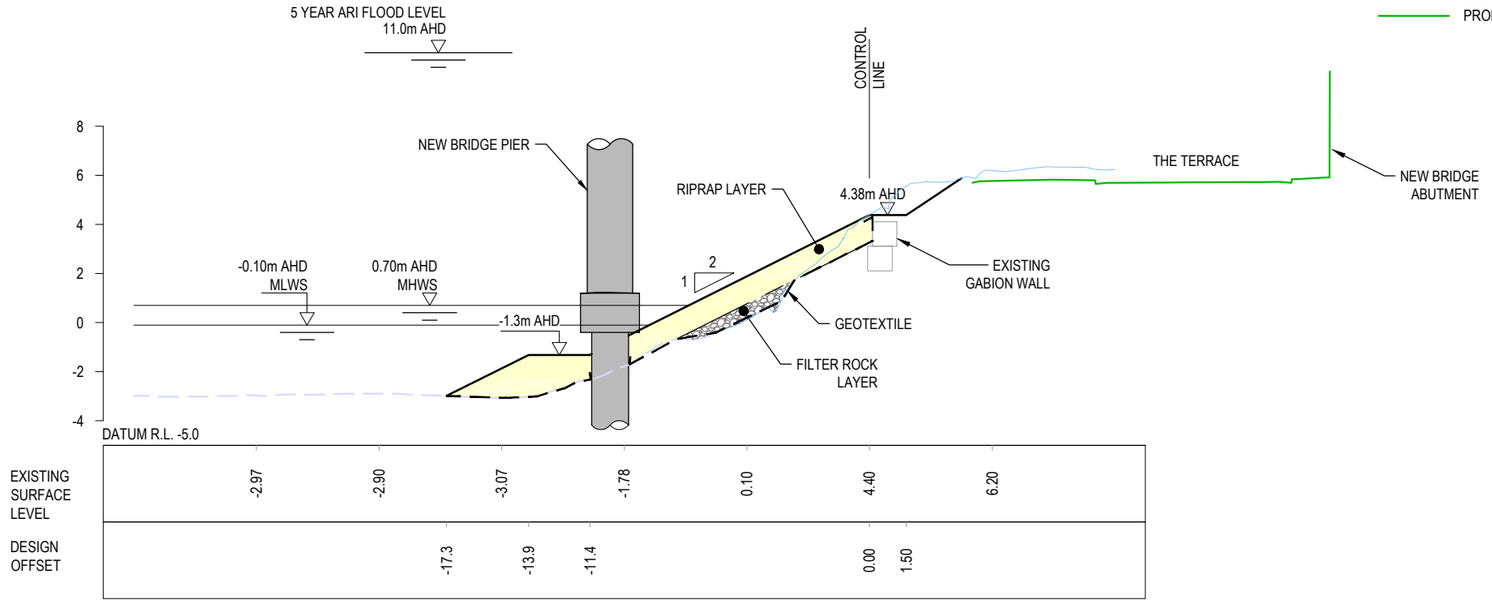
DATE: 12/04/2017 9:26:39 AM LOGIN NAME: PARISH, JORDAN
LOCATION: C:\Users\parishj\AppData\Local\projectwise\rms_projects\dms026886\NB98005-ECC-DG-0931-0934.dwg

LEGEND:

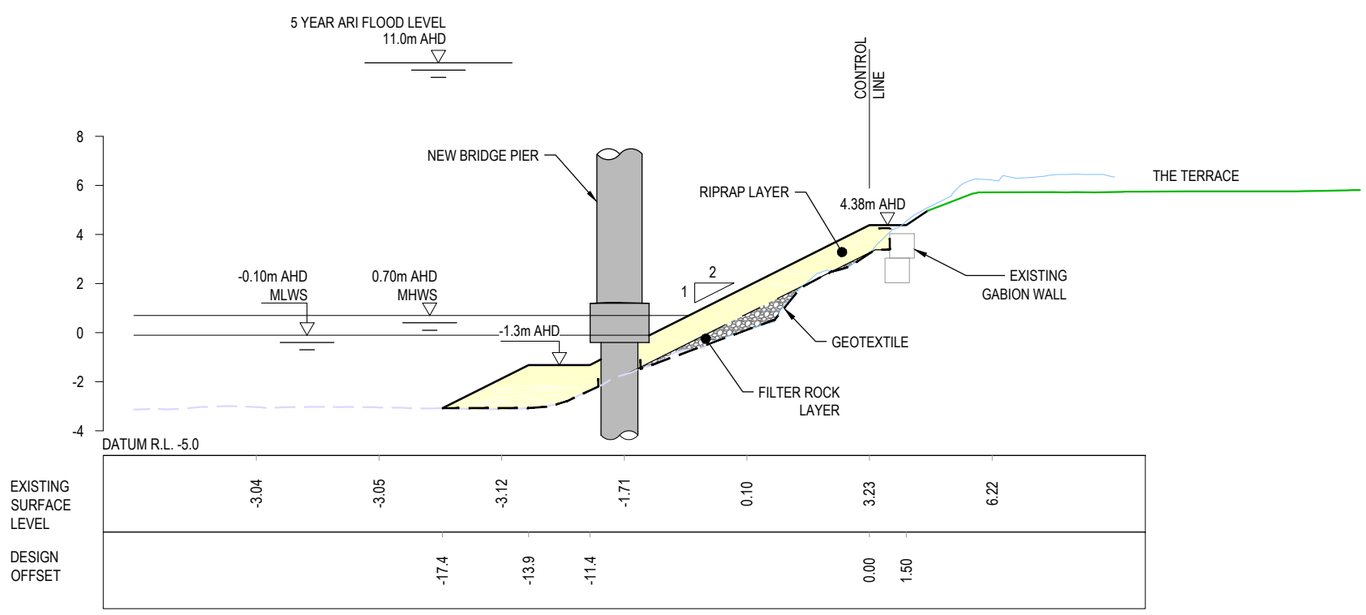
EXISTING NATURAL SURFACE (TOPOGRAPHIC SURVEY)

EXISTING RIVER BED (BATHYMETRIC SURVEY)

PROPOSED ROAD DESIGN



CH 30.0



CH 26.65

REV	DATE	DESCRIPTION	DRAWN	REVIEWED	APPROVAL
4	13.04.17	ISSUED FOR 100% DETAILED DESIGN	RMD	BDP	TR
3	-	NOT USED	-	-	-
2	-	NOT USED	-	-	-
1	-	NOT USED	-	-	-
0	-	NOT USED	-	-	-

0 5 10 15 20 25 mm ON A3 ORIGINAL

This Drawing may have been prepared using colour and may be incomplete if copied

TITLE	INITIAL	DATE
DRAFTSPERSON	RMD	
DRAFTING CHECK	SH	
DESIGNER	RMD	
DESIGN CHECK	SR	
PROJECT MANAGER	TR	

ORIGINAL DRAWING AT A3 SIZE

SCALE 1:250 2.5 0 2.5 5 AT A3

CO-ORDINATE SYSTEM: MGA Zone 56 HEIGHT DATUM: A.H.D.

DRAWINGS / DESIGN PREPARED BY

JACOBS

177 Pacific Highway
North Sydney, SYDNEY, NSW 2060
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MR182 - BRIDGE STREET, WINDSOR
WINDSOR BRIDGE REPLACEMENT
SCOUR PROTECTION
CROSS SECTIONS
SOUTHERN EMBANKMENT SHEET 2

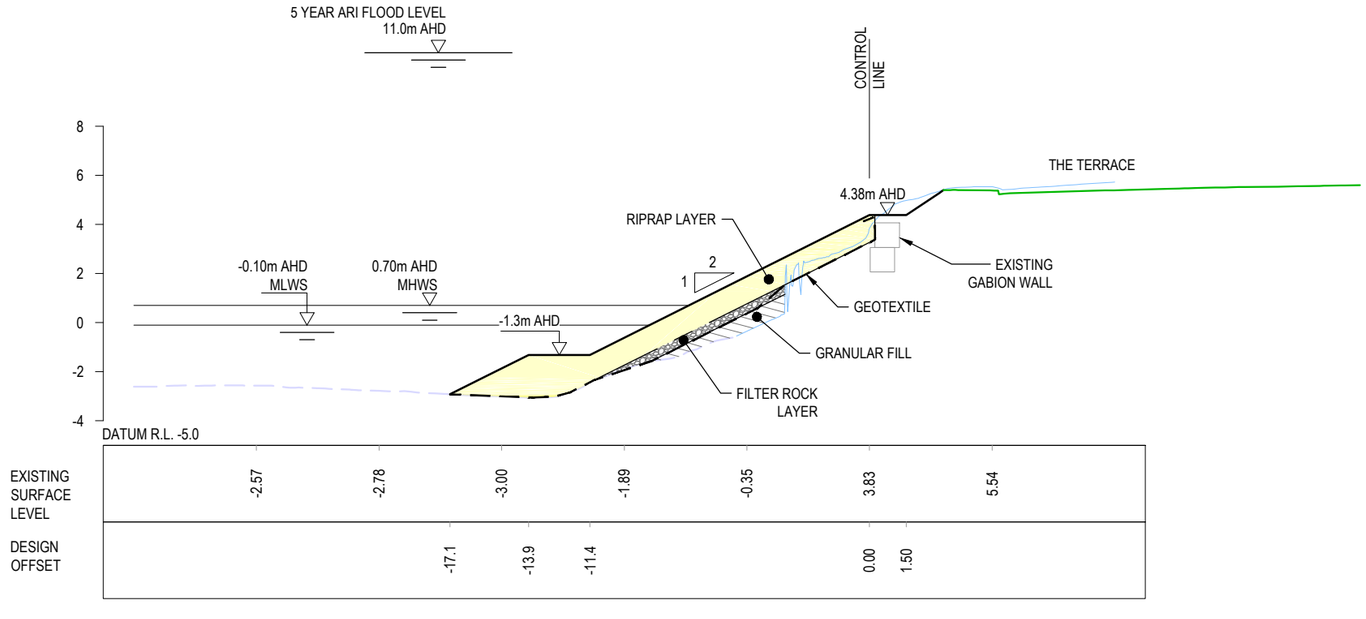
STATUS
NOT FOR CONSTRUCTION

VOLUME	RMS REGISTRATION No	
09	DS2012/000289	
PHASE	DRAWING No	REV
100%	NB98005-ECC-DG-0932	4

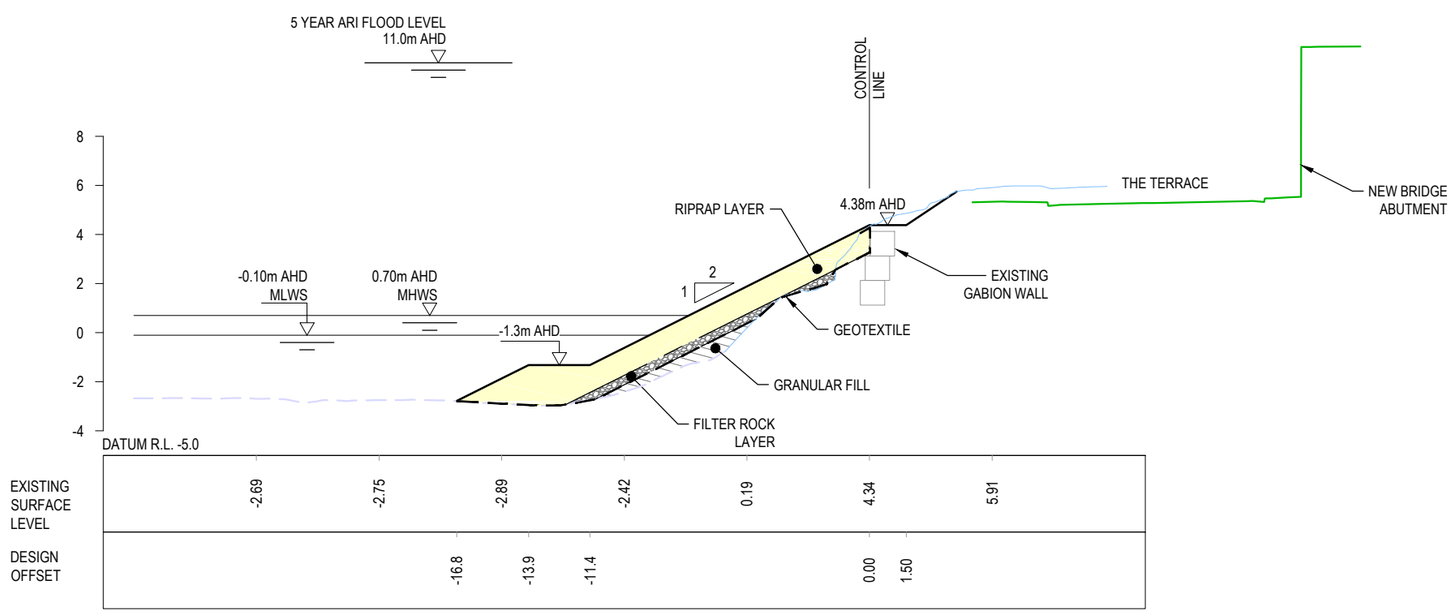
DATE: 12/04/2017 9:26:41 AM LOGIN NAME: PARISH, JORDAN
LOCATION: C:\Users\parishj\AppData\Local\Projectwise\rms_projects\dms02688\NB98005-ECC-DG-0931-0934.dwg

LEGEND:

- EXISTING NATURAL SURFACE (TOPOGRAPHIC SURVEY)
- EXISTING RIVER BED (BATHYMETRIC SURVEY)
- PROPOSED ROAD DESIGN



CH 50.0



CH 40.0

REV	DATE	DESCRIPTION	DRAWN	REVIEWED	APPROVAL
4	13.04.17	ISSUED FOR 100% DETAILED DESIGN	RMD	BDP	TR
3	-	NOT USED	-	-	-
2	-	NOT USED	-	-	-
1	-	NOT USED	-	-	-
0	-	NOT USED	-	-	-

0 | 5 | 10 | 15 | 20 | 25 mm ON A3 ORIGINAL

This Drawing may have been prepared using colour and may be incomplete if copied

TITLE	INITIAL	DATE
DRAFTSPERSON	RMD	
DRAFTING CHECK	SH	
DESIGNER	RMD	
DESIGN CHECK	SR	
PROJECT MANAGER	TR	

ORIGINAL DRAWING AT A3 SIZE
SCALE 1:250 2.5 0 2.5 5 AT A3

CO-ORDINATE SYSTEM: MGA Zone 56 | HEIGHT DATUM: A.H.D.

DRAWINGS / DESIGN PREPARED BY

JACOBS
177 Pacific Highway
North Sydney, SYDNEY, NSW 2060
AUSTRALIA
Tel: (02) 9928 2100 Fax (02) 9928 2500
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HAWKESBURY CITY COUNCIL AREA
MR182 - BRIDGE STREET, WINDSOR
WINDSOR BRIDGE REPLACEMENT
SCOUR PROTECTION
CROSS SECTIONS
SOUTHERN EMBANKMENT SHEET 3

STATUS
NOT FOR CONSTRUCTION

VOLUME	RMS REGISTRATION No	
09	DS2012/000289	
PHASE	DRAWING No	REV
100%	NB98005-ECC-DG-0933	4

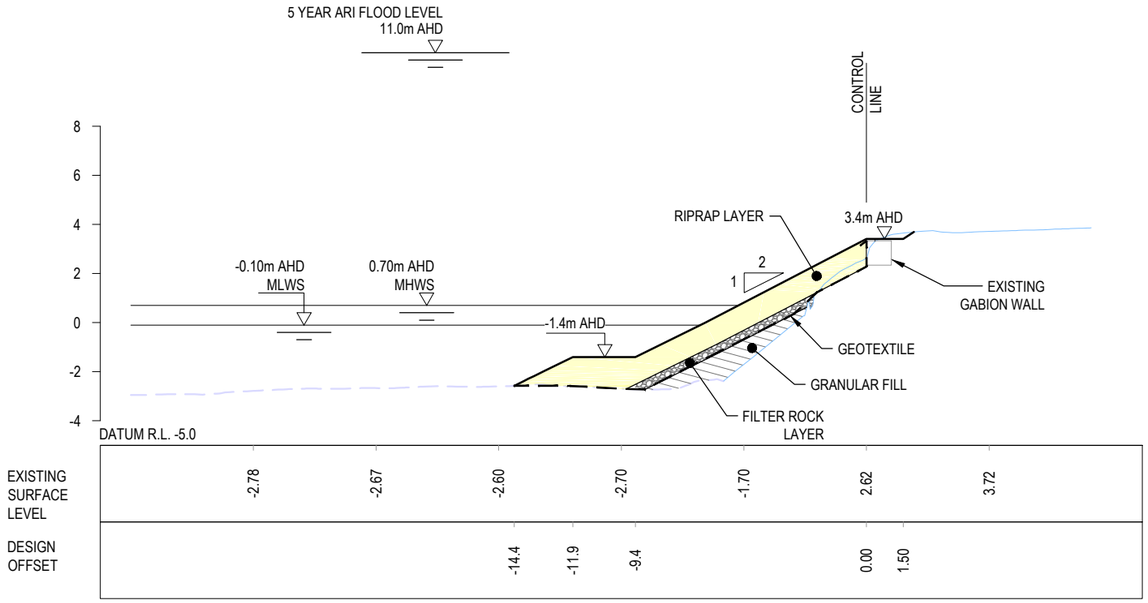
DATE: 12/04/2017 9:26:43 AM LOGIN NAME: PARISH, JORDAN
LOCATION: C:\Users\parishj\AppData\Local\Projectwise\rms_projects\dms02688\NB98005-ECC-DG-0931-0934.dwg

LEGEND:

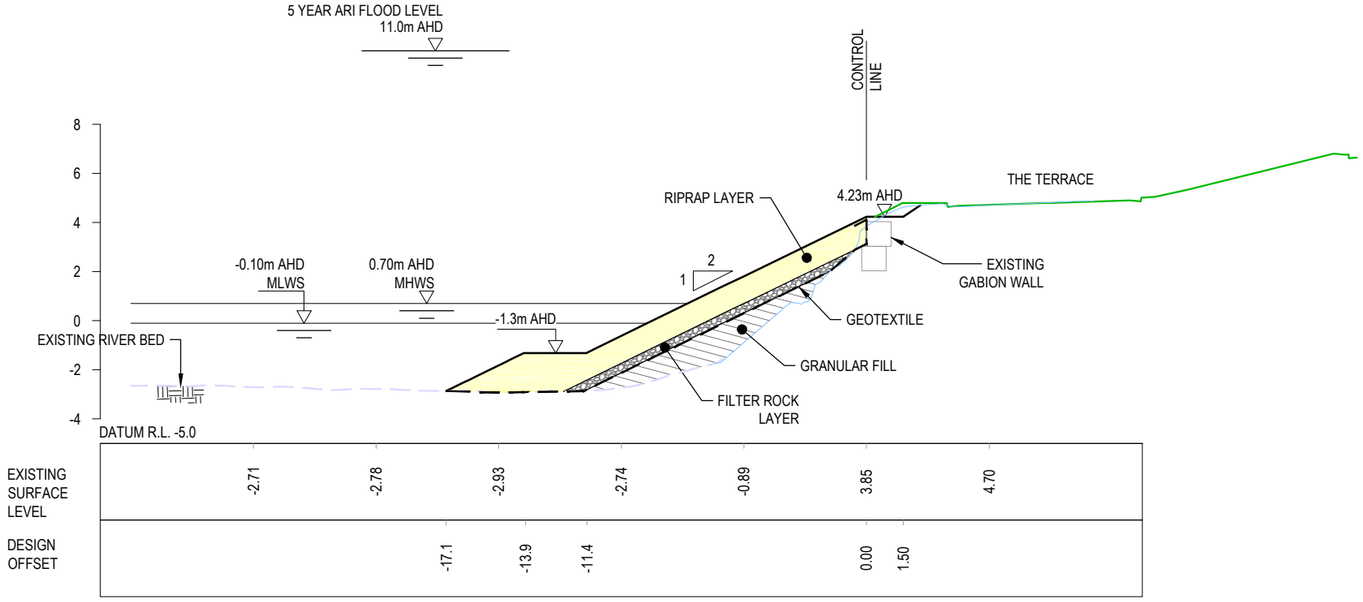
EXISTING NATURAL SURFACE (TOPOGRAPHIC SURVEY)

EXISTING RIVER BED (BATHYMETRIC SURVEY)

PROPOSED ROAD DESIGN



CH 70.0



CH 60.0

REV	DATE	DESCRIPTION	DRAWN	REVIEWED	APPROVAL
4	13.04.17	ISSUED FOR 100% DETAILED DESIGN	RMD	BDP	TR
3	-	NOT USED	-	-	-
2	-	NOT USED	-	-	-
1	-	NOT USED	-	-	-
0	-	NOT USED	-	-	-

0 | 5 | 10 | 15 | 20 | 25 mm ON A3 ORIGINAL

	INITIAL	DATE
DRAFTSPERSON	RMD	
DRAFTING CHECK	SH	
DESIGNER	RMD	
DESIGN CHECK	SR	
PROJECT MANAGER	TR	

ORIGINAL DRAWING AT A3 SIZE

SCALE 1:250 2.5 0 2.5 5 AT A3

CO-ORDINATE SYSTEM: MGA Zone 56

HEIGHT DATUM: A.H.D.

DRAWINGS / DESIGN PREPARED BY

JACOBS

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North Sydney, SYDNEY, NSW 2060
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SYDNEY OUTER

PROJECT

HAWKESBURY CITY COUNCIL AREA
MR182 - BRIDGE STREET, WINDSOR
WINDSOR BRIDGE REPLACEMENT
SCOUR PROTECTION
CROSS SECTIONS
SOUTHERN EMBANKMENT SHEET 4

STATUS
NOT FOR CONSTRUCTION

VOLUME	RMS REGISTRATION No	
09	DS2012/000289	
PHASE	DRAWING No	REV
100%	NB98005-ECC-DG-0934	4

DATE: 12/04/2017 9:26:47 AM LOGIN NAME: PARISH, JORDAN
LOCATION: C:\Users\parishj\AppData\Local\projectwise\rms_projects\dms02688\NB98005-ECC-DG-0931-0934.dwg

SETOUT TABLE		
POINTS (SP)	EASTING	NORTHING
SP 0.00	297896.72	6279775.90
SP 2.00	297898.49	6279776.84
SP 14.50	297908.42	6279782.12
SP 27.83	297922.59	6279784.79
SP 38.07	297932.79	6279784.81
SP 46.46	297940.77	6279787.32
SP 55.48	297948.97	6279791.06
SP 64.49	297957.17	6279794.80
SP 86.10	297973.82	6279808.23
SP 106.19	297992.02	6279816.60
SP 116.28	298000.25	6279822.41

N

TO FREEMANS REACH

PROPOSED SHARED PATH

SCOUR PROTECTION CONTROL LINE

EXISTING BRIDGE ABUTMENT TO BE RETAINED

SCOUR PROTECTION RETURN TO BE CONFIRMED DURING CONSTRUCTION

CREST OF SCOUR PROTECTION

RETAIN EXISTING POPLAR TREE IF POSSIBLE

SCOUR PROTECTION RETURN TO BE CONFIRMED DURING CONSTRUCTION

TOE OF SCOUR PROTECTION

NEW BRIDGE PIER No. 4

REFER VOLUME 03 - DRAINAGE AND WATER QUALITY FOR HEADWALL PENETRATION DETAILS

HAWKESBURY RIVER

EXISTING BRIDGE TO BE DEMOLISHED

FROM SYDNEY

BRIDGE STREET

BRIDGE STREET REPLACEMENT BRIDGE

SP 0 SP 2.00 SP 10 SP 14.50 SP 20 SP 29.00 SP 30 SP 38.07 SP 40 SP 46.46 SP 50 SP 55.48 SP 60 SP 64.49 SP 70 SP 80 SP 86.10 SP 90 SP 100 SP 106.19 SP 110 SP 116 SP 116.28

PLAN

SCALE 1:500

REV	DATE	DESCRIPTION	DRAWN	REVIEWED	APPROVAL
4	13.04.17	ISSUED FOR 100% DETAILED DESIGN	RMD	BDP	TR
3	-	NOT USED	-	-	-
2	-	NOT USED	-	-	-
1	-	NOT USED	-	-	-
A	14.05.13	ISSUED FOR 80% DETAILED DESIGN (8A136/MA/0010)	ADS	BM	GB

TITLE	INITIAL	DATE
DRAFTSPERSON	RMD	
DRAFTING CHECK	SB	
DESIGNER	BAM	
DESIGN CHECK	SB	
PROJECT MANAGER	GB	

ORIGINAL DRAWING AT A3 SIZE
SCALE 1:500 5 0 5 10 AT A3

CO-ORDINATE SYSTEM: MGA Zone 56 | HEIGHT DATUM: A.H.D.

0 | 5 | 10 | 15 | 20 | 25 mm ON A3 ORIGINAL

DRAWINGS / DESIGN PREPARED BY
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Royal HaskoningDHV Enhancing Society Together

CLIENT
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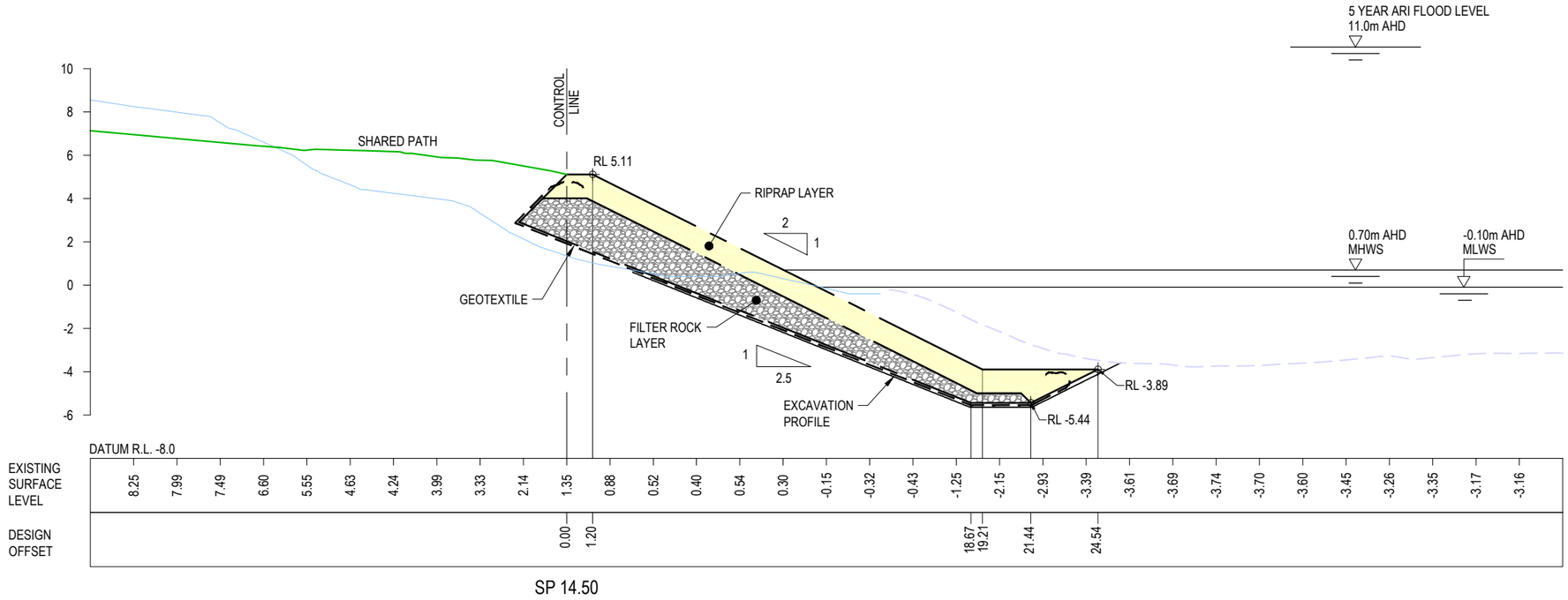
SYDNEY OUTER

PROJECT
HAWKESBURY CITY COUNCIL AREA
MR182 - BRIDGE STREET, WINDSOR
WINDSOR BRIDGE REPLACEMENT
SCOUR PROTECTION
GENERAL ARRANGEMENT PLAN
NORTHERN EMBANKMENT

STATUS
NOT FOR CONSTRUCTION

VOLUME	RMS REGISTRATION No	
09	DS2012/000289	
PHASE	DRAWING No	REV
100%	NB98005-ECC-DG-0941	4

DATE: 12/04/2017 9:26:55 AM LOGIN NAME: PARISH, JORDAN
LOCATION: C:\Users\parisj\j4p\pDataLocal\projectwise\rms_projects\rms02688\NB98005-ECC-DG-0941.dwg



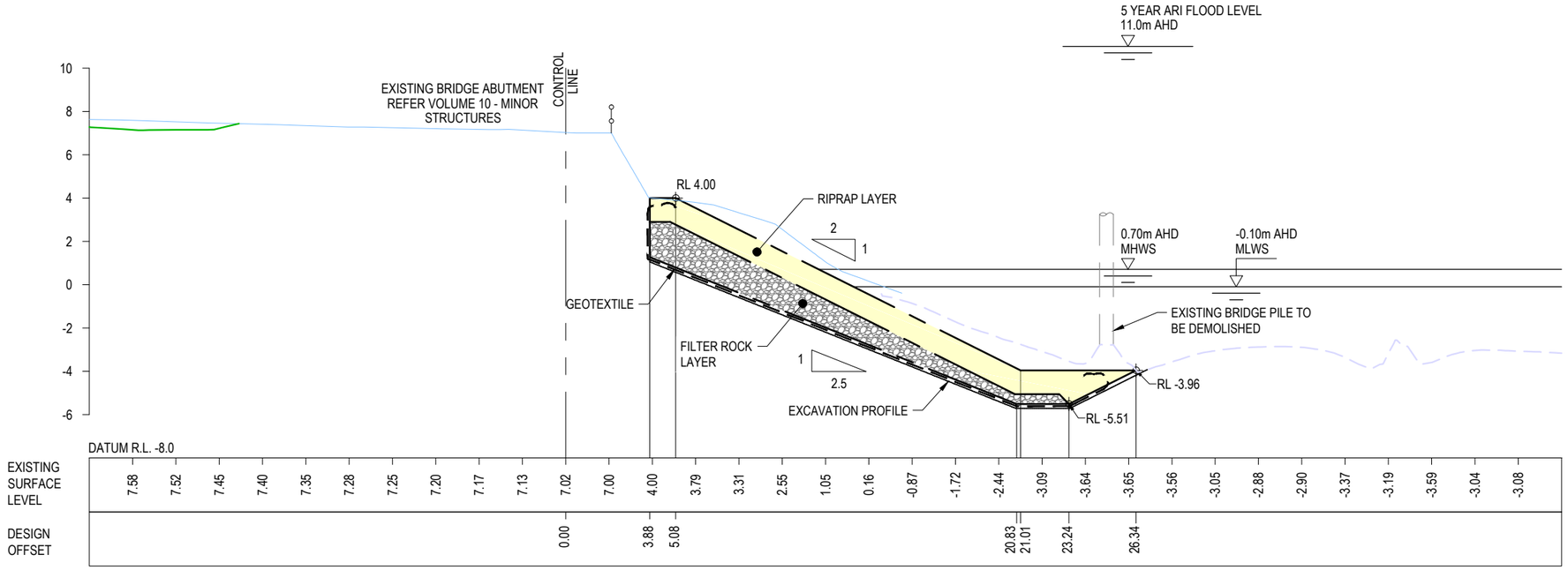
SP 14.50

NOTES:

1. MEAN HIGH WATER SPRINGS (MHWS) AND MEAN LOW WATER SPRINGS (MLWS) LEVELS SHOWN ARE APPROXIMATE ONLY.
2. TOPOGRAPHIC SURVEY BASED ON TRIMMED SURVEY, PROVIDED BY JACOBS AND MANAGED BY RMS BETWEEN NOV 2011 AND JAN 2013.
3. BATHYMETRIC SURVEY PROVIDED BY JACOBS, DATED 02.06.2016.

LEGEND:

- EXISTING NATURAL SURFACE (TOPOGRAPHIC SURVEY)
- EXISTING RIVER BED (BATHYMETRIC SURVEY)
- PROPOSED ROAD DESIGN (JACOBS)



SP 2.00

REV	DATE	DESCRIPTION	DRAWN	REVIEWED	APPROVAL
4	13.04.17	ISSUED FOR 100% DETAILED DESIGN	RMD	BDP	TR
3	-	NOT USED	-	-	-
2	-	NOT USED	-	-	-
1	-	NOT USED	-	-	-
A	14.05.13	ISSUED FOR 80% DETAILED DESIGN (8A136/MA/0020)	ADS	BM	GB

TITLE	INITIAL	DATE
DRAFTSPERSON	RMD	
DRAFTING CHECK	SB	
DESIGNER	BAM	
DESIGN CHECK	SB	
PROJECT MANAGER	GB	

ORIGINAL DRAWING AT A3 SIZE
SCALE 1:250
2.5 0 2.5 5
AT A3

CO-ORDINATE SYSTEM: MGA Zone 56
HEIGHT DATUM: A.H.D.

DRAWINGS / DESIGN PREPARED BY
JACOBS
Royal HaskoningDHV
Enhancing Society Together

CLIENT
NSW GOVERNMENT Transport Roads & Maritime Services

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SYDNEY OUTER

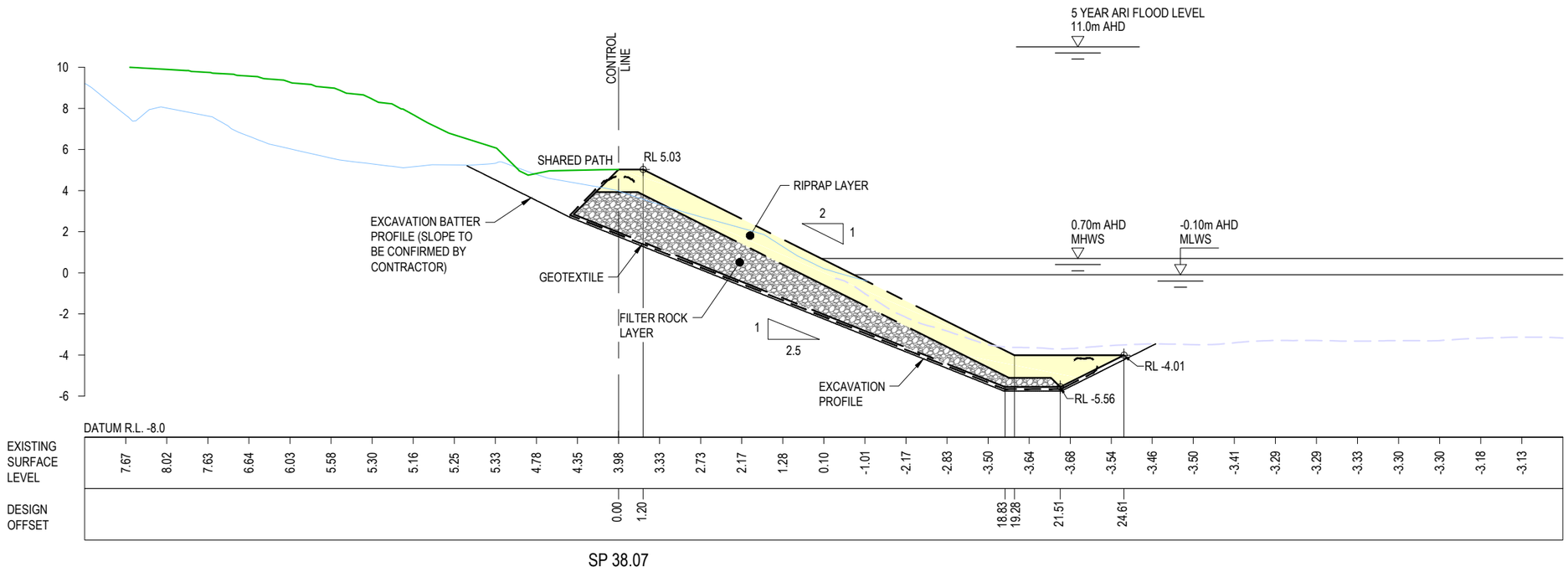
PROJECT
HAWKESBURY CITY COUNCIL AREA
MR182 - BRIDGE STREET, WINDSOR
WINDSOR BRIDGE REPLACEMENT
SCOUR PROTECTION
CROSS SECTIONS
NORTHERN EMBANKMENT SHEET 1

STATUS
NOT FOR CONSTRUCTION

VOLUME	RMS REGISTRATION No	
09	DS2012/000289	
PHASE	DRAWING No	REV
100%	NB98005-ECC-DG-0951	4

DATE: 12/04/2017 9:25:48 AM LOGIN NAME: PARISH, JORDAN
LOCATION: C:\Users\parish\AppData\Local\projectwise\rms_projects\dms026686\NB98005-ECC-DG-0951-0955.dwg

0 | 5 | 10 | 15 | 20 | 25 mm ON A3 ORIGINAL



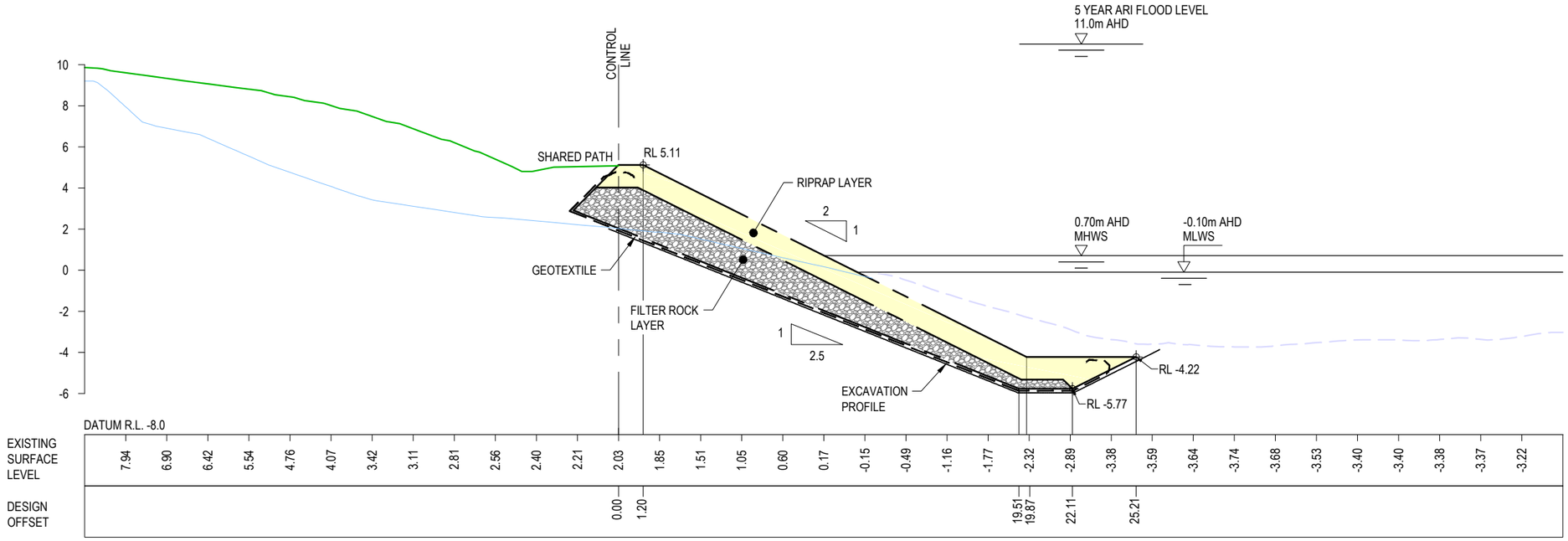
SP 38.07

NOTES:

1. MEAN HIGH WATER SPRINGS (MHWS) AND MEAN LOW WATER SPRINGS (MLWS) LEVELS SHOWN ARE APPROXIMATE ONLY.
2. TOPOGRAPHIC SURVEY BASED ON TRIMMED SURVEY, PROVIDED BY JACOBS AND MANAGED BY RMS BETWEEN NOV 2011 AND JAN 2013.
3. BATHYMETRIC SURVEY PROVIDED BY JACOBS, DATED 02.06.2016.

LEGEND:

- EXISTING NATURAL SURFACE (TOPOGRAPHIC SURVEY)
- EXISTING RIVER BED (BATHYMETRIC SURVEY)
- PROPOSED ROAD DESIGN (JACOBS)



SP 29.00

REV	DATE	DESCRIPTION	DRAWN	REVIEWED	APPROVAL
4	13.04.17	ISSUED FOR 100% DETAILED DESIGN	RMD	BDP	TR
3	-	NOT USED	-	-	-
2	-	NOT USED	-	-	-
1	-	NOT USED	-	-	-
A	14.05.13	ISSUED FOR 80% DETAILED DESIGN (8A136/MA/0021)	ADS	BM	GB

TITLE	INITIAL	DATE
DRAFTSPERSON	RMD	
DRAFTING CHECK	SB	
DESIGNER	BAM	
DESIGN CHECK	SB	
PROJECT MANAGER	GB	

ORIGINAL DRAWING AT A3 SIZE
SCALE 1:250 2.5 0 2.5 5 AT A3
CO-ORDINATE SYSTEM: MGA Zone 56
HEIGHT DATUM: A.H.D.

DRAWINGS / DESIGN PREPARED BY
JACOBS
Royal HaskoningDHV Enhancing Society Together

CLIENT
NSW GOVERNMENT Transport Roads & Maritime Services

PREPARED FOR
GREATER SYDNEY PROJECT OFFICE
SYDNEY OUTER

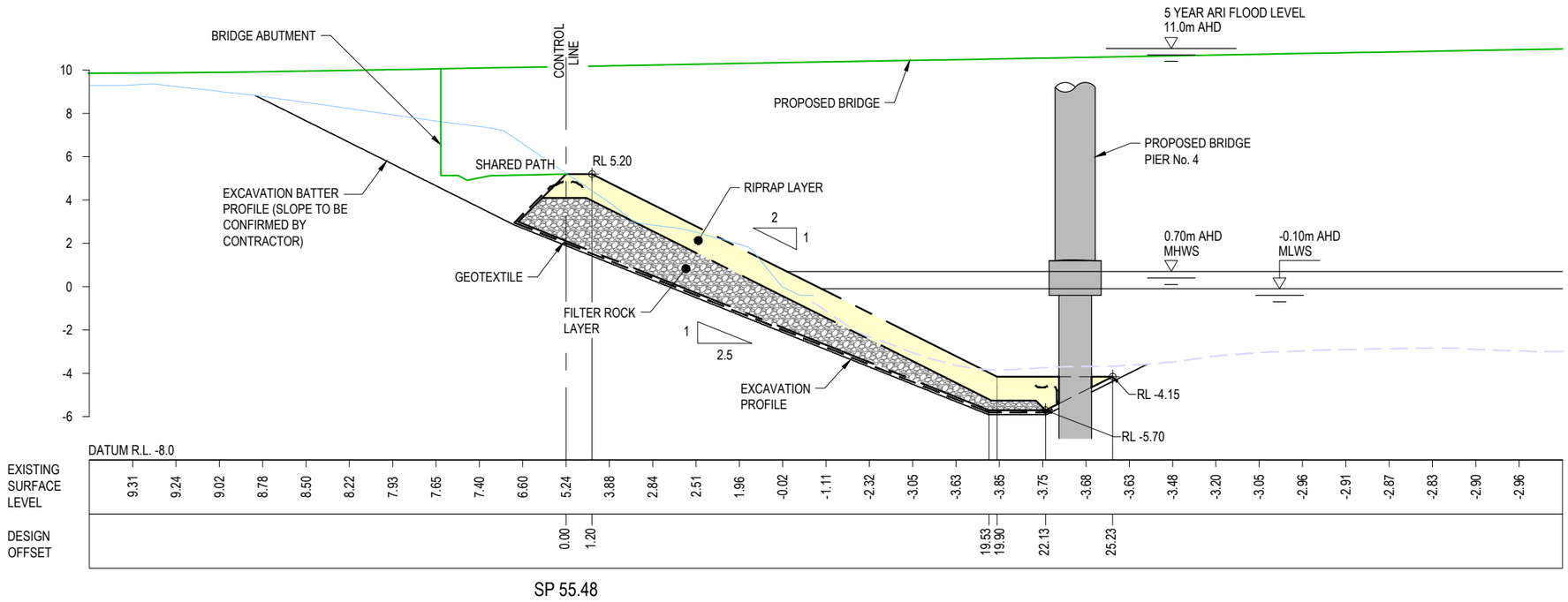
PROJECT
HAWKESBURY CITY COUNCIL AREA
MR182 - BRIDGE STREET, WINDSOR
WINDSOR BRIDGE REPLACEMENT
SCOUR PROTECTION
CROSS SECTIONS
NORTHERN EMBANKMENT SHEET 2

STATUS
NOT FOR CONSTRUCTION

VOLUME	RMS REGISTRATION No	
09	DS2012/000289	
PHASE	DRAWING No	REV
100%	NB98005-ECC-DG-0952	4

DATE: 12/04/2017 9:25:51 AM LOGIN NAME: PARISH, JORDAN
LOCATION: C:\Users\parish\AppData\Local\projectwise\ms_projects\dms026686\NB98005-ECC-DG-0951-0955.dwg

0 5 10 15 20 25 mm ON A3 ORIGINAL



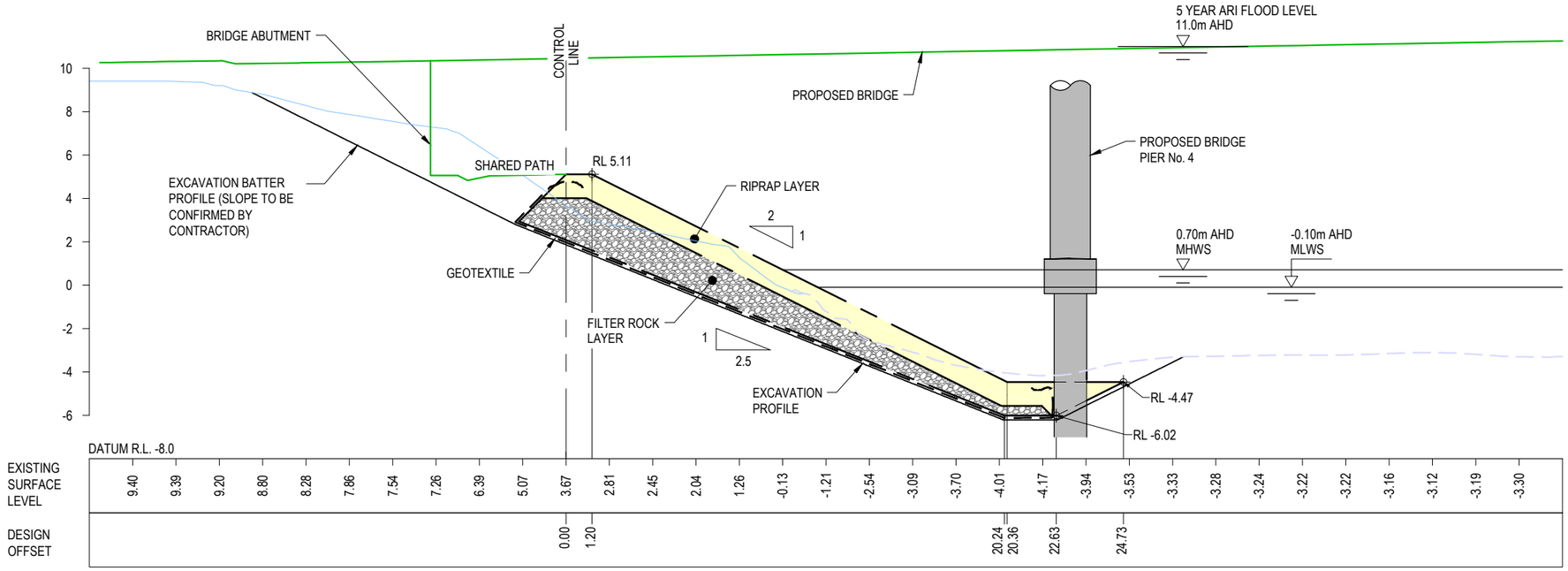
SP 55.48

NOTES:

1. MEAN HIGH WATER SPRINGS (MHWS) AND MEAN LOW WATER SPRINGS (MLWS) LEVELS SHOWN ARE APPROXIMATE ONLY.
2. TOPOGRAPHIC SURVEY BASED ON TRIMMED SURVEY, PROVIDED BY JACOBS AND MANAGED BY RMS BETWEEN NOV 2011 AND JAN 2013.
3. BATHYMETRIC SURVEY PROVIDED BY JACOBS, DATED 02.06.2016.

LEGEND:

- EXISTING NATURAL SURFACE (TOPOGRAPHIC SURVEY)
- EXISTING RIVER BED (BATHYMETRIC SURVEY)
- PROPOSED ROAD DESIGN (JACOBS)



SP 46.46

REV	DATE	DESCRIPTION	DRAWN	REVIEWED	APPROVAL
4	13.04.17	ISSUED FOR 100% DETAILED DESIGN	RMD	BDP	TR
3	-	NOT USED	-	-	-
2	-	NOT USED	-	-	-
1	-	NOT USED	-	-	-
A	14.05.13	ISSUED FOR 80% DETAILED DESIGN (8A136/MA/0022)	ADS	BM	GB

TITLE	INITIAL	DATE
DRAFTSPERSON	RMD	
DRAFTING CHECK	SB	
DESIGNER	BAM	
DESIGN CHECK	SB	
PROJECT MANAGER	GB	

ORIGINAL DRAWING AT A3 SIZE
SCALE 1:250
2.5 0 2.5 5
AT A3
CO-ORDINATE SYSTEM: MGA Zone 56
HEIGHT DATUM: A.H.D.

DRAWINGS / DESIGN PREPARED BY
JACOBS
Royal HaskoningDHV
Enhancing Society Together

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NSW GOVERNMENT Transport Roads & Maritime Services

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SYDNEY OUTER

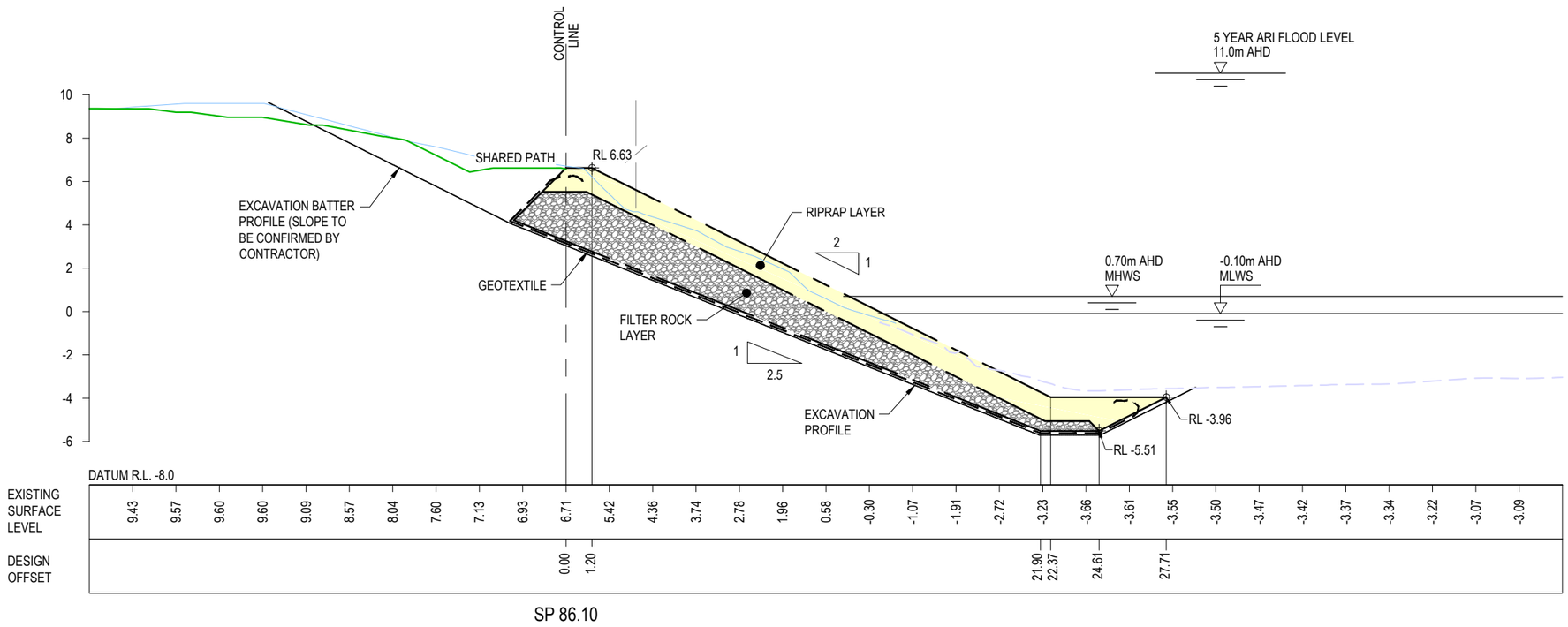
PROJECT
HAWKESBURY CITY COUNCIL AREA
MR182 - BRIDGE STREET, WINDSOR
WINDSOR BRIDGE REPLACEMENT
SCOUR PROTECTION
CROSS SECTIONS
NORTHERN EMBANKMENT SHEET 3

STATUS
NOT FOR CONSTRUCTION

VOLUME	RMS REGISTRATION No	
09	DS2012/000289	
PHASE	DRAWING No	REV
100%	NB98005-ECC-DG-0953	4

DATE: 12/04/2017 9:25:53 AM LOGIN NAME: PARISH, JORDAN
LOCATION: C:\Users\parish\AppData\Local\projectwise\ms_projects\dms026686\NB98005-ECC-DG-0951-0955.dwg

0 5 10 15 20 25 mm ON A3 ORIGINAL



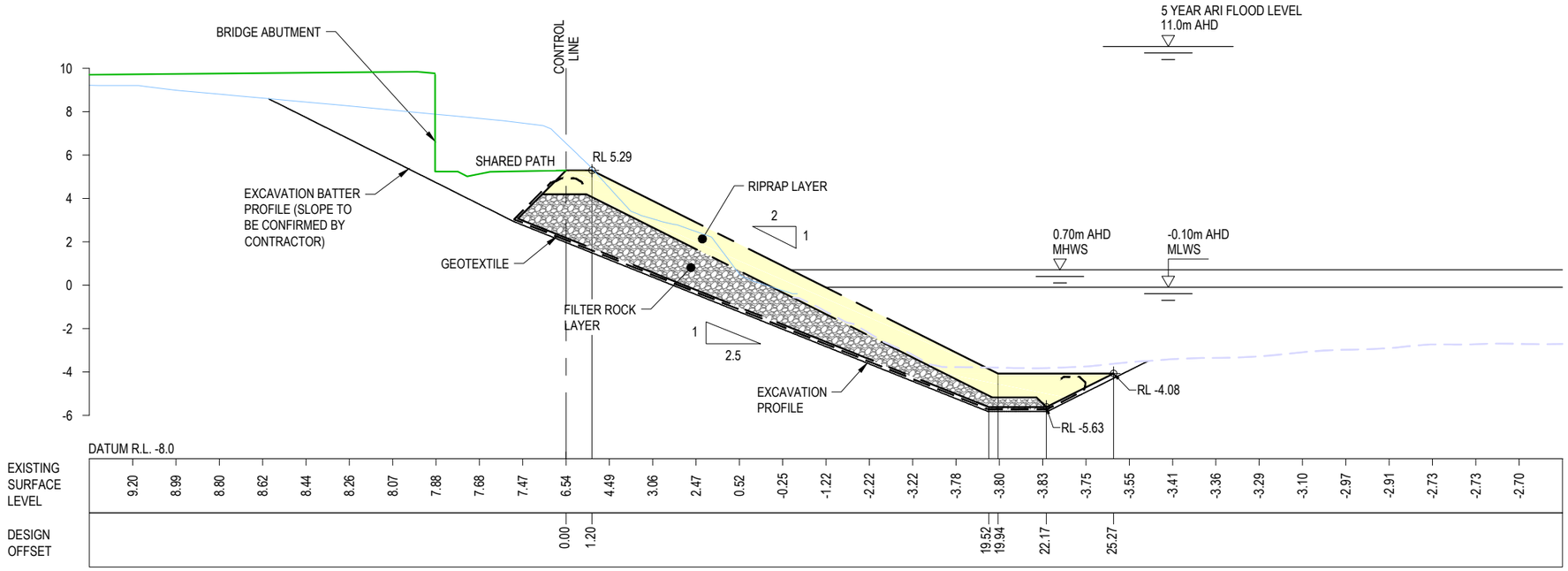
SP 86.10

NOTES:

1. MEAN HIGH WATER SPRINGS (MHWS) AND MEAN LOW WATER SPRINGS (MLWS) LEVELS SHOWN ARE APPROXIMATE ONLY.
2. TOPOGRAPHIC SURVEY BASED ON TRIMMED SURVEY, PROVIDED BY JACOBS AND MANAGED BY RMS BETWEEN NOV 2011 AND JAN 2013.
3. BATHYMETRIC SURVEY PROVIDED BY JACOBS, DATED 02.06.2016.

LEGEND:

- EXISTING NATURAL SURFACE (TOPOGRAPHIC SURVEY)
- EXISTING RIVER BED (BATHYMETRIC SURVEY)
- PROPOSED ROAD DESIGN (JACOBS)



SP 64.49

REV	DATE	DESCRIPTION	DRAWN	REVIEWED	APPROVAL
4	13.04.17	ISSUED FOR 100% DETAILED DESIGN	RMD	BDP	TR
3	-	NOT USED	-	-	-
2	-	NOT USED	-	-	-
1	-	NOT USED	-	-	-
A	14.05.13	ISSUED FOR 80% DETAILED DESIGN (8A136/MA/0023)	ADS	BM	GB

0 | 5 | 10 | 15 | 20 | 25 mm ON A3 ORIGINAL

TITLE	INITIAL	DATE
DRAFTSPERSON	RMD	
DRAFTING CHECK	SB	
DESIGNER	BAM	
DESIGN CHECK	SB	
PROJECT MANAGER	GB	

ORIGINAL DRAWING AT A3 SIZE
SCALE 1:250 2.5 0 2.5 5 AT A3
CO-ORDINATE SYSTEM: MGA Zone 56
HEIGHT DATUM: A.H.D.

DRAWINGS / DESIGN PREPARED BY
JACOBS
Royal HaskoningDHV Enhancing Society Together

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NSW GOVERNMENT Transport Roads & Maritime Services

PREPARED FOR
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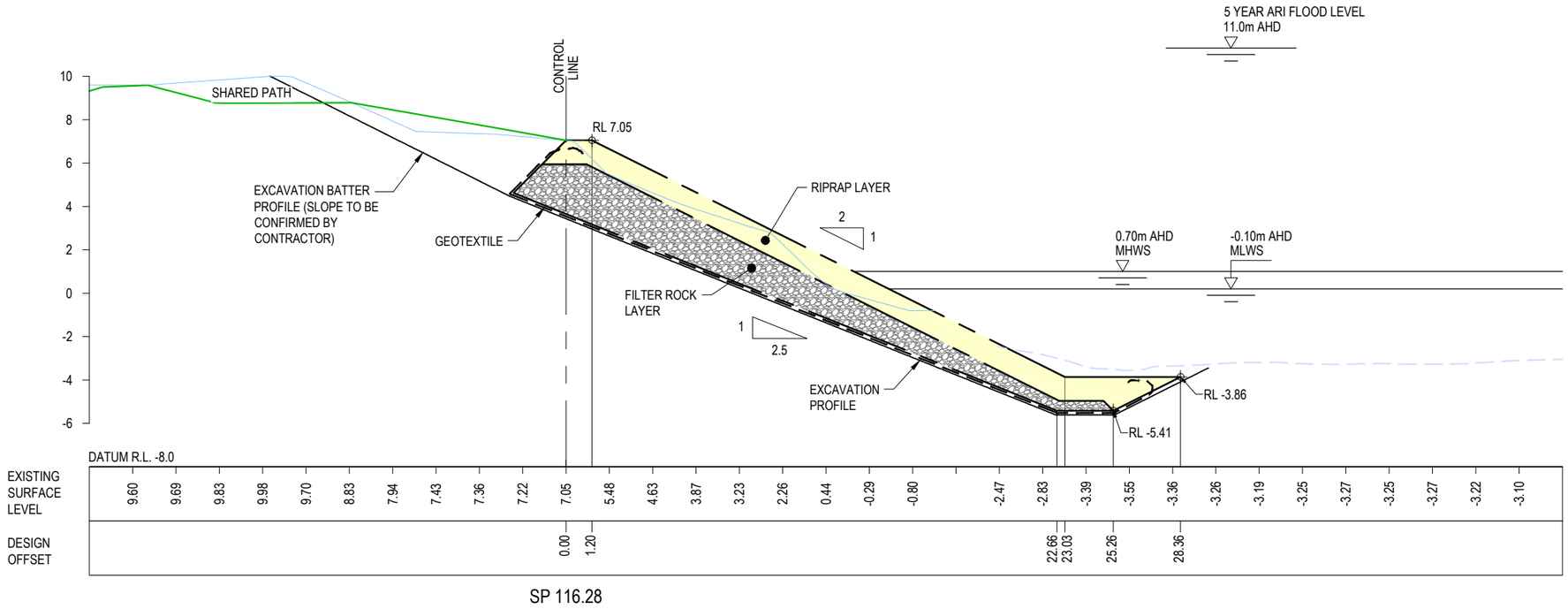
SYDNEY OUTER

PROJECT
HAWKESBURY CITY COUNCIL AREA
MR182 - BRIDGE STREET, WINDSOR
WINDSOR BRIDGE REPLACEMENT
SCOUR PROTECTION
CROSS SECTIONS
NORTHERN EMBANKMENT SHEET 4

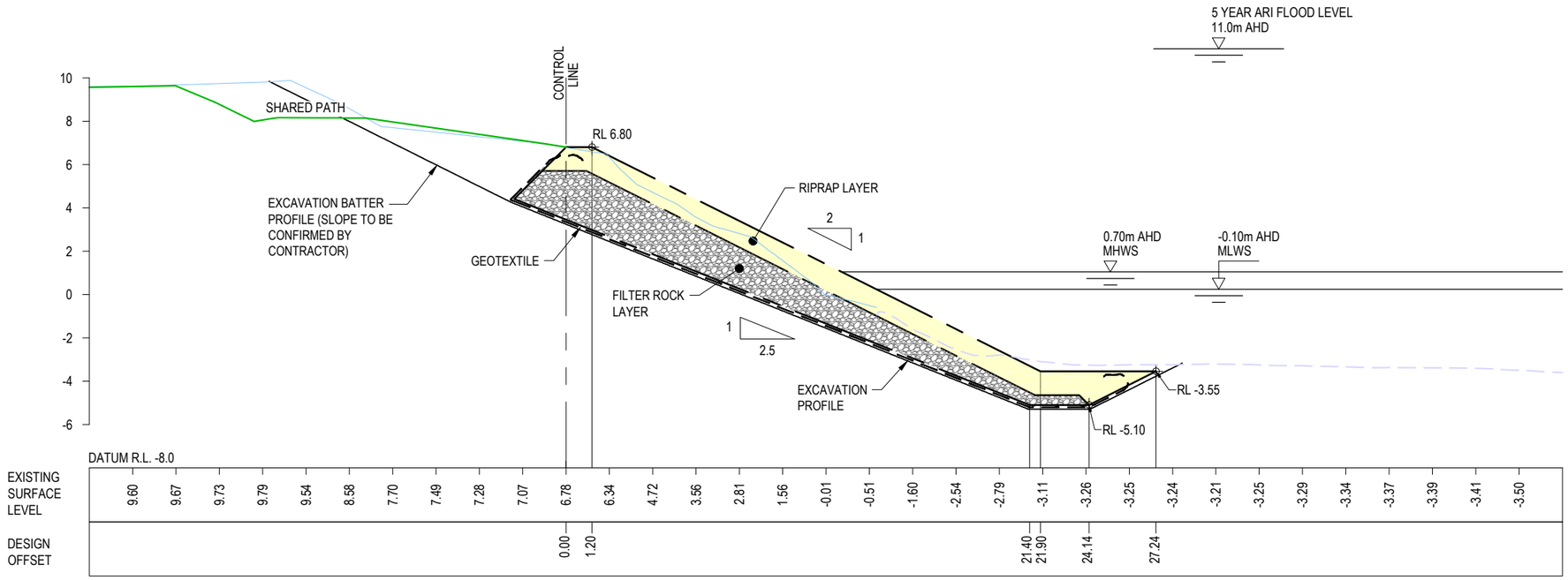
STATUS
NOT FOR CONSTRUCTION

VOLUME	RMS REGISTRATION No	
09	DS2012/000289	
PHASE	DRAWING No	REV
100%	NB98005-ECC-DG-0954	4

DATE: 12/04/2017 9:25:55 AM LOGIN NAME: PARISH, JORDAN
LOCATION: C:\Users\parish\AppData\Local\projectwise\ms_projects\dms026686\NB98005-ECC-DG-0951-0955.dwg



SP 116.28



SP 106.19

NOTES:

1. MEAN HIGH WATER SPRINGS (MHWS) AND MEAN LOW WATER SPRINGS (MLWS) LEVELS SHOWN ARE APPROXIMATE ONLY.
2. TOPOGRAPHIC SURVEY BASED ON TRIMMED SURVEY, PROVIDED BY JACOBS AND MANAGED BY RMS BETWEEN NOV 2011 AND JAN 2013.
3. BATHYMETRIC SURVEY PROVIDED BY JACOBS, DATED 02.06.2016.

LEGEND:

- EXISTING NATURAL SURFACE (TOPOGRAPHIC SURVEY)
- EXISTING RIVER BED (BATHYMETRIC SURVEY)
- PROPOSED ROAD DESIGN (JACOBS)

REV	DATE	DESCRIPTION	DRAWN	REVIEWED	APPROVAL
4	13.04.17	ISSUED FOR 100% DETAILED DESIGN	RMD	BDP	TR
3	-	NOT USED	-	-	-
2	-	NOT USED	-	-	-
1	-	NOT USED	-	-	-
A	14.05.13	ISSUED FOR 80% DETAILED DESIGN (8A136/MA/0024)	ADS	BM	GB

0 5 10 15 20 25 mm ON A3 ORIGINAL

TITLE	INITIAL	DATE
DRAFTSPERSON	RMD	
DRAFTING CHECK	SB	
DESIGNER	BAM	
DESIGN CHECK	SB	
PROJECT MANAGER	GB	

ORIGINAL DRAWING AT A3 SIZE
SCALE 1:250 2.5 0 2.5 5 AT A3

CO-ORDINATE SYSTEM: MGA Zone 56
HEIGHT DATUM: A.H.D.

DRAWINGS / DESIGN PREPARED BY
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Enhancing Society Together

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SYDNEY OUTER

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WINDSOR BRIDGE REPLACEMENT
SCOUR PROTECTION
CROSS SECTIONS
NORTHERN EMBANKMENT SHEET 5

STATUS
NOT FOR CONSTRUCTION

VOLUME	RMS REGISTRATION No	
09	DS2012/000289	
PHASE	DRAWING No	REV
100%	NB98005-ECC-DG-0955	4