MOOREBANK INTERMODAL COMPANY

Moorebank Intermodal Terminal Project Environmental Impact Statement

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Aboriginal Heritage Impact Assessment

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Moorebank Intermodal Terminal

Aboriginal Heritage Assessment

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EXECUTIVE SUMMARY

INTRODUCTION

In May 2010 the Australian Government tasked the (Commonwealth) Department of Finance and Deregulation (DoFD) now the Department of Finance (DoF) to conduct a Feasibility Study into the potential development of an intermodal terminal (IMT) at Moorebank in south western Sydney. The Government has determined that the SME will relocate to new purpose-built facilities at the nearby Holsworthy Barracks with the move to be completed by around mid-2015.

In April 2012 the Australian Government committed to development of the Moorebank Intermodal Terminal (IMT) Project after reviewing the findings of a detailed business case for the facility (CDFD Feb. 2012). The Project is subject to planning approval with an Environmental Impact Statement due to be displayed late in 2012 to enable public feedback. Both Federal and NSW planning approvals are being sought.

Navin Officer Heritage Consultants Pty Ltd (NOHC) was commissioned in 2010 by Parsons Brinckerhoff to undertake a cultural heritage assessment for the Moorebank Defence precinct on behalf of the DoFD as part of the Environmental Impact Statement (EIS) for the Project.

The Moorebank Intermodal Terminal (IMT) Project (the Project) involves the development of approximately 220 hectares (ha) of land at the Project site (refer to Figure 1.1) for the construction and operation of an IMT and associated infrastructure, facilities and warehousing. The Project includes a rail link connecting the Project site to the Southern Sydney Freight Line (SSFL) and road entry and exit points from Moorebank Avenue.

The primary function of the IMT is to be a transfer point in the logistics chain for shipping containers and to handle both international IMEX cargo, and domestic interstate and intrastate (regional) cargo. The key aims of the Project are to increase Sydney's rail freight mode share including: promoting the movement of container freight by rail between Port Botany and western and south-western Sydney; and reducing road freight on Sydney's congested road network.

The Project proponent is Moorebank Intermodal Company (MIC), a Government Business Enterprise set up to facilitate the development of the Project.

The Project site is currently largely occupied by the Department of Defence's (Defence) School of Military Engineering (SME). Under the approved Moorebank Units Relocation (MUR) Project, the SME is planned to be relocated to Holsworthy Barracks by mid-2015, which would enable the construction of the Project to commence.

The key features/components of the Project comprise:

an IMEX freight terminal – designed to handle up to 1.05 million TEU per annum (525,000 TEU inbound and 525,000 TEU outbound) of IMEX containerised freight to service 'port shuttle' train services between Port Botany and the Project;

an Interstate freight terminal – designed to handle up to 500,000 TEU per annum (250,000 TEU inbound and 250,000 TEU outbound) of interstate containerised freight to service freight trains travelling to and from regional and interstate destinations; and

warehousing facilities – with capacity for up to 300,000 square metres (m2) of warehousing to provide an interface between the IMT and commercial users of the facilities such as freight forwarders, logistics facilities and retail distribution centres.

The proposal concept described in the main EIS (refer Chapters 7 and 8) provides an indicative layout and operational concept for the Project, while retaining flexibility for future developers and operators of the Project. The proposal concept is indicative only and subject to further refinement during detailed design.

The Project is subject to both Commonwealth and NSW State Government approvals, and this Environmental Impact Statement (EIS) has been prepared to support applications for both approvals (EPBC number 2011/6086 and SSD-5066).

APPROACH

The assessment has comprised a range of elements including a review of archival sources and existing information, direct physical inspection, archaeological survey and test excavations.

Assessments of cultural heritage significance, and potential impacts to heritage values, have been undertaken for each site that has been identified through the archaeological investigations documented in this report.

These individual site assessments have informed an assessment of the overall cultural heritage significance of the study area. There has been a holistic assessment of sites in terms of their landscape context and the research potential that exists across the study area.

Research questions were developed for the subsurface testing program in order to focus the results and the program towards answering specific questions.

Aboriginal consultation

Aboriginal consultation has been undertaken in various stages for this project.

The DECCW Interim (2005) *Guidelines for Aboriginal Consultation* were enacted in 2010. This was in response to the requirements outlined by the then Department of Planning.

In 2012 the proponent for the project restarted the Aboriginal consultation and instigated the *Aboriginal cultural heritage consultation requirements for proponents 2010* (NSW DECCW 2010). This was done so as to ensure that the consultation process was as thorough and up to date as possible.

Aboriginal representatives from the registered Aboriginal parties participated in both the field survey of the study area and the subsurface testing program.

Field Survey and subsurface testing

Aboriginal heritage field survey was conducted of the Commonwealth land to the east of the Georges River in December 2010, of the LCC land in February 2013 and of the Commonwealth land to the west of the Georges River and the central and southern rail options in May 2014. In each case the field survey was attended by invited representatives of Aboriginal groups.

The subsurface testing undertaken in September 2012 used a combination of mechanical test pit excavation and by-hand test pit excavation. In total 59 test pits were excavated. The subsurface excavation work was attended by invited representatives of Aboriginal groups and was undertaken in line with pre-agreed methodology statement.

The mechanical test pit methodology was employed in all test locations where the predicted archaeological potential is no greater than low (MA1 & PAD1, MA5 and representative sample location 3).

The by-hand excavation methodology was employed for all test pits in areas of predicted moderate to high archaeological sensitivity (MAPAD1, PAD2 & minor tributary Riparian zone, and representative sample locations 1), to minimise the likelihood of damage to artefacts.

Predictive Modelling

Three zones of predicted Aboriginal archaeological potential were recognised within the study area:

- the Georges River Riparian Corridor – 100 m either side of the Georges River (inclusive of the 1890s eastern riverbank configuration);
- minor Tributary Riparian Zones – 100 m either side of tributary drainage lines (inclusive of the pre-European drainage alignment, as best determined from historical mapping and 1943 aerial photography); and
- the elevated slopes and riverside margin of a locally elevated Tertiary alluvial terrace edge situated adjacent to the Georges River – zone 100 m wide.

These zones are based on a generalised model of Aboriginal site location which indicates that the majority of sites are situated on locally elevated, well-drained and low gradient ground, located in relative proximity to a fresh or estuarine water source (a majority of sites, and most larger sites, occur within 100 m).

EXISTING ENVIRONMENT

Field survey results 2010

Eight Aboriginal archaeological recordings have been made in the Project area as a result of the 2010 field survey including:

- five artefact occurrences (MA1-MA5);
- three scarred trees of possible Aboriginal origin (MA6-MA8).
- three potential archaeological deposits (PADs) have been identified (MAPAD1, PAD1 and PAD2);
- and three archaeologically sensitive landform types have been defined.

Field survey results 2013

One Potential Archaeological Deposit (PAD) was identified during the 2013 field survey (MAPAD2), located on an archaeologically sensitive landform.

Field survey results 2014

No surface evidence of Aboriginal occupation was observed within the central rail access option; however areas of potentially intact deposits were identified along the banks of the Georges River that may contain archaeological evidence.

No surface evidence of Aboriginal occupation was observed within the southern rail access option, however it was noted that the potential exists for relatively intact deposits at depth that may contain archaeological evidence.

Survey of the southern rail access option was restricted to the eastern bank; the western bank being the Glenfield landfill, which displays low archaeological potential.

Excavation results 2012

Summary of the results of the subsurface testing program undertaken in September 2012

- Fifty-nine (59) test pits were excavated across the Moorebank IMT study area (Figure 10.1);
- Detailed geomorphological analysis was undertaken at select pits at MA5, MAPAD1 and PAD2;
- 264 artefact recovered from 26 pits;
-

Excavation results 2013

A summary of the results at site MAPAD2 in the LCC Northern Powerhouse land in 2013:

- Forty-five (45 – refer to Figure 10.13) test pits were excavated across MAPAD2 comprising 37 by-hand test pits and eight (8) mechanical pits;
- Detailed geomorphological analysis was undertaken at Pits 28, 29, 30, 31, 36, 41 and 42;
- Deposits excavated across MAPAD2 comprised three groups:
  - poorly sorted clayey gravels that have been introduced in some areas, most notably across the southern and northern extremities of the test area, as fill (Unit 3);
  - well sorted light grey or light brown clean sands with well-preserved bedding structures and minimal soil development (Unit 2); and
  - dark grey-brown silty sands with abundant charcoal (Unit 1).
- 14 artefacts were recovered from 9 pits (Pits 1, 5, 9, 10, 12, 13, 14, 34 and 42 – refer to Figure 10.14);

Site Designations

On the balance of evidence it would appear that there are three sites present within the area defined as MAPAD2. These sites comprise:

- MA 11: artefacts associated with the Unit 3 fill that has been reworked and deposited as the result of mechanical earth works at the southern end of MAPAD2 (Pits 1 and 5);
- MA12: artefacts associated with Unit 2 fluvial sands across the central southern portion of MAPAD2 (Pits 9, 10, 12, 13, 14 and 42); and
- MA13: a single artefact associated with the Unit 1 silts at the northern end of the test area (Pit 34, Spit 9).

Given that it was not possible, to fully test the nature of the Unit 1 deposits, due to their depth (i.e. over 1.2 m deep and beyond the safe work depth), within the scope of the existing test excavation methodology, the area of archaeological potential identified as MAPAD2 remains

Responses to research questions

Investigations east of the Georges River

Research question	Response

Research question	Response
What do the test results indicate about the past Aboriginal occupation of the Project area and the Sydney region?	Where intact deposits occur, Aboriginal occupation appears to be focussed upon the tertiary terrace edge. The upper catchment of Anzac Creek (PAD2) does not appear to have been a focus of Aboriginal occupation. The broader implication is that the river-side margins of elevated flats, in close proximity to higher order drainage (e.g. Georges River) were favoured locations for repeated and/or longer term encampments. The confluence of resources at MA9 (freshwater lake within a Tertiary terrace bordering Georges River) appear to have been a target of Aboriginal activity. Excavation results from this site indicate a relatively continuous, moderate to high density distribution of artefacts with a diverse range of artefact and material types present. Aboriginal occupation along the Tertiary terrace bordering the eastern side of the Georges River appears to have been variable. It is not entirely clear whether the variation in assemblage richness across MA1, MA5, MA9 and MA10 relates to differing levels of site integrity, or whether other local geographic and microtopographic variations are responsible.
How do the test results compare with other local and regional archaeological results and models?	The survey and test results are broadly in keeping with the local and regional predictive models. The site types recorded included scarred trees, isolated finds, artefact scatters and potential archaeological deposits, as per the predictive model. While surface occurrences of artefacts were recorded during survey, the excavation results have shown that subsurface archaeological deposits are more widely distributed than what surface evidence would suggest. This is exactly as predicted by the local site model. The most extensive and diverse archaeological deposits were encountered within well drained aggrading landforms, in a valley floor context, in association with permanent water sources. Again, this follows local and regional models.

Research question	Response
Does the subsurface archaeological resource accurately reflect the predictions on which the sensitive landform mapping is based?	In general terms the subsurface test results were in keeping with the predicted sensitive landform mapping: archaeological sensitivity was greatest within the tertiary terrace bordering the river corridor. Landforms further removed from the river corridor were found to be of low archaeological sensitivity. See Figure 10.1 for the location of areas of predicted sensitivity following the testing program. At this stage access constraints, including issues relating to workplace health and safety, have inhibited effective testing within relatively undisturbed sections of the river corridor that will be potentially impacted by the Moorebank IMT. The only test area where results were markedly different to what was predicted was PAD2. The absence of any artefactual material across the 21 test pits excavated in this area suggests that the margins of this minor tributary were not the target of Aboriginal activity. Instead Aboriginal occupation appears to have been focused further to the west, within landforms closer to the Georges River.
Based on the test excavation results, how can the local predictive model be refined or corrected?	Minor tributaries appear more likely to have been a focus of Aboriginal activity if they are associated with other resource zones, e.g the Georges River Riparian Corridor. A broader and more detailed analysis of site variation within Tertiary terraces bordering the Georges River is necessary in order to clarify whether the variation in assemblage size and richness observed during the current test excavation program relates to Aboriginal activity or post depositional site disturbance. Analysis at this level would require open area excavation. As such, it is outside the scope of the current heritage assessment process; it would form a component of mitigation works undertaken prior to construction.

Investigations west of the Georges River

Research question	Response
What do the test results indicate about the past Aboriginal occupation of the Project area and the Sydney region?	The lower lying landforms adjacent the Georges River, such as the floodplain area tested at MAPAD2 may not have been a focus of Aboriginal occupation. The results of the test excavation program did not reveal any evidence of areas of high use or focused activity. However, given that the extent of fluvial deposition of sands inhibited the opportunity to test the lower floodplain deposits, the extent of archaeological material within and below the 1836 floodplain is still largely unknown. Additional testing is required in order to establish the geomorphic and archaeological nature of the Unit 1 deposits at MAPAD2.
How do the test results compare with other local and regional archaeological results and models?	As was the case with the results of the test excavations conducted in 2012 (NOHC 2013), the current excavation results have demonstrated that an absence of surface artefacts is not necessarily indicative of an absence of artefacts in a subsurface context, which is in keeping with what is predicted by the local site model. However, as stated above, the test excavation program was unable to satisfactorily test the nature of the Unit 1 (pre-European floodplain) deposits across the study area. Additional testing is required in order to establish the geomorphic and archaeological nature of the Unit 1 deposits at MAPAD2.
Does the subsurface archaeological resource accurately reflect the predictions on which the sensitive landform mapping is based?	The subsurface test results have revealed a lower than predicted incidence of Aboriginal artefacts within the Georges River Riparian Corridor. However, this can be explained by the fact that the testing program was only able to adequately test deposits that appear to be less than 200 years old. The question of whether or not substantial archaeological material exists at depth (>1.2-1.5 m) within the MAPAD2 area is still unknown. Additional testing is required in order to establish the geomorphic and archaeological nature of the Unit 1 deposits at MAPAD2.

Research question	Response
Based on the test excavation results, how can the local predictive model be refined or corrected?	Sandy deposits at or below 10 m AHD within the Casula-Moorebank section of the Georges River Riparian Corridor are likely to be the result of sedimentation processes that post-date the Liverpool Weir (1836), as such the archaeological potential of these deposits is limited. Given that the current test excavation methodology did not enable sufficient testing of the Unit 1 deposits (inferred pre-European floodplain surface) below the sandy Unit 2 deposits, the test excavation results have not been able to indicate any refinements or changes to the predictive model with regard to the nature of Aboriginal use of the Georges River Riparian Corridor. However they have refined our understanding of the depth at which potential archaeological deposits relating to Aboriginal use of the river corridor may occur. Additional testing is required in order to establish the geomorphic and archaeological nature of the Unit 1 deposits at MAPAD2.

SIGNIFICANCE ASSESSMENT

The majority of the Moorebank IMT study area is not assessed to be of Aboriginal heritage significance. However, the undisturbed portions of the river corridor and Tertiary terrace are assessed to be of moderate to high significance at local and regional levels due to the research potential that exists in these areas. The Moorebank IMT portions of the Georges River corridor and terraces are also relatively unique examples of such archaeological resources in the context of the broader southern Sydney region. The Georges River Corridor and terraces meet the threshold for listing on the Commonwealth Heritage List.

The test excavation program within the Northern Powerhouse land demonstrated that while the archaeological significance of the upper 120-150 cm of deposits is generally low, these deposits are likely to have significance in terms of being a representative example of environmental changes that resulted from European settlement, in particular the construction of the Liverpool Weir. The Unit 1 and Unit 2 deposits have the potential to be of significance in terms of their scientific value, natural value, educational value, representativeness and social value (importance to the Aboriginal community and the broader Australian community) at local, State and National levels.

The Georges River Corridor and terraces have previously been assessed to meet the threshold for listing on the Commonwealth Heritage List (NOHC 2013a); the results of the current subsurface testing program at MAPAD2 indicate the potential for increased significance of these landforms.

Artefact occurrences MA1-MA4 comprise small, low density surface scatters with negligible archaeological potential. The predicted low archaeological potential at these sites is due to site location and/or the extent of disturbance at the site. These sorts of sites are common across the Sydney region; they offer limited educational value and are assessed to be of low scientific significance. However, these sites have Aboriginal cultural value.

The three scarred trees of possible Aboriginal origin have the potential to be of moderate to high scientific and educational value, if they are confirmed to be of Aboriginal origin. However, there is some uncertainty regarding the origin of the scars at MA6, MA7 and MA8. As such, the scientific and educational value of these recordings is not possible to be determined at this stage. Nevertheless, Aboriginal consultation has indicated that some of the RAPs identify these trees as sites of high significance to the Aboriginal community.

All sites meet the threshold for listing on the Commonwealth Heritage List.

Test excavations have revealed archaeological deposits to be present at MA1, MA5, MA9 (MAPAD1) and MA10 (MRSA1).

The archaeological significance of the deposits within the Moorebank IMT study area have also been assessed in the context of their geomorphology.

Results show the study area preserves a) a highly specific historical and prehistoric record of recent sand aggradation and vertical accretion superimposed on b) an earlier floodplain surface. The cause of the change in sedimentary regime appears to be the construction of the Liverpool Weir in 1836. The sediment record is thus an historic archaeological artefact of European design (ponding behind the weir to create a freshwater supply free of tidal saline influence) while the lower stratigraphy only partly observed in this study records the broader prehistoric changes prior to that impact.

Aboriginal cultural value

The RAPs for the Project have pointed to a number of sites of particular cultural value as well as indicating that the Project area as a whole has cultural value and significance.

Verbal and written advice received has highlighted that the recorded scarred trees (MA6-8) and site MAPAD1 (MA9) (pond area in the north of the Project site) have cultural significance.

CBNTCAC stated that:

> *There are areas within the proposed development that have cultural significance to Cubbitch Barta ...*

DCAC stated that:

> *The area is significant to our people due to the area and also the resources that would have been in this area. The interesting aspect of this project is the discrepancy of the boundaries of our people(s) areas such as this if investigated sufficiently can give is some answers that our people need. Our group has discussed the boundaries of the Darug people many times and agree that we had large areas that were shared areas, the Georges River would also have been shared.*
>
> and
>
> *This area is highly significant to the Darug people due to the evidence of continued occupation, within this development there is a complex of highly significant sites, this is an Aboriginal (Darug) landscape. The Georges River is part of the landscape that is traditionally known as a border for our traditional area, our group believes that areas that border our boundaries are large shared areas, as this area is the significance for us is very high.*

MOOREBANK IMT PROJECT IMPACTS

This classification of impact is made relative to the identified heritage place or item. Where a development would result in physical loss or change to a place or change to a place or item, this is a direct impact. Direct impact may affect a part or all of a place or item.

Where a development would avoid direct impact to a place or item, but would change its context or surroundings, this is termed an indirect impact. This is mostly caused by a development being situated in relative proximity to the place or item, and consequently changing the setting of the place or item to a significant degree. Indirect impacts may reduce the contextual integrity of a place or item, and compromise the interpretation or visual appreciation of the site.

Impacts to heritage across the study area

Impacts to Aboriginal sites from the Project vary across the Project stages.

Site rehabilitation works will be carried out on site following the MUR which will involve the following activities that may impact Aboriginal sites:

- decontamination and site stabilisation on the site of the plant and equipment operation training area on the western side of the Project site known as the 'dust bowl'; and
- construction of secure perimeter fencing.

This work does not form part of the current approval and all Aboriginal sites will be fenced and protected during these works.

The activities that will impact Aboriginal sites from the Early Works will be in the form of direct ground disturbance i.e. excavating for services, indirect ground disturbance ie vehicle movements across sites and removal of trees.

The greatest level of construction activity would likely occur during the early phase of the Project, during Project Phase A. Again impacts to Aboriginal sites will occur from direct ground disturbance, indirect ground disturbance and removal of trees.

Project Phase B to full build are essentially the operating stages of the project with some additional construction impacts. As all Aboriginal sites will have been impacted by the previous stage of work these phases will see little or no additional impacts to Aboriginal sites.

The following summarises the nature and extent of potential impacts to recorded Aboriginal sites that would result from the three current Moorebank IMT concept design (northern, central and southern rail option layouts).

Summary of impacts for each rail access option

Rail access option	Directly impacted	Within a conservation area
Northern	Georges River Corridor west bank MA1 MA2 MA5 (partial) MA9 (partial) MA10 MA11 MA12 MA13 MRSA2 (partial) MAPAD2 (partial)	MA3 MA4 MA5 (partial) MA6 MA7 MA8 MA9 (partial) MRSA2 (partial) MAPAD2 (partial)
Central	Georges River Corridor east and west bank MA2 MA5 MA6 MA9 (partial) MRSA2 (partial) MAPAD2 (partial)	MA1 MA3 MA4 MA5 (partial) MA7 MA8 MA9 (partial) MA10 MA11 MA12 MA13 MRSA2 (partial) MAPAD2 (partial)
Southern	Georges River Corridor east and west bank MA2 MA4	MA1 MA3 MA8 MA9 (partial)

Rail access option	Directly impacted	Within a conservation area
	MA5 MA6 MA7 MA9 (partial) MA10 (partial) MRSA2 (partial)	MA10 (partial) MA11 MA12 MA13 MRSA2 (partial) MAPAD2

MITIGATION RECOMENDATIONS

The following mitigation measures are considered appropriate to manage the impacts of the Project:

- Conservation areas
- Interpretation
- Additional Testing of Archaeological Deposits
- A stepwise strategy - phased improvement of the information base for Heritage assessment of significance and mitigative planning at Northern Powerhouse land (Moorebank IMT)
- Specialist analysis of Scarred trees
- Salvage of archaeological deposits
- Surface salvage of Aboriginal objects
- Care and management of recovered artefacts

For the Project it is recommended that:

- Where practicable, explore options in the detailed design stage to conserve *in situ* sites of moderate to high or greater significance;
- An Aboriginal heritage interpretation strategy for the Project should be developed in close consultation with the registered Aboriginal parties. The strategy could consider combining both European and Aboriginal interpretation within the Project area;
- A program of archaeological subsurface testing within MRSA2 and the western component of MA10 should be undertaken in order to inform the full scope of salvage excavations. The extent of such testing and salvage will be determined during detailed design when the exact nature of development impact can be defined. Planning for these investigations will need to include management of risks associated with snakes and impacts to Endangered Ecological Communities (EEC);
- If the northern rail access option is to go ahead then the following should be undertaken:
    - The phased approach to further investigations at MAPAD2 outlined above in Table 14.1 should be adopted.
    - Immediate further data gathering, in a stepped progressive build of information should be undertaken to fill the following knowledge gaps regarding MAPAD2:
        - desktop study (of geotechnical borehole data and levels);

        - drilling to recover undisturbed sediment core (for assessment and dating and as an archive sequence); and
        - subsurface bulk sample retrieval (using augered mud bucket) to assess preservation conditions and artefact presence/absence at depth.
    - Information recovered from future investigations at MAPAD2 should be incorporated into an Aboriginal heritage interpretation strategy for the project as a whole, developed in close consultation with the Registered Aboriginal parties. The strategy could consider combining both European and Aboriginal interpretation within the project area;

- If the central rail access option is to go ahead a program of Aboriginal subsurface archaeological investigation should be undertaken. The testing program would need to assess the upper metre of deposits as well as deposits at depth. An approach similar to that outlined in the northern Powerhouse land addendum report (NOHC 2014a) would be applicable to addressing the assessment of deposits at depth;

- If the southern rail access option is to go ahead a combined geotechnical and archaeological assessment should be undertaken to assess the nature of any deposit and the need for further archaeological investigation and/or salvage;

- Options for avoidance of impacts at MA6 and MA7 should be explored during the detailed design phase. If impacts cannot be avoided, consultation should be undertaken with the Aboriginal community regarding options for specialist investigations (e.g. a suitably qualified specialist in eucalypts of the Sydney region and dendrochronology be engaged to formally assess the age of the trees and their scars) and culturally appropriate mitigation strategies;

- MA5 and MA9 contain archaeological deposits of moderate to high archaeological significance. No impacts should occur at these locations without the prior conduct of archaeological salvage;

    - Consideration should be given to combine archaeological and geomorphological mitigation measures, as outlined in the technical report at Appendix 3.

    - Consideration should be given to conserving both sites *in situ,* within open space reserves, or an extension of the proposed vegetation buffer zone/conservation area. In particular consideration should be given to MA9 due to the existence of both unique remnant landscape features and subsurface archaeological deposits.

- Surface artefacts have been recorded at MA1, MA2, MA3 and MA4. Salvage of surface artefacts should be undertaken prior to any impacts in these areas;

- Consultation should be ongoing with the registered Aboriginal parties throughout the life of the Project and would include:

    - Consultation on the future care and management of recovered Aboriginal objects;
    - Methodologies for any future investigations;
    - Finalisation of management and mitigation strategies subject to detailed design; and
    - The provision for comments on a draft version of this report.

- No further archaeological investigations are warranted at MRSA3 or PAD2; and

- The unanticipated discoveries protocol at Appendix 10 should be followed in the event that Aboriginal objects or suspected burials are encountered during construction works.

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GLOSSARY AND ABREVIATIONS

CUST	Cullen Universal Steel Truss
Defence	Department of Defence
SEARs	Secretary's Environamenela Assessment Requirements
DoE	(Commonwealth) Department of the Environment
DoF	Department of Finance
DoFD	(Commonwealth) Department of Finance and Deregulation
EIS	Environmental Impact Statement
EM&A	Eric Martin and Associates
g	grams
ha	hectares
IMT	Intermodal Terminal
LCC	Liverpool City Council
LEP	local environmental plan
MIC	Moorebank Intermodal Company
MUR	Moorebank Units Relocation
NOHC	Navin Officer Heritage Consultants Pty Ltd
OEH	Office of Environment and Heritage
P&E	NSW Department of Planning and Environment
PAD	potential archaeological deposit
RAAF	Royal Australian Air Force
RAE	Royal Australian Engineers
RAP	Registered Aboriginal Party
SME	School of Military Engineering
SSD	State significant development
SSFL	Southern Sydney Freight Line
WWI	World War I
WWII	World War II

alluvial - pertaining to alluvium and fluvial processes.

alluvium - unconsolidated deposit of gravel, sand, mud etc., formed by water flowing in identifiable channels. Commonly well-sorted and stratified.

archaeological site - A site is defined as any material evidence of past Aboriginal activity which remains within a context or place which can be reliably related to that activity. Usually a site classification requires a minimum of two detected artefacts.

artefact - an object, normally portable, made or modified by human hand (see 'stone artefact').

assemblage - see lithic assemblage.

background discard - There is no single concept for background discard or 'scatter', and therefore no agreed definition. The definitions in current use are based on the postulated nature of prehistoric activity, and often they are phrased in general terms and do not include quantitative criteria. Commonly agreed is that background discard occurs in the absence of 'focused' activity involving the production or discard of stone artefacts in a particular location. An example of unfocussed activity is occasional isolated discard of artefacts during travel along a route or pathway. Examples of 'focussed activity' are camping, knapping and heat-treating stone, cooking in a hearth, and processing food with stone tools.

In practical terms, over a period of thousands of years an accumulation of 'unfocussed' discard may result in an archaeological concentration that may be identified as a 'site'. Definitions of background discard comprising only qualitative criteria do not specify the numbers (numerical flux) or 'density' of artefacts required to discriminate site areas from background discard.

background lithic material - natural stone (in the form of pebbles and/or fragments) of types used by Aborigines to make artefacts (such as quartz, tuff, silcrete, chalcedony and quartzite) and occurring in or near a prehistoric archaeological site.

background scatter - can be generally defined as manuport and artefactual material which is *insufficient either in number or in association* with other material to suggest focused activity in a particular location. However, a specific definition of 'background scatter' is inappropriate because it may imply more than simply a pattern of dispersed isolated finds.

backing (retouch) - abruptly angled flaking (retouch) which has shaped a thick back part to an implement such as an elouera or microlith. The process of flaking varies from bipolar impact (on some eloueras) to delicate application of pressure with a small stone ('chimbling' used to make microliths).

bending initiation - the commencement of a fracture by the application of a bending load or force, as in breaking a bar of chocolate, where the load is applied away from the point at which the object breaks. Bending initiation is common in the fracture of a tool's cutting edge during its use, and is commonly caused by human treadage at a site. It normally occurs on thin edges (see also 'snap fractures or flakes').

bioturbation - the process of mixing soil materials or sediments by living organisms.

bipolar core - A core (nucleus) that is supported on a stone anvil surface and struck repeatedly with a hammerstone from above. Diagnostic attributes of bipolar fracture damage are point or sinuous ridge type initiation platforms, crushing, cracks, and concentrated overlapping step fractures emanating from areas of hammer impact.

bipolar flake - (and broken bipolar flake) -a flake retaining evidence of bipolar fracture damage on at least one end. Some of these are 'compression flakes' formed by substantial compressive force. A broken bipolar flake has a transversely oriented breakage.

bipolar flaking - a method of making flakes or retouched flake tools by smashing a piece of stone, often a quartz pebble, rested on a stone surface and repeatedly striking the core from above with a stone hammer.

broken bipolar flake - Transversely broken flake from a bipolar core.

broken flake - A flake with two or more breakages but retaining its area of flake initiation.

chalcedony - a compact variety of silica, formed of quartz crystallites, often fibrous in form and with sub-microscopic pores which contain water (about 1% of weight). Coloured varieties include carnelian (yellow brown), sard (brown), agate (varicoloured) and jasper (red). Chalcedony can form veins or can occur as pseudomorphs, resulting from silica-charged solution infiltrating voids or cavities in rock, sometimes by gradually replacing decaying organic matter. Chalcedony, like fine quality chert, was a valued stone tool material. Mohs hardness always registers within half a point of 7. Chalcedony appears very fine-grained to the naked eye and can be translucent, banded and include a wide variety of colours. This rock type breaks by the process of conchoidal (shell-like) fracture and provides flakes that have sharp durable edges.

chert - a highly siliceous rock type formed biogenically from the compaction and precipitation of the silica skeletons of diatoms. Normally there is a high percentage of cryptocrystalline quartz. This rock type breaks by the process of conchoidal (shell-like) fracture and provides flakes that have sharp durable edges.

clast - a grain or crystal with a finer grained matrix (usual in silcrete).

colluvium - an unconsolidated deposit of gravel, sand, mud etc., formed by water flowing across a hillslope surface (slopewash, sheetwash, rainwash) and/or by mass movement. Commonly poorly sorted and stratified.

cobble - waterworn stones of diameter greater than 64 mm (about the size of a tennis ball) and less than 256 mm (about the size of a basketball). Archaeologists often refer to cobbles as pebbles (see also 'pebble').

conchoidal flake - a flake created by Hertzian initiation (a cone crack). This is the most common type of flake produced by tool making, but occasionally also occurs in nature. It is distinguished by a partial or complete cone crack and a bulb of force; other fracture surface features are éraillure scar, lances and undulations (see these other glossary entries, and Cotterell and Kamminga 1987, 1992). The inside fracture surface of a well-formed conchoidal flake is similar to that of a bivalve shell, hence the term 'conchoidal'. 'Conchoidal fracture' refers to the process of this flake formation.

concretion and nodules - a mineral forming in isolated aggregates, sometimes as spherical or ellipsoidal forms. Concretions display a concentric zonation of matrix components, whereas nodules display an undifferentiated internal fabric.

cone crack initiation - a Hertzian cone initiation which leads to the formation of a conchoidal flake. A Hertzian cone is similar in shape to the neck of a milk bottle with the top of this cone being the initiation of the circular fracture. On a flake surface the cone is not fully formed and is represented by one side, because the fracture-initiating force was applied from above at an angle of about forty five degrees, not ninety degrees. Other terms in current usage are 'focussed initiation' and 'split cone'.

conjoin analysis - piecing together or 'conjoining' artefacts helps in reconstructing prehistoric 'events' (such as tool manufacture, tool use activities and cutting-edge rejuvenation), determining chronology and assessing site integrity.

core (synonymous with nucleus) - a piece of stone, often a pebble or cobble but also quarried stone, from which flakes have been struck for the purpose of making stone tools. (see also 'tabular nucleus'). The core (or core fragment) is generally amorphous in shape. Flakes removed from a core are called 'primary flakes' and may be further shaped by finer flaking, called 'retouch'. The term 'nucleus' refers to cores and flakes or cores that have been retouched.

core rotation - rotation of a core so that another surface is presented from which to initiate fractures that create flakes or blades. Usually this occurs when the previously flaked part of the core because unsuitable for further flake removals. Core rotation may be in any direction. The process may be opportunistic or planned, and is aimed at maximising the number of suitable flakes detached from the core.

cortex - cortex is the weathered exterior of rocks formed by long periods of exposure to chemical and physical weathering. The percentage of cortex remaining on either the dorsal (if limited to the dorsal), the platform (if limited to the platform) or both dorsal and platform (if occurring on both) is recorded in 10% increments. On flaked pieces, cortex is recorded as an estimation of the total surface area covered

cortex type - cortex type varies according to the environment in which it formed and the subsequent processes by which it came to be transported to its current position. Three types of cortex are recorded for all artefacts preserving a cortical remnant. These are angular, rounded and irregular.

debitage - commonly used French word for the stone refuse from flaking activity. Usually there is a large quantity of flaking debitage for every finished stone implement.

discard - when referring to lithic scatters the term discard means the incidental, intended and unintended scatter of artefacts on the ground surface or directly into a sediment.

distal portion or end - the end of a flake or microblade (the opposite end to the that of the point of fracture origin on the ventral (or inside) surface. Tabular cortex is the weathered surface of a tabular shaped nucleus (core).

dorsal face/facet - the outside surface(s) of a flake, the inside surface of the flake being one side of the fracture created during the formation of the flake. The speed at which these fracture formed ranges from about 200 m to over one kilometres a second (see also 'ventral face').

edge-ground axe - Implement shaped on at least one margin by grinding against another surface. Such implements are often shaped by flaking, pecking, flaking and pecking or grinding and/or burnishing around much of their exterior.

end scraper - A flake with a flat ventral surface and steeply retouched distal end.

Éraillure flake - a secondary flake, always very thin in cross-section, that usually remains attached by a fine bridge of stone to the bulbar surface of a conchoidal negative flake scar. The fine attachment is easily removed by applying a very small force. A negative éraillure scar is left on one side of the bulb of force, which is in the upper part of the ventral surface of the primary flake from which it was detached, and is often referred to as 'bulbar scar'. This flake type has no initiation platform, is round or ovoid in plan view, and is always very thin. This flake type is not significant for the purposes of analysis other than to indicate conchoidal flaking.

flake - (General) a piece of stone detached from a nucleus such as a core. A complete or substantially complete flake of lithic material usually with evidence of hard indenter initiation, or occasionally bending initiation. A general category for substantially complete conchoidal flakes, and rarely bending-initiated flakes.

The most common type of flake is called 'conchoidal flake'. In certain circumstances flakes (especially conchoidal flakes) may be the result of natural fracture of stone. The flake's primary fracture surface (the ventral or inside surface) exhibits features such as fracture initiation, bulb of force, and undulations and lances that indicate the direction of the fracture front. Very occasionally a conchoidal flake comprises only a bulb of force (see also 'core', 'fracture initiation', 'bulb or force', 'lances' and 'undulations', and specific flake types).

flake portion - multiple breaks/proximal, distal/longitudinal, indicting the portion of the original flake. Multiple breakages indicates a fragment of a flake exhibiting more than one breakage but still retaining at least some of its initiation area. Proximal portion of a flake is synonymous with 'step-terminated flake'. This variety of flake sustains a breakage at its distal end either because it was detached from the nucleus by a bending force that created a second, transverse break or was broken transversely by a bending force after it was detached (such as when it struck the ground during knapping or subsequently by treadage at the site).

flake fragment - A category comprising flake fragments without areas of fracture initiation but which display sufficient fracture surface attributes (normally conchoidal markings) for identification as a lithic artefact fragment.

flake rotation contact damage -the fine flake scars damage on the distal end of a flake (such as a microlith backing flake) a fraction of a second after it has been created and before it separates fully from the nucleus. This fracturing is caused by the continued application of load or force to the flake as its upper part moves outwards and away from the nucleus.

flaked piece - A flaked piece is defined as any piece of rock clearly derived from the process of conchoidal fracture, but for which no attributes exist to identify it as a core, a flake or any other identifiable technological category.

flake from bipolar core - A flake retaining evidence of bipolar fracture damage on at least one end. Some of these are 'compression flakes' formed by substantial compressive force.

flake portion - a proximal portion retains the area of flake initiation, a distal portion exhibits a flake termination. Longitudinally broken flakes and ones with an oblique break are also recognised.

flat - a landform element which is planar or near horizontal; creek flat - flat adjacent to a creek usually a floodplain.

floodplain - valley floor flat adjacent to a stream which is flooded by the 'annual' flood (often considered to be the flood with a recurrence interval of about 1.6 years).

fluvial - pertaining to a stream or river.

fracture or flake initiation - the point or area defining the beginning of a flake-forming fracture (always found at the top of the top of the flake scar or ventral (inside) surface of the flake (see also 'initiation surface').

fresh breakage or fracture - fracturing of a lithic item during archaeological excavation or sieving. Such fracture, which has no adhering sediment or sediment stain, may be caused by trowel, pick, shovel or earth moving machinery.

heat fracture - fractures cause by heating the stone, either from natural causes, a campfire, or intentional heat treatment. Generally, these are undesirable effects though larger pieces of stone fractured by heat sometimes are used as cores or made into implements because of their convenient shape or size. Attributes indicating heat fracture include colour change, cracking, crazing, potlidding and creation of highly irregular fracture surface topography (often referred to as 'crenation' or 'crenulation'.

hammerstone /anvil - A piece of stone with such evidence of use in the form of diagnostic abrasion and other fracture damage.

heat treatment - the intentional slow heating of stone, such as silcrete, above 300°C to improve its flaking properties.

hinge termination - when the end of the flake or fracture continuously turns at ninety degrees to the surface of the nucleus or outside surface of the flake (see also 'retroflexed hinge termination').

indeterminate retouched piece in artefact or piece of an artefact with retouch along at least one margin. The purpose of this retouch cannot be determined, though some items are probably fragments of microlithic items, scrapers or utilised flakes listed above

implement (of stone) - synonym for a stone tool, usually denoting a tool that has been shaped by flaking (retouch).

initiation - see 'fracture or flake initiation'.

initiation platform - see 'initiation surface'.

initiation surface - the surface of a stone (sometimes called a platform) that is struck with a hammerstone at low angle for the purpose of detaching a flake. This surface is where a flake-forming crack commences; commonly part of it is retained on the flake. The load applied to this surface may be delivered by a hammerstone or by continuous increasing pressure with a length of dense wood or bone (a pressor or pressure flaking tool).

isolated find - a single stone artefact, not located within a rock shelter, and which occurs without any associated evidence of Aboriginal occupation within a specified radius, such as 60 metres (depending on which archaeological convention is used). This term is normally useful only in the context of surface archaeological survey results and subsurface testing results. Isolated finds may be constituent components of background discard, or indicative of obscured, remnant and disturbed sites.

knapping episode - a series of flaking events (see also 'knapping event')

knapping event - a single act of flaking a piece of stone resulting in the *in-situ* deposition of stone flaking debris. Such an event may occur as part of a series of events

lamination - a fine layer within the matrix of a lithic material. This layer is less than 2 mm thick.

lateral margin (of a flake) - the edge along the side of a flake, running from the flake's initiation surface to its termination.

lithic - in an archaeological context, items of a hard, usually siliceous, stone of a type selected by Aborigines for tool making. These items are often nondescript fragments but some also finely shaped implements.

lithic assemblage (of stone) - a collection of whole and fragmentary stone artefacts and manuports obtained from an archaeological site, either by collecting items scattered on the present ground surface (see lithic scatter) or by controlled excavation (see also 'stone artefact').

lithic fragment - a nondescript lithic item that does not have sufficient morphological attributes to identify it as a complete artefact or a portion of an artefact. The lithic fragment category comprises items which are identified only to the level of manuport fragments, even though it contains nondescript flaking shatter and fragments of flakes not individually identifiable as such. Some fragments exhibit attributes characteristic of heat stress, such as occurs during bushfire, hearth fire or intentional heat treatment. Evidence of heat fracture on lithic fragments (and identifiable artefacts) has been recorded in the comments for each entry. Depending on the nature of the cultural sediment and non-Aboriginal land-use practices this group may also contain a small number of non-artefactual fragments exhibiting fresh fracture surfaces.

lithic item - a piece of stone exhibiting fracture surfaces and not identified as a natural piece of stone.

manuport - an object or fragment of an object (called item in this report) carried by human agency to the locality in which it is found.

margin - the surface immediately adjacent to an edge, the letter being the intersection of two margins.

microdebitage - flaking waste or debris (debitage) up to 10 mm in maximum size. There is no uniform metrical definition of micro-debitage and some archaeologists specify a maximum size of 5 mm.

microlith (synonym 'backed blade') - a variety of small, delicately retouched implements of various shapes such as asymmetric (bondi) point, segment, crescent, triangle, trapeze, rectangle and oblique ended. These implements are commonly thought to have been spear barbs.

microlith preform - a microblade with some degree of initial backing retouch, often along the distal end. Recognised portions are proximal, distal and fragment.

mottles (on stone surface) - masses or blotches of subdominant colours in an area of stone surface.

mottles (in soil/sediment) - masses or blotches of subdominant colours within a soil mass. Often evidence of poor drainage or extensive bioturbation.

nondescript core or core fragment A core (or core fragment) of generally amorphous shape.

nucleus see 'core', 'polyhedral core', 'tabular nucleus'.

outrépasse termination - a flake ending that turns inwards within the nucleus taking off part of its base. This occurs when the fracture front approaches the bottom of a nucleus and must turn in one direction or the other, as the stresses on either side of the fracture front cannot be equal. If the fracture front turns sharply towards in the other direction the flake will terminate in a hinge. A modest to pronounced outrépasse termination is common on microlith backing flakes and occasionally is seen on microblades.

pebble - by geological definition, a waterworn stone less than 64 mm in diameter (about the size of a tennis ball). Archaeologists often refer to waterworn stones larger than this as pebbles though technically they are cobbles.

pH - acidity or alkalinity of soil or water. Expressed in logarithmic units either side of 7 which is neutral, <7 = acid, >7 = alkaline.

pit - a below ground level ('subsurface') testing location, either excavated by hand and sometimes referred to as a *spade pit* or *shovel pit*, or excavated by machine, such as with a backhoe or machine auger and sometimes referred to as a *trench*.

porphyry - An igneous rock rich in phenocrysts. The term 'porphyritic' refers to ones in which relatively large crystals are set in a fine-grained or glassy groundmass.

potlid - A piece of lithic material that has a generally convex or dome-shaped ventral surface, often with evidence of fracture initiation from a location within the surface and not from the edge.

preform - a flake or blade selected for shaping by retouch into an implement. For inclusion in this category an artefact must have some degree of retouch (see also 'retouch' and 'blank').

primary fracture surface One of the two conjoining fracture surfaces created on a nucleus and flake after the flake has detached. The primary fracture surface on the flake is called the ventral surface.

proximal - the top part of a flake beginning with the initiation surface or ridge. It is the same for an implement (or tool). The opposite end of flake is called the distal end.

quarry - a site where stone was obtained by excavation from bedrock with extraction tools of simple design (see also Stone procurement site or place).

quartz - a mineral composed of crystalline silica SiO^2. Quartz is a very stable mineral that does not alter chemically during weathering or metamorphism. It is hard, usually colourless or white ('milky'). In its massive form quartz occurs as geodes or veins, from which pebbles are formed by weathering. Despite the often unpredictable nature of fracture in quartz the flakes often have sharp cutting edges. Quartz is common and abundant, and the Aborigines used it throughout Australia to make convenient light-duty cutting tools.

quartzite - A hard, silica rich stone formed from a sandstone that has been recrystallised by heat (meta-quartzite) or strengthened by slow infilling of silica in the voids between sand grains (orthoquartzite). The essential difference between sandstone and quartzite is that major fracture will propagate around the larger grains in sandstone and through the grains in quartzite.

Quaternary - The most recent geological time period. Divided into the Holocene and the Pleistocene. Began 1.8 million years ago (see also 'stone procurement site').

reduction process - the process of removing flakes from a core, or of manufacturing an implement by flaking and/or grinding, or progressively rejuvenating a tool's working edge.

reduction strategy - strategy of flaking and/or grinding a piece of stone in predetermined stages to produce an implement.

residues on stone tools - residue analysis concerns the identification of tool use activities from preserved organic and inorganic residues of worked materials. These residues may be compacted into small flake scars on the edges of utilised artefacts or adhere strongly to their surfaces. Routine examination of residues is aided by low-magnification microscopy.

retouch or retouching - an area of flake scars on an artefact resulting from intentional shaping, resharpening, or rejuvenation after wear or breakage. In resharpening a cutting edge the retouch is invariably found only on one side (see also 'indeterminate retouched piece', retouch flake' etc).

sandstone - a cemented or compacted rock consisting of detrital grains which range in size from 2 mm. Because of its chemical stability quartz often comprises the majority of the grains. The nature of the cement is denoted by terms such as argillaceous (clayey), calcareous, ferruginous and tuffaceous sandstone.

sieve damage - fracture damage on lithic items caused by abrasive contact with the sieve mesh during the process of sieving. This occurs more commonly with wet sieving of clayey sediment.

silcrete - (also known as 'porcellanite' and 'grey billy') A hard, fine grained siliceous stone flaking properties similar to quartzite and chert. It is formed by the cementation and/or replacement of bedrock, weathering deposits, unconsolidated sediments, soil or other material by a low temperature physico-chemical process.

Silcrete is essentially composed of quartz grains cemented by microcrystalline silica (SiO^2). Mineral composition is highly variable, but it comprises more than 85% silica, and includes aluminium, iron and titanium in small but significant amounts. The bonding matrix is often composed of microcrystalline quartz or chalcedony. Clasts are most often quartz grains but may also include chert or chalcedony or some other hard mineral particle. Mechanical properties and texture are equivalent to the range exhibited by chert at the fine-grained end of the scale to silcrete at the coarse-grained end. Silcrete is used by Aborigines for stone tool manufacture throughout most of Australia.

site designation - name or identification given to a site identified as a result of subsurface testing.

site integrity - the degree of post-depositional disturbance to a site.*

spit - an arbitrary interval of excavated depth in an archaeological excavation, such as in: spit 2 was the layer of deposit excavated between 10 and 20cm below ground level.

stone artefact - a piece or fragment of stone showing evidence of intentional human creation or modification.

stone layer - a sheet or layer of gravel sized materials found within a body of soil material. Commonly formed at the lower limit of bioturbation and often contains a concentration of artefacts.

stone material - (synonymous with 'lithic material', 'stone type' and 'raw material' which is a less specific but commonly used term).

stone procurement place (or site) - a place where stone is obtained for making into artefacts. As a prehistoric site type in Australia, stone procurement places range on a continuum, from pebble beds in watercourses (where there may be little or no archaeological evidence of human activity) to extensively quarried outcrops of bedrock where there is clear evidence of procurement activity, such as quarry pits, discarded hammerstones and large consolidated cultural deposits of primary flaking debris. (See also quarry)

stone tool - a piece of flaked or ground stone used in an activity or fashioned for use as a tool. A synonym of stone tool is implement, which is more often used by archaeologists to describe a flake tool fashioned by more delicate flaking (retouch).

technological attributes analysis - methods of reconstructing reduction sequences in stone technology (see reduction sequence). Discrete and metrical attributes of artefacts are identified, recorded and examined mathematically.

termination (of a flake) - the distal end

use fractures - breakages on the edges of stone tools resulting from tool use (see also 'use-wear').

use-wear - microscopic and macroscopic damage to the surfaces of stone implements resulting from its use. Routine examination for use-wear is aided by low-magnification microscopy. Major use-wear forms are edge fractures, use-polish and smoothing, abrasion, and edge rounding and bevelling.

ventral face - the inside surface of a flake created during the flake's formation. The speed of the fracture ranges from about 200 metres to over one kilometres per second (see also 'dorsal face').

volcanic stone - rock types formed by volcanic activity display a wide range of mechanical and flaking properties. Freshly fractured volcanic stone tends not to have fine, durable edges suitable for cutting. Only a few types are utilised for making stone tools, often ones that are shaped by grinding.

working edge - the edge of a tool in contact with the worked substance or material during its usage.

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1. INTRODUCTION

1.1 Project background

In May 2010 the Australian Government tasked the (Commonwealth) Department of Finance and Deregulation (DoFD) now the Department of Finance (DoF) to conduct a Feasibility Study into the potential development of an intermodal terminal (IMT) at Moorebank in south western Sydney. The Moorebank IMT site is currently occupied by the Department of Defence (Defence) including the School of Military Engineering (SME) to the west of Moorebank Avenue. The Australian Federal Government has approved the relocation of SME to new purpose-built facilities at the nearby Holsworthy Barracks (the Moorebank Unit Relocation (MUR) project) with the move to be completed by around mid-2015. The impacts of the MUR project are the subject of a separate assessment and approval process.

Navin Officer Heritage Consultants Pty Ltd (NOHC) was commissioned in 2010 by Parsons Brinckerhoff to undertake a cultural heritage assessment for the Moorebank Defence precinct on behalf of the DoFD as part of the Environmental Impact Statement (EIS) for the project.

The results of interim heritage studies conducted to date (surface & built environment), including field survey, the identification and assessment of heritage values, and a review of potential development constraints, have been reported in two preliminary reports:

- A scoping report which presented a summary of known and potential constraints based on a desktop review (NOHC 2011); and

- A report on existing Aboriginal and European Heritage (CDFD Aug 2011) which supported a Preliminary Project Environmental Overview (CDFD Dec 2011).

In April 2012 the Australian Government committed to development of the Moorebank Intermodal Terminal (IMT) Project after reviewing the findings of a detailed business case for the facility (CDFD Feb. 2012). The Project is subject to planning approval with an Environmental Impact Statement due to be displayed late in 2012 to enable public feedback. Both Federal and NSW planning approvals are being sought.

The Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) has determined that the Moorebank IMT Project is a Controlled Action requiring the development of an EIS for assessment and approval under the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).* The Commonwealth has lodged a submission under the EPBC Act and elected to make a submission under Part 4.1 of the New South Wales *Environmental Planning and Assessment Act 1979* EP&A Act. Pursuant to the provisions of S 83(B) of the EP&A Act, a staged development application is proposed. This application is for a Stage 1 development application for the entire IMT. A staged development application sets out the concept proposals for the development of a site for which detailed proposals for separate parts of the site are to be the subject of subsequent development applications.

In March 2014, the NSW Department of Planning and Environment (P&E) issued Director General's Requirements (SEARs) for the Project.

Consultation with P&E and through them the NSW Office of Environment and Heritage (OEH) was undertaken on the proposed methodology for the project. Meetings were also held with P&I regarding the methodology which was ultimately approved by them, see Section 3.5.1 for further information on this process.

This report was commissioned by Parsons Brinckerhoff on behalf of Moorebank Intermodal Company (MIC).

1.2 The project site

The Project is situated on land in the Sydney suburb of Moorebank, NSW (refer Figure 1.1). The Project Site is approximately 220 hectares (ha) in area, and is located within a locality that includes the residential suburbs of Casula, Wattle Grove and North Glenfield, as well as industrial, commercial and Defence land.

The Project would provide connectivity to Port Botany by rail, and would connect to major regional and interstate roads and highways via the M5 and M7 Motorways.

Three separate rail access options are included as part of the proposal concept as detailed in this EIS, as shown in Figure 1.1. These options comprise:

- *northern rail access option* — with rail access from the north-western corner of the IMT site, passing through the former Casula Powerhouse Golf Course (which is currently owned by Liverpool City Council (LCC)) and crossing the Georges River and floodplain;

- *central rail access option* — with rail access from the centre of the western boundary of the IMT site, passing through Commonwealth land on the western bank of the Georges River (referred to as the 'hourglass land'); and

- *southern rail access option* — rail access from the south-western corner of the IMT site, passing through the Glenfield Landfill site (owned by Glenfield Waste Services) and crossing the Georges River and floodplain.

1.3 Planning and assessment process

The Project is subject to both Commonwealth and NSW State Government approvals, and this EIS has been prepared to support applications for both approvals (EPBC number 2011/6086 and SSD-5066). The Project is a 'controlled action' under the (Commonwealth) *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Therefore, MIC is seeking approval for the construction and operation of the Project from the (Commonwealth) Department of the Environment (DoE) under Part 9 of the EPBC Act.

Under the (NSW) *Environmental Planning and Assessment Act 1979* (EP&A Act), MIC is seeking a staged development approval for the Project as State significant development (SSD). At this stage, MIC is seeking Stage 1 SSD development approval for the proposal concept (as described in Chapter 1 of the EIS) from NSW Planning and Environment (NSW P&E) under Part 4, Division 4.1 of the EP&A Act (hereafter referred to as the Stage 1 SSD development approval). The Stage 1 SSD development approval application also includes a package of 'early works' that comprises remediation, clean-up and demolition or relocation of existing buildings, and establishment of a conservation area. This EIS is seeking approval for these early works without the need for any further approvals. Subject to Stage 1 SSD development approval being received, the Project (with the exclusion of the early works) will be subject to further development applications and environmental assessment under the EP&A Act (hereafter referred to as the Stage 2 SSD development approvals).

Therefore, this Technical Paper and the EIS assess the impacts of all five proposed development stages of the Project to a concept level, and also provides a detailed assessment of matters protected under the EPBC Act. Further details of the Project would be the subject of future development applications under the NSW EP&A Act as those details are developed, with environmental impact assessments to be conducted in detail at that time. Impacts and mitigation measures would be confirmed following detailed design.

1.4 Environmental impact assessment requirements

This Technical Paper has been prepared by Navin Officer Heritage Consultants to address environmental impact assessment requirements of both the Commonwealth Government under the EPBC Act (the 'Final EIS Guidelines'); and the NSW Government under the EP&A Act ('the Secretary's Environmental Assessment Requirements (SEARs)')

Specifically this Technical Paper addresses the requirements outlined in the Table 1.1.

Table 1.1 EIS requirements addressed within this Technical Paper

Requirement	Where addressed in the technical Report Section #
EPBC Act – Final EIS Guidelines	
Provide description of the existing environmental values including.... cultural ... values, of the site which may be affected by the proposal.	4, 5, 6, 11
Identify, describe and map all places and items of indigenous cultural value.	5,6, 7, 8, 9, 10, 11
Describe the impacts the proposed action would have on Indigenous cultural values including the continuing practice of traditional beliefs and access to sites. Provide evidence of an understanding of potential impacts to Indigenous heritage values through appropriate consultation.	3, 5, 12, Appendix 5
NSW EP&A Act – SEARs	
Outline the proposed mitigation and management measures (including measures to avoid significant impacts and an evaluation of the effectiveness of the measures) generally consistent with the Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (DEC 2005).	5, 13
Be undertaken by a suitably qualified heritage consultant(s).	3
Demonstrate effective consultation with Aboriginal communities in determining and assessing impacts and developing and selecting options and mitigation measures (including the final proposed measures	5
Demonstrate that an appropriate archaeological assessment methodology, including research design (where relevant), has been undertaken to guide physical archaeological test excavations of areas of potential archaeological deposits. The full spatial extent and significance of any archaeological evidence shall be established and results of excavations are to be included.	3, 9, 11, Appendix 2
Assess and document the archaeological and cultural significance of cultural heritage values of affected sites	12
Develop an appropriate assessment methodology, including research design, in consultation with the Department and the Office of Environment and Heritage, to guide physical archaeological test excavations of the sites and areas of PAD identified in a manner that establishes the full spatial extent and significance of any archaeological evidence across each site/area of PAD, and include the results of these excavations.	3

The Draft SEWPaC Guidelines for the Content of a Draft EIS states that:

> *Consultation with Indigenous stakeholders is an essential component for identifying and assessing the presence and significance of indigenous heritage items and places. Each of the following sections must include reference to how consultation with Indigenous stakeholders has informed the impact assessment process.*

1.5 Scope of this report

This report comprises an Aboriginal heritage assessment for the Moorebank IMT EIS. It includes the results of fieldwork including:

- The NOHC 2010 field survey that identified eight Aboriginal sites (MA1 – 8), one potential archaeological deposit (MAPAD1), and three sensitive landform zones within the project area.

- The subsurface testing program at MA1, MA5, representative sample locations 1 and 3, MAPAD1, and PAD2 (Figure 1.5). Results of this program and the associated analysis are documented in this report as part of the EIS for the project.

- The NOHC 2013 field survey and subsurface archaeological testing program of the northern rail connection on land to the west of the Georges River, owned and managed by the Liverpool City Council (LCC).

- The NOHC 2014 field survey of the central and southern rail corridor options.

1.5.1 Report outline

This report:

- describes the proposed development/works etc. (Section 2);

- describes the methodology employed in the study (Section 3);

- provides details of an Aboriginal cultural context and the Aboriginal consultation program undertaken as part of the study (Section 5);

- describes the results of the, data review, field survey, archaeological subsurface testing program and excavation analysis conducted in the context of the assessment (Sections 6-10);

- provides an assessment of heritage significance for items identified within the study area (Section 11);

- provides an assessment of potential development impacts to sites (Section 12); and

- provides management and mitigation strategies based on the results of the investigation (Section 13).

1.5.2 Copyright

Copyright to this report rests with the Department of Finance and Deregulation except for the following:

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- Generic content and formatting which is not specific to this project or its results (copyright to this material rests with Navin Officer Heritage Consultants Pty Ltd);

- Descriptive text and data relating to Aboriginal objects which must, by law, be provided to OEH for its purposes and use;

- Information which, under Australian law, can be identified as belonging to Indigenous intellectual property;

- Content which was sourced from and remains part of the public domain

1.5.3 Restricted Information

Information in this report relating to the exact location of Aboriginal sites should not be published or promoted in the public domain.

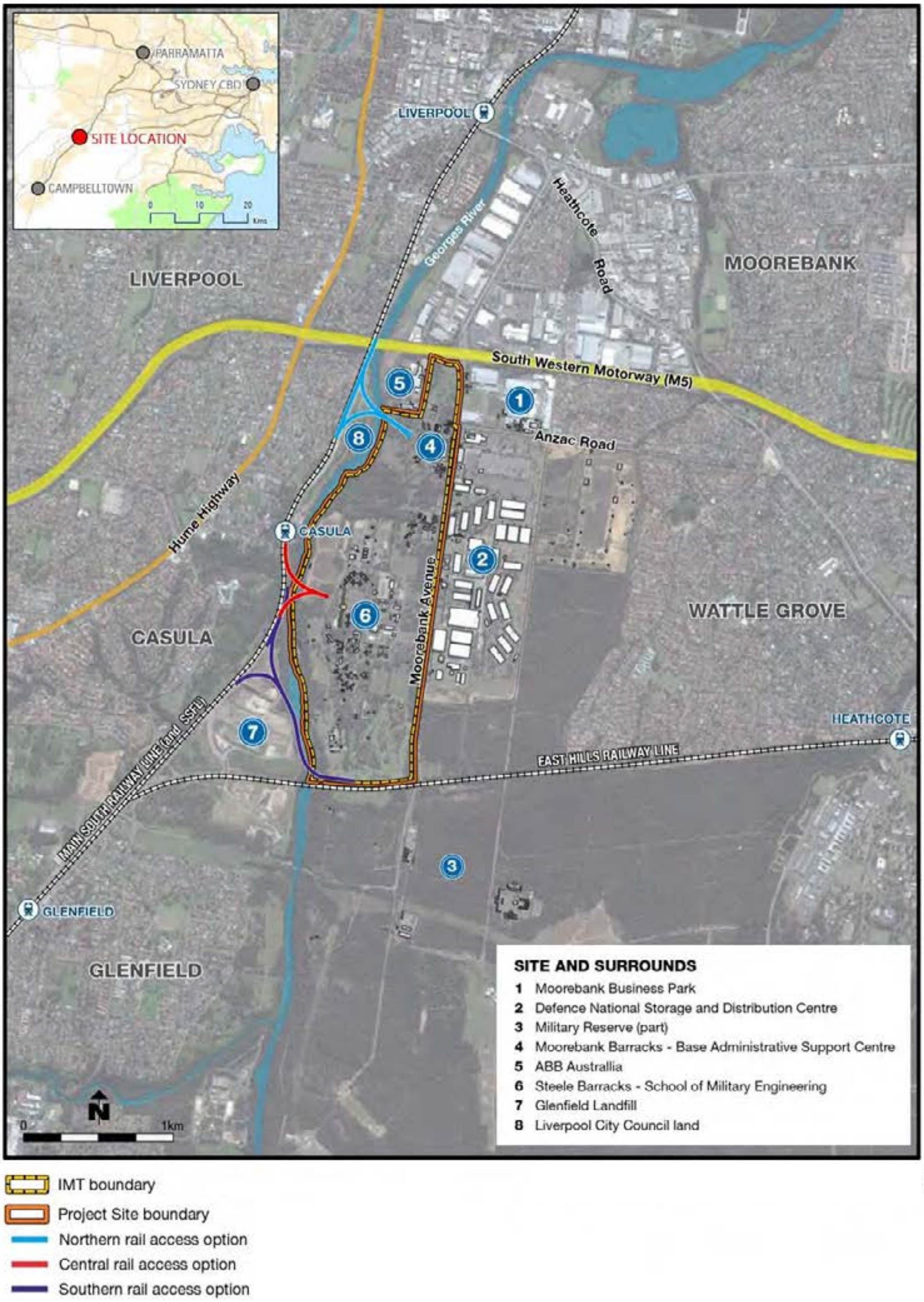

Figure 1.1 Study area, Project site and context

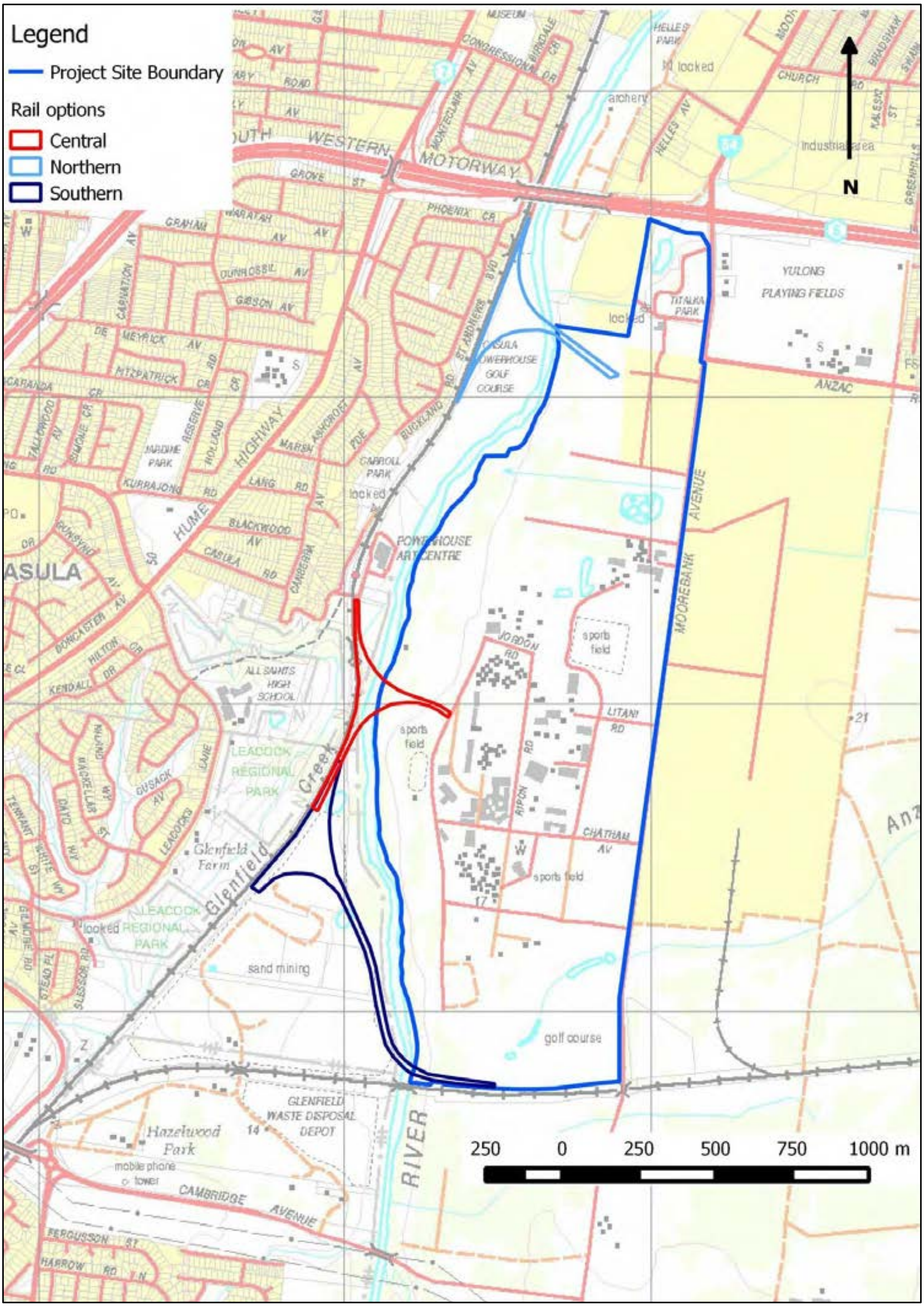

Figure 1.2 Study area, including the three rail access options

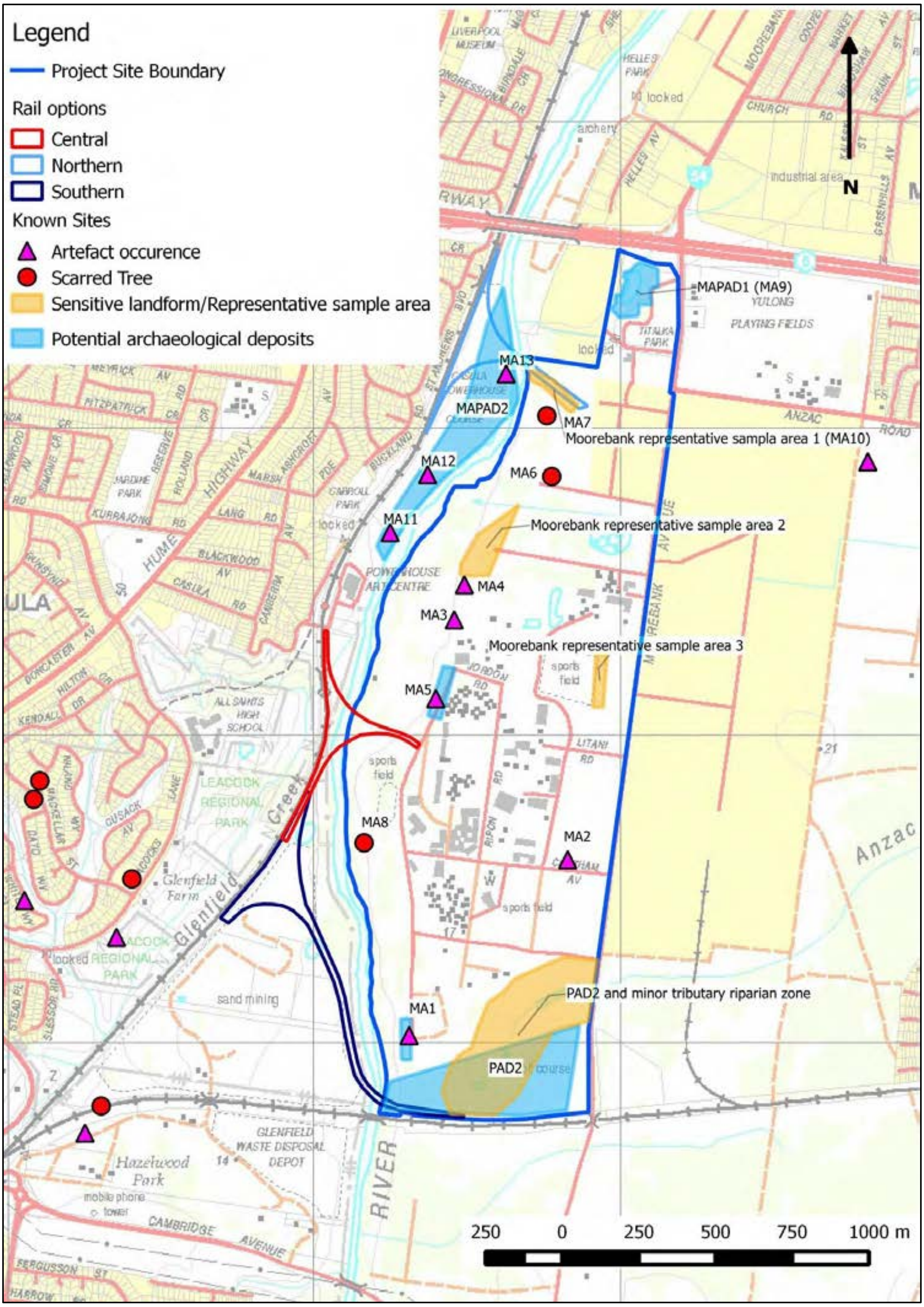

Figure 1.3 Location of Aboriginal test excavation areas – orange and blue shading – relative to recorded Aboriginal sites and the Project Boundary.

2. PROPOSED DEVELOPMENT

The Moorebank Intermodal Terminal (IMT) Project (the Project) involves the development of approximately 220 hectares (ha) of land at the Project site (refer to Figure 1.1) for the construction and operation of an IMT and associated infrastructure, facilities and warehousing. The Project includes a rail link connecting the Project site to the Southern Sydney Freight Line (SSFL) and road entry and exit points from Moorebank Avenue.

The primary function of the IMT is to be a transfer point in the logistics chain for shipping containers and to handle both international IMEX cargo, and domestic interstate and intrastate (regional) cargo. The key aims of the Project are to increase Sydney's rail freight mode share including: promoting the movement of container freight by rail between Port Botany and western and south-western Sydney; and reducing road freight on Sydney's congested road network.

The Project proponent is Moorebank Intermodal Company (MIC), a Government Business Enterprise set up to facilitate the development of the Project.

The Project site is currently largely occupied by the Department of Defence's (Defence) School of Military Engineering (SME). Under the approved Moorebank Units Relocation (MUR) Project, the SME is planned to be relocated to Holsworthy Barracks by mid-2015, which would enable the construction of the Project to commence.

The key features/components of the Project comprise:

- *an IMEX freight terminal* – designed to handle up to 1.05 million TEU per annum (525,000 TEU inbound and 525,000 TEU outbound) of IMEX containerised freight to service 'port shuttle' train services between Port Botany and the Project;
- *an Interstate freight terminal* – designed to handle up to 500,000 TEU per annum (250,000 TEU inbound and 250,000 TEU outbound) of interstate containerised freight to service freight trains travelling to and from regional and interstate destinations; and
- *warehousing facilities* – with capacity for up to 300,000 square metres (m^2) of warehousing to provide an interface between the IMT and commercial users of the facilities such as freight forwarders, logistics facilities and retail distribution centres.

The proposal concept described in the main EIS (refer Chapters 7 and 8) provides an indicative layout and operational concept for the Project, while retaining flexibility for future developers and operators of the Project. The proposal concept is indicative only and subject to further refinement during detailed design.

2.1 Rail access options and layouts

The Project is intended to connect to the SSFL, which was commissioned in January 2013 within the Main South Railway Line corridor. The SSFL connects Port Botany to west and south-western Sydney, and would provide a direct route for freight trains from Port Botany to the Project site.

In order to maintain flexibility for future developers and operators of the Project, the proposal concept, as presented in this EIS, provides three indicative IMT internal layouts; one for each of three proposed rail access options. Once the selected developer/operator has been appointed, the Project would progress to the detailed design phase and one of the three rail access options identified in Section 1.2 would be selected.

2.2 Indicative project development phasing

The Project is proposed to be phased (staged) in its development, as summarised in Figure 2.1. The proposed indicative phasing includes both construction and operational phases, which are likely to overlap at certain times. For the purposes of assessment of the Project, five project development phases have been identified and detailed in this EIS. These are indicative only, but illustrate the type of construction and operation activities that would occur over time at the Project site.

The Project would likely commence in 2015 with the Early Works development phase and would progress with concurrent construction and operation through to the Project Full Build Phase (operation of full IMEX terminal, warehousing and interstate terminal) by approximately 2030.

The development phasing is proposed in line with the forecast market demand for processing of containers through the Project.

2.3 Road access to the site

Freight trucks would access the Project site from Moorebank Avenue, via the M5 Motorway. Trucks would then access the M7 Motorway and Hume Highway by the M5 Motorway. An upgrade to Moorebank Avenue would be included as part of the first phase of Project development (Project Phase A) to enable safe and efficient access to the Project site.

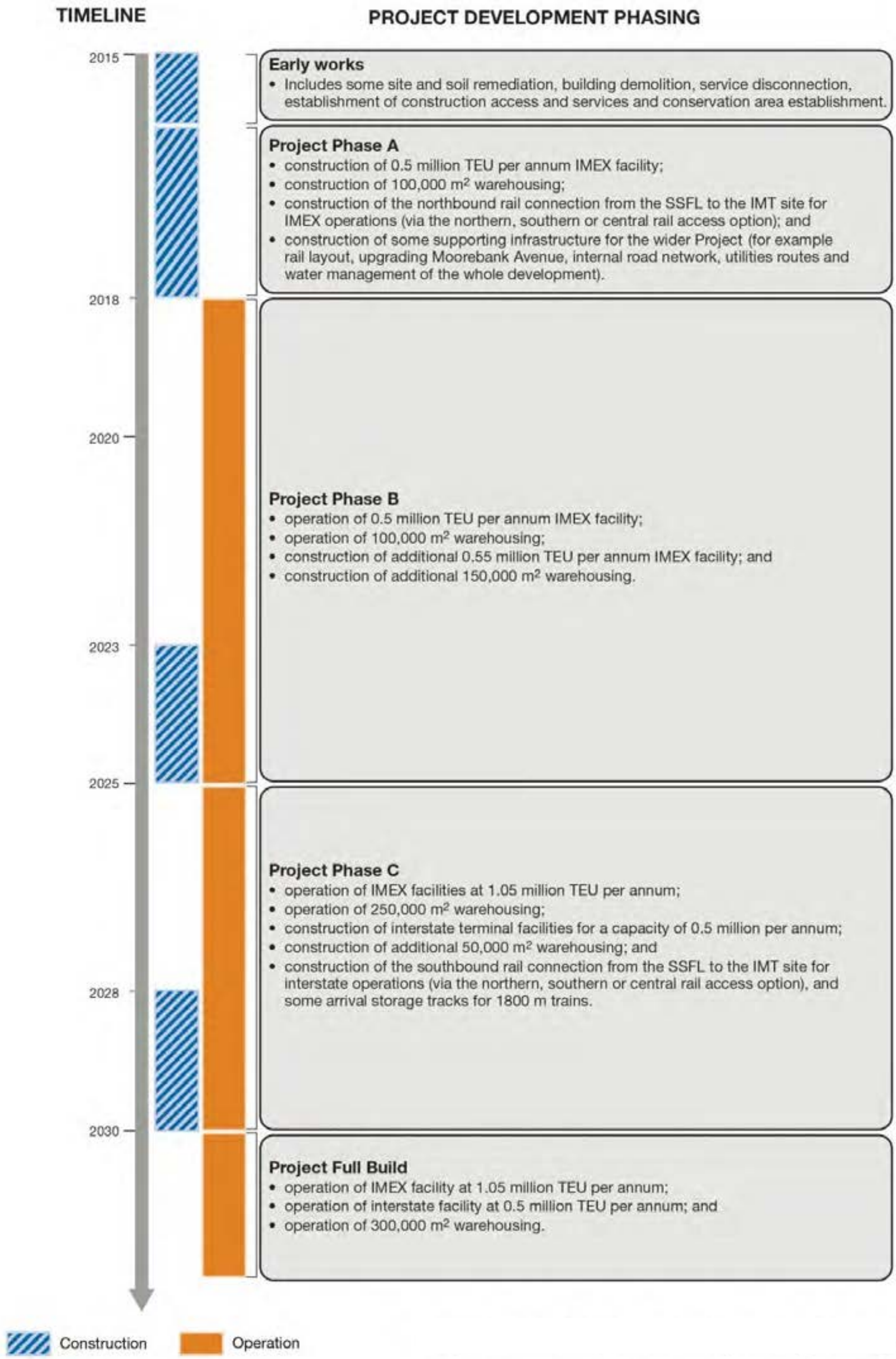

Figure 2.1 Project development phasing

3. STUDY METHODOLOGY

3.1 Contributors

Preliminary field surveys were undertaken by Kelvin Officer and Adrian Cressey in December 2010 and historical research for the preliminary investigations was conducted by Brendan O'Keefe and Kelvin Officer.

The excavation methodology and research design was developed by Rebecca Parkes and Kelvin Officer.

Test excavations were directed by Rebecca Parkes, field assistants included Thomas Knight, Travis Gottschutzke and Joanne Dibden.

Specialist reports on geomorphology and lithics analysis were provided by Anthony Barham and Daryl Wesley respectively.

Field inspection of the central and southern rail corridor options was undertaken by Rebecca Parkes and Tony Barham.

This report has been prepared by Rebecca Parkes, Kelvin Officer and Nicola Hayes.

3.2 Land Access and Scope of Assessment

The area subject to assessment consists of the lands and Defence property that would potentially be directly impacted by the construction and operation of the proposed Moorebank intermodal terminal. This is collectively defined as the Project area, the boundaries of which are presented as the Project Boundary in Figure 3.1. These lands and the corresponding scope of the assessment are:

- the Defence lands situated to the east of the Georges River, owned and managed by the Commonwealth;
- land to the west of the Georges River, owned and managed by the Liverpool City Council (LCC);
- the Glenfield Landfill site;
- Commonwealth land on the western bank of the Georges River; and
- a small portion of the Georges River, being unalienated Crown land.

The assessment of the Defence lands has been comprehensive and based on a review of archival sources and existing information, direct physical inspection, archaeological survey and test excavations.

. Direct physical inspection and archaeological survey have occurred subsequent to the assessment of the main Project area (February 2013) to the lands to the west of the river, the LCC land, resulting in a more comprehensive assessment of the archaeological potential of this area, as well as the potential impacts of the Project. Subsequent subsurface testing of the area has been undertaken and included in this report. A more detailed report on this assessment is reported on in a separate addendum report found at Appendix 11.

The Glenfield Landfill was not able to be accessed for this assessment; therefore a desktop assessment of this area was undertaken.

The assessment of the Commonwealth land west of the Georges River has been comprehensive and based on a review of archival sources and existing information as well as direct physical inspection and archaeological survey.

The small portion of the submerged bed of the Georges River was not directly surveyed for this assessment. The archaeological potential of this area was based on a review of historical source material, heritage registers and predictive analysis.

Assessments of cultural heritage significance, and potential impacts to heritage values, have been undertaken for each site that has been identified through the archaeological investigations documented in this report.

These individual site assessments have informed an assessment of the overall cultural heritage significance of the study area. There has been a holistic assessment of sites in terms of their landscape context and the research potential that exists across the study area.

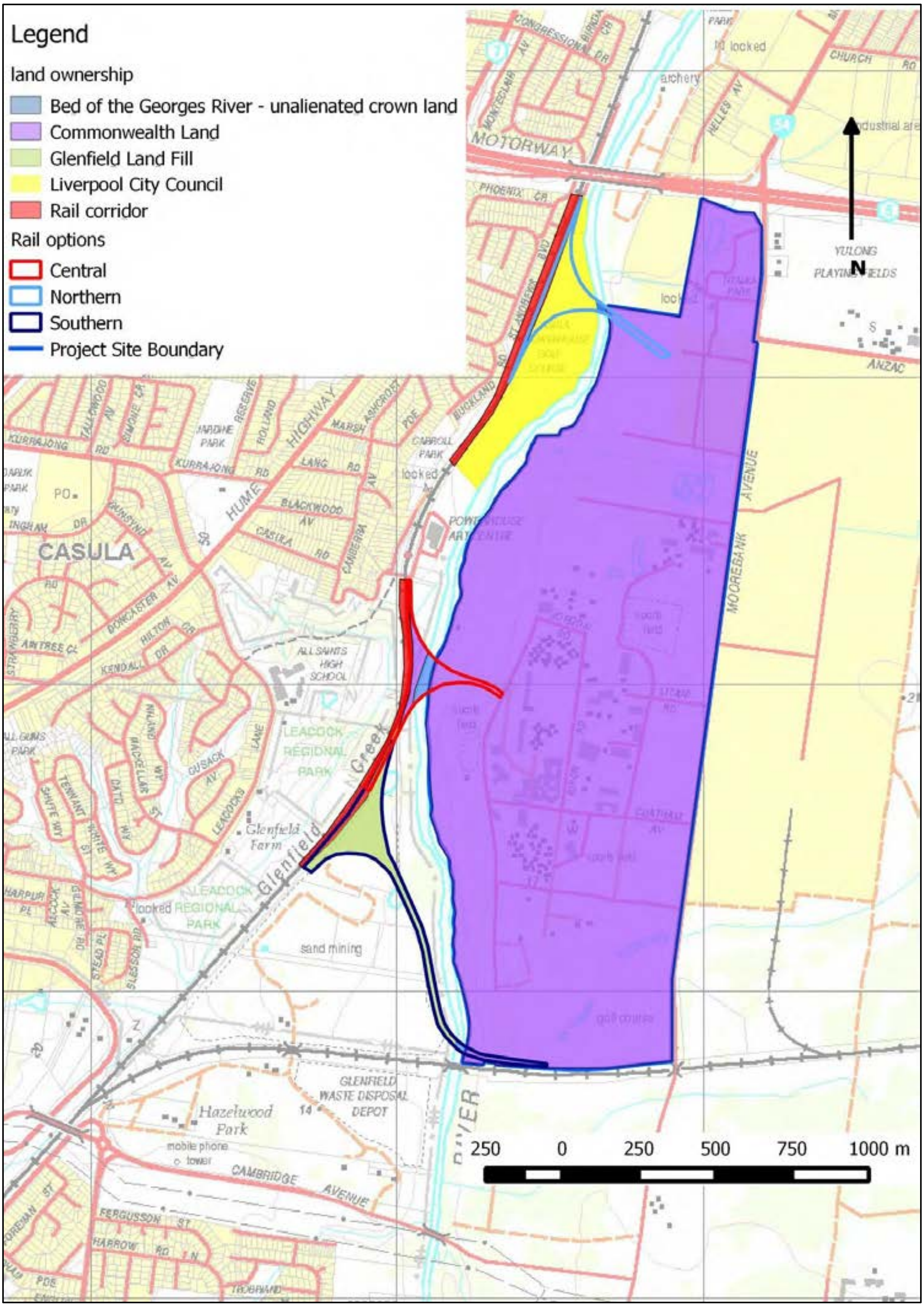

Figure 3.1 The Project area and various constituent land categories

3.3 Literature and database review

A range of archaeological data was reviewed for the Moorebank Intermodal Terminal study area and its surrounds. This literature and data review was used to determine if known Aboriginal sites were located within the area under investigation, to facilitate site prediction on the basis of known regional and local site patterns, and to place the area within an archaeological and heritage management context.

Aboriginal literature sources included the Aboriginal Heritage Information Management System (AHIMS) maintained by the NSW Office of Environment and Heritage (OEH) and associated files and catalogue of archaeological reports; and theses held in the library of the School of Archaeology and Anthropology, the Australian National University. Sources of historical information included regional and local histories, heritage studies and theses; parish maps; and where available, other maps, such as portion plans.

3.4 Field survey

Aboriginal heritage field survey was conducted of the Commonwealth land to the east of the Georges River on the 6th and 8th December 2010, of the LCC land on the 13th February 2013 and of the Commonwealth land to the west of the Georges River and the central and southern rail options on the 8th May 2014. Survey was conducted by walking in systematic transects across all landforms within the study area. Particular attention was given to those landforms, identified through the literature review, as most likely to be archaeologically sensitive and/or subject to minimal disturbance through land-use practices during the past two centuries.

The field team spread out with 5-10 m spacing between individuals to ensure maximum coverage. The survey included inspections of:

- all ground exposures for the presence of stone artefacts or other evidence of Aboriginal occupation; and
- all trees of sufficient age to have the potential for cultural scars.

The recording of items included the use of photography, and basic site type, location and condition descriptions.

The 2010 field survey was attended by personnel from NOHC and invited representatives of the Tharawal Local Aboriginal Land Council (TLALC) and Cubbitch Barta Native Title Claimants Aboriginal Corporation (CBNTCAC).

The 2013 field survey was attended by personnel from NOHC and invited representatives of the Registered Aboriginal Parties (RAPs) including Tim Wells and Gordon Morton of the Darug Aboriginal Cultural Heritage Assessment (DACHA), Neale Sampson (TLALC), Leanne Watson of the Darug Custodian Aboriginal Corporation (DCAC), Danny Franks of Tocomwall Pty Ltd (TPL) and Ron Workman of Darug Land Observations (DLO).

The 2014 field survey was attended by personnel from NOHC and invited representatives of the RAPs including Tim Wells (DACHA), Abbi Whillock (TLALC), Glenda Chalker (CBNTCAC), Justine Coplin (DCAC), Shaun Lynch, Adam Saba and Des Dyer of Darug Aboriginal Landcare Incorporated (DALI), Jennifer Norfolk (TPL), Gordon Workman and Jamie Workman (DLO)

The invited representatives were identified through the implementation of DECCW Interim (2005) *Guidelines for Aboriginal Consultation* and the *Aboriginal cultural heritage consultation requirements for proponents 2010* (see Section 5.3). The representatives were invited to communicate any knowledge that they may hold regarding archaeological and cultural sites, and the landscape.

3.4.1 Recording parameters

The following section presents the methodologies used in basic site identification, together with those for the recording the site types encountered by this investigation.

The archaeological survey aimed at identifying material evidence of Aboriginal occupation as revealed by surface artefacts and areas of archaeological potential unassociated with surface artefacts. Potential recordings fall into two broad categories: sites and potential archaeological deposits (PADs).

Sites

A site is defined as any material evidence of past Aboriginal activity that remains within a context or place which can be reliably related to that activity.

Most Aboriginal sites are identified by the presence of three main categories of artefacts: stone or shell artefacts situated on or in a sedimentary matrix, marks located on or in rock surfaces, and scars on trees.

Frequently encountered site types within south eastern Australia include stone artefact occurrences - including isolated finds and open artefact scatters, coastal and freshwater middens, rock shelter sites - including occupation deposit and/or rock art, grinding groove sites and scarred trees.

Stone artefact occurrences

Stone artefact occurrences are the most commonly recorded site type in Australia. They may consist of single artefacts - described as isolated finds; or as a distribution of more than one artefact – often described as an artefact scatter or 'open camp site' when recording surface artefacts, or as a subsurface artefact distribution when dealing with an archaeological deposit.

Where artefact incidence is very low, either in terms of areal distribution (artefacts per square metre) or density (artefacts per cubic metre), then the differentiation of the recording from background artefacts counts or *background scatter* may be an issue.

Isolated finds

An isolated find is a single stone artefact, not located within a rock shelter, and which occurs without any associated evidence of Aboriginal occupation within a radius of 60 metres. Isolated finds may be indicative of:

- Random loss or deliberate discard of a single artefact;
- The remnant of a now dispersed and disturbed artefact scatter; and
- An otherwise obscured or sub-surface artefact scatter.

Except in the case of obscured or sub-surface artefact scatters, isolated finds may be considered to be constituent components of the *background scatter* present within any particular landform.

The distance used to define an isolated artefact varies according to the survey objectives, the incidence of ground surface exposure, the extent of ground surface disturbance, and estimates of *background scatter* or *background discard* densities. In the absence of baseline information relating to background scatter densities, the defining distance for an isolated find must be based on methodological and visibility considerations. Given the varied incidence of ground surface exposure and deposit disturbance within the study area, and the lack of background baseline data, the specification of 60 metres is considered to be an effective parameter for surface survey methodologies. This distance provides a balance between detecting fine scale patterns of Aboriginal occupation and avoiding environmental biases caused by ground disturbance or high ground surface exposure rates. The 60 metre parameter has provided an effective separation of low density artefact occurrences in similar southeast Australian topographies outside of semi-arid landscapes.

Background scatter

Background scatter is a term used generally by archaeologists to refer to artefacts which cannot be usefully related to a place or focus of past activity (except for the net accumulation of single artefact losses).

There is no single concept for background discard or 'scatter', and therefore no agreed definition. The definitions in current use are based on the postulated nature of prehistoric activity, and often they are phrased in general terms and do not include quantitative criteria. Commonly agreed is that background discard occurs in the absence of 'focused' activity involving the production or discard of stone artefacts in a particular location. An example of unfocused activity is occasional isolated discard of artefacts during travel along a route or pathway. Examples of 'focused activity' are camping, knapping and heat-treating stone, cooking in a hearth, and processing food with stone tools. In practical terms, over a period of thousands of years an accumulation of 'unfocused' discard may result in an archaeological concentration that may be identified as a 'site'. Definitions of background discard comprising only qualitative criteria do not specify the numbers (numerical flux) or 'density' of artefacts required to discriminate site areas from background discard.

Artefact scatters

Artefacts situated within an open context are classed as an open artefact scatter (or 'open camp site') when two or more occur no more than 60 metres away from any other constituent artefact. The 60 metre specification relates back to the definition of an isolated find (*Refer above*). The use of the term *scatter* is intended only to be descriptive of the current archaeological evidence and does not infer the original human behaviour which formed the site. The term *open camp site* has been used extensively in the past to describe open artefact scatters. This was based on ethnographic modelling suggesting that most artefact occurrences resulted from activities at camp sites. However, in order to separate the description from the interpretation of field evidence, the terms *artefact scatter*, *artefact distribution* or *artefact occurrence* are now more extensively used. The latter two options can also be used to categorise artefacts occurring in sub-surface contexts.

Scarred trees

Trees with scars of Aboriginal origin form the other major type of artefactual evidence. Each tree is normally considered to be a separate site. The identification of a scar as Aboriginal in origin is dependent on a set of inter-related interpretive criteria. The credibility of alternative causal explanations such as natural traumas and other types of human scarring must be tested for each scar.

A range of diagnostic criteria has been developed to assist in the identification of Aboriginal scarred trees. The following criteria are based on archaeological work conducted by Simmons (1977) and Beesley (1989), and the field manual for Aboriginal scarred trees developed by Long (2005):

1. The scar does not normally run to ground level: (scars resulting from fire, fungal attack or lightning nearly always reach ground level). However, ground termination does not necessarily discount an Aboriginal origin (some ethno-historical examples of canoe scars reach the ground);

1(a). If a scar extends to the ground, the sides of the original scar must be relatively parallel: (natural scars tend to be triangular in shape;

2. The scar is either approximately parallel sided or concave, and symmetrical: (few natural scars are likely to have these properties except fire scars which may be symmetrical but are wider at the base than their apex. Surveyors' marks are typically triangular, and often the surface of the scar has been worked with an adze;

3. The scar should be reasonably regular in outline and regrowth: scars of natural origin tend to have irregular outlines and may have uneven regrowth;

4. The ends of the scar should be 'shaped', either squared off, or pointed (often as a result of regrowth): (a 'keyhole' profile with a 'tail' is suggestive of branch loss);

5. A scar which contains adze or axe marks on the original scar surface is likely to be the result of human scarring. Their morphology and distribution may lend support to an interpretation of an Aboriginal origin: (marks produced after the scarring event may need to be discounted);

6. The scar must date to the time of Aboriginal bark exploitation within its region: The traditional Aboriginal exploitation of bark probably ceased in most regions between 100 and 150 years ago. However, in some locations associated with Aboriginal settlement, the Aboriginal removal of bark may have continued to the present day, or restarted as part of new cultural movements.

7. The tree must be endemic to the region: (and thus exclude historic plantings).

Field based identification of Aboriginal scars, is based on surface evidence only and will not necessarily provide a definitive classification. In many cases the possibility of a natural origin cannot be ruled out, despite the presence of several diagnostic criteria or the balance of interpretation leaning toward an Aboriginal origin. For this reason interpretations of an Aboriginal origin are qualified by the recorder's degree of certainty. The following categories were used:

- Aboriginal scar - This is a scar where an Aboriginal origin is considered the most likely. The scar conforms to all of the criteria and a natural origin is considered unlikely and improbable;

- Probable Aboriginal scar - This is a scar that conforms to all of the criteria and where an Aboriginal origin is considered to be the most likely. Despite this, a natural origin cannot be ruled out; and

- Possible Aboriginal scar - This is a scar which conforms to all or most of the criteria and where an Aboriginal origin cannot be reliably considered as more likely than alternative natural causes. The characteristics of this scar will also be consistent with a natural cause.

3.4.2 Potential archaeological deposits

A potential archaeological deposit, or PAD, is defined as any location where the potential for subsurface archaeological material is considered to be moderate or high, relative to the surrounding study area landscape. The potential for subsurface material to be present is assessed using criteria developed from the results of previous surveys and excavations relevant to the region. Where necessary, PADs can be given an indicative rating of their 'archaeological potential' based on a combined assessment of their potential to contain artefacts, and the potential archaeological value of the deposit.

Table 3.1 illustrates the matrix on which this assessment is based. Locations with low potential for artefacts fall below the threshold of classification and do not constitute a PAD. In such cases the potential incidence of artefactual material is considered to be the same as, or close to that for background scatter. Where there is moderate potential for artefacts, the predicted archaeological potential parallels the potential significance of the deposit. For deposits with high potential for artefacts, the assessed archaeological potential is weighted positively.

The boundaries of PADs are generally defined by the extent of particular micro-landforms known to have high correlations with archaeological material. A PAD may or may not be associated with surface artefacts. In the absence of artefacts, a location with potential will be recorded as a PAD. Where one or more surface artefacts occur on a sedimentary deposit, a PAD may also be identified where there is insufficient evidence to assess the nature and content of the underlying deposit. This situation is due mostly to poor ground surface visibility.

Table 3.1 Matrix showing the basis for assessing the archaeological potential (shown in bolded black text) of a potential archaeological deposit.

		Potential to contain Aboriginal objects		
		Low	*Moderate*	*High*
Potential archaeological	*Low*	---	**low**	**moderate**
	Moderate	---	**moderate**	**high**

significance	*High*	---	high	high

3.5 Subsurface testing program

The subsurface testing program was undertaken in 2013

3.5.1 Development of subsurface testing methodology

The methodology for the subsurface testing program was developed in consultation with the NSW Department of Planning and Environment (P&E), the NSW Office of Environment and Heritage (OEH) and the Registered Aboriginal Parties (RAPs). This was in keeping with the Director General's Environmental Assessment Requirements for the Moorebank Intermodal Terminal Project (SSD – 5066), which specified that, the research designs and methodologies for any physical archaeological works undertaken as part of initial heritage assessments should be reviewed by the P&E and the OEH Environmental Protection Authority.

A draft version of the methodology was forwarded to the P&E in July 2012, it was then forwarded by the P&E to the OEH. Comments were received from the OEH on 26/7/2012. Responses to comments and a revised draft were sent to the P&E in August 2012 and a meeting held with NOHC, Parsons Brinckerhoff and the P&E on 29/8/2012. A final draft, before Aboriginal comment, was forwarded to the P&E in September 2012.

Consultation with the RAPs formed part of the Aboriginal consultation procedure required by OEH (DEC 2005, DECCW 2010) and is documented in Section 5.3.

A final version of the methodology was forwarded to the P&E in October 2012.

See Appendix 2 for the final agreed methodology.

3.5.2 Objectives and research questions

The primary objectives of the test excavation program were to:

- conduct an investigation of sufficient scope, to gain a representative sample of the likely archaeological resource present at the test locations;

- determine the nature and significance of any Aboriginal archaeological evidence within the test locations;

- where necessary, determine appropriate strategies for the management of cultural heritage values related to any confirmed archaeological evidence, relative to the proposed Moorebank IMT development.

The test excavation program was directed at the following research questions

- How can the anticipated development impact of the Moorebank IMT Project on any significant Aboriginal heritage values be effectively avoided or mitigated?

- What do the test results indicate about the past Aboriginal occupation of the Project area and the Sydney region?

- How do the test results compare with other local and regional archaeological results and models?

- Does the subsurface archaeological resource accurately reflect the predictions on which the sensitive landform mapping is based?

- Based on the test excavation results, how can the local predictive model be refined or corrected?

3.5.3 Excavation methods

Two excavation methodologies were used (NOHC 2012):

- mechanical test pit excavation using backhoe/excavator; and
- by-hand test pit excavation.

The mechanical test pit methodology was employed in all test locations where the predicted archaeological potential is no greater than low (MA1 & PAD1, MA5 and representative sample location 3).

The mechanical method was suspended and a by-hand excavation methodology adopted in MA5 as a lithic flaking floor in a relatively undisturbed condition was encountered as well as a dense layer or lens of cultural material that could be potentially damaged/fragmented by a mechanical excavation method.

The by-hand excavation methodology was employed for all test pits in areas of predicted moderate to high archaeological sensitivity (MAPAD1, PAD2 & minor tributary Riparian zone, and representative sample locations 1), to minimise the likelihood of damage to artefacts.

At MAPAD1, MA5 and MA1, machinery was used to remove fill and establish a safe surface for hand excavation of intact deposits. Fill was removed by hand at PAD2.

Machinery was used in heavily vegetated test locations to clear the area prior to excavation.

The mechanical test pit methodology was employed initially at the southern end of MAPAD2 where disturbance levels appeared to be greatest[1]. Following completion of excavation at the first six test pits it was decided to change to by-hand excavation as the extent of disturbance was significantly reduced and there appeared to be good potential for *in situ* deposits. The remainder of test pits were excavated by-hand with the exception of the following three pits:

- Test Pit 7, where disturbed fill extended down to such a depth that mechanical excavation of the lower, more intact, deposits proved more efficient;
- Test Pit 30, where excavation of compacted clayey deposits below a disturbed cap of fill proved virtually impossible to excavate by-hand; and
- Test Pit 45, was excavated to test deposits below 80 cm, following geomorphological confirmation that the upper sterile sandy deposits were most likely the result of recent flooding events.

Machinery was also used to remove fill and/or recent sand deposits to establish a safe surface for hand excavation of intact deposits at the following pits:

- Test Pit 7 – cut down 10 cm to natural deposits;
- Test Pit 10 – cut down 10 cm to natural deposits;
- Test Pit 11 – cut down 20 cm to natural deposits;
- Test Pit 28 – cut down 40 cm to natural deposits;

[1] The extent of subsurface disturbance was based on surface survey and information provided through ground penetrating radar survey undertaken to check for underground services.

- Test Pit 39 – cut down 30 cm to natural deposits;
- Test Pit 40 – cut down 25 cm to natural deposits;
- Test Pit 41 – cut down 60 cm through sterile sand deposits to test deposits at greater depth; and
- Test Pit 42 – cut down 60 cm through sterile sand deposits to test deposits at greater depth.

See Appendix 2 for the detailed methodology employed.

3.6 Scope of test excavation pits

Archaeological test excavation occurred within the following landscape categories and combinations, where direct impact from the Moorebank IMT development is anticipated (Figure 1.2):

- tertiary terrace edge: MA5;
- tertiary terrace edge and Georges River riparian zone: MA1 & PAD1, representative sample location 1;
- natural lake basin within a minor tributary riparian zone (adjacent to tertiary terrace edge): MAPAD1;
- minor tributary riparian zone: PAD2;
- tertiary terrace away from (riverside) edge (i.e. an area of predicted no archaeological sensitivity): representative sample location 3.

Three areas were selected for archaeological subsurface testing outside of known sites and PADs. These areas provide a sample of the archaeological sensitivity categories (including the null hypothesis) and have been selected to test the model within areas of lesser disturbance. These areas are described as representative sample areas 1-3:

- representative sample area 1 (MRSA1) is on the edge of the tertiary terrace and the Georges River basin and is located in a relatively undisturbed context.
- representative sample area 2 (MRSA2) is on the tertiary terrace edge and in a relatively undisturbed context.
- representative sample area 3 (MRSA3) is on the tertiary terrace away from its edge and any riparian zones. The area represents an area of predicted low archaeological potential in an area of minimal disturbance.

Wherever possible, test pits were arranged in straight line transects and situated within the anticipated development footprint (the area subject to direct construction impact). The distance between test pits on transects was normally 25 m (or 50 m across PAD2), except in the following circumstances:

- where the avoidance of an erosional or other disturbance feature required a one-off larger or smaller interval;
- an on-site appreciation of landform and archaeological potential indicated that a larger or smaller interval is necessary; or
- an in-field assessment of initial test pit results supported the conduct of additional (contingency) test pits at closer intervals or outside of a formal transect configuration.

Excavation did not go ahead at MRSA2 due to the following:

- there was a risk to personnel due to snakes;

- the only way to make work in this area safer was to undertake substantial vegetation clearance, which was decided against on the grounds that the area contained endangered ecological communities (EEC);
- in order to compensate for the inability to access and test within this area at this time, it was decided to excavate as many of the 'contingency' pits as possible, within the scope of the methodology, at the nearby MA5 test location. MA5 is located on a comparable landform, so the data from this site can be reasonably extrapolated to inform decisions regarding the potential significance and appropriate management of deposits at MRSA2; and
- there is opportunity, should results from this program warrant it, to undertake further investigations at MRSA2 as part of later approval processes.

3.7 Geomorphological analysis

Geomorphological analysis of soil profiles at selected test pits was undertaken as a component of the subsurface testing program. This was done in order to inform conclusions regarding the depositional origin, integrity and likely age of archaeological deposits.

Detailed records of the stratigraphic sequences were made in the field. Recording comprised detailed section drawing, photography and pH testing of units, and examination of sections and inclusions. Reference sediment sampling of drawn sections was undertaken prior to backfilling. Further methods statements, along with the full archived records, are presented at Appendix 3.

3.8 Laboratory analysis

All lithic items were examined in detail by a lithic specialist Daryl Wesley, using a low-power binocular microscope and incident illumination and/or hand lens. Descriptive recording of collected material will be to a level concomitant with the stated aims of the investigation, and the number of artefacts/type of material recovered.

The primary aim of the analysis of the lithic items retrieved from the test locations was to assist in the assessment of the significance of the sites/deposits and to identify appropriate management strategies.

Additional details regarding the artefact analysis are provided at Appendix 4.

4. GEOMORPHOLOGICAL CONTEXT

The following sections provide a geomorphological context for the Moorebank IMT study area. This section concentrates on the land to the east of the Georges River, for a full description of the land to the west of the Georges River please refer to the addendum report (NOHC 2014a). Particular attention has been given to the context of the subsurface test excavations conducted as a component of this heritage assessment. This background informs the available landform and deposit mapping – which in turn underpins the definition of the archaeologically sensitive landforms that have been targeted for subsurface testing.

The primary aims of the geomorphological analysis are to inform:

- the likely depositional origin of the deposits encountered;
- their integrity and likely age;
- the potential of the deposits for preserving archaeological materials; and
- attributes of possible cultural and natural heritage significance.

4.1 Geographical context of the site

The study area comprises low undulating bench and plateau topography overlooking the Georges River. The north-flowing Georges River is incised, as a relatively narrow linear gorge, with steep sides and bedrock outcrops locally, especially on the west bank. Landforms on the east side of the river are significantly lower in altitude than on the west, so flooding will occur across the subject area if the river discharge reaches an overbank condition along this reach.

Unconsolidated sediments form channel lags, flood sand banks, bars, shoals and silt flats in the present channel and floodplain floor adjacent to the study site. Extensive slugs of alluvium are mobile and occur as ephemeral deposits throughout the low gradient reaches of the Georges River upstream of the present day tidal limit (DIPNR 2004). Down-catchment sediment loads are known to have impacted on downstream estuarine ecology as a consequence of European catchment impacts (Dunston 1990; Howarth 2002). Such changes fit into a wider regional pattern of catchment impacts from European settlers and climate changes (Erskine 1994; Gale et al. 2004; Nanson et al. 2003). In the recent past the Georges River channel sediment storages have been mined for aggregate. Weirs and flood protection infrastructure, along with dam construction in the upper catchment, have extensively altered the natural flood discharge regime. The weir constructed at Liverpool in 1837 now marks the tidal limit upstream. The natural tidal limit will have potentially shifted during the Holocene – a factor of significance in relation to prehistoric use of the area.

The natural deposit sequence in the area may also archive evidence of the past estuarine limits during previous interglacial high sea levels (Pickett 2002; Pickett et al. 1997), including the last interglacial Marine Isotope Stage 5. Such deposits, if encountered, would have high natural heritage significance and high scientific importance (Gray 2003), and are likely to occur within the lower reaches of the Georges River area (Nichol and Murray-Wallace 1992; Roy et al. 1980).

The geomorphology, hydrology and wetland habitats of the Georges River seen today close to the study site are probably poor analogues for the river floodplain at European contact or earlier (Nanson et al. 2003). This is important when interpreting features seen in the test pits, and for generally understanding the archaeological record of this area in terms of past environments contemporary with the archaeological evidence.

The sediments seen in the river today reflect disturbance throughout the catchment since the 1830s. Massive mobilization of both sandy and silt-rich sediments has occurred from upper tributary catchments to estuary (Gale et al. 2004; Howarth 2002).

Past and present sediment environments (and sources) in the river are directly relevant to the archaeological record of the study area in at least three ways:

- they illustrate the dynamic nature of the contemporary fluvial environments of the George River as a baseline against which to compare the historic and prehistoric floodplain settings and ecology;

- they represent sediments sources which may have episodically contributed to the stratigraphy across the study area during extreme floods and by wind (aeolian) action; and

- the sedimentary environments reflect and may record the range of floodplain habitats available to Aboriginal people in the past as resources.

Over late Pleistocene to Holocene timescales sediment availability may have exerted strong controls on the deposition of source-bordering sand accumulations on the lower river terraces, and up onto the river bluffs overlooking the floodplain. Dust inputs to soil stratigraphy on the floodplain bluff and plateau edge may also be significant.

The Georges River catchment has the capacity to flood to very high levels in the lower reaches. Maximum historic flood levels are be relevant to the interpretation of archaeology and deposits across this area. Maximum historic floods will only indicate *minimum* likely flows during the Quaternary and Holocene (Maddocks 2001). High magnitude - low frequency megafloods and climate effects on river discharge will determine prehistoric flood heights. River damming from trees may also be significant factors in determining anabranch formation.

The study area is located on low dissected plateau where the orientations and occurrence of minor creeks drain to the NE. The long term landform evolution on the edge of the Woronora Plateau and ramp links to regional tectonism (see Brown 2000; Ollier and Pain 1996). The plateau edge around Moorebank is inset within the major recurve of the Georges River where it turns from its northerly entrenched gorge alignment round to the east and into the SE –E alignment draining into the estuarine reach. The plateau surface is mapped as Tertiary alluvium. Palaeochannel and overbank deposits of both Tertiary and Quaternary age are likely to occur across the area. Some Holocene and historic drainage (e.g. the minor creek and recent "chain-of-ponds" topography may be aligned and superimposed on earlier palaeochannels). Surface anabranches and ponds in the area (e.g. at the MAPAD1 area) may track such palaeogeography.

It is not established whether Holocene mega-floods could overtop the lower plateau margins and flow into the anabranches and ponds. Historic floods are recorded to above the estimated 100 year flood return level of 9 -10m AHD at Liverpool – the 1873 flood reached 11-12m AHD (Maddocks 2001). 500 -1000 year flood recurrence levels could be much higher. Some archaeological assessments have suggested high flood levels may have impacted on archaeological preservation (see AHMS 2012).

Aeolian accession of sands and silts from exposed flood deposits in the Georges River channel and tributaries are likely to be an important contributing soil forming agent, and a process contributing to archaeological context formation. Aeolian accession of fines into soil sequences is now widely recognized as an important late Quaternary soil forming process in eastern Australia, through regional dust mobilization and local source bordering sand transport (Cattle et al. 2009; Chartres and Walker 1988; Humphreys et al. 2002). Checking for accession of fine sediments into soil profiles from flooding and wind is important if dating of sediments (e.g. by Optically Stimulated Luminescence Dating) were considered for archaeological contexts in this area.

Given the complex geological history of the area, soils and sediments of varying ages and sequences will be expected. A regolith landscape approach (see Taylor 2008) where soils may develop and then rework many times as part of landform change will best match the archaeological requirements of understanding complex issues of soil and sediment age, and assessing significance.

4.2 Geological and soil mapping information

4.2.1 Geological mapping

The 1:100,000 sheet mapping shows the study area mostly capped by Tertiary alluvial clayey Quartz sands, silty sands and clays (Ta) inferred to be possibly Pliocene in age. The age estimate is probably based on relative stratigraphic position and elevation only.

Younger sediments and deposits will be locally present in the upper parts of the mapped unit, and many soil features seen across the area are substantially younger, and over-print older deposits and soil profiles. The defined mapped age of "Tertiary" does not preclude near surface deposit sequences being present which might be dated to the Holocene or Quaternary.

The underlying bedrock units are mapped as Triassic-age beds of the Ashfield Shales (Rwa) with outcrops of the underlying Hawkesbury Sandstones located close to the study area, to the south and southwest in particular.

Local bedrock, from which *in situ* regolith and some soils in the area will derive, are variably Triassic sandstones, mudstones and shales. These are basically the same lithologies and mineralogy to the rocks from which the Georges River alluvium and dusts derive across the catchment. This makes identification of the depositional origin of the deeper weathered soils in the area potentially difficult, especially in deep quartzose-rich sand sequences. Some archaeologically sensitive landforms may contain complexes of stratigraphic sequences. Older weathered alluvial units, and soils developed on alluvium of Quaternary or even Tertiary age may be compositionally similar to saprolites, or mixtures of saprolite and alluvium of Tertiary age.

4.2.2 Soils and regolith mapping

The 1:100,000 Penrith Soils Landscape Series is the main source of information – ascribing soils in the area to the Berkshire Park Soil Group (Bannerman and Hazleton 1990). This soils landscape unit is characterized as forming on alluvium, often on elevated terraces and comprising shallow clayey sand soils, with frequent ironstone pisoliths. Mottling is common. The Berkshire Park Soils landscape is mapped on the Penrith Sheet as developed on Tertiary terraces.

Soil Landscape Mapping usually correlates with pre-determined bedrock mapping and alluvial terrace age. If parts of the terrace deposits at Moorebank were re-assigned a Pleistocene age the soil mapping unit would be logically re-assigned to the South Creek Soils Landscapes unit[2].

Soil Landscape Mapping does not provide an especially useful basis for archaeological predictive purposes. Primacy should always be given to primary field observations – especially if the stratigraphy or sediment needs dating. Examination of geotechnical logs from the study area would be a useful input to managing future heritage assessment and strategies.

[2] When using such sources for archaeological investigations/heritage management purposes it should be remembered that primary goal of the NSW Soil Landscape mapping lies in soil conservation and management. Soil landscapes are conceived as areas of land which have recognizable and specifiable topographies and that may be presented on maps and described by concise statements (Northcote 1979). The mapping does not investigate or re-consider deposit ages or the time periods over which soil attributes may have developed on either sediments developed by bedrock weathering *in situ,* or soils developed on previously transported sediments e.g. alluvium or colluvium.

5. ABORIGINAL CULTURAL CONTEXT

5.1 Ethno-history

References to the Aborigines of the Sydney region are found in the journals, diaries and general writings of the early colonists, explorers and settlers. The 'natives' were one of the main subjects of interest to those who arrived in the First Fleet and 'all the journals contain frequent references to them' (Fitzhardinge 1961:102).

Accounts written by early visitors to Australia which document the more obvious details of Aboriginal life include Bradley (1786), Collins (1798), Hunter (1793), Phillip (1789), Tench (1789, 1793, 1961) and White (1790). Although these early commentators were not trained in anthropology or linguistics they provided some useful information regarding the Aborigines around the Sydney region.

Tench (1789:79) describes the equipment of the Aborigines as 'Exclusive of their weapons of offence, and a few stone hatchets very rudely fashioned, their ingenuity is confined to manufacturing small nets, ...and to fish-hooks made of bone, neither of which are skilfully executed'. Tench also notes the use of bark canoes for fishing (Tench 1789:81-82).

Comments were made on the types of Aboriginal shelters observed. These were described as consisting 'only of pieces of bark laid together in the form of an oven, open at one end, and very low, though long enough for a man to lie at full length in … they depend less on them for shelter, than on the caverns with which the rocks abound' (Tench 1789:80). Collins observed that the huts were 'often large enough to hold six to eight people' (Collins 1798:555). These shelters were often grouped together.

Within a short period of time after white settlement the Sydney Aboriginal population was greatly reduced as a result of two epidemics (most probably) smallpox. The first occurred only a short time after settlement in 1789 and the second in 1829-1831 (Butlin 1983). The first outbreak of the disease is believed to have killed 50% of the Aboriginal population (Collins 1798:53, Ross 1988:49, Tench 1961:146, Turbet 1989:10). Loss of life on such a scale caused a major social reorganisation of Aborigines around the area (Ross 1988:49) with 'remnants of bands combining to form new groups' (Kohen 1986:30). Therefore the anthropological observations and other observations by chroniclers of the time do not depict the pre-settlement situation accurately.

There are other accounts dating from the early 1800s that provide more detailed references to Aboriginal life in the Sydney region. However the information must be interpreted and used with caution due to the immense changes that occurred in the Aboriginal population and society during the early years of settlement (McDonald 1994:34).

Detailed anthropological work focussing on a systematic documenting of Aboriginal society was not undertaken until the late 19th century, beginning with R.H. Mathews' work (Mathews 1895, 1898, 1901a, 1901b, 1901c, 1904, 1908, Mathews and Everitt 1900). His anthropological work was, however, undertaken with a greatly changed population of people after more than a hundred years of contact. It does not therefore represent the situation at the time of contact or reflect pre-contact society. He documented some myths and also vocabulary of Aboriginal groups around the Sydney region.

5.2 Tribal and cultural affiliations

The exact boundaries between Aboriginal groups that existed in 1788 are impossible to reconstruct because of the lack of reliable data available from that time. There have been numerous attempts at mapping the pre-contact and contact territories of Aboriginal people in the Sydney region (Capell 1970, Eades 1976, Kohen 1986, 1988, Mathews 1901a and b, Ross 1988, Tindale 1974). The primary data is limited, as the early observers (members of the First Fleet and settlers) did not document how Aboriginal people perceived of their own groups or how they differentiated themselves from one another.

Early anthropological work that was carried out is also not totally reliable. The population of Aboriginal people around Sydney was depleted by disease and aggression by Europeans and many of the survivors would have relocated and/or probably joined other groups.

The linguistic and tribal boundaries and size of areas attributed to the various Sydney region Aboriginal groups vary between different interpreters. Tindale (1974) places the Tharawal tribe in the area south from Botany Bay and Port Hacking to the Shoalhaven River and inland to Campbelltown, Picton and Camden. To the west of this tribal area, Tindale placed the Gandangara tribe, and to the north the Daruk tribe. Tindale has an Eora tribe, which was closely linked to the Tharawal tribe, extending from the northern shores of Port Jackson to the edge of the plateau overlooking the Hawkesbury River and south to Botany Bay and the Georges River. Tindale earlier referred to the Aborigines on the northern side of Botany Bay as the Kameraigal horde, while others refer to this group as the Cadigal or Biddigal.

5.3 Aboriginal consultation

Aboriginal consultation has been undertaken in various stages for this Project.

The OEH Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (DEC, 2005) were enacted in 2010. This was in response to the requirements outlined by the then Department of Planning.

In 2012 the proponent for the Project restarted the Aboriginal consultation and instigated the *Aboriginal cultural heritage consultation requirements for proponents 2010* (NSW DECCW 2010). This was done so as to ensure that the consultation process was as thorough and up to date as possible. The 2010 guidelines are consistent with and indeed exceed the requirements of te 2005 draft guidelines and therefore meet and exceed the Director Generals Requirements for the Project.

Aboriginal representatives from the registered Aboriginal parties participated in both the field survey of the study area and the subsurface testing program.

See Appendix 5 for all correspondence received from the Registered Aboriginal parties.

5.3.1 DECCW interim *Guidelines for Aboriginal Consultation*

Aboriginal parties were invited to register an interest in the Project through public notice (Liverpool Leader 27 Oct 2010) and through direct invitation protocols as defined by OEH requirements, (DEC 2005).

The following Aboriginal parties registered an interest in the Project through the Interim Guidelines:

- Tharawal Local Aboriginal Land Council (TLALC);
- Cubbitch Barta Native Title Claimants Aboriginal Corporation (CBNTCAC);
- Darug Land Observations (DLO);
- Darug Custodian Aboriginal Corporation (DCAC);
- Darug Aboriginal Cultural Heritage Assessments (DACHA);
- Darug Aboriginal Landcare Incorporated (DALI); and
- Banyadjaminga.

Registered Aboriginal parties and those persons/groups whose names were included on a list of Aboriginal parties known to the NSW Office of Environment and Heritage (OEH) that may have an interest in the Project, were informed about the methodology for the Aboriginal archaeological surface field survey. This correspondence (10 Jan 2011, and 11 Mar 2011) included an invitation to read the Project methodology and then provide comments and suggestions back to NOHC.

The methodology explained that the primary aim of the field survey was to identify cultural heritage sites and areas of archaeological sensitivity/potential that are present within the Project area, and that the field survey aimed to achieve a level of ground surface coverage that would enable an informed assessment of potential construction impacts on any sites that may be identified.

Correspondence with comments on the methodology was received from all of the registered Aboriginal parties registered except the TLALC and Ms Bodkin.

The TLALC responded to the initial public notice requesting registration, but did not provide a subsequent submission regarding the methodology (correspondence 8 November 2010).

The DLO provided a registration of interest in response to the methodology and sought involvement in any and all consultation meetings and fieldwork. The DLO advised that they do not support organisations which are not from the Darug nation, and do not attend fieldwork or meetings without payment (18 December 2011).

The DCAC provided a registration of interest in response to the methodology and sought involvement in the Project. The Corporation specifically noted support of the methodology proposed (correspondence 18 December 2011).

The DACHA provided a registration of interest in response to the methodology and expressed a wish to be consulted at all times, and to be involved in all fieldwork. Support was expressed for the proposed methodology (correspondence 25 January 2011).

The DALI provided a registration of interest in response to the methodology and expressed a desire to take part in field work. The proposed methodology was agreed to (correspondence 27 January 2011)

The CBNTCAC responded to the initial public notice requesting registration (correspondence 5 December 2010), and subsequently provided comment on the methodology (correspondence 29 January 2011). The response questioned why the Interim Guidelines for Aboriginal consultation were being complied with when these had been made obsolete by new guidelines issued by DECCW in 2010. The proposed methodology was stated to be fine, apart from the stated compliance with the Interim Guidelines. A list of the identified parties to the Project was requested, together with a description of their involvement.

5.3.2 Field survey 2010

As stated above the field survey was conducted on the 6 and 8 December 2010 and attended by personnel from NOHC and invited representatives of the TLALC and CBNTCAC.

A preliminary report on existing Aboriginal and European heritage was prepared in August 2011 (CDFD August 2011). Given limitations on the preparation and circulation of this report, it was not possible to provide copies of a draft to registered Aboriginal parties or to incorporate submissions on Aboriginal cultural values. For this reason, all of the significance assessments for Aboriginal heritage recordings in the preliminary report were classed as indicative, and based largely on archaeological interpretations, that is, concerned mostly with scientific values (including rarity, representativeness, research and educational value). A full assessment, including the consideration of registered Aboriginal party views, is pending the continuation of the Aboriginal consultation program for the current EIS assessment, including the conduct of the current test excavation proposal.

5.3.3 Aboriginal cultural heritage consultation requirements for proponents 2010

In 2012 the proponent for the Project restarted the Aboriginal consultation and instigated the *Aboriginal cultural heritage consultation requirements for proponents 2010* (NSW DECCW 2010). This was done as part of the preparations for subsurface testing within the Project area, as specified under the Director General's Requirements for "physical archaeological test excavations of areas of potential archaeological deposits".

Again Aboriginal parties were invited to register an interest in the Project through public notice (Liverpool Leader and Liverpool City Champion 25 July 2012) and through direct invitation protocols as defined by OEH requirements.

The following registered Aboriginal parties registered an interest in the Project through the 2010 Guidelines:

Gandangara Local Aboriginal Land Council (GLALC); and

Tocomwall Pty Ltd (TPL).

A site visit and presentation was held on the 26 September 2012. The purpose of this visit was to present the Project information to the registered Aboriginal parties including the presentation of the proposed subsurface testing methodology.

The following RAPs attended the site visit**:**

Ben Staples (DLO)

Des Dyer (DALI)

Glenda Chalker (CBNTCAC)CBNTCAC)

Gordon Morton (DACHA)

Gordon Workman (DLO)

Justine Coplin (DCAC)

Luke Masters (GLALC)

Neale Samson (TLALC)

Scott Franks (TPL)

A draft of the proposed subsurface testing methodology was distributed to all RAPs on 13 September 2012 with a comment period of 28 days. Responses were received from:

Cubbitch Barta Native Title Claimants Aboriginal Corporation (CBNTCAC);

Darug Aboriginal Landcare Incorporated (DALI);

Darug Custodian Aboriginal Corporation (DCAC); and

Darug Aboriginal Cultural Heritage Assessments (DACHA).

A draft of this report was distributed to all RAPs on 25th January 2013 with a comment period of 28 days. Responses were received from:

Darug Aboriginal Cultural Heritage Assessments (DACHA);

Tocomwall Pty Ltd;

Darug Aboriginal Landcare Incorporated (DALI) (via phone); and

Darug Custodian Aboriginal Corporation (DCAC).

Table 5.1 summarises all responses from the RAPs on the Project, particularly as they relate to the cultural values of the Project area and how these have been addressed in this assessment.

Table 5.1 RAP Comments and Responses

RAP/Date	Comment	Response
CBNTCAC (29 January 2011)	Why have the 2005 consultation guidelines been adopted which have been superseded by 2010 guidelines	The 2010 guidelines were subsequently adopted for the Project. (Section 5.3.3)
DCAC (3 October 2012)	DCAC have concerns about the pond and the scarred tree at Moore Bank (sic) and would like further consultation on the management of these areas. The pond and tree are considered to be high significant areas	It is recommended that the pond site MA9 be conserved in-situ (Section 13.1.7). The Aboriginal cultural value of this place has been included in the significance assessment (Section 11.3.4). It is recommended that further assessment of the tree be undertaken by a specialist (Section 13.1.2)
DALI (n/d)	DALI would like to see if the scarred trees can be protected in some way. Ask that any Aboriginal artefacts be salvaged and taken to a safe place or put back once the development is finished	It is recommended that further assessment of the tree be undertaken by a specialist (Section 13.1.2) It is recommended that all Aboriginal objects be repositioned back into the landscape ('returned to country') within reserved open space, in as close a position (as is feasible and safe) to their original find locations (Section 13.1.6).
DACHA (13 February 2013)	Support all of the findings of the report	Noted
Tocomwall (20 February 2013)	Accept and support the recommendations	Noted
DALI (telephone conversation 22 February 2013)	Reiterates previous comments and accepts and support the recommendations in the report	Noted
DCAC (25 February 2013)	Emphasises the very high Aboriginal cultural significance of the Georges River landscape and the archaeology associated. Request that the Aboriginal community decide the nature of specialist investigations at the scarred trees and that the management plan for these items incorporates appropriate mitigation options and interpretive strategies.	Noted and included in the significance assessment in Section 11.3

5.4 Participation in the Subsurface Testing Program

Representatives from all RAPs were invited to participate in the subsurface testing program. The following individuals were present during the excavation program:

Gary Marshall (DLO)

Des Dyer (DALI)

Glenda Chalker, Kirsty-Lee Chalker and Donna Whillock (CBNTCAC)

Timothy Wells (DACHA)

Justine Coplin, Alyce Mervin and Rhiannon Wright (DCAC)

Stephen Foster (GLALC)

Neale Samson (TLALC)

Danny Franks and Steven Verey (TPL)

Throughout the field program, consultation was undertaken with the above representatives to discuss excavation progress and results in order to inform decisions regarding the final number of pits excavated at each test location.

5.5 Field survey 2013 – northern rail corridor option

Archaeological Field Survey was undertaken of the northern rail corridor option on 13 February 2013. All RAPs were invited to take part, with the following RAP representatives attending the field survey:

Ron Workman (DLO)

Gordon Morton (DACHA)

Timothy Wells (DACHA)

Leanne Watson (DCAC)

Neale Samson (TLALC)

Danny Franks (TPL)

5.6 Field survey 2014 – central and southern rail corridor options

Archaeological Field Survey was undertaken for the central and southern rail corridor options on the 8 May 2014. All RAPs were invited to take part, with the following RAP representatives attending the field survey:

Timothy Wells (DACHA)

Abbi Whillock (TLALC)

Glenda Chalker (CBNTCAC)

Justine Coplin (DCAC)

Shaun Lynch, Adam Saba and Des Dyer (DALI)

Jennifer Norfolk (TPL)

Gordon Workman and Jamie Workman (DLO)

5.7 Cultural knowledge and values

Consultation with the RAPs regarding cultural knowledge and values has been an ongoing process. It has included formal invitations to contribute via written form and verbal discussions during field survey (2010), site visit (2012), excavation program (2012), telephone conversations and the provision of a draft of this report.

To date, the following information has been received verbally and in writing, in the course of the September 2012 site visit and subsequent subsurface testing program, regarding cultural knowledge and values of identified sites at Moorebank:

- verbal advice from Glenda Chalker (CBNTCAC), Justine Coplin (DCAC) and Des Dyer (DALC) indicated that the recorded scarred trees (MA6-8) have cultural significance; and

- opinions provided by Timothy Wells (DACHA), Glenda Chalker (CBNTCAC), Justine Coplin (DCAC) and Des Dyer (DALC) indicated that site MAPAD1 (MA9) was an area of cultural significance.

In the course of the 2014 survey there was general agreement from all RAPs present that the Georges River corridor would have been an area utilised by Aboriginal people for the purposes of hunting and gathering and that the more elevated areas on the terraces would have been used for camping activities.

6. ABORIGINAL ARCHAEOLOGICAL CONTEXT

6.1 Previous archaeological research

The following section provides an overview of previous archaeological research in the local region. This literature review, together with the search of the AHIMS database, has informed the development of the predictive model for the Moorebank IMT study area.

6.2 The Sydney Basin

The Sydney Basin has been the subject of intensive archaeological survey and assessment for many years. This research has resulted in the recording of thousands of Aboriginal sites and a wide range of site types and features. The most prevalent sites or features include: isolated finds, open artefact scatters or camp sites, middens, rock shelters containing surface artefacts and/or occupation deposit and/or rock art, open grinding groove sites, and open engraving sites. Rare site types include scarred trees, quarry and procurement sites, burials, stone arrangements, carved trees, and traditional story or other ceremonial places.

Archaeological studies in the Sydney Basin have generated hundreds of reports and monographs and a number of academic theses. Studies generally fall into four categories - projects which have been carried out within a research-oriented academic framework, larger scale planning and management studies (e.g. regional heritage studies) archaeological surveys carried out by interested amateurs, and impact assessment studies which have been carried out by professionals within a commercial contracting framework. The latter deal with specific localities subject to development proposals and constitute a large proportion of the archaeological research carried out to date.

Aborigines have lived in the Sydney region for at least 20,000 years (Stockton & Holland 1974). Late Pleistocene occupation sites have been identified around the fringes of the Sydney Basin at Shaws Creek (13,000 BP [Before Present]) in the Blue Mountain foothills (Kohen et al 1984), and at Mangrove Creek (11,000 BP) at Loggers Shelter (Attenbrow 1981). Nanson et al (1987) have suggested that artefacts found in gravels of the Cranebrook Terrace indicate Aboriginal occupation over 40,000 years ago, however there is some doubt as to the contextual integrity of these artefacts.

The majority of both open and rockshelter sites in the Sydney region date to within the last 3,000 years. A similar trend in occupation age occurs in dated deposits in NSW coastal sites. This has led many researchers to propose that population and occupation intensity increased from this period (Attenbrow 1987, Kohen 1986, Smith 1986, McDonald & Rich 1993, McDonald 1994). The increased use of shelters postdates the time when sea levels stabilised after the last ice age around 5000 years ago (the Holocene Stillstand). Following the stabilisation of sea levels, the development of coastal estuaries, mangrove flats and sand barriers would have increased the resource diversity, predictability, and the potential productivity of coastal environments for Aborigines. In contrast, occupation during the late Pleistocene (prior to 10,000 BP) may have been sporadic and the Aboriginal population relatively small.

The stone technologies used by Aborigines within the Sydney Basin have not remained static and a sequence of broad scale changes through time have been consistently identified. This is known as the Eastern Regional Sequence and can be applied with various degrees of success and allowances for regional differences, to sites throughout eastern seaboard of Australia. Within the Sydney Basin the Sequence can be characterised using the following terminology and phases (based on McDonald 1994):

The Capertian: Artefacts from this period consist mostly of large heavy artefacts including unifacial pebble tools, scrapers, core tools, denticulate saws, and hammerstones. Some bipolar tools and burins also occur. The Capertian is present up to around 5000 years BP.

The Early Bondaian: Within this phase characteristics of the Capertian continue but tools on smaller blades are introduced and become predominant. Blades that are backed (one edge blunted by fine trimming) and ground edge implements are notable introductions. There is a major shift in the type of rocks used for tool manufacture to fine-grained siliceous materials (such as silcrete, chert and tuff/indurated mudstone). The Early Bondaian has been identified in deposits dating between around 5000 and around 3000 years BP.

The Middle Bondaian: In this phase the percentage of Bondi points (a type of backed blade) increases and remains greater than the percentage of bipolar artefacts. Edge ground artefacts are present in higher proportions as are quartz artefacts. This phase dates from around 3000 to as late as 1000 years BP.

The Late Bondaian: This phase is characterised by quartz either becoming the predominant rock type used or markedly increasing in proportion. Bondi points and most types of backed blades become rare or are no longer found. Eloueras, bipolar artefacts and edge ground hatchets are the dominant tool types. Bone and shell implements including fishhooks appear in this phase, particularly in some coastal sites. This phase dates from around 1600 (Attenbrow 1987), or 1000 years BP (McDonald 1994), to the cessation of stone working following contact with European Society.

McDonald notes that the introduction of ground implements around 4000 BP and shell fishhooks in the last 1,000 years were major technological innovations (McDonald 1994:69). The significance and possible reasons for the technological changes in the Eastern Regional Sequence have been the subject of considerable research and debate since their identification. Contemporary theories postulate various changes in social behaviour, group interactions, and population dynamics either as contributing causes or as consequences of these technology changes (e.g. Attenbrow 1987, Beaton 1985, Lourandos 1985, Walters 1988, McDonald 1994). McDonald for example interprets the introduction of the Bondaian in the Sydney Basin as a manifestation of social change brought about by population pressure promoted by sea level rise (1994:347).

6.3 Upper Georges River

The study area is situated within the upper Georges River, which marks a transition zone between the Wianamatta shale country that typifies the Cumberland Plain to the west, and Hawkesbury Sandstone terrain extending from the upper Georges River to the coast. These zones exhibit respective archaeological characteristics that have potential to be found in combination in the study area.

In the early 1980s, Koettig and Hughes (1983) and Haglund (1984) undertook surveys along the proposed route of the East Hills-Glenfield railway and at Glenfield respectively. While no Aboriginal sites were recorded in these areas, it was acknowledged that surface visibility was very low and may have played a role in obscuring surface evidence.

Boot (1990; 1992; 1993; 1994a; 1994b) carried out a series of archaeological investigations at Wattle Grove directly to the east of the study area. Survey was undertaken to the east of Anzac Creek and north of the East Hills Railway Line, incorporating cleared country and patches of bushland. Several artefact scatters were identified, all situated on low ridgelines adjacent to drainage lines or swampy areas. Sites were generally small, low-density scatters containing flaked artefacts and cores primarily composed of volcanics and smaller quantities of silcrete and quartz. An area of remnant bushland in the study area's south was identified as archaeologically sensitive in that it had potential to contain undisturbed artefact scatters (Boot 1992: 9).

Two of the sites recorded by Boot, WGO3-1 and WGO3-2, were subsequently re-investigated by Haglund (1995). This work involved test pitting of the sites in order to determine their subsurface extent and spatial distribution of artefacts. Haglund (1995) concluded that the sites were representative of a single original archaeological complex composed of discrete concentrations of artefacts, most likely specific knapping areas. While the level of disturbance was generally quite high in the area, one part of Site WGO3-2 was deemed likely to contain in situ archaeological deposit and preservation of the location was strongly recommended.

Mills investigated the route of a proposed sewerage pipeline and the location of an effluent reuse rising main and pumping station at Holsworthy in 1995. The pipeline route passed through a combination of existing road easements and heavily disturbed areas. Five isolated artefacts deemed to have low significance were found to the east of Heathcote Road. Two areas of archaeological potential were identified, including the proposed thrust bore exit-point on the northern bank of Georges River. Archaeological monitoring was recommended for these locations.

In 1997 an archaeological survey of an approximately 50 ha area of land spanning the upper reaches of Maxwells Creek at The Crossroads in Liverpool identified a zone of archaeological potential along the Creek (Officer 1997). Twenty one test pits were subsequently excavated along the banks of Maxwells Creek as part of a subsurface archaeological investigation (Navin Officer Heritage Consultants1998). A total of ninety two artefacts were recovered from 16 of the 21 test pits. Six different types of stone material were identified in the lithic assemblage – silcrete, rhyolitic tuff, chert, chalcedony, quartz and quartzite.

The sandstone dominated terrain within the Holsworthy Military Area has been the subject of considerable archaeological interest, particularly in relation to its notable suite of 'sandstone ' sites including rock shelters, pigment art sites, rock engravings and grinding groove complexes.

While important Aboriginal sites have been known in the area since the 1800s, comprehensive surveys in this country commenced with the formation of the Sydney Prehistory Group in the early 1970s. The group, comprising around 20 interested amateurs, recorded 64 sites in the Campbelltown area, including 44 sites in the Holsworthy Military Area and the remainder in sandstone contexts to the west of the Georges River. Their study area included the upper portions of Harris and Williams Creeks, a majority of the Georges River corridor within the Training area, and the terminal portion of Punchbowl creek and the whole of Kalibucca Creek. Site types were primarily rock shelters with archaeological deposit, pigment art sites and grinding grooves.

The Sydney Prehistory Group described site densities of between 0.6 and 1.5 per square kilometre in the Holsworthy Military Area. Variation in site density was interpreted as a function of environmental conditions, particularly the greater density of available shelters due to a higher drainage line density and weathering rates in the interior (Sydney Prehistory Group 1983).

Other formal investigations and site surveys undertaken within the Holsworthy Military Area, or which analysed data pertinent to the area, include Officer (1984), Sharp (1994), Sefton (1994), Axis Environmental/Australian Museum Business Services Consulting (1995) and Mitchell McCotter (1995).

However the most comprehensive and extensive Aboriginal archaeological surveys and assessment of the area were undertaken in 1996 for the Second Sydney Airport EIS (Navin Officer Heritage Consultants 1997). Nineteen open artefact scatters, forty eight scarred trees, sixty four open sites containing grinding grooves, fifteen open sites with engraved art, and one hundred and fifty three shelter sites containing archaeological evidence of Aboriginal occupation (art, cultural deposit) were recorded in the course of the field surveys of the area.

6.4 Moorebank IMT study areas

Five previous archaeological assessments are directly relevant to the study area. These include an Environmental Management Plan compiled in 1996 by Dames and Moore, an archaeological survey conducted by Dallas and Steele (2004), an archaeological assessment of the Southern Sydney Freight Line conducted by Cultural Heritage Connections (2006), a desktop review of the current Moorebank IMT study area (NOHC 2011) and an Aboriginal cultural heritage assessment for the Sydney Intermodal Terminal Alliance undertaken by AHMS (2012). These studies have each included some or all of the current study area.

The Dames and Moore plan (1996) identified an isolated surface artefact (SMEIF1) 160 m south of the study area, on the edge of an elevated terrace formation adjacent to the Georges River. The Dallas and Steele study identified a low density scatter of 16 stone artefacts situated 800 m east of the study area on the slopes of an elevated knoll adjacent to a swamp.

The Dames and Moore plan (1996) provided minimal information on the visibility encountered and coverage achieved during the survey. In contrast, the Dallas and Steele study (2004) presented a breakdown of survey visibility and coverage constraints and went on to identify zones of archaeological sensitivity based on visibility constraints, subsurface potential, and the exclusion of areas displaying substantial past land surface disturbance. Three zones were recognised and associated with recommended management strategies:

- Low sensitivity - (consisting of areas of lesser land surface disturbance, mostly indicated by remnant forest vegetation). Archaeological monitoring of future ground surface disturbance is recommended in this zone.

- Unknown – (consisting of riparian (river margin) areas where the ground surface was obscured by dense vegetation at the time of survey). Further site inspection and assessment is recommended in this zone.

- No sensitivity – (consisting of substantially altered land surfaces such as landscaped, built up urban landscapes). It is recommended that no further assessment is required in these areas.

The Cultural Heritage Connections (2006) assessment of the Southern Sydney Freight Line (SSFL) includes desktop review and targeted field survey of a corridor extending from south of Macarthur Railway Station to east of Sefton Park Junction. It included a portion of the LCC land that form part of the current study area, on the western side of Georges River. This area was not inspected during the 2006 field survey.

A desktop review of cultural heritage constraints was undertaken by NOHC (2011) for the Moorebank Intermodal Terminal. The review showed that while there were no previously recorded Aboriginal sites at that time, there were areas of predicted sensitivity along the Georges River corridor, the margins of adjacent terraces and the margins of tributary creek lines.

Most recently, AHMS (2012) conducted an assessment of the proposed Sydney Intermodal Terminal Alliance (SIMTA) site immediately to the east of the current study area. That investigation also incorporated assessment of the proposed rail corridor to the SIMTA site, along the southern boundary of the current study area. A series of survey transects were inspected within and adjacent the Moorebank IMT study area; two areas of PAD were identified within the current study area. These comprised a section of alluvial terrace at PAD1 and elevated flats adjacent Anzac Creek at PAD2 (Figure 6.1). Two “possible artefacts” (AHMS 2012: 76) were also recorded in association with PAD1.

Other local areas which have been subject to archaeological survey include the Second Sydney Airport study area, situated one kilometre to the south (NOHC 1997) and the Wattle Grove residential development areas located one kilometre to the east (Boot 1990, 1992). The archaeological assessments of these adjacent areas provide a body of comparative site data upon which predictive statements on the likely incidence of Aboriginal sites within the Project area can be based.

6.5 AHIMS search results

A search of the OEH Aboriginal Heritage Information Management System (AHIMS) was initially undertaken in 2010 prior to the field survey. That search revealed that there were no known recordings within the study area.

A subsequent AHIMS search was undertaken on 15 November 2012 across an area of 9 km east-west by 10 km north-south, centred on the study area and on 28 April 2014 taking into account the three rail corridor options (Appendix 6). In total there are 91 separate sites and one Aboriginal Place recorded across both search areas on the AHIMS register. None of these recordings occur within the study area.

The Aboriginal Place is the Collingwood Precinct, a traditional meeting place located 700 m north of the study area, on the western side of the Georges River.

The registered AHIMS sites around the study area comprise:

- grinding groove sites
- art sites
- scarred trees
- potential archaeological deposits; and
- artefact occurrences.

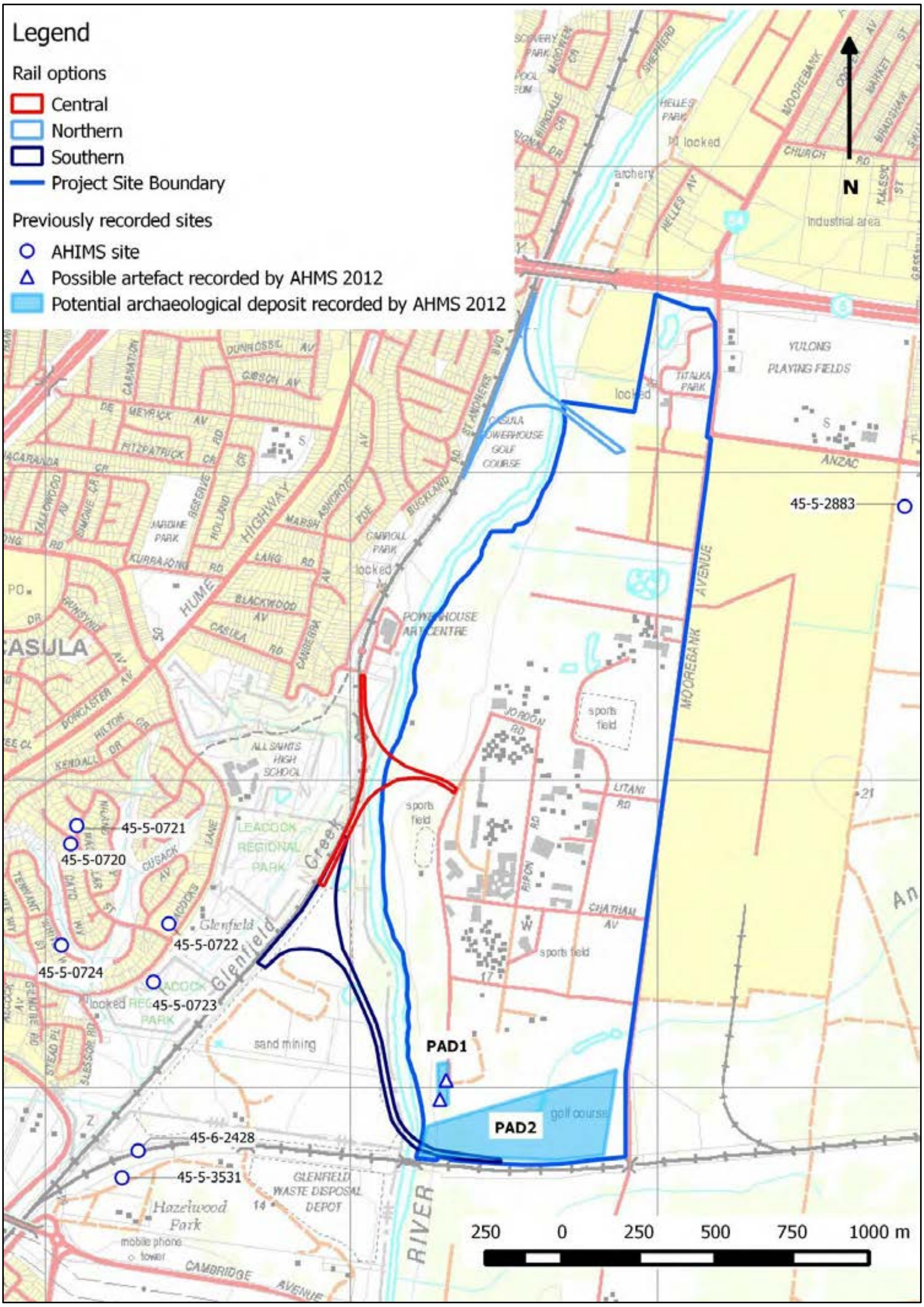

Figure 6.1 Moorebank study area relative to the location of potential archaeological sites, recorded by AHMS (2012), and the closest AHIMS registered site.

The absence of recorded sites within the study area should not be taken as a reliable indication of the Aboriginal archaeological resource within the study area. The absence of recordings may be due to a variety of factors which are relevant to the study area, including:

- the absence of comprehensive archaeological survey across the whole study area
- low ground surface visibility encountered during past surveys across parts of the study area, preventing effective or definitive assessment, and
- the absence of archaeological subsurface testing results which could verify predictive assessments of archaeological potential.

6.6 Predictive modelling and archaeological sensitivity

Based on the results of the previous archaeological assessments (including Dames and Moore 1996, Dallas and Steele 2004, Cultural Heritage Connections 2006 and NOHC 2011), information from the AHIMS and a broader review of archaeological assessments the following predictive statements can be made about the nature of the surviving archaeological resource within the western Sydney and broader Sydney region as it relates to the Moorebank study area.

This model takes account of the known site locational parameters, results of previous archaeological surveys in the local area and of disturbance from previous land use activities in the study area.

Site types

- site types likely to occur are scarred trees, open artefact scatters, isolated finds and potential archaeological deposits; and
- open artefact scatters are likely to be under-represented in surface surveys conducted in uncleared land.

Site location criteria and trends

- major watershed ridgelines may contain higher site densities and/or greater occupation evidence due to their use as access routes;
- open artefact scatters are unlikely to have survived in areas which have been quarried for gravel or heavily impacted by vehicles;
- open artefact scatters and isolated finds are likely to occur on relatively level, well drained ground on the crests of major ridgelines and spurlines, and in valley floor contexts adjacent to water sources. Water sources such as soaks and minor wetlands may be important in determining site locations on ridgeline crests;
- larger sites are most likely to be associated with permanent water sources; and
- Aboriginal scarred trees may occur where ever old growth trees survive.

Potential archaeological deposits

- open sites containing artefacts are unlikely to be detected by surface survey due to the lack, or poor quality of ground exposure, or subsequent burial by later sediments (especially during flooding and after fires); and
- open sites with *in situ* sub-surface artefactual material are most likely to occur in well drained, sedimentary aggrading landforms in valley floor contexts, adjacent to streamlines.

Figure 6.2 presents a map of predicted Aboriginal archaeological sensitivity across the study area. These areas have been identified by plotting predicted archaeological potential, based on landform variables, and then excluding grossly or substantially disturbed land surfaces. This figure builds upon an earlier version of the same subject by Dallas and Steele (2004).

Three zones of predicted Aboriginal archaeological potential have been recognised within the study area:

- the Georges River Riparian Corridor – 100 m either side of the Georges River (inclusive of the 1890s eastern riverbank configuration);
- minor Tributary Riparian Zones – 100 m either side of tributary drainage lines (inclusive of the pre-European drainage alignment, as best determined from historical mapping and 1943 aerial photography); and
- the elevated slopes and riverside margin of a locally elevated Tertiary alluvial terrace edge situated adjacent to the Georges River – zone 100 m wide.

These zones are based on a generalised model of Aboriginal site location which indicates that the majority of sites are situated on locally elevated, well-drained and low gradient ground, located in relative proximity to a fresh or estuarine water source (a majority of sites, and most larger sites, occur within 100 m).

The likely incidence of Aboriginal sites along the Georges River riparian corridor could be expected to be relatively high given its value in prehistory as a source of food, camping locations, raw materials and fresh water (the tidal limit is now situated at the Liverpool Weir, 1.3 km downstream). This expectation should, however, be moderated by factors which are known to obscure or destroy sites along fluvial corridors, notably, the scouring of archaeological deposits during flood events and their concealment by the deposition of flood born sediments.

Given the upper catchment context, and therefore low stream order of the tributary streamlines in the study area (both drain to the northeast and away from the river), the intermittent nature of these water sources limits the potential occurrence of adjacent sites to small and transient campsites with corresponding low incidences of artefact discard. This expectation can be qualified by an appreciation that:

- natural swamp or lake basins (some of which are shown on these tributaries in historical mapping and 1943 aerial photography); may have afforded greater water permanence; and
- such streams may have represented the only fresh water near the river prior to the construction of the Liverpool Weir, when a higher tidal limit in the Georges River may have extended into or upstream of the study area.

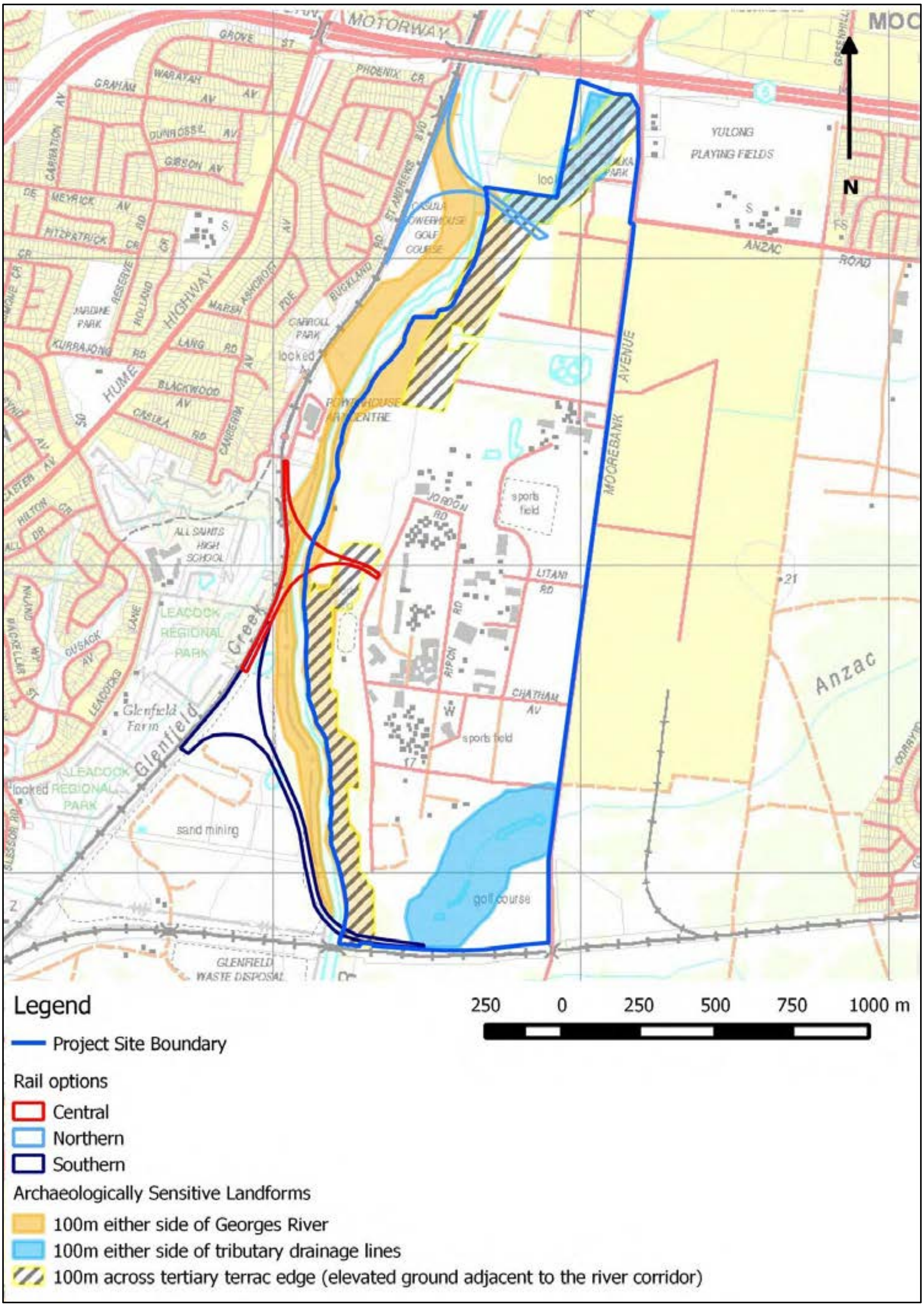

Figure 6.2 Predicted Aboriginal archaeology sensitivity - Note that the areas of archaeological sensitivity do not include areas of major land surface disturbance (refer to NOHC 2011).

7. FIELD SURVEY RESULTS (2010)

This section provides a description of all the artefact occurrences, the PADs and the sensitive landform categories identified as a result of the NOHC 2010 field survey and the AHMS (2012).

7.1 Summary

Eight Aboriginal archaeological recordings have been made in the Project area. These consist of five artefact occurrences (MA1-MA5), and three scarred trees of possible Aboriginal origin (MA6-MA8). In addition, three potential archaeological deposits (PADs) have been identified (MAPAD1, PAD1 and PAD2) and three archaeologically sensitive landform types have been defined.

The PAD and archaeologically sensitive landform, relate to different scales of predicted potential for archaeological deposits. Archaeologically sensitive landforms use a broad scale of identification, typically covering many hectares or square kilometres and are based on the predictive analysis of landform traits, such as geomorphological origin, local elevation and distance to water. The boundaries of a landform classification may be approximate or indicative. The landform classification may not take into consideration micro-topographic variations, or localised areas of low potential (due to disturbance or natural topographic variation). For this reason, it would be inaccurate to classify a sensitive landform as a PAD. A variable proportion of any identified sensitive landform may not have appreciable archaeological potential.

A deposit classification (i.e. a PAD) is a small scale identification, typically covering areas less than a hectare. Its identification will include reference to the characteristics of a specific location (rather than only generalised landform characteristics), and is likely to reflect micro-topographic traits and avoid areas of low potential due to disturbance. The boundaries of a PAD are likely to be definable at a small scale, and be specific to localise traits and reflect localised land use impacts.

7.2 Aboriginal archaeological sites

The location of all recordings relative to the indicative construction footprint of the Moorebank IMT development, are shown in Figure 7.1.

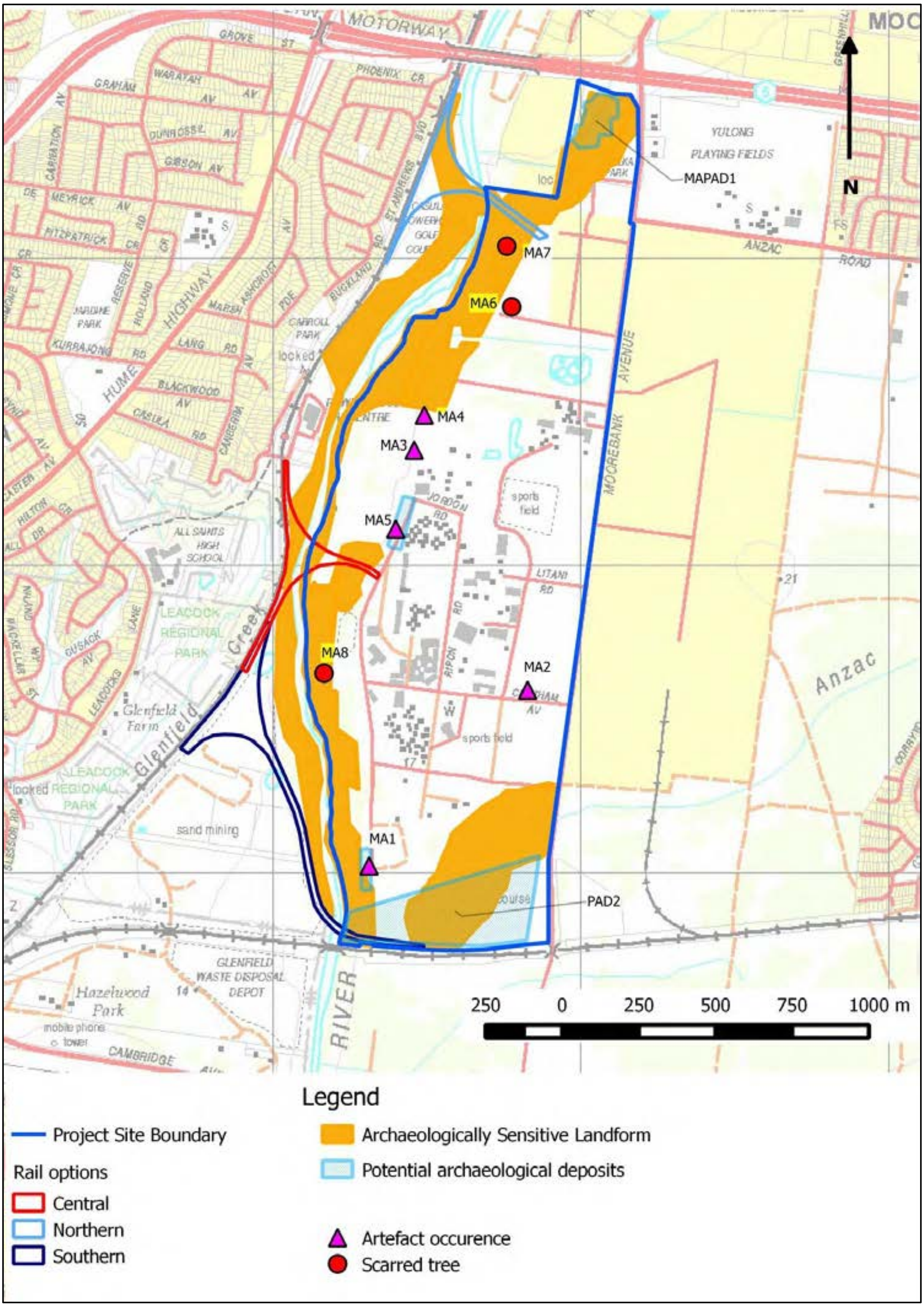

Figure 7.1 Location of Aboriginal recordings and archaeologically sensitive landforms recorded in 2010 and 2012 (refer to figure 6.2 for additional detail) relative to the Project site boundary and rail access options.

Site MA1 (including 'Artefact 5' and 'Artefact 6' (AHMS 2012))

Map Grid Reference: 307309.6240020 (GDA)

This recording consists of three surface artefacts recorded on or adjacent to an approximately 90m interval of roadway (Figure 7.2). The roadway runs parallel to the edge of an elevated terrace formation. One artefact was recorded in 2010 (NOHC 2011) and two further artefacts were recorded in 2011 (AHMS 2012).

The first recording was a single surface artefact in 2010, exposed on the shoulder of a road and situated on the edge of an elevated terrace (around 3-5m high), adjacent to the entrance to the Initial Employment Training Squadron building. The area was noted to be extensively disturbed by earth works, importation of fill and gravel, and the installation of underground services. The incidence of ground surface exposures was around 5%, with visibility in the exposures around 40%.

The artefact was a microblade core and displayed an area of adhering cement to its surface. It was considered possible that the item had been imported to its current location within building materials or fill.

Artefact:

1. Banded grey-brown fine grained metamorphic sedimentary rock, microblade core, 21 x 19 x 12mm

Figure 7.2 MA1 looking north, in 2010 (artefact by foreground bag)

Two further artefacts were recorded in this location by AHMS in 2011 (AHMS 2012:87):

Artefact 5. Consisted of a red silcrete possible flaked piece, found on a sandy exposure, west of the road in survey Transect 3;

Artefact 6. Consisted of a poor quality grey chert/silcrete possible medial flake, fond on a sandy exposure, west of the road in survey Transect 3.

Transect 3 of the AHMS survey consisted of an area of 1.4 hectares, with 98 to 10% exposure visibility and an effective coverage of 10% (AHMS 2012:84). Based on the artefact finds and the landform type, AHMS identified a potential archaeological deposit on the terrace surface in the area of the finds (PAD1). This PAD recording corresponds to the Tertiary terrace archaeologically sensitive landform identified in NOHC (2011).

MA2

Map Grid Reference: 307826.6240593 (GDA)

This recording consists of a single artefact situated in a shallow scald within mown grass north of entry gates and inspection post in SME (Figure 7.3). The area has been previously subject to vegetation clearance, agricultural development, grading, soil removal and construction of surface drainage.

The incidence of ground surface exposures was around 20%, with visibility in the exposures around 25%

This is a possible artefact (use fragment), with most surfaces displaying natural fractures, with the exception of one possible platform edge with bifacial flaking.

Artefact:

1. Banded grey fine grained metamorphic sedimentary rock, possible artefact, 31 x 32 x 13mm (Figures 7.4-7.6)

Figure 7.3 MA2 looking south-east

Figure 7.4 Possible artefact at MA2 (side view)

Figure 7.5 Possible artefact at MA2 (other side view)

Figure 7.6 Possible artefact at MA2 (edge view)

MA3

Map Grid Reference: 307456.6241375 (GDA)

This recording consist of a lone artefact located at the base of the cut and graded tertiary terrace edge and is approximately 300m south of MA 4 (Figure 7.7). The area has been extensively disturbed from Defence related earthworks and excavations.

The incidence of ground surface exposures was around 95%, with visibility in the exposures around 85%

Many introduced gravels are present in the vicinity of the artefact, above and upslope of which lies a narrow vegetated margin of original soil with archaeological potential.

Artefact:

1. Banded grey-grey green rhyolite multi-platform core, at least 4 platforms, 5% cortex, 40 x 28 x 13mm (Figures 7.8-7.9)

Figure 7.7 MA3 looking south-east

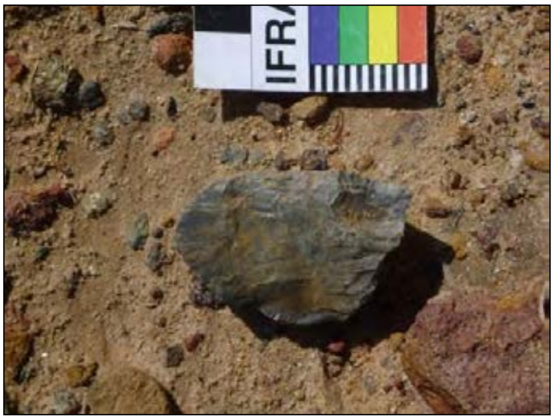

Figure 7.8 Artefact at MA3 (side view)

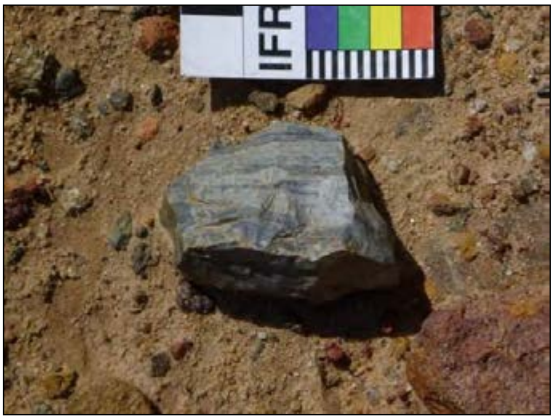

Figure 7.9 Artefact at MA3 (other side view)

MA4

Map Grid Reference: 307489.6241489 (GDA)

This recording is a low density artefact scatter of three artefacts exposed on the edge of a tertiary terrace and situated on a gravelled dirt track sloping down onto river flats ("dirt pans") below (Figure 7.10). The edge of the terrace is highly disturbed due to excavation and landscaping to form a uniform slope and straightened edge.

The incidence of ground surface exposures was around 80%, with visibility in the (track) exposures around 75%.

Artefacts (Figures 7.11-7.12):

1. Red silcrete multi-platform core with at least 3 platforms, 39 x 35 x 30mm
2. Red to light red quartzite bipolar flake, 45% alluvial pebble cortex, 44 x 30 x 14mm
3. Light yellow patinated fine grained tuff steep edge concave scraper, secondary retouch along 75% of margin, remnant platform edge evident, 23 x 31 x 10mm

Figure 7.10 MA4 looking east, note elevated terrace and modified embankment.

Figure 7.11 Artefacts at MA4 (side view)

Figure 7.12 Artefacts at MA4 (other side view)

MA5

Map Grid Reference: 307396.6241118 (GDA)

This recording consists of 3 artefacts situated on the high side of an artificially benched slope atop the tertiary terrace, and is adjacent to the lower lying dirt pan (Figure 7.13). The three artefacts were found in area measuring 25 x 5m.

The incidence of ground surface exposures was around 15%, with visibility in the exposures around 85%

Artefacts (figures 7.14-7.15):

1. Yellow-brown broken flake, approximately 40% cortex, proximal end missing, 30 x 16 x 5mm.
2. Yellow-brown silcrete flake, focal platform, 18 x 12 x 3mm
3. Light brown fine grained metamorphic rock (tuff?), some modern edge damage, 10 x 7 x 1mm.

Figure 7.13 MA5 looking south along edge of terrace

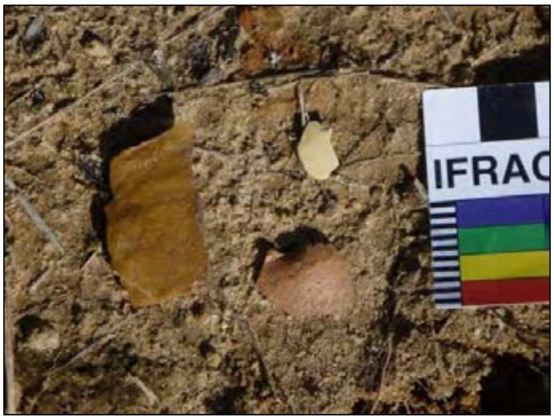

Figure 7.14 Artefacts at MA5 (side view)

Figure 7.15 Artefacts at MA5 (other side view)

MA6

Map Grid Reference: 307774.6241842 (GDA)

This tree is an old growth Eucalyptus in fair to good health, with a number of hollows and missing limbs (Figures 7.16-7.17). The tree measured an approximate height of 18-20 m. The scar was recorded as 0.25 m above the ground with dimensions of 3.45 x 2.0 m. The tree is situated on the south edge of a playing field.

Tree

Approximate height of tree: 18-20 m
girth of tree (at breast height 1.2 m) 4.25 m

Scar

inside scar length (excluding regrowth):	2.8 m
scar length (including regrowth):	3.45 m
maximum width of regrowth	0.55 m
maximum depth of regrowth (including growth into trunk hollow)	0.25 m
maximum scar width (excluding regrowth):	0.67 m
maximum scar width (including regrowth):	2.0 m
height of inside scar above ground:	0.25 m
height of original scar edge above ground	0m
scar faces	west
axe marks?	No

The scar has an irregular and asymmetrical shape, the branch that is situated directly above the top of the scar regrowth may be an epicormic response to trauma and the scar may have extended to the ground. A possible Aboriginal origin is supported by the shape and estimated age of the scar as well the proximity of the tree to the Georges River.

The scar is assessed as being of possible Aboriginal origin.

Figure 7.16 MA6, looking east

Figure 7.17 MA6 scar

MA7

Map Grid Reference: 307758.6242040 (GDA)

The tree was recorded as a smooth barked Eucalyptus (Red gum) (Figures 7.18-7.19). The tree had an approximate height of 18-20m. The scar was recorded as being 0.8m above the ground with dimensions of 2.5 x 1.25 m. The tree is located on the north margin of a playing field, close to the tertiary terrace edge and river bank, approximately 80-100 m from the river. The tree is in relatively good health with some dead lower branches, but no hollows.

Tree

Approximate height of tree:	18-20 m
girth of tree (at breast height 1.2 m)	3.85

Scar

inside scar length (excluding regrowth):	0.84 m
scar length (including regrowth):	≥2.5 m
maximum width of regrowth	0.65 m
maximum depth of regrowth (including growth into trunk hollow)	0.3m
maximum scar width (excluding regrowth):	0.2m
maximum scar width (including regrowth):	1.25 m
height of inside scar above ground:	1.65 m
height of original scar edge above ground	0.8 m
scar faces	south
axe marks?	Possible

The scar regrowth is irregular and the age of the tree and the scar may be post European settlement. A possible Aboriginal origin is supported by the symmetrical shape of the scar, the amount of scar regrowth, the tree type, as well the proximity of the tree to the Georges River.

The scar is assessed as being of possible Aboriginal origin.

Figure 7.18 MA7 looking east

Figure 7.19 MA7 looking north

MA8

Map Grid Reference: 307162.6240648 (GDA)

This tree was recorded as a rough barked Eucalyptus, becoming smooth barked 2/3 up the trunk (Figures 7.20-7.21). The tree was approximately 16-18m in height, with a diameter of 3.5m. The lower boundary of the scar was difficult to judge accurately due the diffuse nature of the lower regrowth; however the recorded dimensions of the scar were 2 x 1.1m. The tree is located on the upslope of the tertiary terrace embankment approximately 60m from the river.

Tree

Approximate height of tree:	16-18 m
girth of tree (at breast height 1.2 m)	3.5 m

Scar

inside scar length (excluding regrowth):	occluded
scar length (including regrowth):	+2.1 m
maximum width of regrowth	0.55 m
maximum depth of regrowth (including growth into trunk hollow)	occluded
maximum scar width (excluding regrowth):	occluded
maximum scar width (including regrowth):	1.1 m
scar faces	west
axe marks?	No

The scar may have been the caused by machinery during the cutting and benching of the area. A possible Aboriginal origin is supported by the possible age and symmetrical shape of the scar, the amount of scar regrowth, the tree type, as well the proximity of the tree to the Georges River.

The scar is assessed as being of possible Aboriginal origin.

Figure 7.20 MA8 looking east

Figure 7.21 MA8 looking east

7.3 Potential archaeological deposits

MAPAD1

Map Grid References (GDA): Approximate perimeter points	*308063.6242558*
	308116.6242453
	308029.6242336
	307958.6242360
	307965.6242432
	307995.6242430
	308009.6242506

This recording consists of the banks and a fringing 50m radius around a natural lake basin situated in the far northern portion of the Project area. The lake basin is situated in the upper reaches of an unnamed first order tributary which drains to the northeast. The proximity of this freshwater lake to the riparian corridor of the Georges River (350m to the west), which may have been estuarine at this point in prehistory, provides a strong basis for predicting evidence of past Aboriginal occupation along its original banks and surrounds.

The banks of the lake are now steep sided and are suggestive of the dumping and encroachment of landfill. This may have occurred as a result of successive Defence related development of the land to the east and south of the basin, and more recent commercial development on the lake's western side (Figure 7.22).

Figure 7.23 presents a comparison of aerial photography of the MAPAD1 area and associated drainage system from 1943 and 2008 (from www.six.nsw.gov.au). It is clear from the catchment comparison that the subject lake is now the last remaining relatively unmodified basin from the local Georges River flood plain, which originally included at least six lakes or anabranches.

2008
(from www.six.nsw.gov.au)

1958
(1958 topographic map, Moorebank Holsworthy Area CEN938d 1/9/57, Amended 22/4/58 (Aust War Mem'l 123, Item 493))

1943
(from www.six.nsw.gov.au)

Figure 7.22 A comparison of aerial photography and mapping across the MAPAD1 area, from 1943, 1958 and 2008, showing the remnant nature of the PAD and the boundary (red) relative to past ground disturbance.

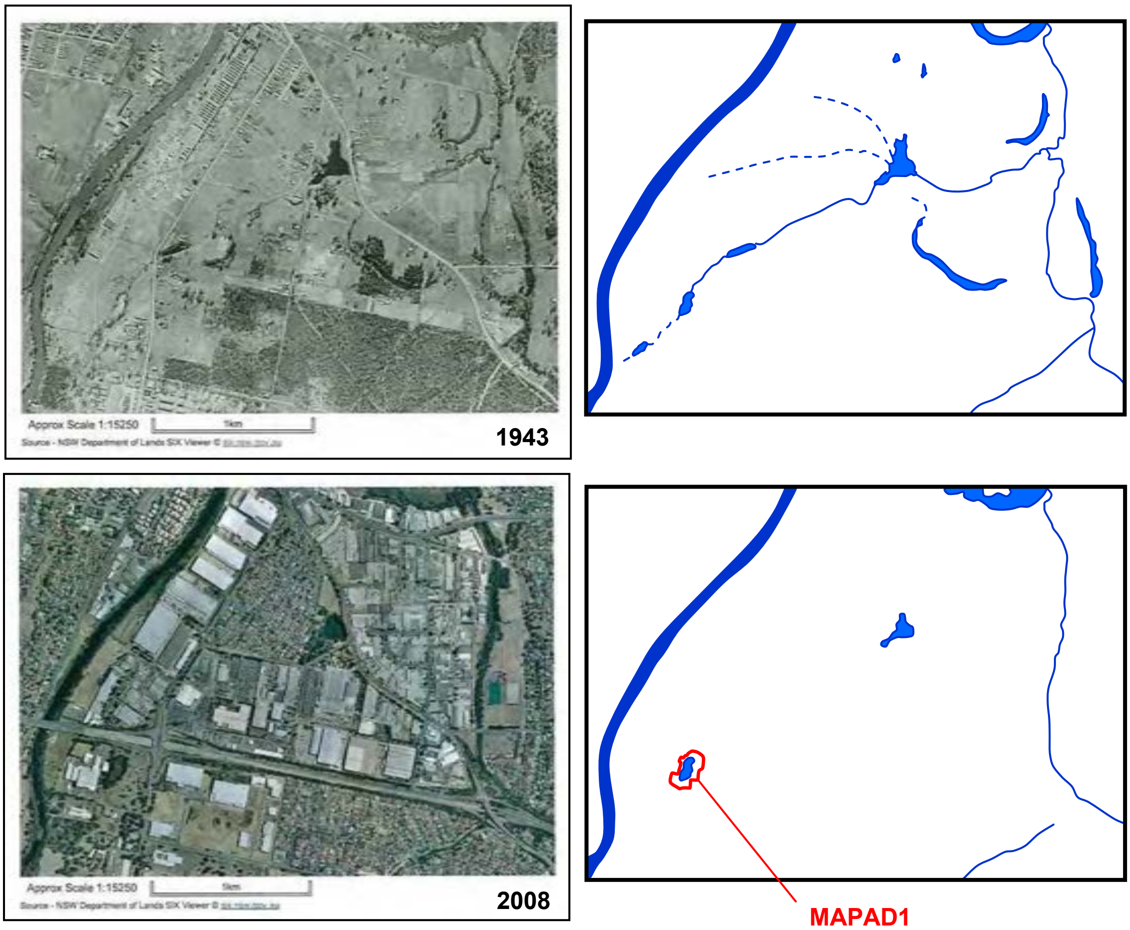

Figure 7.23 A comparison of aerial photography and mapping across the MAPAD1 area, from 1943 and 2008 showing the location of MAPAD1 relative to the pre-urban and contemporary surface drainage network.

PAD1

Map Grid References (GDA): Approximate perimeter points	*307319.6239944* *307276.6239941* *307255.6240103* *307309.6240111*

This potential archaeological deposit was defined by AHMS (2012), based on the landform, the presence of intact soil profile and the presence of artefacts 5 and 6 (AHMS 2012:76). It is described as a:

> River terrace running along the eastern side of the Georges River; largely undisturbed; vegetation cleared; eroding; grassy with exposures; 10% ground surface visibility. (AHMS 2012:87).

As such, this recording forms part of the archaeologically sensitive Tertiary terrace landform identified by NOHC (2011). An assessment of an isolated surface artefact by NOHC in 2011 indicated extensive ground disturbance in the area of the find from road works, importation of fill and underground services.

PAD2

Map Grid References (GDA): Approximate perimeter points *307864.6240004*
307824.6239767
307213.6239765
307235.6239858

This potential archaeological deposit was defined by AHMS (2012), based on the areas elevation above the terrace, the relatively low level of disturbance (despite its context within a golf course), and the presence of an intact soil profile. It was considered to have moderate archaeological potential (AHMS 2012:77).

It is defined as:

> 'Golf course between Anzac Creek and East Hills Rail Line; grassy but possibly some original soil profile, scattered large Eucalypts; 15% ground surface visibility; no artefacts identified on surface' (AHMS 2012:87).

This recording primarily includes three archaeologically sensitive landforms identified by NOHC (2011): the Georges River riparian corridor, the adjacent Tertiary terrace, and the riparian zone surrounding Anzac Creek, a first order tributary.

7.4 Archaeologically sensitive landforms

Following a review of previous local archaeological assessments, site location models (Boot 1990 & 1992, Dallas & Steele 2004, Dames and Moore 1996, NOHC 1997), geomorphological, and land use characteristics, the NOHC preliminary assessments identified three archaeologically sensitive landforms. These are described below and illustrated in Figure 6.2. The identification of these zones represents a refinement of previous work conducted by Dallas and Steele (2004). The sensitive areas were defined by plotting predicted archaeological potential based on landform variables, and then excluding grossly or substantially disturbed land surfaces.

The three archaeologically sensitive landforms are defined as:

- the Georges River Riparian Corridor – 100 m either side of the Georges River (inclusive of the 1890s eastern riverbank configuration);
- minor Tributary Riparian Zones – 100 m either side of tributary drainage lines (inclusive of the pre-European drainage alignment, as best determined from historical mapping and 1943 aerial photography); and
- the elevated slopes and riverside margin of a locally elevated Tertiary alluvial terrace edge situated adjacent to the Georges River – zone 100 m wide. (NOHC 2011:14)

The predicted sensitivity of these landforms is based on a generalised site location model which postulates that the majority of sites occur on locally elevated, well-drained and low gradient ground, located in relative proximity to a fresh or estuarine water source (and that a majority of sites, and most larger sites, occur within 100 m of a fresh or estuarine water source).

The likely incidence of Aboriginal sites along the Georges River riparian corridor could be expected to be relatively high given its value in prehistory as a source of food, camping locations, raw materials and fresh water (the tidal limit is now situated at the Liverpool Weir, 1.3 km downstream). This expectation should, however, be moderated by factors which are known to obscure or destroy sites along fluvial corridors, notably, the scouring of archaeological deposits during flood events and their concealment by the deposition of flood born sediments.

Given the upper catchment context, and therefore low stream order of the tributary streamlines in the study area (both drain to the northeast and away from the river), the intermittent nature of these water sources limits the potential occurrence of adjacent sites to small and transient campsites with corresponding low incidences of artefact discard. This expectation can be qualified by an appreciation that:

- natural swamp or lake basins (some of which are shown on these tributaries in historical mapping and 1943 aerial photography); may have afforded greater water permanence, and

- such streams may have represented the only fresh water near the river prior to the construction of the Liverpool Weir, when the tidal limit in the Georges River may have extended into or upstream of the study area.

The two potential archaeological deposits identified by AHMS are encompassed by the archaeologically sensitive landforms by NOHC.

8. FIELD SURVEY RESULTS (2013)

This section provides a description of the PADs and the sensitive landform categories identified as a result of the 2013 field survey (Figure 8.5).

8.1 Summary

No previous Aboriginal archaeological recordings have been made in either the Southern Sydney Freight Line (SSFL) or the Liverpool City Council (LCC) Lands areas.

One Potential Archaeological Deposit (PAD) has been identified (MAPAD2), and is located on an archaeologically sensitive landform.

8.2 Potential Archaeological Deposit

MAPAD2

Map Grid References (GDA): Approximate perimeter points	*307591.6242466*
	307146.6241582
	307221.6241559
	307644.6242093

The potential archaeological deposit is made up of a portion of the archaeologically sensitive landform identified by NOHC (2011) as the Georges River Riparian Corridor. This PAD is located on the western banks of the Georges River.

Disturbance within this PAD is moderate, and is mostly related to previous use as the Liverpool Golf Course. The most common impacts to the original ground surface of this landform are earthworks, resulting in both cutting into and capping the PAD (see Figures 8.1-8.4). These impacts are in the form of bunkers and built up tees. In addition to impacts relating to past use, the area is current used as public access/parkland, with a concrete path following the alignment of the Georges River, and within approximately 10 m of the current edge of the river bank. These impacts cover localised portions of this PAD, with many areas appearing relatively intact and undisturbed by comparison.

The depth of deposit at this PAD is considered to be in excess of 1 m and is made up of alluvial grey and yellow sands.

Such deposit depth suggests archaeological subsurface potential exists in both disturbed (cut into and capped) and undisturbed areas of this PAD. Overall, potential for intact deposits at depth is considered moderate, while potential for artefacts subsurface is moderate to high.

The adjacent tertiary terrace to the west of this PAD is heavily impacted by both rail and road construction, and is considered too disturbed to contain archaeological deposits with research potential.

Figure 8.1 MAPAD2 looking north

Figure 8.2 MAPAD2 looking north

Figure 8.3 MAPAD2 looking southeast

Figure 8.4 MAPAD2 looking south

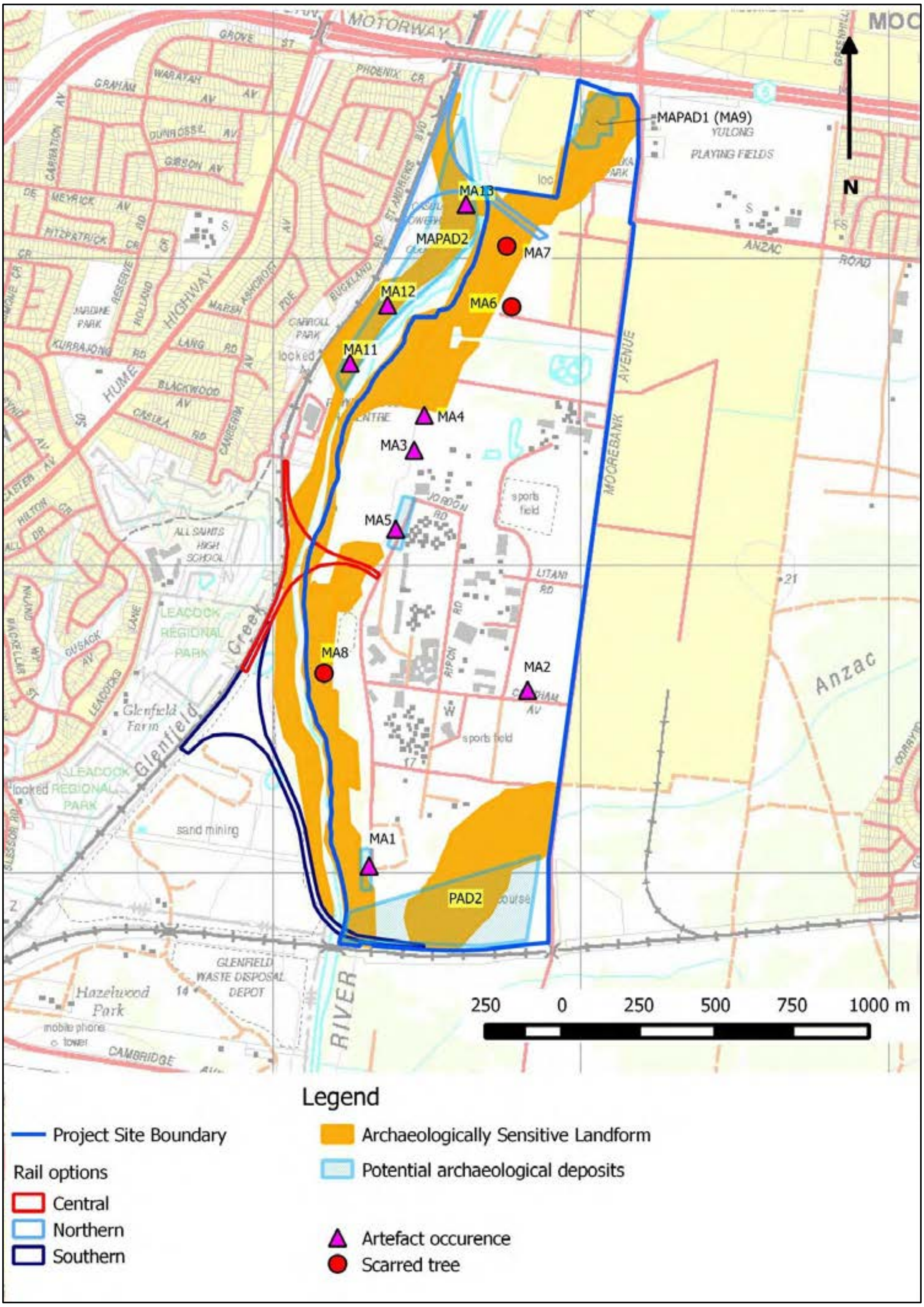

Figure 8.5 Location of all Aboriginal recordings and archaeologically sensitive landforms (refer to Figure 6.2 for additional detail) relative to the Project site boundary and rail access options.

9. FIELD SURVEY RESULTS (2014)

This section provides a description of the sensitive landform categories identified as a result of the 2014 field survey of the central and southern rail access options.

9.1 Summary

No previous Aboriginal archaeological recordings occur within the areas that correspond to the central rail access option and the southern rail access option.

Survey of the central rail access option was comprehensive, including pedestrian survey of both the eastern and western banks. No surface evidence of Aboriginal occupation was observed, however areas of potentially intact deposits (Figure 9.1) were identified along the banks of the Georges River that may contain archaeological evidence.

Survey of the southern rail access option was restricted to the eastern bank (Figure 9.2); the western bank being the Glenfield landfill, which displays low archaeological potential. No surface evidence of Aboriginal occupation was observed, however it was noted that the potential exists for relatively intact deposits at depth that may contain archaeological evidence.

Figure 9.1 Area of relatively undisturbed river bank on the eastern side of the central rail access option.

Figure 9.2 General view west across the Georges River in the vicinity of the southern rail access option.

9.2 Central rail access option

As can be seen above in Figure 8.1, the majority of the central rail access option corresponds to locally elevate and relatively low gradient land surfaces within identified archaeologically sensitive landforms. The only exceptions being the land immediately adjacent the existing railway and part of the floodplain on the eastern side that has been impacted by earthworks. The tertiary terrace at the eastern end of this component of the study area has also had varying degrees of disturbance from vehicular tracks cut into the terrace. Where visible, the A-horizon soils on both the eastern and western banks comprise a humic sandy topsoil that may be indicative of either relatively intact flood deposits that postdate European settlement (i.e. deposits that result from construction of the Liverpool Weir – refer to NOHC 2014a) or relatively intact pre-European deposits.

It is unclear how deep these deposits may be or whether they contain archaeological material. However, on the basis of subsurface investigations further to the north, at the northern powerhouse lands, potential exists for relatively deep deposits that contain evidence of human activity during the past two centuries as well as capping deeper deposits that relate to the pre-European period.

Given that the Georges River is understood to have been an area that was a focus of Aboriginal activity, the relatively undisturbed portions of the central rail access option, as described above and as mapped in Figure 8.1, are confirmed to be archaeologically sensitive. Further assessment of the nature and depth of these deposits would be necessary in order to fully assess their archaeological potential.

9.3 Southern rail access option

As can be seen above in Figure 8.1, the majority of the southern rail access option corresponds to areas of high disturbance on the western side of the Georges River. This area is assessed to be of negligible archaeological potential.

The area on the eastern bank has also been subject to a degree of disturbance from sand mining activities (NOHC 2014b) and vehicular tracks cut into the banks. It is however unclear whether or not this section of the river banks may comprise relatively recent flood deposits, as is indicated within the northern powerhouse lands (NOHC 2014a), that may cap a relatively intact pre-European land surface at depth. The current land surface along this portion of the river bank is of moderate to high gradient.

Given that the portion of the eastern bank that corresponds to the southern rail access option appears to have been subject to more extensive impacts than the portion that corresponds to the central rail access option, and given the surface gradient in this area, the potential for archaeological material in the upper metre of deposits is predicted to be low. Nevertheless, the potential for archaeological evidence within relatively intact deposits at depth cannot be excluded, and as such this area is categorised on a precautionary basis as archaeologically sensitive. Further assessment of the nature and depth of these deposits would be necessary in order to fully assess their archaeological potential.

10. SUBSURFACE TESTING PROGRAM RESULTS

Subsurface testing was undertaken at sites, PADs and archaeologically sensitive landforms identified through the field surveys undertaken in 2010, 2013 and 2014 and literature review (see Sections 7-9). The subsurface testing program was undertaken following the methodology and research design described in Appendix 2.

This section provides the results of the subsurface testing program undertaken in September 2012 including an overview of the test results, a summary of test pits excavated in each test location and summaries of the geomorphological field inspection and artefact analysis. A summary of the Northern Powerhouse land testing program is also provided.

10.1 Summary

- Fifty-nine (59) test pits were excavated across the Moorebank IMT study area (Figure 10.1);
    - MA1 (4 - mechanical)
    - PAD2 (21 – by hand)
    - MA5 (11 – 9 mechanical, 2 by hand)
    - MAPAD1 (10 – by hand)
    - MRSA1 (6 – by hand)
    - MRSA3 (7 – mechanical)
- No test pits were excavated at MRSA2 during this program of investigations due to environmental and occupational health and safety concerns in that area;
- Detailed geomorphological analysis was undertaken at select pits at MA5, MAPAD1 and PAD2;
- Evidence of disturbance from European land use activities was primarily restricted to Spits 1-3, across all areas tested, the only exception to this was at MAPAD1 where European artefacts were recovered down to Spit 11 at Pit 3 and Spit 5 at pit 4;
- 264 artefact recovered from 26 pits;
- The majority of artefacts were recovered from MAPAD1 (N[3]=130) and MA5 (N=110)
- No artefacts were recovered from MRSA3 or PAD2;
- The highest artefact incidence was at MA5 Pit 7, where 62 artefacts were recovered;
- Average artefact incidence was 20.31 artefacts per square metre;
- The majority of artefacts (N=245) were recovered from Spits 1-5, i.e. within the upper 50 cm of intact deposits;
- Ten distinct artefact categories were identified within the Moorebank test excavation assemblage. The dominant assemblage elements were flakes (N=183 – including retouched [N=13] and utilised flakes [N=7]) and flaked pieces (N=55). Cores were the next most common artefact type (N=12), followed by backed artefacts (N=6);

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[3] N=number of artefacts

- The assemblage was dominated by silcrete (N=135), followed by quartz (N=46), quartzite (N=40) and basalt (N=10); smaller amounts of siltstone, fine grained silicious (FGS), indurated mudstone, dolerite, tuff, fine grained igneous, limestone and chert were also present; and one porcelain flake with possible usewear was also identified at MAPAD1.

10.2 Excavation areas

See Figure 10.1 for the location of all subsurface testing areas.

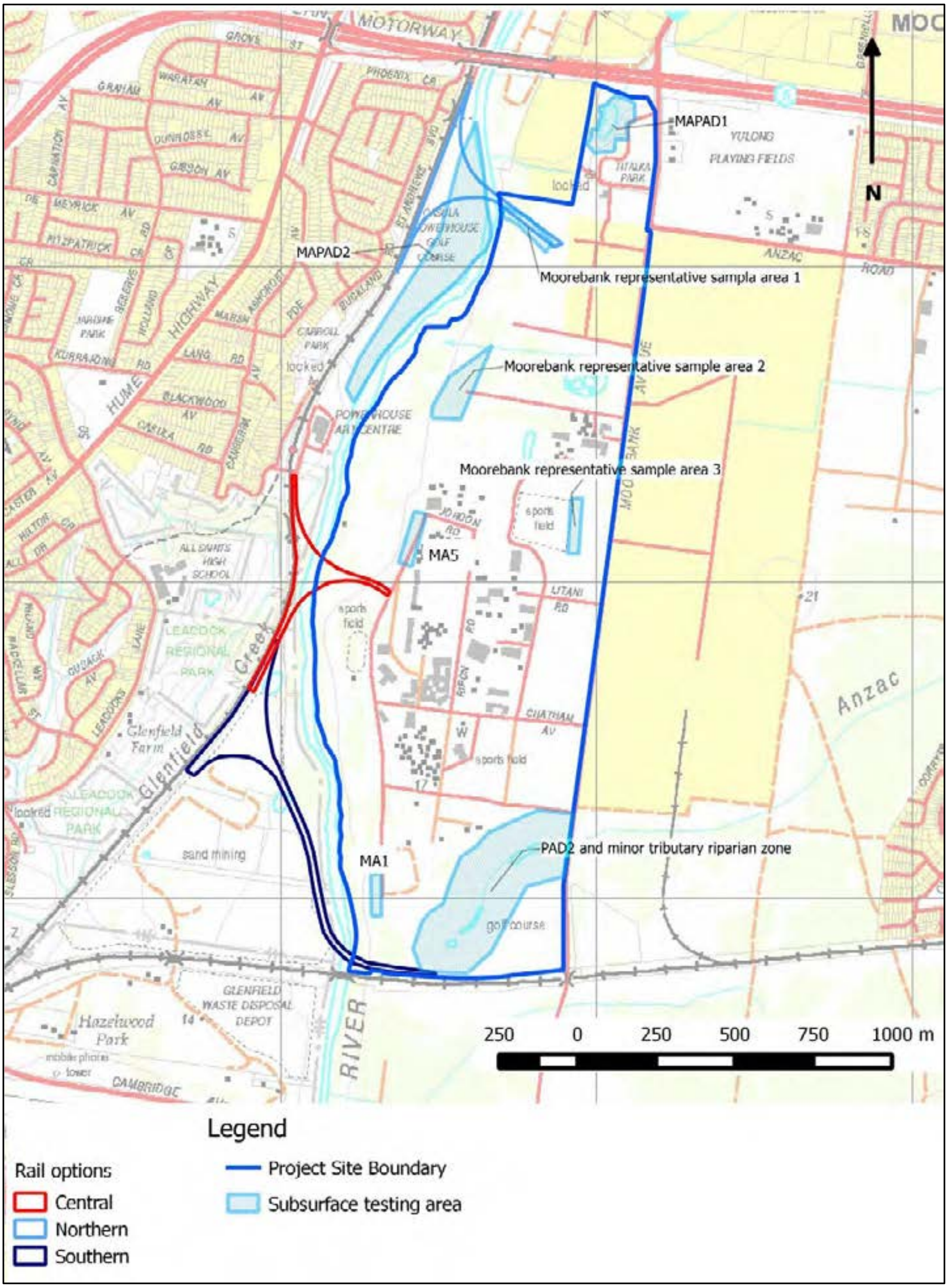

Figure 10.1 Location of All subsurface testing areas

10.2.1 MA1

Four mechanical excavation test pits were conducted at MA1. The area was characterised by very high levels of disturbance, which impacted significantly on the number and placement of test pits. Limited areas of relatively undisturbed deposits were identified at the northern and southern ends of the test transect; two pits were excavated in each of these areas (Figure 10.2).

A cap of disturbed clay fill was encountered at Pits 1, 2, and 4. In these instances, the top of Spit 1 corresponded to the beginning of deposits below this cap of fill. Pit depths varied between 60 cm (Pit 2) and 108 cm (Pit 1).

Eight artefacts were recovered from MA1; artefacts were recovered from all four pits. Artefacts were recovered from spits 1, 2, 4 and 5. Artefact numbers per pit varied from one at Pit 4 to three at Pit 3; two artefacts were recovered from each of Pits 1 and 2.

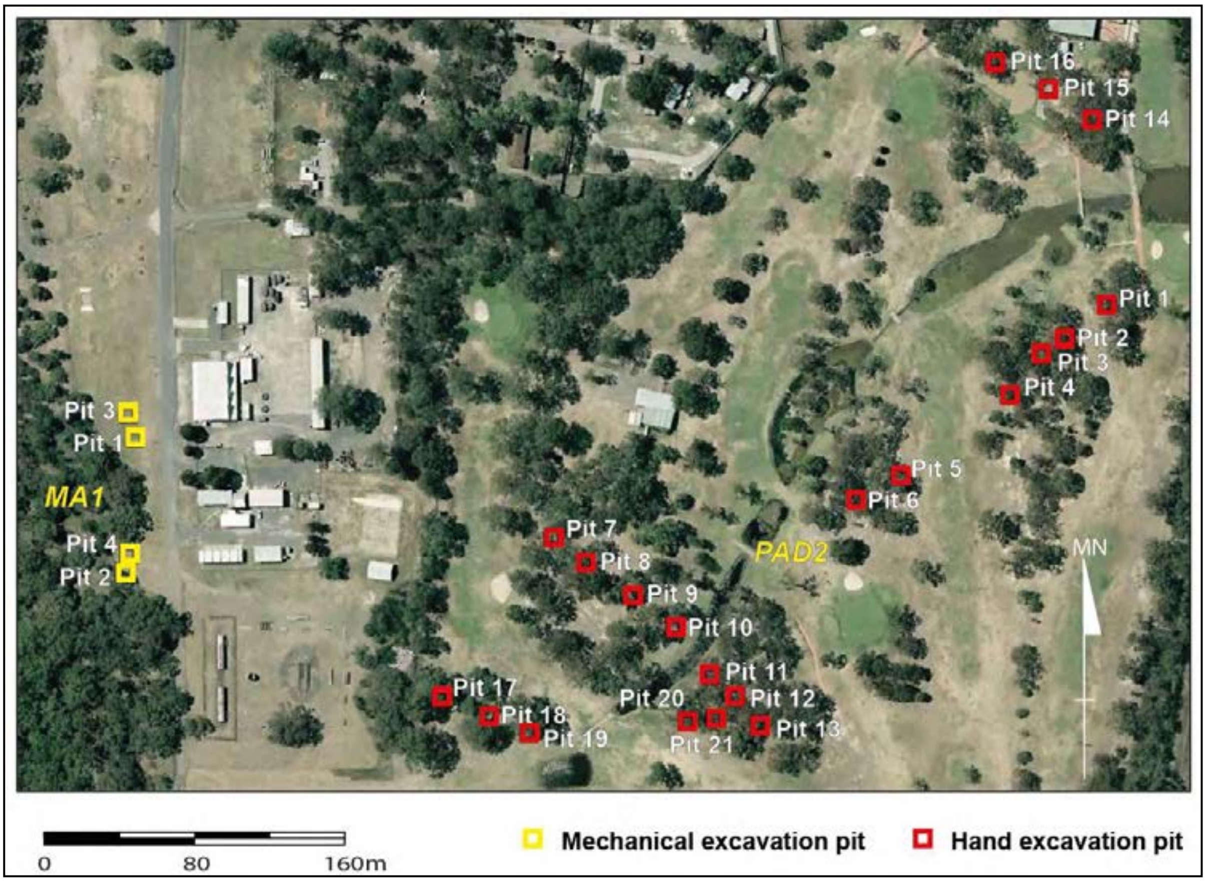

Figure 10.2 Location of test pits at MA1 and PAD2 (Google Earth Pro 2012)

10.2.2 PAD2

Twenty-one (21) test pits were excavated by hand at PAD2. All pits were excavated at 25 m intervals along a series of transects. Test pits targeted areas of least disturbance bordering the creek line through the RAE Golf Course (Figure 10.1). Soil profiles varied from relatively shallow and apparently truncated sandy deposits to deeper, more intact sand deposits with coffee rock formations.

A cap of disturbed clay fill was encountered at Pits 9, 10, 13, 15, 20 and 21. The thickness of this cap varied from 3 cm to 20 cm. In instances where the clay cap was in excess of 5 cm, Spit 1 samples began below the fill layer. Pit depths varied between 25 cm (Pit 3) and 110 cm (Pit 20).

No deposits were sieved from Pit 12 due to the extent of disturbance and clay fill in this location.

No artefacts were recovered from any of the test pits at PAD2.

10.2.3 MA5

Eleven (11) test pits were excavated at MA5, they comprised nine mechanical pits (Pits 1-7 and 9-10) and two by-hand pits (Pits 8 and 11). The by-hand pits were conducted in response to higher numbers of artefacts associated with the presence of relatively intact and undisturbed deposits at the southern end of the site. Pits 1-7 were at a 25 m spacing; four contingency pits (Pits 8-11) were also placed between Pits 3 -7 (Figure 10.3).

A cap of disturbed clay fill of variable thickness was encountered at all pits. No samples were taken from this cap. In most cases, a relatively undisturbed section of deposits was encountered below this cap, however the soil profile appeared to more truncated at the northern end of the site. Pit 3 did not contain any evidence of intact soil horizons.

Pit depths varied between 45 cm (Pit 9) and 105 cm (Pit 7).

One hundred and ten (110) artefacts were recovered from eight of the 11 pits excavated at MA5. Artefacts were recovered from spits 1-7 with the majority coming out of Spit 3 (N=50) and spit 2 (N=18). Where artefacts were present, artefact numbers per pit varied from two at Pits 2, 4 and 11 through to 62 Pit 7.

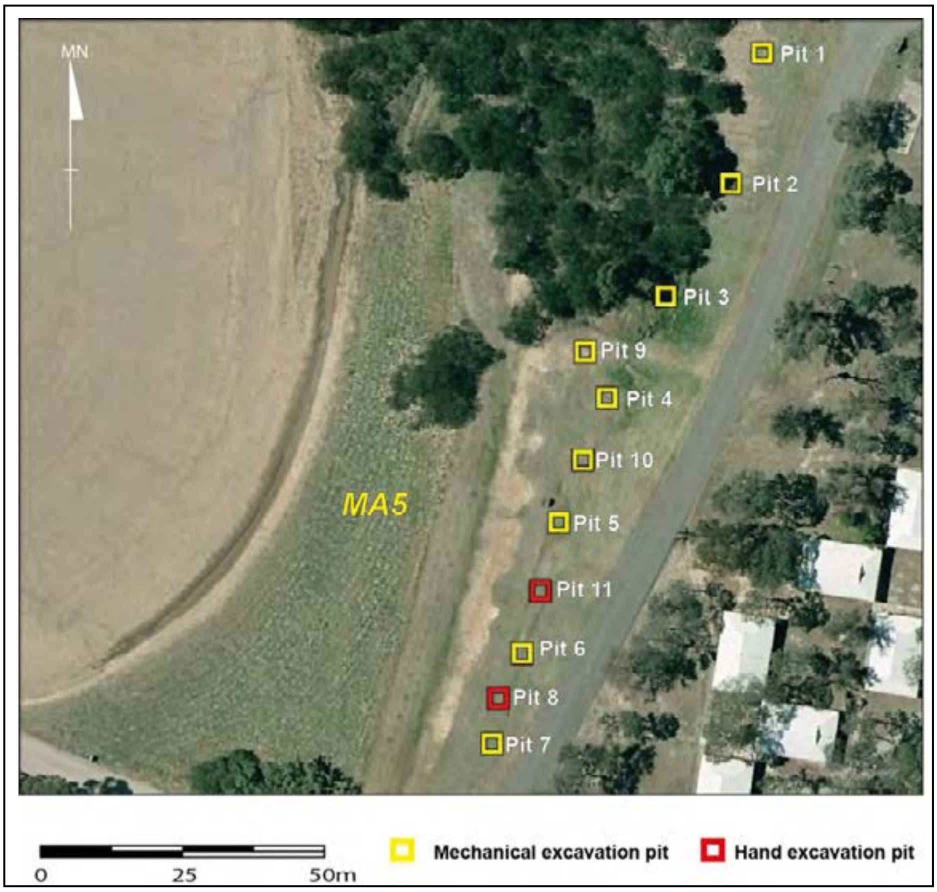

Figure 10.3 Location of test pits at MA5 (Google Earth Pro 2012)

10.2.4 MAPAD1

It was initially predicted that there may be a substantial cap of fill over this area, so excavation began with a hand auger probe (150 mm diameter) to a depth of approximately 30 cm adjacent the location of Pit 5. The results of this probe indicated the presence of apparently natural A-horizon soils with no evidence of fill. A single artefact was recovered from the base of the probe.

Ten test pits were excavated by hand at MAPAD1. Pits 1-6 and 8 were placed at 25 m intervals (Figure 10.4). Pits 7 and 9 were placed approximately 12.5 m either side of Pit 6 in order to gather more information regarding the decrease in artefact numbers at the southern end of the site.

Excavation also began on a tenth pit (Pit 9a) and deposits from Spits 1 and 2 were sieved from this pit before it was discovered that the pit was located on an old services trench. A new Pit 9 was subsequently excavated a few metres to the north.

Pit depths varied between 20 cm (Pit 9a) and 107 cm (Pit 3). The deepest soil profiles were encountered across the northern half of the site, where soils graded from a humic sandy loam to clean sands to sandy clays with coffee rock gravels.

One hundred and thirty (130) artefacts were recovered from MAPAD1; artefacts were recovered from all ten pits, including the abandoned Pit 9a. Artefacts were recovered from Spits 1 through 11, with the majority found in Spit 2 (N=46) or Spit 3 (N=34); only six artefacts were recovered from a depth of 90 cm or more. Artefact numbers per pit varied from one at Pit 1 to 27 at Pit 4.

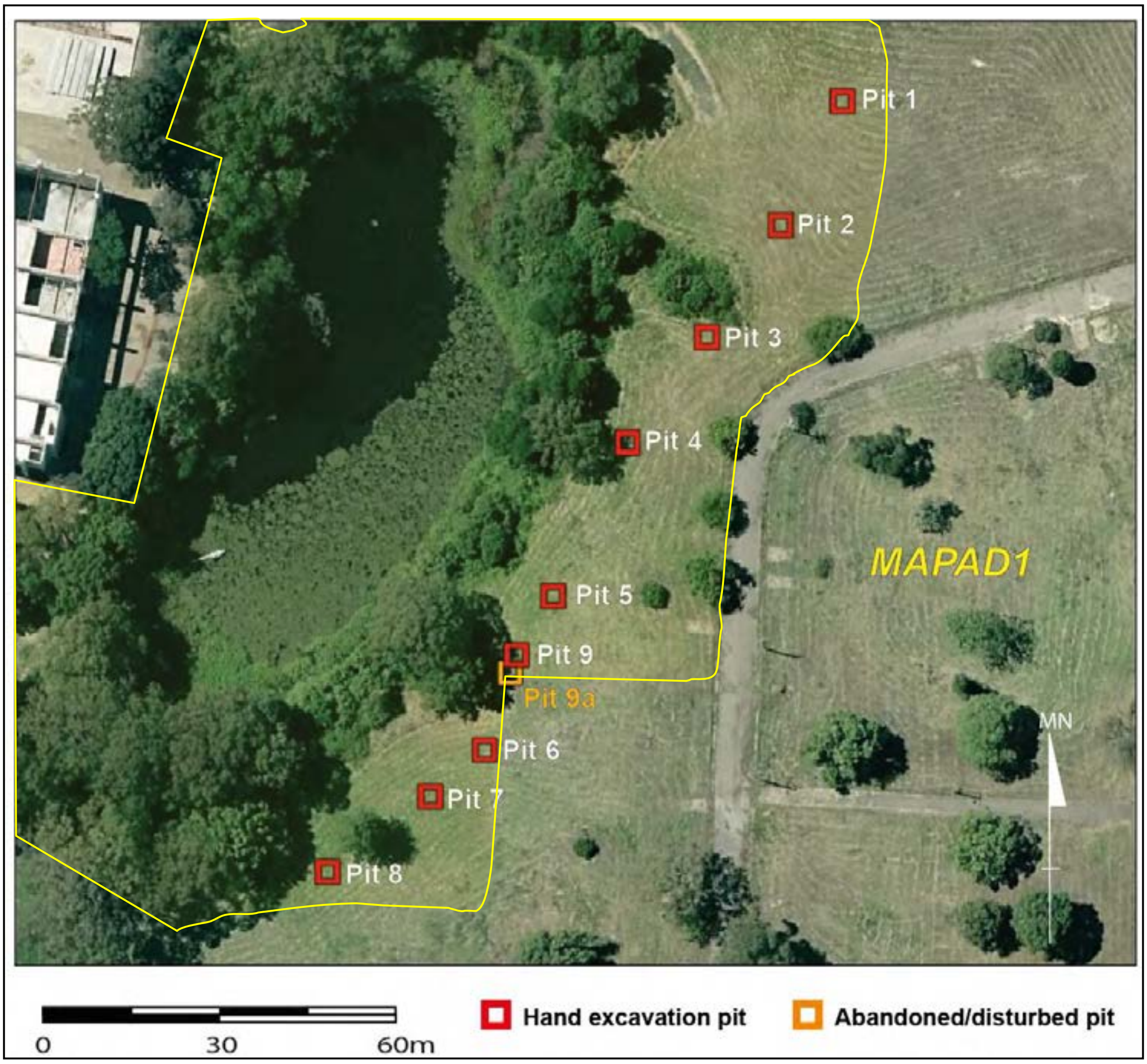

Figure 10.4 Location of test pits at MAPAD1 (Google Earth Pro 2012)

10.2.5 Moorebank Representative Sample Area 1

Six by-hand test pits were excavated at Moorebank Representative Sample Area (MRSA) 1 (Figure 10.5). Pits 1-5 were placed at 25 m intervals; Pit 6 was placed in between Pits 2 and 3. The area was characterised by relatively shallow soil profiles at the eastern end and significantly deeper and more intact sandy deposits at the western end.

Pit depths varied between 28 cm (Pit 1) and 120 cm (Pit 5). Excavation at Pit 5 ceased at 120 cm due to concerns regarding the stability of the pit walls. No artefacts were recovered from the bottom five spits of this pit.

Sixteen (16) artefacts were recovered from four of the six pits excavated at MRSA1. Most artefacts were recovered from Spits 1 (N=6) and Spit 2 (N=5), one artefact was recovered from each of Spits 4, 6 and 7, and two artefacts were recovered from Spit 5. Where artefacts were present, artefact numbers per pit varied from two at Pit 3 through to seven at Pit 2. No artefacts were recovered from Pits 1 or 6.

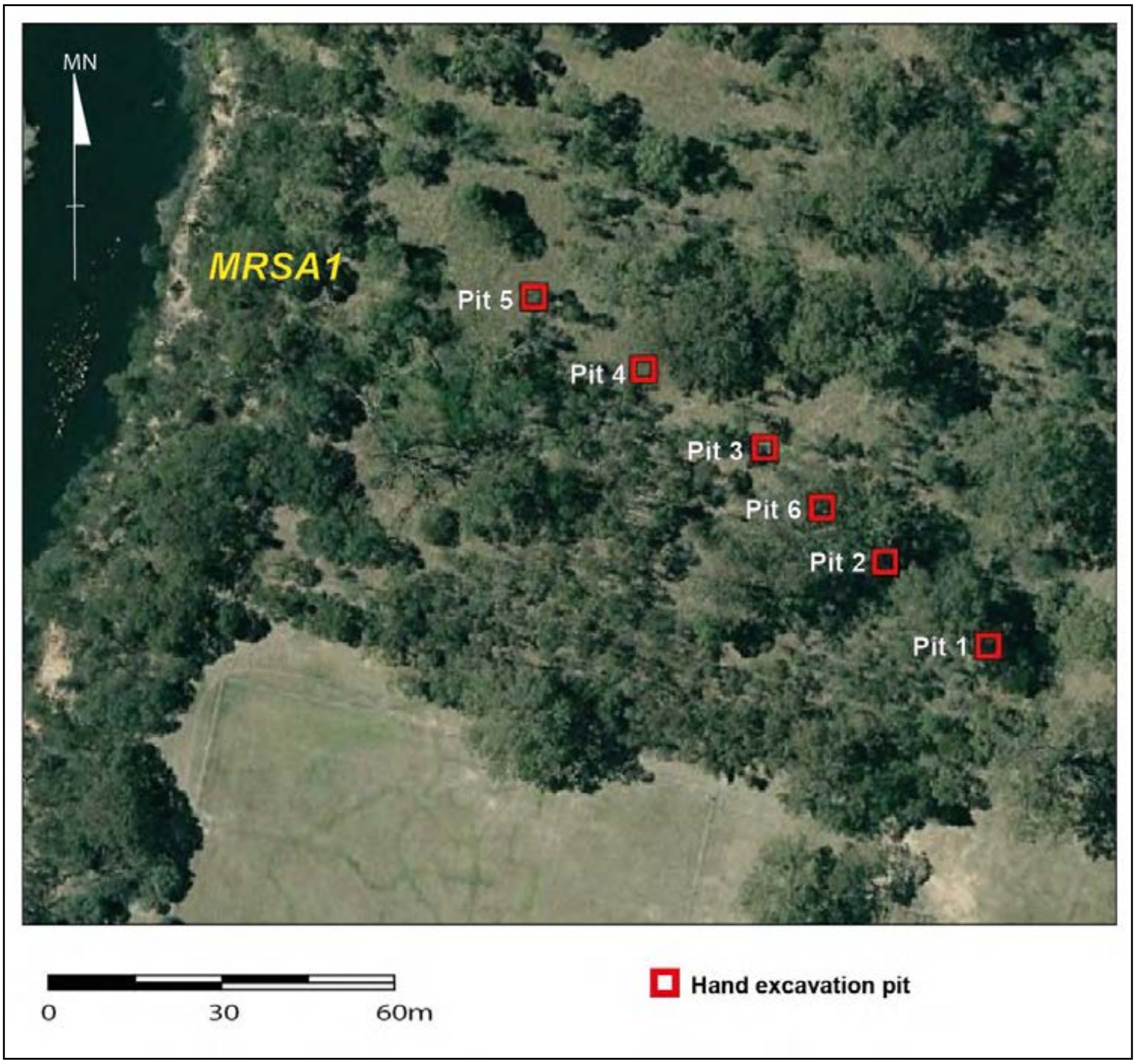

Figure 10.5 Location of test pits at MRSA1 (Google Earth Pro 2012).

10.2.6 Moorebank Representative Sample Area 2

No test pits were excavated at Moorebank Representative Sample Area 2. During inspection of the area for the presence of underground services and potential pit locations, a number of aggressive snakes were encountered within the proposed transect. Discussions were held with the RAPs and advice was sought from an ecologist at Parsons Brinckerhoff (refer to Section 3.6).

As a result of these discussions it was decided that the risks to, and potential impacts on safety and the environment were too high to warrant excavation at this time. In order to compensate for the lack of access to this area and to help inform management decisions regarding MRSA2, the full number of contingency pits were excavated within the southern portion (least disturbed area) of MA5:

10.2.7 Moorebank Representative Sample Area 3

Seven mechanical excavation test pits were excavated at MRSA 3 (Figure 10.6). The pits were placed at 25 m intervals along a north-south transect. The area was characterised by very shallow sandy deposits overlying a stiff yellow-brown clay.

Pit depths varied between 7 cm (Pit 7) and 28 cm (Pit 5).

No artefacts were recovered from this test location.

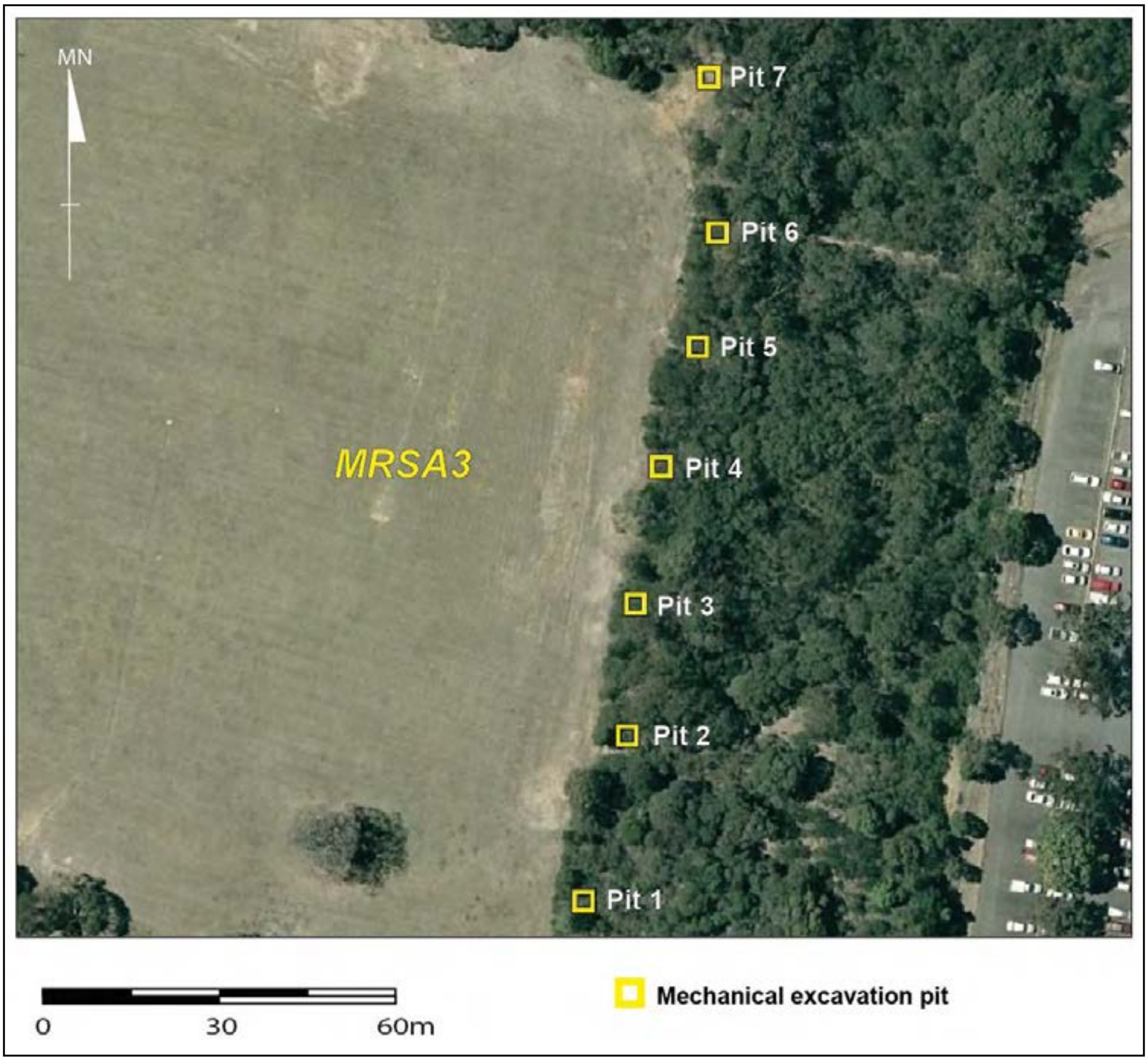

Figure 10.6 Location of test pits at MRSA3 (Google Earth Pro 2012).

10.3 Summary of stratigraphy

Detailed geomorphological analysis was undertaken at select pits at MA5, MAPAD1 and PAD2 (see Appendix 7)

The following is a summary of the stratigraphy inspected across representative pits at PAD2, MA5 and MAPAD1. All test pits examined were between 50cm and 100cm deep, sections were cleaned before being described.

Observation conditions were excellent, with light sun or slightly overcast conditions. Soils were damp to slightly damp when freshly cleaned. One artefact – a broken red silcrete flake – was located during section description at 28cm depth in the SW end of the east-facing (west) section of Test Pit 7 at MA5.

Evidence of disturbance from European land use activities was primarily restricted to Spits 1-3, the only exception to this was at MAPAD1 where European artefacts were recovered down to Spit 11 at Pit 3 and Spit 5 at pit 4

Table 10.1 Summary of Test Pits examined in detail.

Test Pit	GPS log	Depth	Deposit sequence	Interpretation and Significance
PAD 2 Pit 9	0307574E 6239944N	0-100cm	Made ground (15-20cm) over *in situ* undisturbed bleached sands A2 (E) horizons and Bhs “coffee rock” and concretionary gravels. Shale saprolite expected below test depth. Check geotechnical data for bedrock depths.	*In situ* sequence below 20cm may contain archaeology (e.g. to 50cm). Soils reflect and inform regarding past hydrological conditions and drainage – prehistoric lower slope wetland margin predicted. Limited variation/correlations between TPs suggest areal stripping of fill to reveal area suitable for salvage excavation would be possible if warranted by artefacts found during testing.
PAD 2 Pit 10	0307596E 6239930N	0-100cm	Made ground (20cm) over in situ undisturbed A2 (E) and Bh and Bhs + concretionary gravels.	*In situ* sequence below 20cm may contain archaeology (e.g. to 50cm). Soils reflect and inform narratives of past hydrological conditions and drainage – prehistoric lower slope wetland margin predicted as at Pit 9. Salvage excavation would be possible if warranted by artefacts found during testing.

Test Pit	GPS log	Depth	Deposit sequence	Interpretation and Significance
MAPAD 1 Pit 4	0308079E 6242441N	0-100cm	Weak horizons in deep sand sequence – likely Holocene alluvium and with possible aeolian inputs. Bedrock not expected close to BOS.	Well preserved (recent) bioturbation features – probably historic over deep sands – absence of pedogenesis suggests much of sequence may be late Holocene and/or reworked/flood plain. Archaeology possible to base of sequence. Indications of recent European activation/colluviation in upper 30/35cm. Settler and late prehistoric land use narrative probably archived in sequence.
MAPAD 1 Pit 3	0308090E 6242461N	0-100cm	0-32cm dump fill over clean contact onto well preserved deep A1/A2 sands and weakly illuvial B horizons at base	Holocene alluvium expected – possibly very recent - associated with flooding. Wetland marginal environments and sediments contributing from upslope (tillage/colluvium). Settler and late prehistoric land use narrative probably archived in sequence.
MA5 Pit 6	0307394E 6241093N	0-100cm	0-10cm compacted fill over shallow sharp truncation over preserved A1 and shallow A2 sands. Bedrock expected close to BOS.	Pedogenically mature horizons relatively intact and sufficiently deep to be worth salvaging if high density artefacts located. Overlooking floodplain – high archaeological significance possible where truncation by earthmoving minimized.
MA5 Pit 7	0307390E 6241082N	0-100cm	0-15/22cm locally truncated – but relatively undisturbed conformable sands, over incipient B horizons at base of section.	Moderate to well developed soil horizons consistent with valley margin situation over shale saprolite. Area has high potential for salvage – despite localized truncation. Position of artefacts likely to be dispersed within Unit II as bioturbation/mixing within unit has been high.
MA5 Pit 10	0307402E 6241131N	0-100cm	Thin fill over very sharp truncated surface of E horizon / A2 profile. Unmixed subsoil profile through most of section.	Much upper sequence including horizons likely to contain archaeology missing. Thin sequence reflects leveling of landform on valley edge.

10.4 Summary of artefacts

10.4.1 Artefact frequency

Two hundred and sixty-four (264) artefacts were recovered during the subsurface testing program at Moorebank (Tables 10.2 and 10.3). The majority of artefacts (90.90%) were recovered from MAPAD1 (N=130) and MA5 (N=110). Eight artefacts were recovered from MA1 and sixteen were recovered from MRSA1. No artefacts were recovered from MRSA3 or PAD2.

Twenty six (26) of the 59 test pits were found to contain artefacts. Artefact frequency per pit was the highest at MA5, where Pit 7 contained 62 artefacts (124 artefacts/m^2). The next highest frequencies of artefacts were at MAPAD1 Pits 2 and 4, which contained 24 and 27 artefacts respectively. Most pits that contained artefacts displayed a frequency of less than five artefacts per pit.

The average areal incidence of artefacts per square metre, where artefacts were present, ranged from 4/m^2 at MA1 to 27.5/m^2 at MA5. The overall average incidence of artefacts at Moorebank was 20.31/m^2.

The majority of artefacts (N=245) were recovered from Spits 1-5, i.e. within the upper 50 cm of intact deposits. Artefact frequency tended to peak in Spits 2 and 3 with numbers decreasing significantly beyond Spit 4.

10.4.2 Artefact materials and types

Ten distinct artefact categories were identified within the Moorebank test excavation assemblage (Table 10.3). The dominant assemblage elements were flakes (N=183 – including retouched [N=13] and utilised flakes [N=7]) and flaked pieces (N=55). Cores were the next most common artefact type (N=12), followed by backed artefacts (N=6).

In terms of raw materials (Table 10.4), the assemblage was dominated by silcrete (N=135), followed by quartz (N=46), quartzite (N=40) and basalt (N=10); smaller amounts of siltstone, fine grained silicious (FGS), indurated mudstone, dolerite, tuff, fine grained igneous, limestone and chert were also present. One porcelain flake with possible usewear was also identified at MAPAD1.

Table 10.2 Count of artefacts per Site, Pit and Spit.

Provenance	Number of Artefacts
MA1	**8**
Pit 1	**1**
Spit 1	1
Spit 4	1
Pit 2	**2**
2	2
Pit 3	**3**
4	1
5	2
Pit 4	**1**
2	1
MA5	**110**
Pit 2	**2**
5	2
Pit 4	**2**
1	1
2	1
Pit 5	**12**
1	1
2	8
3	3
Pit 6	**9**
1	2
2	3
3	1
4	3
Pit 7	**62**
1	1
2	7
3	40
4	12
5	2
Pit 8	**18**
1	6
2	3
3	4
4	3
7	1
SPOIL	1
Pit 9	**3**
1	1
2	1
3	1
Pit 11	**2**
2	1
3	1
MRSA1	**16**
Pit 2	**7**
1	3
2	4
Pit 3	**2**
1	2
Pit 4	**4**
2	1
4	1
5	2
Pit 5	**3**
1	1
6	1
7	1

Provenance	Number of Artefacts
MAPAD1	**130**
Pit 1	**1**
8	1
Pit 2	**24**
2	13
3	11
Pit 3	**15**
2	3
3	2
4	3
6	1
8	2
9	1
10	1
11	2
Pit 4	**27**
1	1
2	6
3	5
4	5
5	5
6	1
7	1
8	2
9	1
Pit 5	**14**
1	2
2	8
4	2
5	1
Auger	1
Pit 6	**4**
2	3
6	1
Pit 7	**14**
1	7
2	5
3	2
Pit 8	**8**
1	1
2	1
3	5
5	1
Pit 9	**16**
1	5
2	2
3	9
Pit 9A	**7**
1	2
2	5

Table 10.3 Counts of artefact types

Site	Backed Artefact	Core	Flake	Flaked Piece	Fragment	Hammerstone	Hammerstone Fragment	Retouched flake	Utilised Core	Utilised flake	Total
MA1			6	1						1	*8*
MA5	5		74	17	2	1		8		3	*110*
MAPAD1		11	72	35		2	2	4	1	3	*130*
MRSA1	1	1	11	2				1			*16*
Total	*6*	*12*	*163*	*55*	*2*	*3*	*2*	*13*	*1*	*7*	*264*

Table 10.4 Counts of material types

Site	Basalt	Chert	Dolerite	FGI 1	FGS	Ind' Mudstone	Limestone	Porcelain	Quartz	Quartzite	Silcrete	Siltstone	Tuff
MA1									1		1	6	
MA5		1	2	1	2	3	2		7	16	75		1
MAPAD1	10	1	2	2	4	2		1	35	23	47		3
MRSA1									3	1	12		
Total	*10*	*2*	*4*	*3*	*6*	*5*	*2*	*1*	*46*	*40*	*135*	*6*	*4*

Figure 10.7 Example of different materials represented at MA5, Pit 5, Spit 2 (Left to right: silcrete, tuff, silcrete and quartz)

Silcrete and quartz were represented at all four sites, however quartzite only occurred at MA5, MAPAD1 and MRSA1. Siltstone and basalt were only evidenced at MA1 and MAPAD1 respectively. The other material types were only evidenced at MA5 and MAPAD1 (Figure 10.7).

Unsurprisingly, the more common material groups (silcrete, quartz, quartzite and basalt) displayed the greatest diversity of artefact types (Table 10.5).

Silcrete was the only material within the assemblage that had been used for production of backed artefacts (Figure 10.8).

Table 10.5 Breakdown of assemblage by material and artefact type.

Raw Material	Backed Artefact	Core	Flake	Flake Piece	Fragment	Hammerstone	Hammerstone Fragment	Retouched flake	Utilised Core	Utilised flake
Basalt		1	4	2			2	1		
Chert			1						1	
Dolerite			2	1		1				
FGI 1			2			1				
FGS			2	2				1		1
Ind' Mudstone			2	1				1		1
Limestone					2					
Porcelain										1
Quartz		2	25	16		1		2		
Quartzite		2	25	10				2		1
Silcrete	6	7	92	21				6		2
Siltstone			5	1						1
Tuff			3	1						
Total	*6*	*12*	*163*	*55*	*2*	*3*	*2*	*13*	*1*	*7*

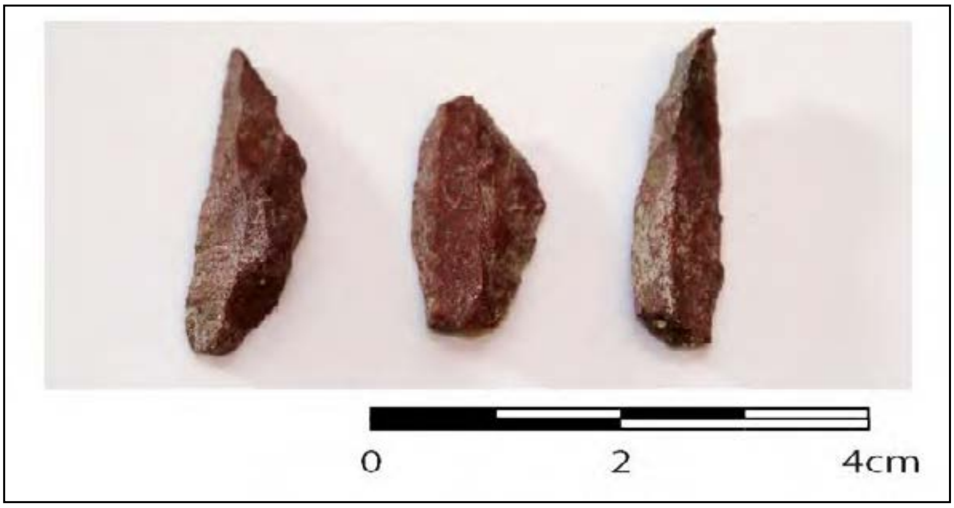

Figure 10.8 Backed silcrete artefacts from MA5 Pit 7 Spit 3

A greater variety of material types were employed for retouched and utilised flakes. Similarly, cores were made from four different material types.

The cores were generally characterised by multiple rotations with varying degrees of reduction. The smallest and most heavily reduced cores were generally on silcrete, many of which displayed varying amounts of pebble cortex. It is unknown whether the silcrete in the assemblage has been sourced locally, however the quantity of silcrete present and the presence of pebble cortex may be indicative of exploitation of silcrete gravel beds along the Georges River.

Bipolar reduction was only evidenced on six artefacts (1 at MA5 and 5 at MAPAD1), it was most commonly applied to quartz, but was also evidenced on FGS and Chert.

Quartz, dolerite, FGI and basalt (Figure 10.9) were all used as hammerstones.

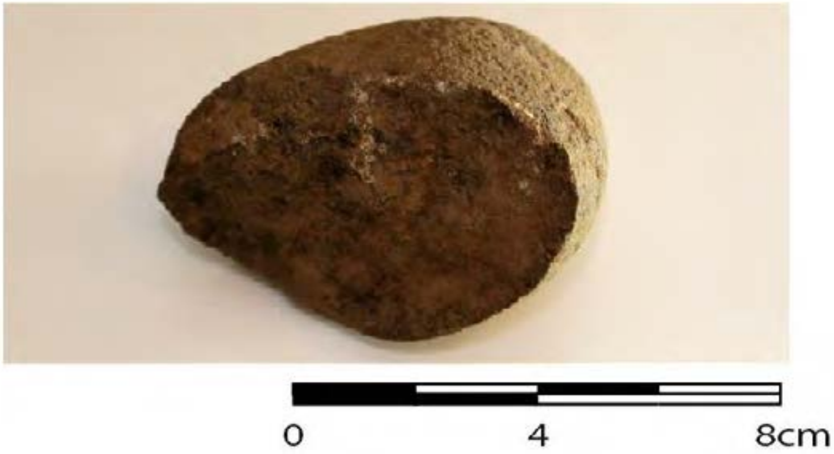

Figure 10.9 Hammerstone from MA5 Pit 8

10.4.3 Retouched and utilised flakes

Backed artefacts and retouched and utilised flakes were primarily evidenced at MA5 and MAPAD1, one backed artefact and retouched flake were also recovered from MRSA1. Examples of retouch and usewear are provided in Figures 10.10-10.12.

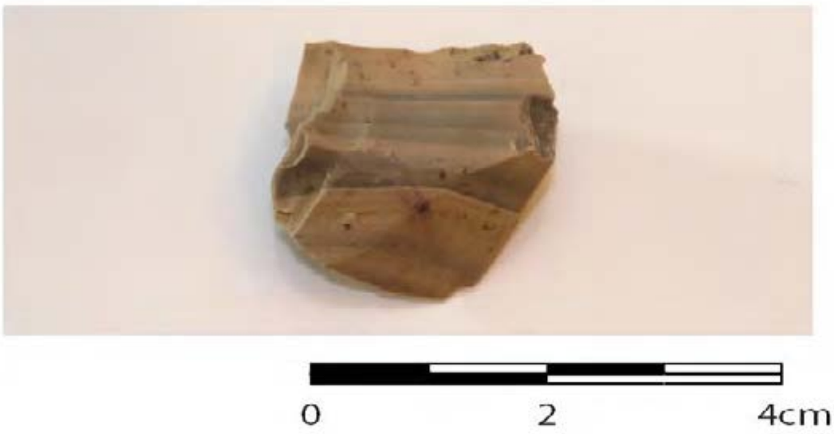

Figure 10.10 Retouched flake from MA5 Pit 9 Spit 3.

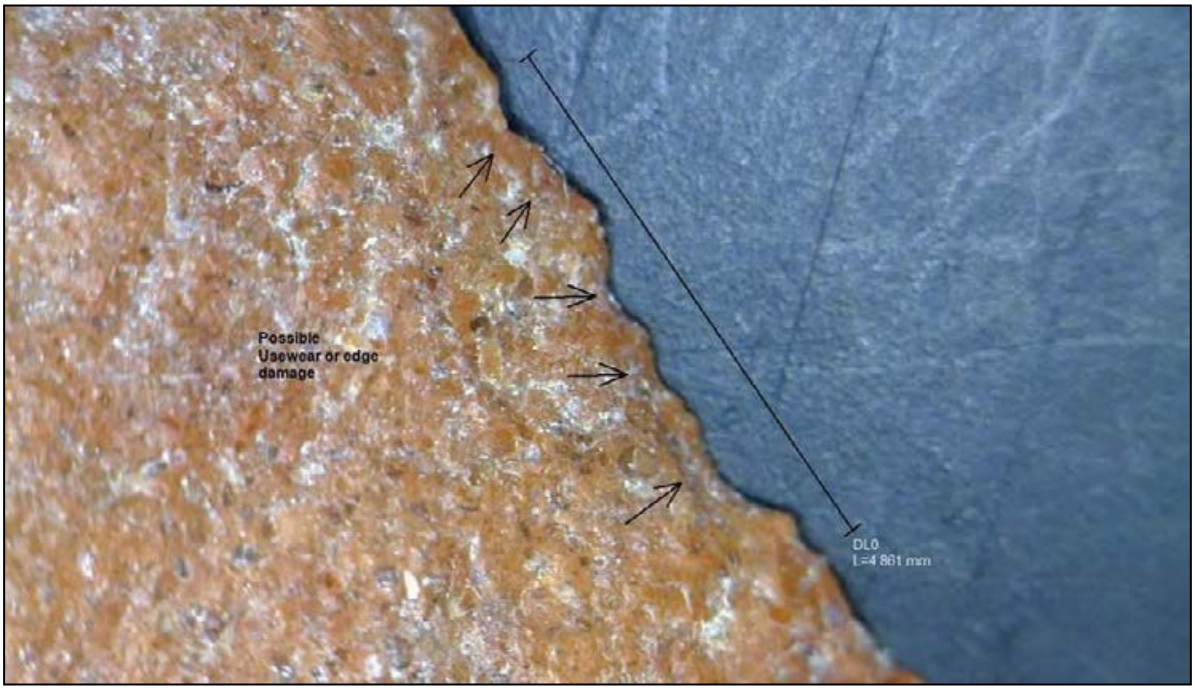

Figure 10.11 Usewear evidenced on a backed artefact at MA5 Pit 7 Spit 3.

Figure 10.12 Evidence of usewear on a flake from MAPAD1 Pit 9 Spit 3.

10.5 Liverpool City Council Northern Powerhouse land

A program of archaeological subsurface testing was undertaken at site MAPAD2 in the LCC Northern Powerhouse land in 2013. The subsurface testing program was undertaken following the methodology and research design that was used in the subsurface testing program for the rest of the Project.

A summary of the results is included below, (see the addendum report (NOHC 2014a) for full results):

- Forty-five (45 – refer to Figure 10.13) test pits were excavated across MAPAD2 comprising 37 by-hand test pits and eight (8) mechanical pits;
- Detailed geomorphological analysis was undertaken at Pits 28, 29, 30, 31, 36, 41 and 42;
- Three additional pits were excavated for the purposes of geomorphological investigation within a portion of MAPAD2 that had proved to be archaeologically sterile in the upper 120 cm;
- Deposits excavated across MAPAD2 comprised three groups:
  - poorly sorted clayey gravels that have been introduced in some areas, most notably across the southern and northern extremities of the test area, as fill (Unit 3);
  - well sorted light grey or light brown clean sands with well-preserved bedding structures and minimal soil development (Unit 2); and
  - dark grey-brown silty sands with abundant charcoal (Unit 1).
- 14 artefacts were recovered from 9 pits (Pits 1, 5, 9, 10, 12, 13, 14, 34 and 42 – refer to Figure 10.14);
- The majority of artefacts were recovered from the southern portion of MAPAD2 (N=13) and the 125 m long section from Pit 9 to Pit 14 (including Pit 42) was the area where artefacts were most consistently recovered (artefacts recovered from 6 out of 10 test pits excavated across this portion of MAPAD2);
- The highest artefact incidence was at Pits 1 and 5, where three artefacts were recovered from each pit;
- The average artefact incidence was 3.11 artefacts per square metre;
- The majority of artefacts (N=10) were recovered from spits 1-7, i.e. within the upper 70 cm of deposits, usually in association with the Unit 3 fill or Unit 2 sands;
- The artefact assemblage from MAPAD2 comprised four complete flakes, seven incomplete flakes, two flaked pieces and one broken core; and
- The assemblage was dominated by silcrete (N=8), followed by fine grained siliceous material (N=5), and quartz (N=1).

Site Designations

Artefacts were recovered from the following test pit locations at MAPAD2:

- Pits 1, 5, 9, 10, 12, 13, 14, 34 and 42.

However, the deposits from which these artefacts were recovered appear, on the basis of geomorphological analysis, to be the result of recent deposition (Unit 2 - post 1836) and/or mechanical reworking of deposits (Unit 3).

On the balance of evidence it would appear that there are three sites present within the area defined as MAPAD2 (Figure 10.15). These sites comprise:

- MA 11: artefacts associated with the Unit 3 fill that has been reworked and deposited as the result of mechanical earth works at the southern end of MAPAD2 (Pits 1 and 5);
- MA12: artefacts associated with Unit 2 fluvial sands across the central southern portion of MAPAD2 (Pits 9, 10, 12, 13, 14 and 42); and
- MA13: a single artefact associated with the Unit 1 silts at the northern end of the test area (Pit 34, Spit 9).

Given that it was not possible, to fully test the nature of the Unit 1 deposits, due to their depth (i.e. over 1.2 m deep and beyond the safe work depth), within the scope of the existing test excavation methodology, the area of archaeological potential identified as MAPAD2 remains

Figure 10.13 Location of test pits at MAPAD2
(Base image: NSW LPI 2013)

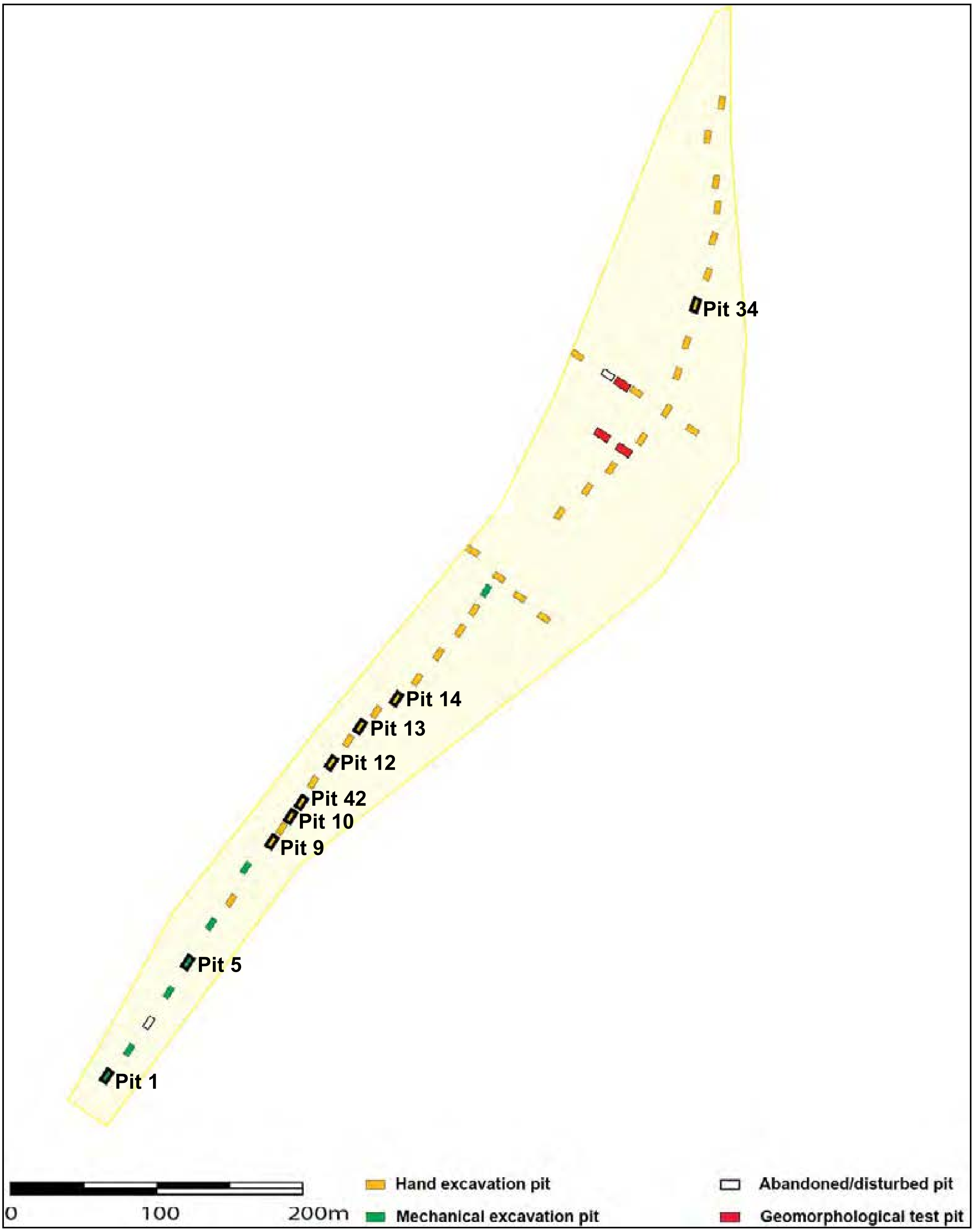

Figure 10.14 Overview of the location of test pits containing artefacts.

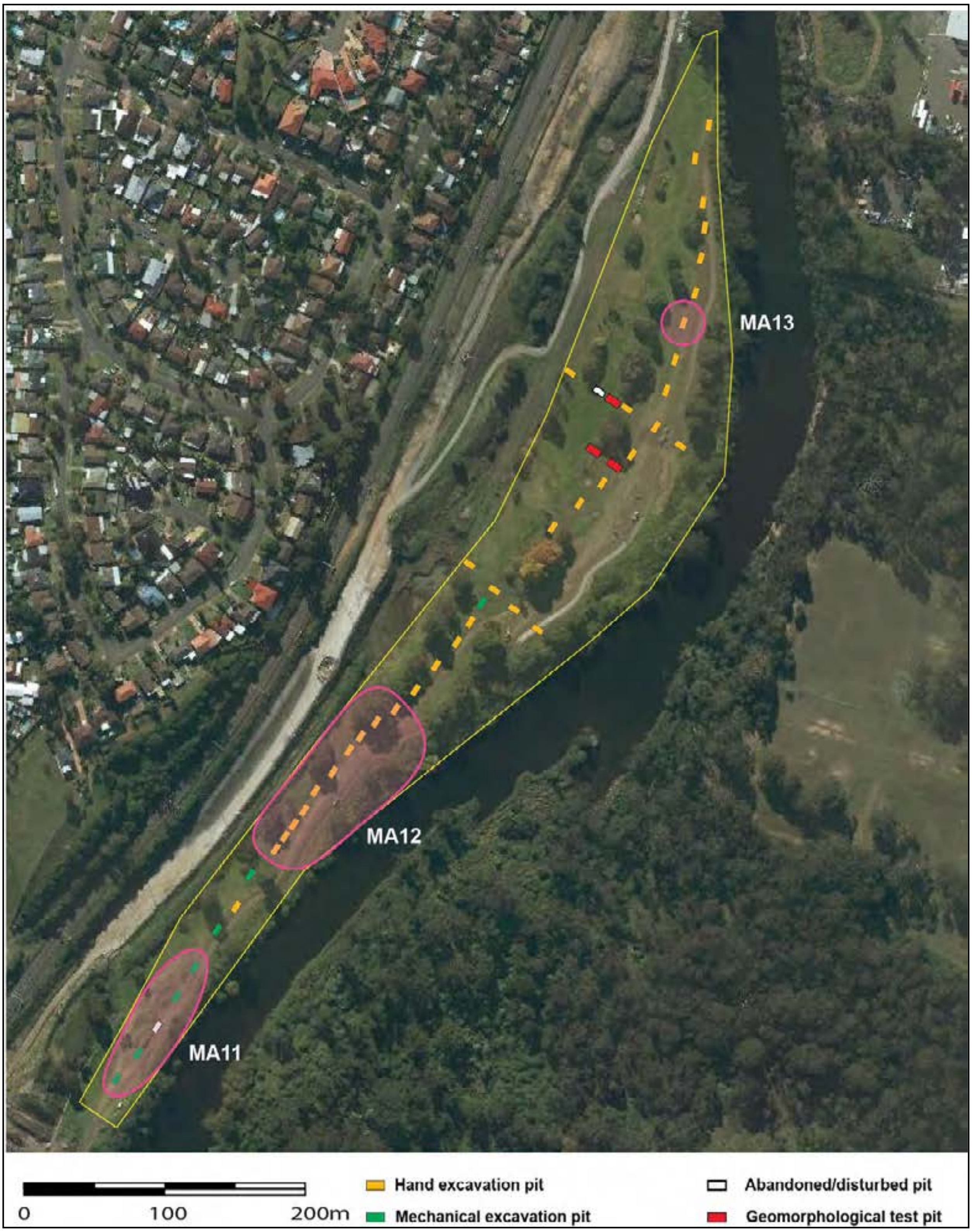

Figure 10.15 Extent of sites defined as a result of the subsurface testing program at MAPAD2.

11. EXCAVATION ANALYSIS

This section provides an overview of the excavation analysis for the subsurface testing program within the Moorebank IMT study area. For further details relating to the lithics and geomorphological analysis the reader is referred to Appendices 3 and 4.

11.1 General properties of the deposits across the study area

The observed soil profiles investigated are consistent with the geological mapping for the area, namely as Tertiary alluvial terrace landscapes.

Relatively deep sandy soils occur over most of the area. The soils show pedogenic properties and horizon development in patterns consistent with elevation and the geomorphological surfaces and landforms on which they occur. Bleached horizons are common in the soils across the area – equivalent to an A2 horizon or E horizon definition (Butt et al. 2005). The bleached horizons overlie less permeable clayey subsoils or incipient pans. Shale saprock is suspected below levels excavated in test pits at some locations (Test Pit 7 and 10 in MA5). The soils are all variants of podzols with variable albic bleaching and coarsening in A2 or E horizons.

Locally bleached horizons are underlain by well developed "coffee rock" iron-humate cemented structures in some test pits (PAD 2 Pits 9 and 10). It would be unwise to assume these soil formation horizons are age-indicative as complex relationships (spanning late Holocene to Quaternary or older timescales) have been proven in shallow (1.0-1.5m deep) Podzol sequences within visually simple E and Bhs horizons (Field and Humphreys 2002).

All test pits showed evidence of recent disturbance in the upper parts of the profiles observed. The study area has sustained substantial modifications by spreading of fill across the surface and modifications of slope (grading). This has been noted in previous evaluations and geotechnical investigations in the area (AHMS 2012; Steele and Dallas 2001). Stratigraphy in the test pits confirms combinations of:

- truncation and removal of upper soil units – especially A0 and A1 sand profiles.
- additions and spreading of subsoils across the area onto a) truncated profiles and b) by plastering onto locally intact soil profiles. The added fill units vary from shaley clayey subsoils to clastic sandstone gravels and very poorly sorted (diamictic) dumps. Some fills are clean. Others are full of age-diagnostic debris and refuse. Depths of fill are typically 10cm-30cm.
- deliberate infilling by dumping around margins of wetter depressions and former channels
- use of machines to cut and truncate soils profiles and also to compress and overconsolidate sediments as made-ground.

The heritage implications of the observed disturbance are a) soil horizons likely to contain archaeology are locally removed and reworked b) *in situ* archaeology and associated undisturbed soils exist in undisturbed A1 horizons and also in near surface situations where fill has been plastered over landsurfaces c) surface observations of artefacts will be minimal (underestimate true archaeological distributions) due to fill cover and d) surface occurrences of artefacts may be unreliable as spatial and quantitative indicators of where archaeological materials occur preserved across the landscape.

The extent of fill makes subsurface archaeological preservation very difficult to predict. Some significant palaeotopography (e.g. small dunes, channels, soaklines and ponds) may be removed or buried.

Conversely, most fill is very easily identified in section or in plan. Normally the contact of fill onto underlying *in situ* soils is sharp, obvious and well preserved. The unmixed nature of many of these sharp truncated interfaces indicates their relatively recent age. If archaeological salvage excavation is justified – quick removal of overburden fill, by machine, down to levels at which salvage excavation can commence will be a practicable quick option.

These observations indicate:

- testing subsurface is the only viable method of detecting *in situ* archaeological materials across much of the area.
- the remaining soil horizons provide good indications of where former intact historic and prehistoric surfaces remain, and also indicate where most topsoils are removed (i.e. the completeness of the sequence can be read).

In area MA5 the pits showed progressive deeper truncation of the former soil sequence northwards. This is consistent with levelling and may indicate removal of former topography e.g. as source bordering sand bodies along the terrace margin. The three test pits suggested the most preserved sequence lies in the south of the test pit transect.

Bedrock was not observed. However, clayey subsoils and locally shaley clasts within subsoils were observed, consistent with Ashfield Shale geology at depth. In PAD 2 and MA5 shale saprolite is expected less than 1.0 m below observed base of sections (BOS). Geotechnical data would usefully be investigated to test these predictions.

The stratigraphic sections seen during field excavation and recording show that soils and deposit sequence preservation across the areas of investigation is patchy, highly variable and difficult to predict. Present and previous land use, development and ongoing geomorphic processes such as minor sheet-flooding, rilling, revegetation together with rejuvenated soil development are transforming remnants of older soil profiles and deposits. These processes are capable of being either locally destructive or protective of preserved heritage values.

Evidence of disturbance, made ground, soil profile truncation, sediment translocation and dumping was ubiquitous. However, there is also evidence of *in situ* weathered A1, A2 (E) and B horizons close to surface, and locally evidence of very well preserved soil structures (especially hydromorphic features) which must relate to ground conditions from earlier (pre 20th century) of historic or prehistoric age close to surface.

11.2 Site designations

No artefacts were recovered from test excavations at PAD2 and MRSA3. On the basis of this result, neither of these areas are considered to be archaeological sites.

Artefacts were recovered from test excavations at MAPAD1 and MRSA1. These areas of archaeological potential have now been confirmed as archaeological deposits and the following site designations apply:

- MA9 - the margins of the lake at MAPAD1; and
- MA10 – transect extending from the eastern bank of Georges River – formerly identified as MRSA1.

11.3 Interrelatedness of sites and landscape integrity

Based on the archaeological results, the Georges River corridor, the unnamed lake adjacent to MAPAD1/MA9, and the associated up-slope terrace edge appear to have been the primary focus of past Aboriginal occupation within the Project area. The edge of the terrace provided an elevated, flat and well drained area for camping and other activities, related to the riparian environment. Prior to European landuse impact, this pattern of Aboriginal occupation would have resulted in a relatively continuous low to moderate density distribution of artefacts, together with discrete areas of higher density. This is a typical pattern for a landform which has been repeatedly used over a long period of time. The current pattern of artefact incidence across the terrace edge has been further complicated and depleted by European landuse impact.

Aboriginal occupation along the tertiary terrace bordering the eastern side of the Georges River appears to have been variable. It is not entirely clear whether the variation in assemblage richness across MA1, MA5, MA9 and MA10 relates to differing levels of site integrity, or whether other local geographic and micro-topographic variations are responsible.

Site MA5 may be an example of an intact deposit that reflects sporadic activity through time, inclusive of acts such as stone knapping that produce localised spikes in artefact distribution.

It appears that site MA9 is a genuine activity node that reflects activity adjacent the lake/pond (i.e. repeated focus of activity through time). Subsequent disturbance has not impacted this site to the extent of the impact to the tertiary terrace.

That portion of the terrace situated away from the Georges River and lake basins does not appear to have been a focus of activities (such as camping or tool maintenance) that would have resulted in the discard of significant amounts of archaeological material. The absence of archaeological evidence at PAD2 and MRSA3 supports this conclusion as does the isolated nature of the finds within this landscape, such as MA2. Aboriginal use of these areas appears to have primarily been for movement through country and activities such as resource procurement, which result in very ephemeral or low level archaeological signatures.

Following European settlement most of the Project area was cleared of native vegetation for agriculture. Defence related impacts from the turn of the twentieth century further disturbed the land, but also allowed regeneration of native and introduced vegetation species along the river corridor and steeper slopes. As a consequence, the Georges River corridor is now characterised by discontinuous regenerating forest and associated understoreys, inclusive of both native and introduced species. The overall visual impression is evocative of a former pre-European landscape and is thus a valuable element in the interpretation and appreciation of the associated Aboriginal archaeological resource of the corridor. The proposed inclusion of a vegetation buffer or conservation zone within the river corridor and across some of the terrace slopes provides an opportunity for the conservation of landforms contiguous with sites MA5, MA9 and MA10. Such an inclusion would support the integrity of the corridor as a cultural landscape and heritage resource.

Apart from some minor drainage works and use of areas of existing large scale ground disturbance, the IMT proposal will not impact the eastern river bank or its lower flats. Consequenty these landforms have not been a priority for the assessment program within the Commonwealth lands.

The eastern bank of the river has been investigated during the 2013 Northern Powerhouse testing program of MAPAD2. Stratigraphic profiles observed in the test pits are broadly consistent with the geological mapping for the area, namely showing components of a very recent (Holocene) floodplain alluvial landscape. The test pits show a very high degree of well-preserved bedding structure. This was not expected, and is interpreted as reflecting very recent active sand mobilization and re-deposition associated with 19th and 20th century flood events.

11.4 Responses to research questions

11.4.1 Investigations east of the Georges River

Table 11.1 provides an overview of responses to the research questions that were developed for the Moorebank subsurface testing program. A more detailed analysis of the excavation results is provided in the geomorphology and lithics reports in Appendices 3 and 4.

Table 11.1 Response to research questions

Research question	Response
What do the test results indicate about the past Aboriginal occupation of the Project area and the Sydney region?	Where intact deposits occur, Aboriginal occupation appears to be focussed upon the tertiary terrace edge. The upper catchment of Anzac Creek (PAD2) does not appear to have been a focus of Aboriginal occupation. The broader implication is that the river-side margins of elevated flats, in close proximity to higher order drainage (e.g. Georges River) were favoured locations for repeated and/or longer term encampments. The confluence of resources at MA9 (freshwater lake within a Tertiary terrace bordering Georges River) appear to have been a target of Aboriginal activity. Excavation results from this site indicate a relatively continuous, moderate to high density distribution of artefacts with a diverse range of artefact and material types present. Aboriginal occupation along the Tertiary terrace bordering the eastern side of the Georges River appears to have been variable. It is not entirely clear whether the variation in assemblage richness across MA1, MA5, MA9 and MA10 relates to differing levels of site integrity, or whether other local geographic and microtopographic variations are responsible.
How do the test results compare with other local and regional archaeological results and models?	The survey and test results are broadly in keeping with the local and regional predictive models. The site types recorded included scarred trees, isolated finds, artefact scatters and potential archaeological deposits, as per the predictive model. While surface occurrences of artefacts were recorded during survey, the excavation results have shown that subsurface archaeological deposits are more widely distributed than what surface evidence would suggest. This is exactly as predicted by the local site model. The most extensive and diverse archaeological deposits were encountered within well drained aggrading landforms, in a valley floor context, in association with permanent water sources. Again, this follows local and regional models.

Research question	Response
Does the subsurface archaeological resource accurately reflect the predictions on which the sensitive landform mapping is based?	In general terms the subsurface test results were in keeping with the predicted sensitive landform mapping: archaeological sensitivity was greatest within the tertiary terrace bordering the river corridor. Landforms further removed from the river corridor were found to be of low archaeological sensitivity. See Figure 10.1 for the location of areas of predicted sensitivity following the testing program. At this stage access constraints, including issues relating to workplace health and safety, have inhibited effective testing within relatively undisturbed sections of the river corridor that will be potentially impacted by the Moorebank IMT. The only test area where results were markedly different to what was predicted was PAD2. The absence of any artefactual material across the 21 test pits excavated in this area suggests that the margins of this minor tributary were not the target of Aboriginal activity. Instead Aboriginal occupation appears to have been focused further to the west, within landforms closer to the Georges River.
Based on the test excavation results, how can the local predictive model be refined or corrected?	Minor tributaries appear more likely to have been a focus of Aboriginal activity if they are associated with other resource zones, e.g the Georges River Riparian Corridor. A broader and more detailed analysis of site variation within Tertiary terraces bordering the Georges River is necessary in order to clarify whether the variation in assemblage size and richness observed during the current test excavation program relates to Aboriginal activity or post depositional site disturbance. Analysis at this level would require open area excavation. As such, it is outside the scope of the current heritage assessment process; it would form a component of mitigation works undertaken prior to construction.

11.4.2 Investigations west of the Georges River

Table 11.2 provides an overview of responses to the research questions that were developed for the Moorebank subsurface testing program as they apply to the Northern Powerhouse land. A more detailed analysis of the excavation results is provided in the addendum report (NOHC 2014a)

Table 11.2 Response to research questions

Research question	Response
What do the test results indicate about the past Aboriginal occupation of the Project area and the Sydney region?	The lower lying landforms adjacent the Georges River, such as the floodplain area tested at MAPAD2 may not have been a focus of Aboriginal occupation. The results of the test excavation program did not reveal any evidence of areas of high use or focused activity. However, given that the extent of fluvial deposition of sands inhibited the opportunity to test the lower floodplain deposits, the extent of archaeological material within and below the 1836 floodplain is still largely unknown. Additional testing is required in order to establish the geomorphic and archaeological nature of the Unit 1 deposits at MAPAD2.
How do the test results compare with other local and regional archaeological results and models?	As was the case with the results of the test excavations conducted in 2012 (NOHC 2013), the current excavation results have demonstrated that an absence of surface artefacts is not necessarily indicative of an absence of artefacts in a subsurface context, which is in keeping with what is predicted by the local site model. However, as stated above, the test excavation program was unable to satisfactorily test the nature of the Unit 1 (pre-European floodplain) deposits across the study area. Additional testing is required in order to establish the geomorphic and archaeological nature of the Unit 1 deposits at MAPAD2.
Does the subsurface archaeological resource accurately reflect the predictions on which the sensitive landform mapping is based?	The subsurface test results have revealed a lower than predicted incidence of Aboriginal artefacts within the Georges River Riparian Corridor. However, this can be explained by the fact that the testing program was only able to adequately test deposits that appear to be less than 200 years old. The question of whether or not substantial archaeological material exists at depth (>1.2-1.5 m) within the MAPAD2 area is still unknown. Additional testing is required in order to establish the geomorphic and archaeological nature of the Unit 1 deposits at MAPAD2.

Research question	Response
Based on the test excavation results, how can the local predictive model be refined or corrected?	Sandy deposits at or below 10 m AHD within the Casula-Moorebank section of the Georges River Riparian Corridor are likely to be the result of sedimentation processes that post-date the Liverpool Weir (1836), as such the archaeological potential of these deposits is limited. Given that the current test excavation methodology did not enable sufficient testing of the Unit 1 deposits (inferred pre-European floodplain surface) below the sandy Unit 2 deposits, the test excavation results have not been able to indicate any refinements or changes to the predictive model with regard to the nature of Aboriginal use of the Georges River Riparian Corridor. However they have refined our understanding of the depth at which potential archaeological deposits relating to Aboriginal use of the river corridor may occur. Additional testing is required in order to establish the geomorphic and archaeological nature of the Unit 1 deposits at MAPAD2.

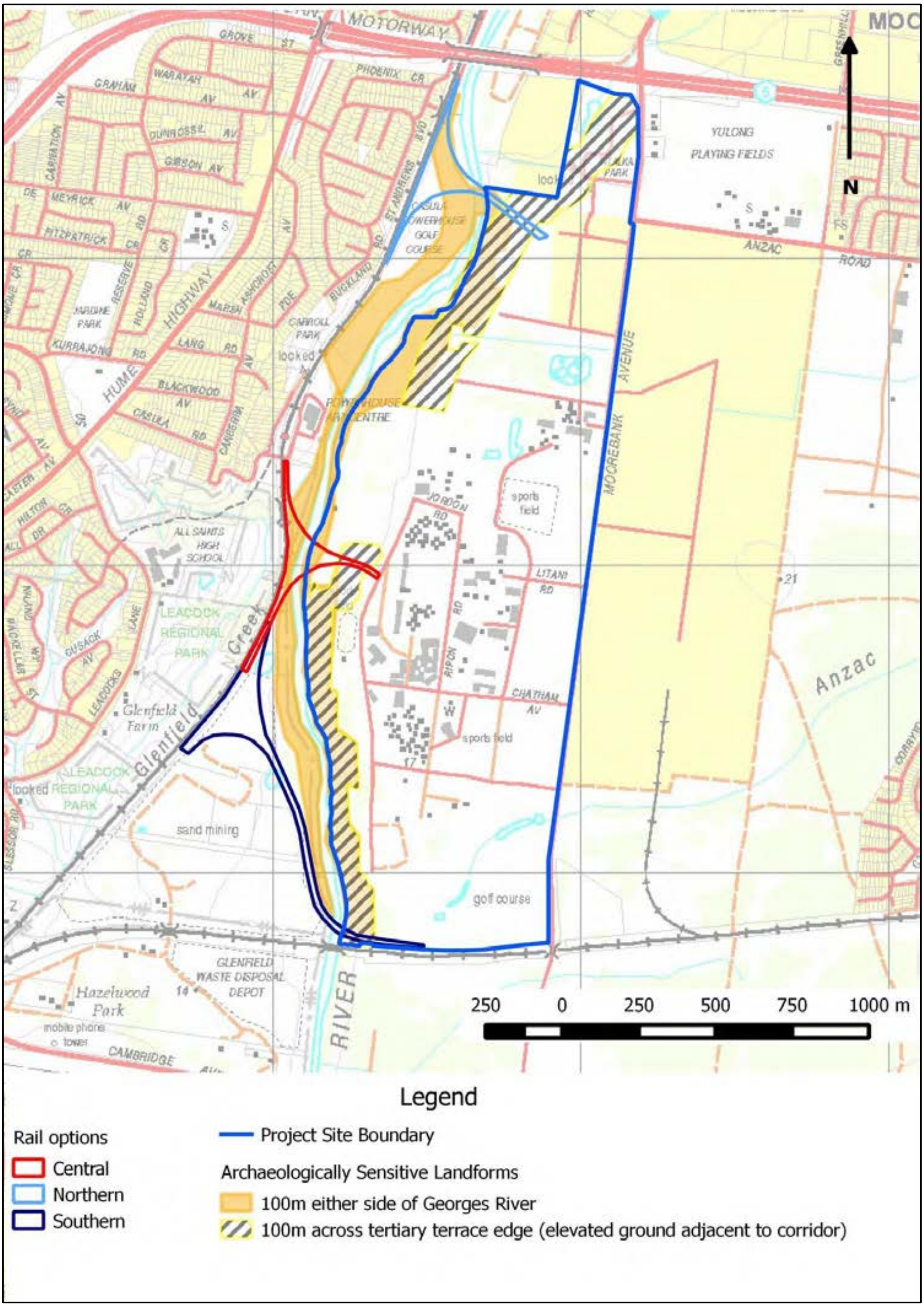

Figure 11.1 Predicted Aboriginal archaeological sensitivity following the subsurface testing program

12. SIGNIFICANCE ASSESSMENT

12.1 Burra Charter assessment criteria

The Burra Charter of Australia defines cultural significance as 'aesthetic, historical, scientific or social value for past, present and future generations' (Aust. ICOMOS 1987). The assessment of the cultural significance of a place is based on this definition but often varies in the precise criteria used according to the analytical discipline and the nature of the site, object or place.

In general, Aboriginal archaeological sites are assessed using five potential categories of significance:

- significance to contemporary aboriginal people;
- scientific or archaeological significance;
- aesthetic value;
- representativeness; and
- value as an educational and/or recreational resource.

Many sites will be significant according to several categories and the exact criteria used will vary according to the nature and purpose of the evaluation. Cultural significance is a relative value based on variable references within social and scientific practice. The cultural significance of a place is therefore not a fixed assessment and may vary with changes in knowledge and social perceptions.

Cultural significance can be defined as the cultural values of a place held by and manifest within the local and wider contemporary Aboriginal community. Places of significance may be landscape features as well as archaeologically definable traces of past human activity. The significance of a place can be the result of several factors including: continuity of tradition, occupation or action; historical association; custodianship or concern for the protection and maintenance of places; and the value of sites as tangible and meaningful links with the lifestyle and values of community ancestors. Aboriginal cultural significance may or may not parallel the archaeological significance of a site.

Scientific significance can be defined as the present and future research potential of the artefactual material occurring within a place or site. This is also known as archaeological significance.

There are two major criteria used in assessing scientific significance:

1. The potential of a place to provide information which is of value in scientific analysis and the resolution of potential research questions. Sites may fall into this category because they: contain undisturbed artefactual material, occur within a context which enables the testing of certain propositions, are very old or contain significant time depth, contain large artefactual assemblages or material diversity, have unusual characteristics, are of good preservation, or are a constituent of a larger significant structure such as a site complex.

2. The representativeness of a place. Representativeness is a measure of the degree to which a place is characteristic of other places of its type, content, context or location. Under this criteria a place may be significant because it is very rare or because it provides a characteristic example or reference.

The value of an Aboriginal place as an educational resource is dependent on: the potential for interpretation to a general visitor audience, compatible Aboriginal values, a resistant site fabric, and feasible site access and management resources.

The principal aim of cultural resource management is the conservation of a representative sample of site types and variation from differing social and environmental contexts. Sites with inherently unique features, or which are poorly represented elsewhere in similar environment types, are considered to have relatively high cultural significance.

The cultural significance of a place can be usefully classified according to a comparative scale which combines a relative value with a geographic context. In this way a site can be of low, moderate or high significance within a local, regional or national context. This system provides a means of comparison, between and across places. However it does not necessarily imply that a place with a limited sphere of significance is of lesser value than one of greater reference.

The following assessments are made with full reference to the scientific, aesthetic, representative and educational criteria outlined above. Reference to Aboriginal cultural values has also been made where these values have been communicated to the consultants. It should be noted that Aboriginal cultural significance can only be determined by the Aboriginal community, and that confirmation of this significance component is dependent on written submissions by the appropriate representative organisations.

12.2 Commonwealth assessment criteria

The Commonwealth Heritage List is a register of natural and cultural heritage places owned or controlled by the Australian Government. These may include places associated with a range of activities such as communications, customs, defence or the exercise of government. The *Environment Protection and Biodiversity Conservation Act 1999* establishes this list and nominations are assessed by the Australian Heritage Council.

In accordance with the *Environment Protection and Biodiversity Conservation Act 1999* a place has a Commonwealth Heritage value if it meets one of the Commonwealth Heritage criteria (section 341D).

A place meets the Commonwealth Heritage listing criterion if the place has significant heritage value because of one or more of the following:

The Commonwealth Heritage Criteria (SEWPaC 2011) for a place are any or all of the following:

a) The place has significant heritage value because of the place's importance in the course, or pattern, of Australia's natural or cultural history.

b) The place has significant heritage value because of the place's possession of uncommon, rare or endangered aspects of Australia's natural or cultural history.

c) The place has significant heritage value because of the place's potential to yield information that will contribute to an understanding of Australia's natural or cultural history.

d) The place has a significant heritage value because of the place's importance in demonstrating the principal characteristics of:

   i) A class of Australia's natural or cultural places, or

   ii) A class of Australia's natural or cultural environments.

e) The place has a significant heritage value because of the place's importance in exhibiting particular aesthetic characteristics valued by a community or cultural group.

f) The place has significant heritage value because of the place's importance in demonstrating a high degree of creative or technical achievement at a particular period.

g) The place has significant heritage value because of the place's strong or special association with a particular community or cultural group for social, cultural or spiritual reasons.

h) The place has significant heritage value because of the place's special association with the life or works of a person, or group of persons, of importance in Australia's natural or cultural history.

i) The place has significant heritage value because of the place's importance as part of Indigenous tradition.

Note: The cultural aspect of a criterion means the Indigenous cultural aspect, the non-Indigenous cultural aspect, or both.

Thresholds

While a place can be assessed against the above criteria for its heritage value, this may not always be sufficient to determine whether it is worthy of inclusion on the Commonwealth Heritage List. The Australian Heritage Council may also need to use a second test, by applying a 'significance threshold', to help it decide. This test helps the Council to judge the level of significance of a place's heritage value by asking 'just how important are these values?'

To be entered on the Commonwealth Heritage List a place will usually be of local or state-level significance, but must have 'significant' heritage value.

Commonwealth heritage management principles

In addition to the above criteria and thresholds, Schedule 7B of the Environment Protection and Biodiversity Conservation Regulations 2000 (Regulation 10.03D) lists the Commonwealth Heritage Management Principles. These principles are:

1. The objective in managing Commonwealth Heritage places is to identify, protect, conserve, present and transmit, to all generations, their Commonwealth Heritage values.

2. The management of Commonwealth Heritage places should use the best available knowledge, skills and standards for those places, and include ongoing technical and community input to decisions and actions that may have a significant impact on their Commonwealth Heritage values.

3. The management of Commonwealth Heritage places should respect all heritage values of the place and seek to integrate, where appropriate, any Commonwealth, State, Territory and local government responsibilities for those places.

4. The management of Commonwealth Heritage places should ensure that their use and presentation is consistent with the conservation of their Commonwealth Heritage values.

5. The management of Commonwealth Heritage places should make timely and appropriate provision for community involvement, especially by people who:

    a) Have a particular interest in, or associations with, the place; and

    b) May be affected by the management of the place.

6. Indigenous people are the primary source of information on the value of their heritage and that the active participation of indigenous people in identification, assessment and management is integral to the effective protection of indigenous heritage values.

7. The management of Commonwealth Heritage places should provide for regular monitoring, review and reporting on the conservation of Commonwealth Heritage values.

When assessing the Commonwealth heritage significance of places within the study area in addition to applying the primary and secondary tests of the Commonwealth Heritage Listing criteria and the significance thresholds, reference also needs to be made to the above Commonwealth Heritage Management Principles. The latter is particularly relevant to the study area where there are:

- Other heritage values of the place that are the responsibility of the ACT Government (Principle 3); and

- A number of indigenous places for which the primary source of information on the value of their heritage has been provided through the active participation of local Aboriginal communities (Principle 6).

Heritage significance can apply to a building or a place at either local, State or Commonwealth level. The principal mechanisms recognising heritage places located on Commonwealth owned or managed land, the National Heritage List and the CHL. Each list has its own criteria for assessment of significance. As the whole of the Project area is owned by the Department of Defence the assessment of cultural heritage significance will be undertaken using the CHL criteria. If the assessment indicates that the place or elements within it meet the criteria for entry on the CHL, preparation of a nomination to the CHL may be recommended for the relevant places.

12.3 The Moorebank IMT study area

The following sections provide discussions of general values identified at each site and across the study area as a whole. Due to the complexities associated with assessing the significance of the subsurface deposits, these have been dealt with separately from surface sites.

The assessment of significance across the study area as a whole includes consideration of the implications of the subsurface testing program for identified sensitive landforms.

A summary of significance assessments for all recorded sites is provided in Table 11.1, which includes assessments against the Burra Charter significance values and the Commonwealth Heritage list criteria. Figure 11.1 shows areas within the Project area assessed as meeting the threshold for listing on the Commonwealth Heritage List.

Moorebank representative sample area 2 (MRSA2) will not be assessed for its significance as this location is not an Aboriginal site or an area of potential archaeological deposit, rather it is a representative landform requiring archaeological subsurface testing to confirm the site location model for the area.

12.3.1 Significance of the Moorebank IMT study area

See Appendix 8 for a detailed assessment of the Moorebank IMT Project area against the Commonwealth Heritage list criteria.

The initial desktop assessment (NOHC 2011) and the research design for the current testing program (NOHC2012) identified three sensitive landform types within the Moorebank IMT study area. The results of the current program of subsurface testing have confirmed the presence of relatively undisturbed deposits with moderate to high areal incidence of artefacts within the Tertiary terrace at MA5 and the overlap between the terrace and a tributary drainage line at MA9 (MAPAD1). Furthermore, the subsurface testing program has confirmed that the areas to the east of the Tertiary terrace are of very low archaeological potential. No artefacts were recovered from MRSA3, nor were any recovered from the margins of the tributary drainage line at PAD2.

Essentially the survey and subsurface testing have demonstrated that the areas of greatest Aboriginal significance and archaeological research value are the landforms within and immediately bordering the Georges River. The remainder of the study area is of low to negligible heritage significance. This is due to the combination of Aboriginal activity in this area and the effects of European landuse. That is, the basal slopes bordering the eastern terrace do not appear to have been the focus of activities such as camping that would have resulted in the deposit of significant amounts of archaeological material. Instead they are likely to represent areas used primarily for movement through country and activities such as hunting and gathering, which result in very ephemeral archaeological signatures. During the past two centuries of European land use, and particularly during the past 100 years of military activity, the effects of vegetation clearance, land surface modification, and building construction, modification and removal have significantly compromised the integrity of any ephemeral archaeological traces that may have remained.

The majority of the Moorebank IMT study area is not assessed to be of Aboriginal heritage significance. However, the undisturbed portions of the river corridor and Tertiary terrace are assessed to be of moderate to high significance at local and regional levels due to the research potential that exists in these areas. The Moorebank IMT portions of the Georges River corridor and terraces are also relatively unique examples of such archaeological resources in the context of the broader southern Sydney region. These landforms have significance against Commonwealth Heritage List criteria: b, c, d, g and i.

The Georges River Corridor and terraces meet the threshold for listing on the Commonwealth Heritage List.

12.3.2 Significance of the Moorebank IMT Northern Powerhouse Study Area

See Appendix 7 of the addendum report (NOHC 2014a) for a detailed assessment of the Northern Powerhouse land against the Commonwealth Heritage list criteria.

Initial desktop assessment and field survey identified an area of archaeological potential along the western bank of the Georges River (MAPAD2). Subsurface testing within the upper 120-150 cm of deposits at MAPAD2 has revealed an intermittent and low density of stone artefacts within deposits that are thought to have formed during the past 200 years (MA11 and MA12). These artefacts are interpreted as not being *in situ*. A single small silcrete flake was also recovered from lower deposits thought to relate to the pre-1836 floodplain (MA13).

The identified sites (MA11-MA13), together with the broader area of archaeological potential in which they are situated, contribute to the overall significance of the Northern Powerhouse land and the Moorebank IMT study area as a whole.

The test excavation program within the Northern Powerhouse land has demonstrated that while the archaeological significance of the upper 120-150 cm of deposits is generally low, these deposits are likely to have significance in terms of being a representative example of environmental changes that resulted from European settlement, in particular the construction of the Liverpool Weir. The Unit 1 and Unit 2 deposits have the potential to be of significance in terms of their scientific value, natural value, educational value, representativeness and social value (importance to the Aboriginal community and the broader Australian community) at local, State and National levels.

The Georges River Corridor and terraces have previously been assessed to meet the threshold for listing on the Commonwealth Heritage List (NOHC 2013a); the results of the current subsurface testing program at MAPAD2 indicate the potential for increased significance of these landforms.

12.3.3 Significance of recorded surface sites

See Appendix 8 for a detailed assessment of each site against the Commonwealth Heritage list criteria.

The majority of sites identified within the Moorebank IMT study area are surface scatters of artefacts and/or areas of archaeological deposit (MA1-5 and MA9-10). Three scarred trees of possible Aboriginal origin (MA6-8) and a representative sample area (MRSA2) have also been identified within the study area.

Given that MRSA2 is an area of predicted archaeological sensitivity with no surface evidence of archaeological material, it is not possible to assess the significance of this site in the absence of excavation data. This site is excluded from the following significance assessment.

Artefact occurrences MA1-MA4 comprise small, low density surface scatters with negligible archaeological potential. The predicted low archaeological potential at these sites is due to site location and/or the extent of disturbance at the site. These sorts of sites are common across the Sydney region; they offer limited educational value and are assessed to be of low scientific significance. However, these sites have Aboriginal cultural value.

The three scarred trees of possible Aboriginal origin have the potential to be of moderate to high scientific and educational value, if they are confirmed to be of Aboriginal origin. However, there is some uncertainty regarding the origin of the scars at MA6, MA7 and MA8. As such, the scientific and educational value of these recordings is not possible to be determined at this stage. Nevertheless, Aboriginal consultation has indicated that some of the RAPs identify these trees as sites of high significance to the Aboriginal community.

All sites meet the threshold for listing on the Commonwealth Heritage List.

12.3.4 Significance of the deposits east of the Georges River

Test excavations have revealed archaeological deposits to be present at MA1, MA5, MA9 (MAPAD1) and MA10 (MRSA1).

The archaeological significance of the deposits within the Moorebank IMT study area have also been assessed in the context of their geomorphology. The following is a summary of the assessed significance of the deposits; it has informed the overall significance assessments provided below in Table 12.1.

The majority of the stratigraphic sequences are variants of podzols. Hydromorphic properties suggest poor drainage and depths to saprolite and bedrock are important factors in determining soil properties throughout the area. Some soils may indicate proximity to wetlands in the past – ie indicate past local habitats and resources available to prehistoric human populations. Observations of catenary (lateral) soil developments along transects would help validate such interpretations.

All soils observed have sufficiently deep sandy subsoil units to act as very efficient traps in A1 and A2 parts of the profile for discarded artefacts. Bioturbation and upcasting of sediments in these soils is likely to “spread” artefacts vertically through, and potentially deep within, the sequence. The depth distribution of artefacts may not be archaeologically meaningful – incipient “stone lines” of artefact rich zones may result. Historic ploughing may have exacerbated such movement tendencies. Activations of down-slope movements of sandy silts was interpreted at pits in the MA9 (MAPAD1) area.

The deposits and soils horizons developed on them do represent relatively stable environments as land surfaces overlooking the floodplain of the Georges River. Dating will be possible on these quartz rich sands. For dating techniques like OSL to be effective and reliable, close consideration should first be given to the process and soil formation histories of the target deposits. Micromorphological investigations may assist in reaching this goal (Davidson and Simpson 2001; Kemp 1985).

The archaeological significance of the deposits is evaluated provisionally as moderate to locally high based on the capacity of the observed sequences:

- to preserve soil histories and information on past environments (especially around ponds and water courses)
- to preserve discarded materials within the stratigraphy at depth
- to preserve features (cuts, burn out features)
- the quartzose sand and charcoal observed - which can be used to produce age-estimates
- observations of artefacts subsurface

The significance of the terrain units is archaeologically reduced by extensive landscaping and surface modification. However, while reducing significance, it does not remove all heritage values as soil subhorizons preserve intact at most points observed.

Extent of deposit disturbance

Vegetation clearance and European landuse will have affected the vertical integrity of archaeological material, especially where they occur in relatively low densities. (Vertical integrity refers to the ability to identify the original sequence of discard from the current position of the artefact within the soil profile).

At sites MA5, MA9 and MA10 deposit disturbance has been restricted to upper stratigraphic units and/or layers of fill. Below these levels disturbance is low.

Stratigraphic integrity

The stratigraphic integrity within the Moorebank study area was high at sites MA5 and MA9. As above layers of fill and/or disturbance these locations displayed a degree of vertical integrity.

Stratigraphic/vertical integrity was also found in pockets at site MA1 and the western portion of MA10.

Presence of cultural features

No cultural features were found at any testing location.

Areal incidence of artefacts

The average areal incidence of artefacts per square metre, where artefacts were present, ranged from $4/m^2$ at MA1 to $27.5/m^2$ at MA5. The overall average incidence of artefacts at Moorebank was $20.31/m^2$.

Aerial incidence is relatively low MA1 and MA10 and relatively high at MA5 and MA9. These assemblages also displayed higher richness and diversity then the other locations.

Representativeness (Local and Regional Context)

MA5 and MA9 are representative of larger and more diverse assemblages associated with more extensive sites in well drained aggrading landforms, in a valley floor context, in association with permanent water sources.

Sites MA5 and MA9 are also representative of the archaeological research potential that exists in undisturbed sections of tertiary terraces bordering the Georges River. As such these sites could be considered relatively rare in a local and regional context.

In keeping with local models the assemblage is dominated by silcrete and quartz while also containing evidence of more diverse raw material exploitation.

12.3.5 Significance of the deposits west of the Georges River

Results show the study area preserves a) a highly specific historical and prehistoric record of recent sand aggradation and vertical accretion superimposed on b) an earlier floodplain surface. The cause of the change in sedimentary regime appears to be the construction of the Liverpool Weir in 1836. The sediment record is thus an historic archaeological artefact of European design (ponding behind the weir to create a freshwater supply free of tidal saline influence) while the lower stratigraphy only partly observed in this study records the broader prehistoric changes prior to that impact.

Heritage values of the Unit 3 – Fill

The fill reflects recent historical land use, and land modification. It may have minor educational value, and community interest. It has no particular heritage value as the process it reflects is ubiquitous across the broader area.

Heritage values of the Unit 2 – Avulsion sands.

The key points are that across most test pits the covering deep (Unit 2) sands show:

a) properties of bedding and sequence development reflecting deposition under water flow conditions, depositing sands on levees by avulsion. Significant archaeological preservation is unlikely in these sands. Some older higher levee surfaces may preserve some small prehistoric sites.

b) Specific bedding properties and sediment structures recognised in sedimentological literature as typical of deposition either on a levee, or marginal to a levee or point bar (Brown 1997; Conybeare and Crook 1982; Miall 1992: Reid and Frostick 1994).

c) The soils show very weakly developed pedogenic properties and horizon development.

Many test pits showed evidence of recent disturbance in the upper parts of the profiles observed. The study area has sustained substantial modifications by spreading of fill across the surface. This has been noted in previous evaluations and geotechnical investigations across the broader area (Steele and Dallas 2001).

The Heritage values (natural and cultural) lie in the fact that these upper sands, as flood deposits, geomorphological landforms and land surfaces, provide a tangible physical record of historical events and ecological changes that are of wider significance in the context of the development of Liverpool, the past nature and environment of the Georges River, and as a rare example of early floodplain manipulation and management by a (convict constructed) weir structure.

Scientific values include information on the nature of hydrological adjustment of the river, an ongoing process, where better understanding of the trajectory of change in the last 180 years provides baselines and context for present flood and river ecological issues and management.

Floods and flooding are significant parts of the collective community history and folk memory in Liverpool. Tangible examples of the processes are rarely seen so well preserved in geological archives. The sequence investigated sits on a buried floodplain surface, and so the overall deposit sequence also records the processes of change from the floodplain ecology known for thousands of years to Aboriginal people, and its environmental transformation through to the present day.

The sequence at the study area is also unique in that no other major floodplain adjustments and ecological shifts due to construction from a convict constructed weir are known in Australia. The sequence would fit the heritage definition of a unique geological record of early human impact on a pristine ecosystem comparable in its context with e.g. first manipulation of the Tiber by Roman engineers, or Fenland drainage and transformation initiated by the Earl of Bedford in the 1630s and engineered by Vermuyden.

The upstream landscape consequences of convict weir construction at Liverpool are poorly documented, and this sequence clearly has the capacity to provide illustrations, dates and tangible experiences which illustrate the (unintended) hydrological and landscape “knock-on” effects of the historic construction.

The sequence identified may be part of a broader sequence of deposits. The extent to which the sequence is preserved elsewhere is not known. On present evidence the parsimonious conclusion would be that it is one of the few places where this historic stratigraphic record has survived development impacts.

The overall conclusion is that the heritage values are very considerable, and work should be undertaken to archive the information in the sequence proportional to scheme impacts.

Heritage value of the Buried Floodplain Surface and Alluvium (Unit 1)

Our observations of this unexpected deposit sequence are partial and restricted by on-site safety requirements.

The model of the stratigraphic sequence development presented above suggests this unit has the highest *potential* heritage significance. The floodplain surface appears to be preserving soil and event stratigraphy (particularly massive burning events) which we think relate quite specifically to the period of European insurgence into the river valley, prior to 1836. Records of the types of floodplain vegetation present in the period 1790-1830 may be well preserved as the surface was then sealed by sands.

The composite nature of a floodplain soil surface means we would expect evidence of the prior condition of the floodplain to also be preserved in the sequence (e.g. as microfossil inclusions such as pollen, diatoms) or as larger features (tree burn outs, flood event layers).

It is possible that very early European historic structures, ditches, fences and even river margin structures or boats could be preserved across this stratigraphic surface *if* the age model we infer is correct. Certainly root systems and other *in situ* evidence of floodplain habitats may be well preserved as the consequence of weir construction will have been a raised permanent water table.

Preliminary levelling data suggest the buried surface at 7.5-8.0 m AHD represents an excellent medium for local organic preservation. Clearly it is not possible to predict the presence/absence of such features, at any level spatial precision. Present data suggest the potential for preservation is high and the risk to scheme from inadvertent impacts on important cultural and natural heritage deposits could be considerable.

This view, it must be emphasised, is based on an *assumed chronology*. To adequately assess *the* heritage significance and the risk to scheme from unexpected impacts *the model needs to be validated.* Dating the main events in the sequence is a pre-requisite to improved heritage management outcomes and will provide better certainty to estimates of Heritage values.

Our present partial and restricted observations of the underlying floodplain alluvium suggest that this predominantly buried bounding surface of the underlying unit has considerable potential heritage significance. Unit 1 deposits may contain significant environmental information on the historic and immediately prehistoric environments at close to the upper tidal limit of the Georges River. Over a broader area archaeological sites may occur on this buried floodplain surface, obscured, but well preserved at depth. These sites could be early European, contact Aboriginal, or pre-contact indigenous Aboriginal sites. A range of time periods will be preserved on a buried flood plain surface.

The assessed significance is high as the deposits reflect a quite rare occurrence sealing of the floodplain due to rapid changes to channel hydrology caused by weir construction.

Stratigraphic integrity

The site identified as MA11 displayed no stratigraphic integrity. All of the artefacts recovered from this site were from introduced fill of unknown provenance.

The site identified as MA12 displayed high stratigraphic integrity however the artefacts are interpreted to be present in these deposits as the result of fluvial reworking of sediments during flood events of the nineteenth/twentieth centuries.

The site identified as MA13 displayed high stratigraphic integrity. A single small artefact was recovered from the upper portion of the Unit 1 deposits. However, given that the age and nature of the Unit 1 deposits is yet to be determined, the circumstances surrounding the deposition of the recovered artefact cannot be accurately inferred.

The stratigraphic integrity at MAPAD2 as a whole was very high, however it should be noted that the majority of stratigraphic units investigated during the subsurface testing program appear to relate to sedimentation processes during the past 200 years. Nevertheless, the potential for intact deposits at depth across MAPAD2 is high.

12.3.6 Aboriginal cultural value

An assessment of the Aboriginal Cultural Value of the Project area can only be made by the Aboriginal community, therefore this assessment has included a comprehensive program of Aboriginal consultation (see Section 5.3).

The RAPs for the Project have pointed to a number of sites of particular cultural value as well as commenting on the overall value of the area.

Verbal advice from Glenda Chalker (CBNTCAC), Justine Coplin (DCAC) and Des Dyer (DALC) indicated that the recorded scarred trees (MA6-8) have cultural significance. The cultural significance of these trees has been reiterated in a letter from Leanne Watson (DCAC).

Opinions provided by Timothy Wells (DACHA), Glenda Chalker (CBNTCAC), Justine Coplin (DCAC) and Des Dyer (DALC) indicated that site MAPAD1 (MA9) was an area of cultural significance.

The RAPs have stated that the Project area as a whole has cultural value and significance.

CBNTCAC stated that:

> *There are areas within the proposed development that have cultural significance to Cubbitch Barta ...*

DCAC stated that:

> *The area is significant to our people due to the area and also the resources that would have been in this area. The interesting aspect of this project is the discrepancy of the boundaries of our people(s) areas such as this if investigated sufficiently can give is some answers that our people need. Our group has discussed the boundaries of the Darug people many times and agree that we had large areas that were shared areas, the Georges River would also have been shared.*
>
> and
>
> *This area is highly significant to the Darug people due to the evidence of continued occupation, within this development there is a complex of highly significant sites, this is an Aboriginal (Darug) landscape. The Georges River is part of the landscape that is traditionally known as a border for our traditional area, our group believes that areas that border our boundaries are large shared areas, as this area is the significance for us is very high.*

12.3.7 Overview of significance against the Commonwealth Heritage List criteria

Criterion (a): *The place has significant heritage value because of the place's importance in the course, or pattern, of Australia's natural or cultural history*

The Unit 1 and Unit 2 deposits at MAPAD2 have been assessed to have heritage value against this criterion in terms of their association with the course of Australia's natural and cultural history, in particular their connection to environmental conditions prior to and subsequent to European settlement.

The significance of the Unit 1 and Unit 2 deposits is predicted to be such that it confers a degree of significance for the entire study area against this criterion. While the majority of the Project area is assessed as not having significance against this criterion, the significance of the Unit 1 and Unit 2 deposits is interconnected with the environmental evidence that exists across the broader study area.

Criterion (b): *The place has significant heritage value because of the place's possession of uncommon, rare or endangered aspects of Australia's natural or cultural history*

Within the Project area, east of the Georges River, none of the individual sites have been assessed to have significant heritage value against this criterion.

The Georges River corridor and terraces are assessed as having significance against this criterion as they are relatively rare examples of undisturbed portions of the river corridor and Tertiary terrace that contain Aboriginal archaeological deposits.

Furthermore, the sequence identified in the northern Powerhouse land study area is unique in that no other major floodplain adjustments and ecological shifts due to construction from a convict constructed weir are known in Australia.

The Unit 1 and Unit 2 deposits at MAPAD2 have been assessed to have heritage value against this criterion due to the fact that they appear to comprise a hitherto unrecorded example of changes in flood regime that appear to archive:

- regional properties in the catchment sediment record; and
- a record of recent sand aggradation and vertical accretion superimposed on the earlier floodplain surface caused by the construction of the Liverpool Weir in 1836.

Individual sites MA12 and MA13 contribute to the significance of the Unit 1 and Unit 2 deposits against this criterion.

The significance of the Unit 1 and Unit 2 deposits is predicted to be such that it confers a degree of significance for the entire study area against this criterion. While the majority of the Project area is assessed as not having significance against this criterion, the significance of the Unit 1 and Unit 2 deposits is interconnected with the environmental evidence that exists across the broader study area.

Criterion (c): *The place has significant heritage value because of the place's potential to yield information that will contribute to an understanding of Australia's natural or cultural history*

Individual sites MA5 and MA9 are assessed having significance against this criterion as the sites have an archaeological deposit that has the potential to yield information that will contribute to an understanding of Australia's cultural history.

Individual sites MA6, MA7 and MA8 are assessed as having potential significance against this criterion as the items may be able to yield information about the use of bark/wood by Aboriginal people in the past. An assessment of the tree is required to confirm its status as an Aboriginal object.

The Unit 1 and Unit 2 deposits at MAPAD2 have been assessed to have heritage value against this criterion due to their potential to:

- yield information on the nature of the hydrological adjustment of the river – an ongoing process – where better understanding of the trajectory of change in the last 180 years provides baselines and context for present riparian ecological issues and management;
- yield information on the types of floodplain vegetation present in the period 1790-1830 that may be well preserved in Unit 1 sealed by the Unit 2 sands; and
- contain evidence of the prior condition of the floodplain preserved in the sequence (e.g. as microfossil inclusions such as pollen, diatoms) or as larger features (tree burn outs, flood event layers).

Individual sites MA12 and MA13 have the potential to contribute to the significance of the Unit 1 and Unit 2 deposits against this criterion in terms of any information that will contribute to the above themes and research potential.

The abovementioned deposits and recordings are assessed as having significance against this criterion as they display the potential to yield information that will contribute to an understanding of Australia's natural and cultural history.

The significance of the Unit 1 and Unit 2 deposits is interrelated with the heritage value of other sites and landforms, within the Moorebank IMT study area as a whole, that are within or form part of the Georges River corridor. Together these sites confer a degree of significance on the study area as a whole against this criterion.

More generally, the Georges River corridor and terraces are assessed as having significance against this criterion as this landscape has an archaeological deposit that has the potential to yield information that will contribute to an understanding of Australia's cultural history.

Criterion (d): *The place has a significant heritage value because of the place's importance in demonstrating the principal characteristics of:*

i) A class of Australia's natural or cultural places, or

ii) A class of Australia's natural or cultural environments.

Individual sites MA5 and MA9 are assessed as having significance against this criterion as the sites have an archaeological deposit that has the potential to yield information that will contribute to an understanding of Australia's cultural history.

The Unit 1 and Unit 2 deposits at MAPAD2 appear to demonstrate the principal characteristics of a pre-European/early contact floodplain that has been capped by overflow sands as the result of floodplain adjustments in response to the construction of the Liverpool Weir. As noted in the geomorphological analysis of the deposits, Unit 2 displays text book structures produced by migrating bedforms, moving in the direction of flow, over a reactivation surface (see Allen 1965).

Together with the previously assessed sites MA5 and MA9 (NOHC 2013a), the Unit 1 deposits are representative of Aboriginal land use along the Georges River and the environment that existed prior to European settlement. As such they have significance against this criterion in terms of the ways in which they demonstrate the principal characteristics of the pre-European environment along this section of the upper estuarine limits of the Georges River and some of the principal characteristics of the ways in which this landscape was inhabited by Indigenous Australians.

The Georges River corridor and terraces are assessed as having significance against this criterion as they are representative of the scientific (natural and cultural) research potential that exists in relatively undeveloped and undisturbed landforms bordering the Georges River. The river corridor and the sites identified along it contribute to the overall significance of the Moorebank IMT study area against this criterion.

Criterion (e): *The place has a significant heritage value because of the place's importance in exhibiting particular aesthetic characteristics valued by a community or cultural group.*

Within the Project area none of the individual sites have been assessed to have significant heritage value against this criterion.

The Project area as a whole is assessed as not having significance against this criterion.

Criterion (f): *The place has significant heritage value because of the place's importance in demonstrating a high degree of creative or technical achievement at a particular period.*

The Unit 2 deposits at MAPAD2 appear to be the direct result of early nineteenth century innovation and technical achievement with regard to modification of a river system in order to secure a fresh water supply for Liverpool. As such, these deposits are potentially of importance as an indirect demonstration of that early nineteenth century technical achievement.

The Unit 2 deposits within the Georges River corridor are assessed as having potential heritage significance against this criterion.

Criterion (g): *The place has significant heritage value because of the place's strong or special association with a particular community or cultural group for social, cultural or spiritual reasons.*

Individual sites MA6, MA7, MA8, MA9 and MA10 are assessed as having high significance against this criterion as they display a connection for the Aboriginal community to past cultural events.

The identified sites MA11, MA12 and MA13 and the artefacts recovered from them are assessed as having significance against this criterion as they display a connection for the Aboriginal community to past cultural events.

More broadly, the Unit 1 and Unit 2 deposits at MAPAD2 are likely to be of importance to both the Aboriginal community and the local Liverpool community in terms of the record they appear to archive of ecological change, flooding patterns and potential information regarding the pre-European landscape.

The individual sites MA11, MA12 and MA13, together with the Unit 1 and Unit 2 deposits at MAPAD2 contribute to the overall significance of the Georges River corridor and terraces against this criterion as well as the significance of the Moorebank IMT study area as a whole.

Criterion (h): *The place has significant heritage value because of the place's special association with the life or works of a person, or group of persons, of importance in Australia's natural or cultural history.*

The Unit 2 deposits at MAPAD2 appear to be the direct result of construction of the Liverpool Weir, which was designed by David Lennox, an engineer who was also important within NSW and Victoria due to his involvement in bridge design and construction. The life and works of David Lennox are thus important in the context of local history, as well as the history of infrastructure within NSW and Australia as a whole. As such, these deposits are potentially of importance as direct evidence of the effect of the works of David Lennox.

The Unit 2 deposits within the Georges River corridor are assessed as having potential heritage significance against this criterion.

Criterion (i): *The place has significant heritage value because of the place's importance as part of Indigenous tradition.*

Individual sites MA1-13 are assessed as having significance against this criterion for the connection they provide between the present Aboriginal community and Indigenous tradition.

The Unit 1 deposits at MAPAD2 have the potential to contain archaeological and paleo-environmental evidence that would be of importance in terms of understanding Indigenous traditions and life-ways. Such evidence would be of importance as a connection between the present Aboriginal community and Indigenous tradition.

The Georges River corridor and terraces have previously been assessed as having significance against this criterion and the Unit 1 deposits at MAPAD2 are likely to add to the overall significance of the Georges River corridor and the study area as a whole against this criterion.

Table 12.1 Summary of significance assessments for the individual Aboriginal recordings within the Project area. Significance of each site is assessed in terms of the Burra Charter and the Commonwealth Heritage List criteria.

Site	Burra Charter Significance	CHL Criteria
MA1	Low archaeological significance at a local level Aboriginal cultural value	This site meets the threshold for listing on the Commonwealth Heritage List under criterion i.
MA2	Low archaeological significance at a local level Aboriginal cultural value	This site meets the threshold for listing on the Commonwealth Heritage List under criterion i.
MA3	Low archaeological significance at a local level Aboriginal cultural value	This site meets the threshold for listing on the Commonwealth Heritage List under criterion i.
MA4	Low archaeological significance at a local level Aboriginal cultural value	This site meets the threshold for listing on the Commonwealth Heritage List under criterion i.
MA5	Moderate to high archaeological significance at a local level. Moderate to high representative level at a local level. Aboriginal cultural value	This site meets the threshold for listing on the Commonwealth Heritage List under criterion c d, and i, with potential for g.
MA6	High Aboriginal cultural value	This site meets the threshold for listing on the Commonwealth Heritage List under criterion g and i. Potential for significance against criterion c.
MA7	High Aboriginal cultural value	This site meets the threshold for listing on the Commonwealth Heritage List under criterion g and i. Potential for significance against criterion c.
MA8	High Aboriginal cultural value	This site meets the threshold for listing on the Commonwealth Heritage List under criterion g and i. Potential for significance against criterion c.
MA9	Moderate to high archaeological significance at a local level Moderate to high representative level at a local level. Aboriginal cultural value	This site meets the threshold for listing on the Commonwealth Heritage List under criterion c, d, and i with potential for g.

Site	Burra Charter Significance	CHL Criteria
MA10	Moderate to low archaeological significance at a local level. Requires further investigation at western end to fully determine significance Aboriginal cultural value	This site meets the threshold for listing on the Commonwealth Heritage List under criterion i. Potential significance against criteria c and g. The site requires further investigation at western end to fully determine significance.
MAPAD2 (Unit 1)	Potentially of high scientific, educational, natural, representative and Aboriginal cultural value at local, State and National levels	The site requires further investigation to fully determine significance. Potential significance against criteria a, b, c, d, g and i
MAPAD2 (Unit 2)	Potentially of high scientific, educational, natural, representative and Aboriginal cultural value at local, State and National levels	The site requires further investigation to fully determine significance. Potential significance against criteria a, b, c, d, f, g and h
MA11	Low archaeological significance at a local level Aboriginal cultural values at a local level	This site does not meet the threshold for listing on the Commonwealth Heritage List.
MA12	Low archaeological significance at a local level Aboriginal cultural values at a local level	This site meets the threshold for listing on the Commonwealth Heritage List under criteria b, c, d, g, and i.
MA13	Low to moderate archaeological significance at a local level Aboriginal cultural values at a local level	This site meets the threshold for listing on the Commonwealth Heritage List under criteria b, c, d, g, and i.

It should be noted that the identified potential for historical, natural and environmental significance of the Unit 1 and Unit 2 deposits also implies significance against the NSW Heritage Council criteria, however assessment against these criteria was outside the scope of the current investigations.

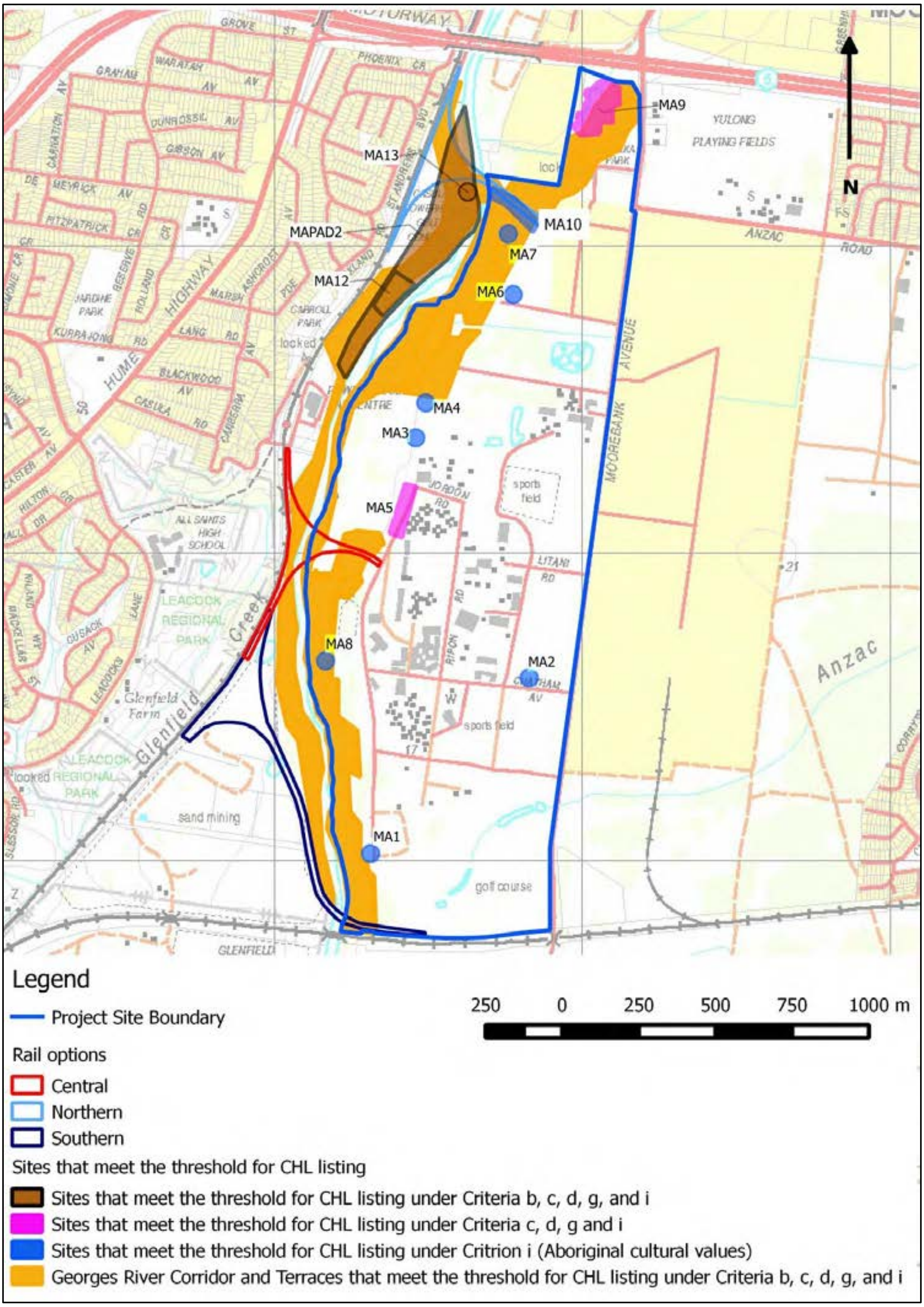

Figure 12.1 Location of sites that meet the threshold for listing on the Commonwealth Heritage List

13. ASSESSMENT OF IMPACTS

The proposed Moorebank Intermodal Terminal would have impacts on Aboriginal sites within and adjacent to the proposed construction footprint.

The classification of development impact falls into two broad categories, direct or indirect impact. This classification is made relative to the identified heritage place or item. Where a development would result in physical loss or change to a place or change to a place or item, this is a direct impact. Direct impact may affect a part or all of a place or item.

Where a development would avoid direct impact to a place or item, but would change its context or surroundings, this is termed an indirect impact. This is mostly caused by a development being situated in relative proximity to the place or item, and consequently changing the setting of the place or item to a significant degree. Indirect impacts may reduce the contextual integrity of a place or item, and compromise the interpretation or visual appreciation of the site.

The following sections consider impacts to identified Aboriginal recordings followed by impacts to broader areas of heritage significance across the entire study area.

13.1 Impacts to heritage across the study area

Impacts to Aboriginal sites from the Project vary across the Project stages.

13.1.1 Site rehabilitation

The School of Military Engineering (SME) currently located at the site will be moved as part of the Moorebank Units Relocation (MUR) Project. The MUR Project includes the removal and relocation to Holsworthy of some existing items and buildings on the Project site with significance to Defence. Site rehabilitation works will be carried out on site following the MUR which will involve the following activities that may impact Aboriginal sites:

- decontamination and site stabilisation on the site of the plant and equipment operation training area on the western side of the Project site known as the 'dust bowl'; and
- construction of secure perimeter fencing.

This work does not form part of the current approval and all Aboriginal sites will be fenced and protected during these works.

13.1.2 Early works

The activities that will impact aboriginal sites from the Early Works development phase include:

- establishment of construction facilities;
- demolition or relocation of existing buildings, structures and hazardous buildings not being removed as part of the MUR Project or the site rehabilitation works;
- some contaminated land remediation including removal of unexploded ordnance (UXO) and explosive ordnance waste (EXO) if found, removal of asbestos contaminated buildings and remediation of an area known to contain asbestos;
- relocation of hollow bearing trees (i.e. those that provide ecologically important roosting habitats);
- service utility terminations and diversions; and
- establishment of the conservation area including seed banking and planting.

Impacts will be in the form of direct ground disturbance ie excavating for services, indirect ground disturbance i.e. vehicle movements across sites and removal of trees.

This stage of works will have the most impact to Aboriginal sites and will directly impact any site within the construction zone.

13.1.3 Project Phase A – Construction of initial IMEX terminal and warehousing

The greatest level of construction activity would likely occur during the early phase of the Project, during Project Phase A. The key elements that will have an impact on Aboriginal sites are:

- geotechnical works to determine the requirement for piles and other supporting structures for Georges River bridge;
- modification of the site drainage system and construction of temporary and permanent stormwater detention basins and drainage channels to Georges River;
- vegetation clearing within the footprint of construction footprint of Project Phase A to enable construction works;
- bulk earthworks for IMEX terminal facility;
- construction of IMEX terminal buildings (for a capacity of 0.5 million TEUs per annum) including separate rail maintenance facilities and a terminal operating plant and equipment facility;
- construction of IMEX rail infrastructure (including rail-mounted gantry lines);
- establishment of concrete batching plant to provide for the construction of hardstand areas and other concrete surfaces;
- retaining wall construction (where required);
- construction of the rail access and associated bridge structure over Georges River to service the IMEX facility (and in the case of the northern rail access option, a turnout to the interstate section of the bridge);
- installation and commissioning of a utilities duct (for water, gas, electricity and sewerage) and substation for IMEX terminal and initial warehousing precinct, with stub connections provided for future connections;
- installation of major drainage infrastructure and lighting;
- construction of internal road network and access points;
- construction of hard stand pavements;
- installation of noise attenuation infrastructure;
- landscaping; and
- construction of ancillary services (such as the service centre and truck stop).

Again impacts to Aboriginal sites will occur from direct ground disturbance, indirect ground disturbance and removal of trees.

As most of the Aboriginal sites will have already been impacted by the early works this stage will see less impact to Aboriginal sites with the exception of any work across the Georges River for the rail access and associated bridge. All remaining impacted sites not impacted by the early works will be impacted as part of this phase.

13.1.4 Project Phase B to Full Build

Project phase B to full build are essentially the operating stages of the project with some minor construction impacts. The construction activities from these phases that will have an impact of Aboriginal sites are:

- vegetation removal, site preparation and bulk earthworks for footprint for Project Phase B;
- construction of IMEX terminal buildings and facilities for an additional 500,000 TEU per annum capacity (providing for a total capacity of 1.05 million TEUs per annum)
- construction of additional 150,000 sq. m of warehousing buildings, hardstands and car parking;
- utility connections (to connect to major utilities installed during Project Phase A);
- road works (internal roads), connecting to internal roads constructed as part of Project Phase A;
- vegetation clearing within the construction footprint for Project Phase C;
- site preparation, including bulk earthworks and remediation of Project Phase C area;
- provision of a concrete batching plant for construction activities during Project Phase C;
- geotechnical works for the development of the interstate terminal area;
- construction of the southbound rail connection for service the interstate terminal (in the case of the central rail access option this involves the construction of a new bridge structure over Georges River);
- utility connections and additional minor drainage works to connection to major utilities and drainage installed during Project Phase A and Project Phase B;
- construction of rail infrastructure for interstate terminal, including rail-mounted gantry lines;
- construction of interstate terminal buildings and associated facilities including maintenance facility, administration, car parking and fuel storage;
- construction of additional 50,000 sq. m of warehousing buildings, hardstands and car parking;
- construction of internal roads;
- construction of pavements and hardstand;
- construction of retaining walls;
- installation of noise attenuation infrastructure;
- landscaping; and
- lighting.

As all Aboriginal sites will have been impacted by the previous stage of work these phases will see little or no additional impacts to Aboriginal sites.

13.2 Impacts to Aboriginal recordings

As discussed above in Section 12.3, the Georges River Corridor and terraces meets the threshold for listing on the Commonwealth Heritage List. Figures 13.1a, b and c show the extent of proposed impacts within this area.

As demonstrated in Figures 13.1 a-c the proposed Moorebank IMT would impact less than a quarter of the Tertiary terrace margins within the study area that are identified to be archaeologically sensitive. Moreover, the Project would impact an even smaller portion of the Georges River riparian corridor. This means that the proposed Moorebank IMT construction footprint primarily corresponds to areas of low archaeological potential that are not assessed to be of heritage significance.

Table 13.1 summarises the nature and extent of potential impacts to recorded Aboriginal sites that would result from the three current Moorebank IMT concept design (northern, central and southern rail option layouts). A visual representation of the location of Aboriginal recordings relative to the proposed construction footprint is provided in Figures 13.1 a-c.

Table 13.1 Impact Assessment

Site Number	Rail access option	Type of Harm	Degree of Harm	Consequence of Harm
Georges River Corridor and terraces	Northern	partly within construction footprint on western bank	partially impacted	potential destruction part of site
	Central	partly within construction footprint on eastern and western banks	partially impacted	potential destruction part of site
	Southern	partly within construction footprint on eastern and western banks	partially impacted	potential destruction part of site
MA1	Northern	partly within construction footprint	partially impacted	potential destruction of part of site
	Central	partly within construction footprint	partially impacted	potential destruction of part of site
	Southern	within conservation zone	not impacted	nil
MA2	Northern	within construction footprint	directly impacted	potential destruction of whole or part of site
	Central	within construction footprint	directly impacted	potential destruction of whole or part of site
	Southern	within construction footprint	directly impacted	potential destruction of whole or part of site
MA3	Northern	within conservation zone	directly impacted	potential destruction of whole or part of site
	Central	within conservation zone	directly impacted	potential destruction of whole or part of site
	Southern	within conservation zone	directly impacted	potential destruction of whole or part of site
MA4	Northern	within conservation	directly impacted	potential destruction of whole or part of site
	Central	within conservation zone	directly impacted	potential destruction of whole or part of site
	Southern	within construction footprint	directly impacted	potential destruction of whole or part of site
MA5	Northern	within construction footprint	directly impacted	potential destruction of whole or part of site
	Central	within construction footprint	directly impacted	potential destruction of whole or part of site
	Southern	within construction footprint	directly impacted	potential destruction of whole or part of site

Site Number	Rail access option	Type of Harm	Degree of Harm	Consequence of Harm
MA6	Northern	within conservation zone	not impacted	nil
	Central	within construction footprint	directly impacted	potential destruction of whole or part of site
	Southern	within construction footprint	directly impacted	potential destruction of whole or part of site
MA7	Northern	within conservation zone	not impacted	nil
	Central	within conservation zone	not impacted	nil
	Southern	within construction footprint	directly impacted	potential destruction of whole or part of site
MA8	Northern	within conservation zone	not impacted	nil
	Central	within conservation zone	not impacted	nil
	Southern	within conservation zone	not impacted	nil
MA9	Northern	within construction footprint	directly impacted	potential destruction of whole or part of site
	Central	within construction footprint	directly impacted	potential destruction of whole or part of site
	Southern	within construction footprint	directly impacted	potential destruction of whole or part of site
MA10	Northern	within construction footprint	directly impacted	potential destruction of whole or part of the site (deposit is likely to extend to the north and south beyond the construction footprint)
	Central	within conservation zone	not impacted	nil
	Southern	within construction footprint	directly impacted	potential destruction of whole or part of the site (deposit is likely to extend to the north and south beyond the construction footprint)
MA11	Northern	within construction footprint	directly impacted	potential destruction of whole or part of site
	Central	within conservation zone	not impacted	nil
	Southern	within conservation zone	not impacted	nil

Site Number	Rail access option	Type of Harm	Degree of Harm	Consequence of Harm
MA12	Northern	within construction footprint	directly impacted	potential destruction of whole or part of site
	Central	within conservation zone	not impacted	nil
	Southern	within conservation zone	not impacted	nil
MA13	Northern	within construction footprint	directly impacted	potential destruction of whole or part of site
	Central	within conservation zone	not impacted	nil
	Southern	within conservation zone	not impacted	nil
MRSA2	Northern	within construction footprint;	directly impacted	potential destruction of whole or part of site
	Central	within construction footprint;	directly impacted	potential destruction of whole or part of site
	Southern	within construction footprint;	directly impacted	potential destruction of whole or part of site
MAPAD2	Northern	within construction footprint;	directly impacted	potential destruction of whole or part of site
	Central	within conservation zone	not impacted	nil
	Southern	within conservation zone	not impacted	nil

13.3 Impacts associated with rail spur options

The impacts to sites from the Project for each rail option are outlined in Table 13.2 and Figures 13.1 a-c.

Each option will impact the east and west banks of the Georges River, however the extent of impacts to the Georges River corridor and individual sites varies across each option. The only exception is MA9, which would have the same level of impacts across all three options.

In general terms, the northern option would result in direct impacts to the greatest number of sites and potentially the greatest impacts within any intact deposits along the Georges River corridor. The central option would result in the least amount of direct impacts to sites, however there would still potentially be impacts to intact deposits on both sides of the Georges River. The southern option on the other hand has the least potential to impact intact deposits along the river but would result in the most extensive impacts to high value sites such as MA5, MA6 and MA7.

13.3.1 Northern option

The northern option would result in direct impacts to the greatest number of sites (10), however it should be noted there would in this instance be no direct impacts to the three identified scarred trees (MA6-8) or artefact occurrences MA3 and MA4. All other sites and sensitive landforms would have direct impacts, albeit partial impacts to the Georges River Corridor, MA5, MA9, MRSA2 and MAPAD2.

13.3.2 Central option

The central option would result in direct impacts to only six sites and portions of the eastern and western banks of the Georges River. There would be no direct impacts to scarred trees MA7 and MA8 or artefact occurrences MA1, MA3, MA4, MA10, MA11, MA12 and MA13. Direct impacts would occur at scarred tree MA6, isolated find MA2 and portions of MA5, MA9, MRSA2 and MAPAD2. There would also be limited impacts within areas of potentially intact deposits on both sides of the Georges River.

13.3.3 Southern option

The southern option would result in direct impacts to eight sites and very limited portions of identified sensitive landforms within the Georges River Corridor. There would be no direct impacts to scarred tree MA8 or artefact occurrences MA1, MA3, MA10, MA11, MA12 and MA13. Direct impacts would occur to scarred trees MA6 and MA7, artefact occurrences MA2, MA4 and MA5, and portions of MA9, MA10 and MRSA2. Impacts within the Georges River Corridor would largely be within areas of previous disturbance, particularly on the west bank. This option has the least potential for disturbance to any intact subsurface deposits along the Georges River corridor.

Table 13.2 Summary of impacts for each rail access option

Rail access option	Directly impacted	Within a conservation area
Northern	Georges River Corridor west bank MA1 MA2 MA5 (partial) MA9 (partial) MA10 MA11 MA12 MA13 MRSA2 (partial) MAPAD2 (partial)	MA3 MA4 MA5 (partial) MA6 MA7 MA8 MA9 (partial) MRSA2 (partial) MAPAD2 (partial)

Rail access option	Directly impacted	Within a conservation area
Central	Georges River Corridor east and west bank MA2 MA5 MA6 MA9 (partial) MRSA2 (partial) MAPAD2 (partial)	MA1 MA3 MA4 MA5 (partial) MA7 MA8 MA9 (partial) MA10 MA11 MA12 MA13 MRSA2 (partial) MAPAD2 (partial)
Southern	Georges River Corridor east and west bank MA2 MA4 MA5 MA6 MA7 MA9 (partial) MA10 (partial) MRSA2 (partial)	MA1 MA3 MA8 MA9 (partial) MA10 (partial) MA11 MA12 MA13 MRSA2 (partial) MAPAD2

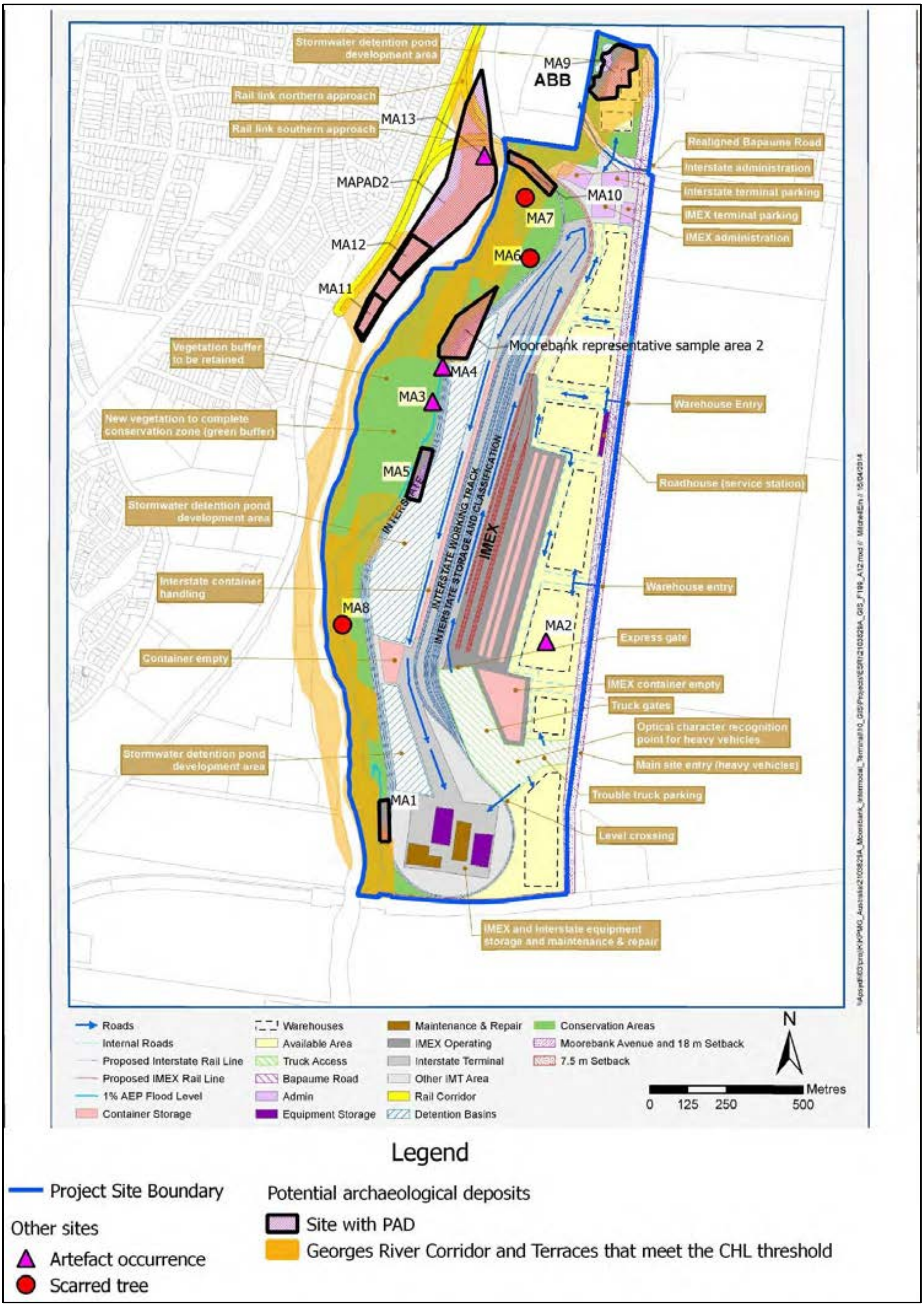

Figure 13.1a Location of recorded Aboriginal sites and remaining untested sample areas relative to the Moorebank IMT proposed construction footprint and archaeologically sensitive landforms – northern rail access option.

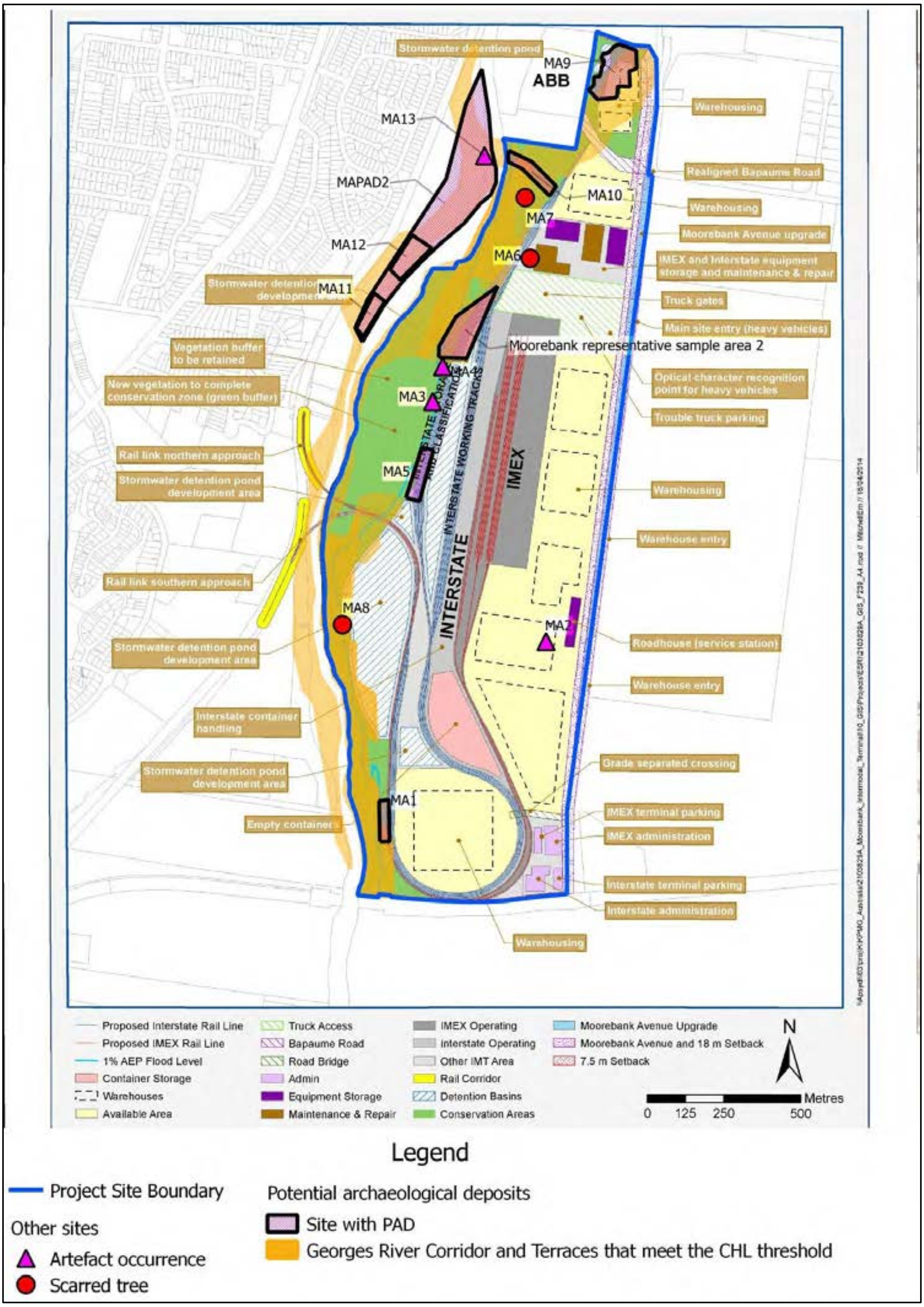

Figure 13.1b Location of recorded Aboriginal sites and remaining untested sample areas relative to the Moorebank IMT proposed construction footprint and archaeologically sensitive landforms – central rail access option.

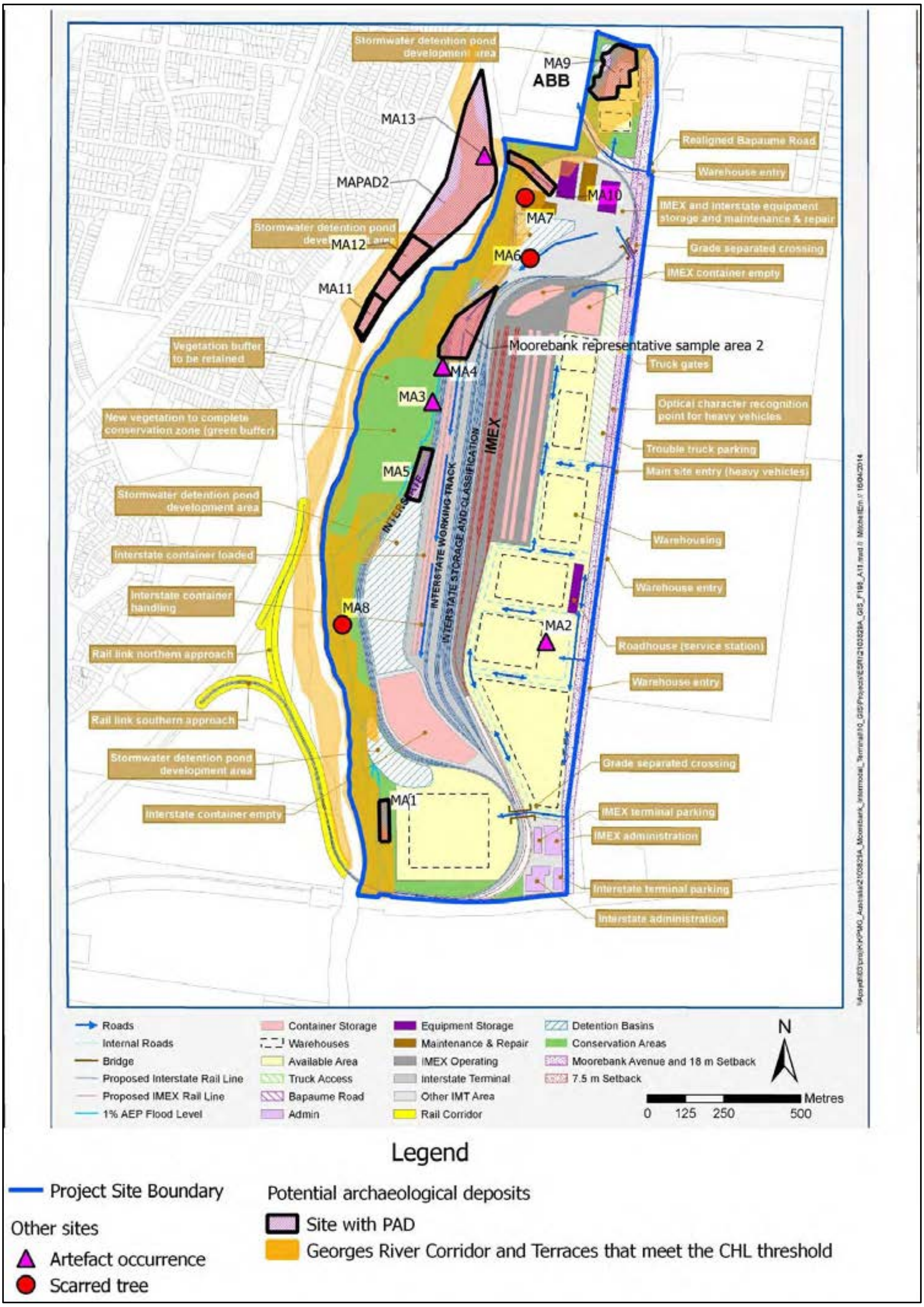

Figure 13.1c Location of recorded Aboriginal sites and remaining untested sample areas relative to the Moorebank IMT proposed construction footprint and archaeologically sensitive landforms – southern rail access option.

14. MANAGEMENT AND MITIGATION STRATEGIES

The proposed concept master plan for the Moorebank Intermodal Terminal has the potential to directly impact the majority of the identified Aboriginal sites within the study area. Further assessment of the potential impacts of the Project and more detailed development of mitigation measures would be conducted during the detailed design phase of the Project.

Given that the proposed impacts to Aboriginal heritage have the potential to result in the loss of heritage values, a range of mitigation strategies need to be considered and implemented where applicable, i.e. where it is not practicable to avoid impacts, mitigation strategies will help minimise and/or offset the loss of heritage values.

14.1 Basis for mitigation measures

One of the primary research questions that drove this heritage assessment, including both the survey and excavation components, was the question of how the proposed development impact of the Project on any significant Aboriginal heritage values might be effectively avoided or mitigated.

The following mitigation measures are considered appropriate to manage the impacts of the Project:

- Conservation areas
- Interpretation
- Additional Testing of Archaeological Deposits
- A stepwise strategy - phased improvement of the information base for Heritage assessment of significance and mitigative planning at Northern Powerhouse land (Moorebank IMT)
- Specialist analysis of Scarred trees
- Salvage of archaeological deposits
- Surface salvage of Aboriginal objects
- Care and management of recovered artefacts

14.1.1 Conservation areas

The concept design for the Project has proposed a conservation area/vegetation buffer zone between the Georges River and the proposed IMT developed lands. This zone includes a majority of the eastern river bank and lower flats, and the scarred tree at MA8. As such, the buffer would conserve the predicted archaeological resource of the banks and lower flats, and MA8. Despite this, the currently defined buffer only includes limited portions of the river-side terrace margin and the northern lake basin. These inclusions are not enough to protect the known archaeological deposits and sites of moderate or greater significance on these landforms, notably MA5, and MA9. In addition site MA6 is impacted by the central rail option and MA7 by the southern rail option.

Opinions provided by registered Aboriginal parties during the site visit, ensuing fieldwork and subsequent written correspondence indicated that site MA9 (MAPAD1) is considered to be an area of cultural significance. The *in situ* conservation of this area was raised by the RAPs as their preferred option for this site.

Options during detailed design should consider the possibility of establishing a 20 m buffer along the eastern edge of the identified PAD at MA9.

If avoidance of impacts at MA9 (MAPAD1) is not practicable, salvage excavations within affected portions of the site would be necessary.

The scarred trees at MA6 and MA7 have similarly been identified by the RAPs as items of considerable Aboriginal significance that should be considered for conservation. If avoidance of impacts at MA6 and MA7 is not practicable, appropriate mitigation strategies should be developed in consultation with the Aboriginal community.

Consideration should be given at the detailed design stage to the *in situ* conservation of all sites of moderate to high or greater significance. The optimal strategy for realising this objective would be to extend the boundaries of the vegetation buffer to include these areas. Other options would be conservation within the development area by reserving and delineating the site area as open space and maintaining minimal disturbance. All sites should be identified on relevant construction plans and demarcated by physical fencing during the construction phase of the Project so that no inadvertent impact occurs.

14.1.2 Interpretation

The Project area contains both tangible and intangible Aboriginal cultural values. Physical conservation and salvage strategies can mitigate impact to the tangible resource (such as Aboriginal objects and archaeological deposits), but can be ineffective at addressing intangible values. The latter includes traditions and cultural values related to place, custodial practise, history, and memory. Such values can be maintained through recognition, the telling of stories and the use of names.

In order to address impact to intangible values, it is proposed to develop an Aboriginal heritage interpretation strategy for the Project. The strategy may consider the inclusion of commemorative signage within the Project area, and/or the development of a visitor's pamphlet detailing the past Aboriginal use of the area and the Project areas current connection with local Aboriginal people. This information can also be included on web sites and other public documents. The naming of elements within the Project area such as roads and buildings could also be a way of acknowledging the past Aboriginal use and current connection to the site.

The Aboriginal heritage interpretation strategy should be developed in close consultation with the RAPs for the Project. The strategy should be mindful not to draw attention to the physical location of vulnerable sites within the project area. The strategy could consider combining both European and Aboriginal interpretation within the project area.

14.1.3 Additional Testing of archaeological deposits

Occupational health and safety and land access constraints prevented archaeological testing within MRSA2, the western component of MA10 and section of the Georges River corridor impacted by the central and southern rail access options. The investigation of MAPAD2 indicates that further investigation of the archaeological deposits is required. This is detailed in the stepwise strategy below.

Based on investigations detailed in this report, in particular the results of subsurface testing of the Tertiary terrace, the full scope of salvage excavations will need to be informed by a program of archaeological subsurface testing within MRSA2, the western component of MA10 and if impacted the central or southern section of the Georges River corridor (Figure 13.1). The extent of such testing and salvage will be determined during detailed design when the exact nature of development impact can be defined.

14.1.4 A stepwise strategy - phased improvement of the information base for heritage assessment of significance and mitigative planning at Northern Powerhouse land (Moorebank IMT).

It is neither sensible nor practicable to attempt to predict with certainty archaeological site presence/absence under deeply stratified (and water logged) alluvium. A sound approach, which will aim to meet due diligence criteria, and final EIS guidelines under the EPBC and E&PA, is to progressively acquire information at a generic level. Ideally this process will simultaneously:

- Improve description and ranking of environmental values and cultural heritage values

- Interact with scheme design to reduce the need for expensive archaeological salvage interventions and aid preservation of sensitive valued stratigraphy *in situ*.

- Provide security of timeline planning for both concept design, geotechnical investigations and engineering design process.

- Acquire information and data in formats which a) inform design decisions by adequately filling knowledge gaps in timely manner b) archive that data to inform community consultation, educational and public outreach outcomes, and c) which ideally may feed in to medium term social and community benefits and yield long-term(archived) heritage resources in the public domain.

The study area shows considerable potential for high heritage significance as an archive of floodplain change, across historic and prehistoric timescales, and cultural historic, prehistoric and natural values.

However, significant unknowns include:

- Time periods represented in the buried floodplain

- Preservation conditions above and below the water table

- Past environments present/absent in the sequence

- The presence/absence of earlier Holocene deposits eg mangrove/saltmarsh at depth (e.g. perhaps at +1.5 to -3.0m AHD). Such deposits would, as records of environmental change, add to the heritage significance of the sequence. Such data would also be important to recognise as part of geotechnical considerations – as likely Acid Sulphate Soils (ASS).

- Presence/absence of significant rare deposits e.g. buried soils predating sea level rise/transgression up valley 7000 years ago; last interglacial deposits.

The case for further investigation of the buried floodplain surface, and the unknown unconsolidated deposits beneath (over rockhead) emerges as a mitigation issue for careful consideration. The merits and justifications for this also hinge on:

a) on the nature and scale of the impacts on this surface by the proposed scheme

b) the extent of the deposit under threat

c) the engineering procedures (e.g. dewatering/piling) that may form part of the scheme design impacting on the deposits

d) the likelihood of similar deposits sequences existing elsewhere, in areas likely to be preserved e) the degree to which the deposit sequences are demonstrably unique, in the Georges River, when compared to other river-estuarine areas in the broader area.

Early assessment of geotechnical data from an archaeological perspective is an advisable pathway to follow, to aid informed mitigation design, and as due diligence. Some dating of the deposit sequence would also greatly assist the evaluation of significance of the lower deposit sequence, and define the need for phased mitigation.

Table 14.1 illustrates a range of mitigative options and approaches which may need to be considered in order to adequately assess and archive the heritage values of the alluvial sequence at the study site. These are ordered according to a structure which will progressively build information, in a timely manner. It also offers a means of planning mitigation in a phased, progressive and cost-effective manner.

14.1.5 Specialist analysis of the scarred trees

Three scarred trees of possible Aboriginal origin have been identified within the study area. One of these, MA8, is outside the proposed construction footprint and will not be impacted, whereas MA7 is immediately adjacent the proposed construction footprint and will be directly impacted by the southern rail option. MA6 will be impacted by the central and southern rail options. The archaeological evidence, gathered through field survey, regarding the origin of the scars at these recordings is inconclusive. Opinions from the registered Aboriginal parties who have inspected the trees are also mixed. However the CBNTCAC, DCAC and DALI groups have all emphasised the cultural significance of these trees. The importance of the Aboriginal community being given the right to decide appropriate levels of investigation and mitigation has also been highlighted by DCAC.

While the archaeological assessment, based on non-intrusive survey, is inconclusive, consultation with the Aboriginal community suggests that these trees are of high cultural significance to the CBNTCAC, DCAC and DALI groups.

In order to provide further direction on the required scope of impact mitigation it is recommended that extensive consultation be undertaken with the Aboriginal community regarding the management of these trees. Options that might be presented to the Aboriginal community include: explore the opportunities that exist within the detailed design phase for conservation of MA6 and MA7; if conservation is not practicable, consult with the RAPs regarding alternative mitigation options (relocation and preservation of a portion of the tree, development of interpretive strategies); and a suitably qualified specialist in eucalypts of the Sydney region and dendrochronology be engaged to formally assess the age of the trees and their scars.

It should be noted that specialist investigation requires direct impact to the scar and its re-growth therefore this strategy is best implemented at detailed design stage when the exact nature of development impact can be defined and investigations involving direct impacts to the tree may be justified.

14.1.6 Salvage of archaeological deposits

MA5 and MA9 contain archaeological deposits of moderate to high archaeological/scientific significance. In addition geomorphological analysis indicates that sequence preservation is demonstrated at these sites. These sites will be directly impacted by the Project. An archaeological salvage program would mitigate this impact. Figure 13.1 shows the portions of these sites that would warrant salvage excavation under the current concept plan.

Given that these sites display archaeological and geomorphological value, and given that geomorphological analysis will assist in interpretation of the archaeology, it would be valuable to combine archaeological and geomorphological mitigation measures, as outlined in the technical report at Appendix 3. It should also be noted that the geomorphology report outlines ways in which such mitigation measures might be streamlined (e.g. through access to existing geotechnical data and the use of machinery to strip fill across salvage areas).

MA1 comprises disturbed deposits with isolated pockets of relatively undisturbed archaeological deposits containing low areal incidence of artefacts. The research value at this site is low; it is assessed to be of low archaeological/scientific significance. This site will be directly impacted by the northern and central rail options. However, given the limited research potential at this site, no further mitigation measures are warranted at MA1.

The eastern component of MA10 (MRSA1) comprises sections of disturbed deposits as well as areas of relatively undisturbed archaeological deposits. However, these deposits contain a low areal incidence of artefacts, so the research value across the eastern portion of this site is low and is assessed to be of low archaeological/scientific significance. This site will be directly impacted by the southern rail option. No further mitigation measures are warranted across the eastern portion of MA10, where testing has already been conducted.

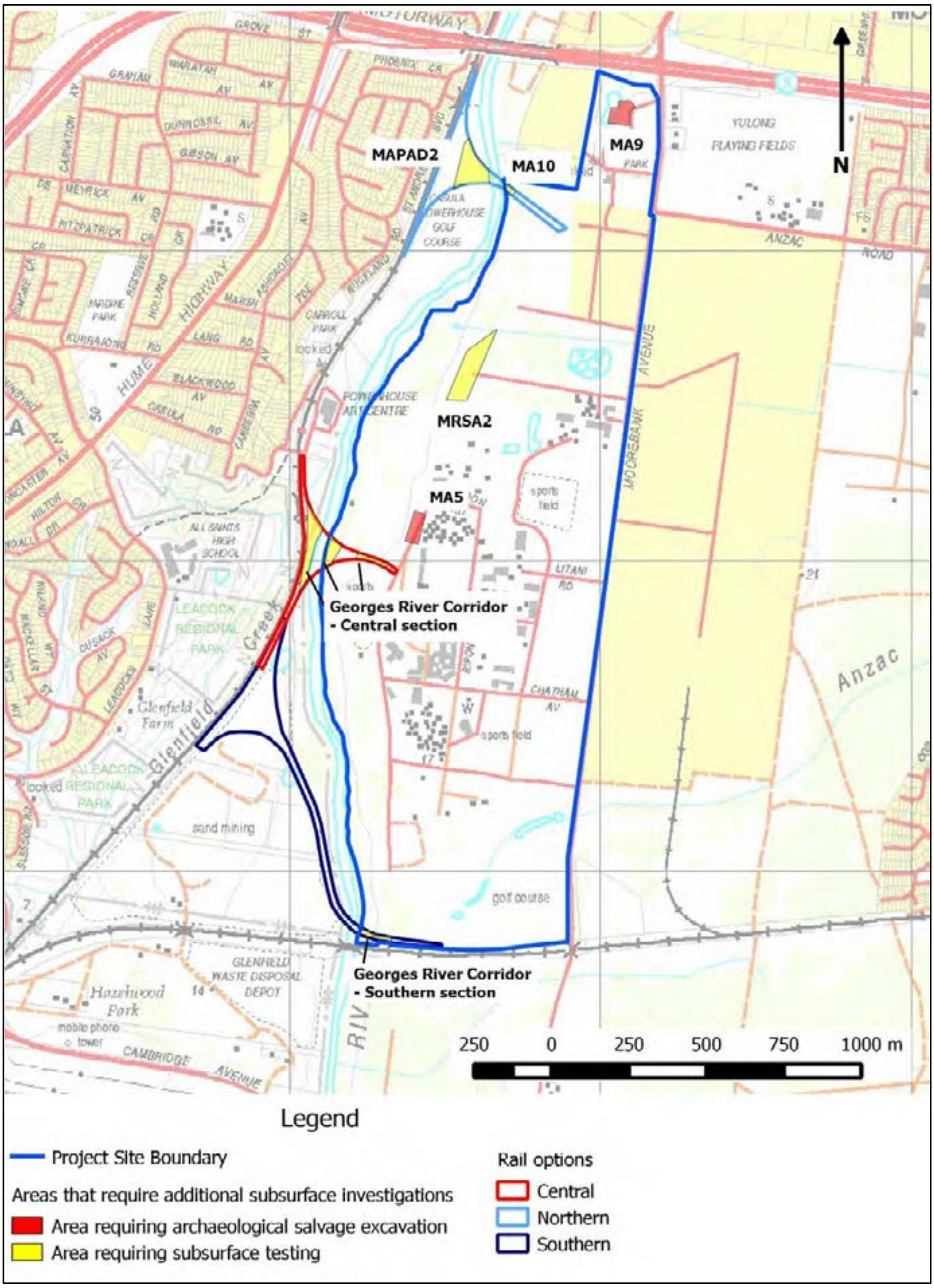

Figure 14.1 Areas that will require additional subsurface testing and/or archaeological salvage excavation

14.1.7 Surface salvage of Aboriginal objects

Recordings MA1, MA2, MA3, MA4 and MA5 all included surface artefacts (see Figure 13a-c). Site MA1 will be impacted by the northern and central rail options, MA2 and MA5 will be impacted by all options and MA4 will be impacted by the southern rail option. Sites MA3 will not be impacted.

If directly impacted the mitigation measure applicable to these sites is the conduct of a surface salvage program. If not impacted these sites should be fenced during all construction activities in their vicinity and clearly marked on all-onsite plans and maps.

14.1.8 Care and management of recovered artefacts

After examination and measurement, all recovered artefacts have been stored individually in standard resealable plastic bags. These containers are labelled in permanent black pen with the item's unique identification number (where generated and appropriate), and/or details of its provenance within the excavation (as appropriate).

The containers will be stored at the NOHC laboratory until the final location of the artefacts is decided.

It is proposed that all Aboriginal objects be repositioned back into the landscape ('returned to country') within reserved open space, in as close a position (as is feasible and safe) to their original find locations. Suitable locations would include those sections of the Georges River corridor that will not be impacted by the construction footprint (Figure 12.1). Ongoing consultation with the registered Aboriginal parties would be necessary in order to secure agreement on the exact location(s). This will also be informed by the subsequent detailed design stages of the Project.

The manner, format and containment of the artefact repositioning would be subject to agreement by the registered Aboriginal parties.

All locations of repositioned artefacts would be recorded on appropriate OEH forms and lodged with the AHIMS, administered by OEH.

In the event that the registered Aboriginal parties resolve to retain some (or all of the artefacts) in the care and custody of one or more individuals or organisations, then this would be subject to the approval of a Care Agreement by the OEH.

In the event that there is no agreement or consensus by the registered Aboriginal parties regarding the long term management of the recovered artefacts, then an application will be made to the Australian Museum (Sydney) for lodgement of the collection. If this application is rejected, then a management solution will be finalised through negotiation between the Moorebank Project Office, Department of Defence, OEH and the Registered Aboriginal Parties.

14.1.9 Rail access options

Northern rail access option

The proposed concept master plan for the Moorebank IMT has the potential to directly impact the majority of the identified Aboriginal sites within the northern rail access option study area. Further assessment of the potential impacts of the Project and more detailed development of mitigation measures would be conducted during the detailed design phase of the Project.

Given that the proposed impacts to Aboriginal heritage have the potential to result in the loss of heritage values, a range of mitigation strategies need to be considered and implemented where applicable, i.e. where it is not practicable to avoid impacts, mitigation strategies will help minimise and/or offset the loss of heritage values.

Table 14.1 illustrates a range of mitigative options and approaches which may need to be considered in order to adequately assess and archive the heritage values of the alluvial sequence at the study site. These are ordered according to a structure which will progressively build information, in a timely manner. It also offers a means of planning mitigation in a phased, progressive and cost-effective manner.

Central rail access option

Surface survey indicates that it is likely that flood deposits on the eastern and western banks of the Georges River, within the central rail access option study area, may be similar to what was found during the northern Powerhouse land testing. Further investigation through a program of archaeological subsurface testing is required to effectively assess the nature, extent and significance of any deposits that may be impacted by this option. On the basis of what was found during the northern Powerhouse testing program any methodology should include strategies for testing the first metre of deposits and deposits at depth incorporating strategies outlined in Table 14.1.

Southern rail access option

Surface survey indicates that it is however unclear whether or not the eastern river bank within the southern rail access option study area may comprise relatively recent flood deposits, as is indicated within the northern Powerhouse lands (NOHC 2014a), that may cap a relatively intact pre-European land surface at depth. The potential for archaeological evidence within relatively intact deposits at depth cannot be excluded, and as such this area is categorised on a precautionary basis as archaeologically sensitive. Further assessment of the nature and depth of these deposits would be necessary in order to fully assess their archaeological potential. Additional investigation through a combined archaeological and geotechnical program should be undertaken. Geotechnical data should be used in the first instance to understand the nature of deposits at depth, to determine whether or not they are similar to the northern Powerhouse deposits. The need for further archaeological investigation will be determined through this process.

Table 14.1 Phased Heritage Approach for consideration at Northern Powerhouse land. This applies to the Northern Powerhouse land only.

Phase A: Immediate/early Priority tasks These tasks aim to refine the knowledge base and remove knowledge gaps/risk to scheme. Some tasks are prioritized as early land access is essential. Some tasks might be aligned to coincide with other project tasks e.g. contaminated land/ASS/geotechnical investigations. Not all options may be required. Others might be identified.

Task Code	Task/activity	Knowledge gap	Decision trigger	Approach	Heritage outcomes
A1	Topographic surface and subsurface mapping (DTM model) to AHD	Precision on present flood inundation and historic flood inundation datums	Adequacy of present interpretive model + heritage significance assessment improvement	Desk top integration of client/project data and heritage field survey data	Baseline mapping of surface improved prediction of deposits at depth/preservation
A2	Desktop research of boreholes from study area and adjacent lands	Areal extent of similar deposits and sequence stratigraphy at depth/depth to rockhead	Adequacy of present interpretive model + heritage significance assessment improvement	Desk top integration of client/project data and heritage field survey data	Three 3-D visualization of deposit sequence in study + preservation conditions at depth
A3A	Purposive bulk sampling of buried floodplain surface at defined high points under levee	Preservation conditions + artefact presence/absence on buried floodplain	Adequacy of present data /interpretive model + heritage significance assessment improvement	Bulk sampling with powered auger mud bucket	Quantification and recovery for archive of artefacts/plant remains/charcoals/midden remains
A3B	Drilling for undisturbed core samples	Sequence properties through deposits and past environments preserved (to rockhead)	Adequacy of present data /interpretive model + heritage significance assessment improvement	Hydraulic drill recovery of 1m lengths of undisturbed core + assessment of potential of core	Archive sample of complete sequence (research archive) + preliminary data on preservation at depth (scopes possibility of detailed environment record).

Task Code	Task/activity	Knowledge gap	Decision trigger	Approach	Heritage outcomes
A4	Radiocarbon dating	Age of buried floodplain sequence	Adequacy of present data /interpretive model + heritage significance assessment improvement	Accelerator Mass Spectrometry (AMS) dating of charcoal /organics from well-defined contexts	Improved certainty over age /depth properties of buried floodplain Significance assessment completion
A5	Core scanning	Suitability/justification for sequence having very high significance/ heritage values	Adequacy of data – design of salvage options/requirements	ITRAX core scanning – X radiographic imaging, magnetic susceptibility	Options for preservation through archive of representative sequence and/or decision on need for any further investigations/mitigation
A6	Data synthesis from Group A tasks	Requirements for mitigation	Approvals process milestone	Report completion	Milestone advice on requirements for further investigations/mitigation based on Group A tasks completed.

Phase B: Intermediate – medium term tasks These tasks will normally be triggered by results and knowledge outcomes, achieved in Phase A. A raising of heritage significance through information developed in Phase A will be the expected trigger. Tasks at this stage are indicative – not all would be expected to be triggered.

Task Code	Task/activity	Knowledge gap	Decision trigger	Approach	Heritage outcomes
B1	Paleo-environmental analysis e.g. of microfossils/ macrofossils in deposits	Specification of past environmental changes and events identified in the deep alluvial sequence – deemed heritage significant	Demonstration through prior assessment (phase A) that high quality proxy data are preserved and sequence has high heritage significance/natural and cultural values	Analysis by specialist	Proxy narratives of floodplain environmental change through time and human interactions with the ecologies and habitats identified. Preservation through analysis and archive. Feeds into the overall interpretation strategy.
B2	Radiocarbon dating	Ages of defined contexts of significance – calibration of floodplain sequence development and proxy environmental records eg pollen and charcoal sequences in the floodplain record.	Demonstrated significance of the deposit/context and need to define age	Accelerator Mass Spectrometry (AMS) dating of charcoal /organics from target levels and events in the deposits – commercial laboratory	Improved certainty over age /depth properties of buried floodplain and past environments/events Completion of narrative of changes in floodplain ecology; human use of floodplain; ecological changes dated. Feeds into the overall interpretation strategy

Task Code	Task/activity	Knowledge gap	Decision trigger	Approach	Heritage outcomes
B3	Open area excavation of large plan areas at depth near watertable	Requirement to salvage and archive properties of a highly significant object/context by hand excavation	Excavation salvage preferred over conservation *in situ* of identified remains/contexts – highly significant / sensitive context (e.g. buried levee with signs of bone preservation/burials)	Coffer dam protected excavations with pumps	Preservation through excavation and archive Feeds into the overall interpretation strategy
B4	Post-excavation analysis, finds analysis, AMS dating, and public dissemination of results from major excavation of buried floodplain surface	Requirement to salvage and archive properties of a highly significant object/context by hand excavation - in preference to scheme redesign or conservation *in situ*	Excavation salvage preferred over conservation *in situ* of identified remains/contexts Exceptional levels of impact on pre-determined contexts of national/international significance	Multi-skilled team delivering project analysis and write up to publication.	Preservation through excavation and archive + wide public dissemination of results. Feeds into the overall interpretation strategy
B5	Site avoidance	Uncertainty of number or extent of sites, or absence of salvage options in areas where high sensitivity is proven	Determination that preservation *in situ* is optimum scheme design	Engineering and geotechnical project team design reduced impacts on subsurface deposits at risk – including e.g. avoidance of dewatering/vibrocoring impacts etc.in buffer zone around deposits at risk	Long term preservation *in situ* + monitoring of groundwater with remediation planning and/or groundwater intervention options (pumped water; pH control)

Phase C: Advanced tasks –high level/high impact/ high significance mitigation tasks These tasks will be triggered only by exceptional circumstances such as unexpected finds of international /national heritage significance (e.g. discovery of *in situ* 1820s boat preserved on the floodplain surface, or human burials on floodplain levees) or by scheme design/ impact resulting in complete destruction of highly significant deposits/sites. Normally the phased design approach should prevent Phase C tasks being triggered (e.g. by scheme design avoidance of high impacts or design of adequate preservation *in situ*) or at least prevent unscheduled interventions.

Tasks at this stage are indicative – few would be expected to be triggered.

Task Code	Task/activity	Knowledge gap	Decision trigger	Approach	Heritage outcomes
C1	Open area excavation of large plan areas at depth near water table	Requirement to salvage and archive properties of a highly significant object/context by hand excavation	Inadvertent discovery or exceptional levels of impact on pre-determined contexts of national/international significance	Coffer dam protected excavations with pumps	Preservation through excavation and archive Feeds into the overall interpretation strategy
C2	Post-excavation analysis, finds analysis, AMS dating, and public dissemination of results from major excavation of buried floodplain surface	Requirement to salvage and archive properties of a highly significant object/context by hand excavation	Inadvertent discovery or exceptional levels of impact on pre-determined contexts of national/international significance	Multi-skilled team delivering project analysis and write up to publication.	Preservation through excavation and archive + wide public dissemination of results. Feeds into the overall interpretation strategy
C3	Conservation of remains form excavation – possibly involving specialist techniques to conserve wood, or skeletal remains including tissue.	Not applicable	Location of archaeological materials through excavation	Delivery by specialists in analysis of human remains, wood remains and conservation	Museum curation, conservation and possible display, or curation in keeping places, or re-burial. Feeds into the overall interpretation strategy

C4	Engineered and monitored stability conditions at depth	Not applicable	Location of archaeological materials through excavation	Geotechnical interventions to maintain in situ preservation at depth e.g. by coffer dam protection of areas with maintained redox/pH/throughflow/ dissolved oxygen saturation conditions	In situ preservation

14.1.9 Effectiveness of mitigation measures

During the current assessment, various measures to avoid and mitigate harm have been considered. However, there are very limited options in terms of altering the Project impact area.

The majority of the Project area is within landscape units identified as having low archaeological and/or cultural significance, thus it will result in minimum harm to landscape features that have been assessed as being archaeologically and culturally significant. As such, the mitigation measures proposed above have been developed with a focus on mitigating impacts in those areas of greatest heritage significance.

The mitigation strategies endeavour to ensure the long term security of Aboriginal objects within the Project area through specialist investigations, artefact collection and comprehensive programs of subsurface testing and salvage excavations within archaeologically sensitive areas. These measures will maximise information yielded from impacted sites as well as ensuring retention of such information for future generations.

Any direct harm to Aboriginal heritage resulting from the Moorebank IMT will effectively be offset by the physical salvage of Aboriginal objects within the Project area and the interpretation of the archaeological record recovered during future phases of investigation. The Aboriginal interpretation strategy will mitigate against the loss of the intangible cultural values associated with the site. Moreover, the detailed design phase of the Project may also present additional opportunities to identify areas for conservation, thus further mitigating any impacts.

While the heritage significance of MAPAD2, and other sections of the Georges River corridor that may be impacted by the various rail access options, have not yet been fully determined, the approach outlined in Table 14.1 includes a comprehensive range of strategies that would adequately mitigate heritage impacts at a number of levels.

Most importantly impacts to Units 1 and 2 will be partial in the first instance and opportunities to limit impacts are available.

There are no heritage constraints posed by the Project that cannot be mitigated using the phased approach outlined above.

14.2 Impact Mitigation

For the Project it is recommended that:

- Where practicable, explore options in the detailed design stage to conserve *in situ* sites of moderate to high or greater significance;

- An Aboriginal heritage interpretation strategy for the Project should be developed in close consultation with the registered Aboriginal parties. The strategy could consider combining both European and Aboriginal interpretation within the Project area;

- A program of archaeological subsurface testing within MRSA2 and the western component of MA10 should be undertaken in order to inform the full scope of salvage excavations. The extent of such testing and salvage will be determined during detailed design when the exact nature of development impact can be defined. Planning for these investigations will need to include management of risks associated with snakes and impacts to Endangered Ecological Communities (EEC);

- If the northern rail access option is to go ahead then the following should be undertaken:

    - The phased approach to further investigations at MAPAD2 outlined above in Table 14.1 should be adopted.

    - Immediate further data gathering, in a stepped progressive build of information should be undertaken to fill the following knowledge gaps regarding MAPAD2:

        - desktop study (of geotechnical borehole data and levels);

        - drilling to recover undisturbed sediment core (for assessment and dating and as an archive sequence); and

        - subsurface bulk sample retrieval (using augered mud bucket) to assess preservation conditions and artefact presence/absence at depth.

    - Information recovered from future investigations at MAPAD2 should be incorporated into an Aboriginal heritage interpretation strategy for the project as a whole, developed in close consultation with the Registered Aboriginal parties. The strategy could consider combining both European and Aboriginal interpretation within the project area;

- If the central rail access option is to go ahead a program of Aboriginal subsurface archaeological investigation should be undertaken. The testing program would need to assess the upper metre of deposits as well as deposits at depth. An approach similar to that outlined in the northern Powerhouse land addendum report (NOHC 2014a) would be applicable to addressing the assessment of deposits at depth;

- If the southern rail access option is to go ahead a combined geotechnical and archaeological assessment should be undertaken to assess the nature of any deposit and the need for further archaeological investigation and/or salvage;

- Options for avoidance of impacts at MA6 and MA7 should be explored during the detailed design phase. If impacts cannot be avoided, consultation should be undertaken with the Aboriginal community regarding options for specialist investigations (e.g. a suitably qualified specialist in eucalypts of the Sydney region and dendrochronology be engaged to formally assess the age of the trees and their scars) and culturally appropriate mitigation strategies;

- MA5 and MA9 contain archaeological deposits of moderate to high archaeological significance. No impacts should occur at these locations without the prior conduct of archaeological salvage;
  - Consideration should be given to combine archaeological and geomorphological mitigation measures, as outlined in the technical report at Appendix 3.
  - Consideration should be given to conserving both sites *in situ,* within open space reserves, or an extension of the proposed vegetation buffer zone/conservation area. In particular consideration should be given to MA9 due to the existence of both unique remnant landscape features and subsurface archaeological deposits.
- Surface artefacts have been recorded at MA1, MA2, MA3 and MA4. Salvage of surface artefacts should be undertaken prior to any impacts in these areas;
- Consultation should be ongoing with the registered Aboriginal parties throughout the life of the Project and would include:
  - Consultation on the future care and management of recovered Aboriginal objects;
  - Methodologies for any future investigations;
  - Finalisation of management and mitigation strategies subject to detailed design; and
  - The provision for comments on a draft version of this report.
- No further archaeological investigations are warranted at MRSA3 or PAD2; and
- The unanticipated discoveries protocol at Appendix 10 should be followed in the event that Aboriginal objects or suspected burials are encountered during construction works.

15. REFERENCES

Australia ICOMOS 1987 The Australia Icomos Charter for the Conservation of Places of Cultural Significance (The Burra Charter), Guidelines to the Burra Charter: Cultural Significance and Conservation Policy. Pamphlet, Australia Icomos (Inc).

Archaeological & Heritage Management Solutions Pty Ltd (AHMS) 2012 Aboriginal Cultural Heritage Assessment [Final]. Appendix U In, *SIMTA Sydney Intermodal Terminal Alliance Part 3A Concept Application,* Hyder Consulting Pty Ltd.

Attenbrow, V. 1987 The Upper Mangrove Creek Catchment: A Study of Quantitative Changes in the Archaeological Record. Unpublished PhD Thesis. University of Sydney.

Axis Environmental/Australian Museum Business Services Consulting 1995 Holsworthy Training Area Environmental Audit, Main Report and Appendix 1. Report for the Department of Defence.

Bates, M.R., Barham, A.J., Pine, C.A. and Williamson, V.D. 2000 The use of borehole stratigraphic logs in archaeological evaluation strategies for deeply stratified alluvial areas. In: Roskams, S. (ed.) *Interpreting Stratigraphy: site evaluation, recording procedures and stratigraphic analysis, 49-69.* BAR International Series 910. Oxford: Archaeopress.

Beaton, J. M. 1985 “Evidence for a Coastal Occupation Time-Lag at Princess Charlotte Bay (North Queensland) and Implications for coastal Colonisation and Population Growth Theories for Aboriginal Australia” in *Archaeology in Oceania* 20(1):1-20.

Beesley, J. 1989 The Scarred Tree. Unpublished report to the Victoria Archaeological Survey, Melbourne.

Boot, P. 1990 Archaeological Survey of Proposed Defence Housing Authority Subdivision at Holsworthy, NSW. Report prepared for Kinhill Engineers Pty Ltd, Report by South-East Archaeology.

Boot, P. 1992 Archaeological survey of additions to Defence Housing Authority subdivision at Wattle Grove, NSW. Report prepared for Wattle Grove Development, Report by South-East Archaeology.

Boot, P. 1993 Artefact scatters at Wattle Grove, NSW. A report on results of archaeological salvage work conducted under the terms and conditions of consent to destroy and permit to salvage No. 514 issued on 26 August 1993 under the provisions of the National Parks and Wildlife Act 1974. Report to Wattle Grove Development.

Boot, P. 1994a Archaeological survey of Option 3 land, Defence Housing Authority sub-division at Wattle Grove, NSW. Report to Wattle Grove Development.

Boot, P. 1994b Monitoring of tree and topsoil removal from artefact scatters at Wattle Grove, NSW. A report on results of archaeological monitoring conducted under the terms and conditions of consents to destroy and permit to salvage Nos. 506 & 514 issued on 30 June 1993 and 26 August 1993 under the provisions of the National Parks and Wildlife Act 1974. Report to Wattle Grove Development.

Bradley, W. (1786-92). *A voyage to New South Wales; the journal of L.T. William Bradley RN of HMS Sirius*. Ms. A3631, Mitchell Library, Sydney. Published 1969 by William Dixon Foundation, Publication, Publication No. 11, Ure Smith Pty Ltd.

Brown, M.C. 2000 Cenozoic tectonics and landform evolution of the coast and adjacent highlands of southeast New South Wales. *Australian Journal of Earth Sciences* 47: 245-257.

Bryant, E.A., Young, R.W amd Price, D.M. 1989 Late Quaternary coastal landforms along the Illawarra coastline, NSW. In Dunkerley D.I. (ed.) *Australian and New Zealand Geomorphology Group – Fourth Conference, Abstracts*, pp 56-57. Department of Geography and Environmental Science, Monash University, Melbourne.

Bryant, E.A., Young, R.W. and Price, D.M. 1997 Late Pleistocene marine deposition and TL chronology of the New South Wales, Australian coastline. *Zeitshrift für Geomorphologie N.F. Band* 41(2): 205-227.

Bryant, E.A., Young, R.W., Price, D.M. and Short, S.A. 1990. Thermoluminescence and Uranium-Thorium chronologies of coastal landforms of the Illawarra region, New South Wales. *Australian Geographer* 21: 101-112.

Butlin, N.G. (1983). Our Original Aggression: *Aboriginal Populations of South-eastern Australia 1788-1850*. George Allen and Unwin, Sydney.

Butt, C.R.M., Scott,K.M., Cornelius, M. and Robertson,I.D.M. 2005 Sample media. Pp 53-79 In Butt, C.R.M., Scott, K.M., Cornelius, M. and Robertson, I.D.M. (eds) *Regolith expression of Australian Ore Systems.* CRC LEME: Perth.

Capell, A. (1970). "Aboriginal Languages in the South Central Coast, New South Wales: Fresh Discoveries" in Oceania 41(1) pp 20-27.

Cattle, S.R., Greene, R.S.B. and McPherson, A.A. 2009 The role of climate and local regolith-landscape processes in determining the pedological characteristics of æolian dust deposits across south-eastern Australia. *Quaternary International* 209 (1-2) 95-106

Chartres, C.J. and Walker, P.H. 1988 The effect of aeolian accession on soil development on granitic rocks in southeastern Australia.III Micromorphological and geochemical evidence of weathering and soil development. *Australian Journal of Soil Research* 26: 33-53.

Collins, D. (1798). *An Account of the English Colony in New South Wales: With Remarks on the Dispositions, Customs, Manners, etc of the Native Inhabitants of that Country*. Reprinted in 1975 by AH and AW Reed. Sydney.

Commonwealth Department of Finance and Deregulation (CDFD) Aug. 2011 Moorebank Intermodal Terminal – Existing Aboriginal and European Heritage. Prepared by Parsons Brinckerhoff, Sydney.

Commonwealth Department of Finance and Deregulation (CDFD) Dec. 2011 *Moorebank Intermodal Terminal Preliminary Project Environmental Overview in Support of the Application*. Prepared by Parsons Brinckerhoff.

Commonwealth Department of Finance and Deregulation (CDFD) Feb 2012 *Moorebank Intermodal Terminal Project, Detailed Business Case,* Prepared by KPMG and Parsons Brinckerhoff, Sydney.

Courty, M-A., Goldberg, P. and Macphail, R. 1989. *Soils and Micromorphology in Archaeology.* Cambridge University Press: Cambridge.

Cultural Heritage Connection 2006, Southern Sydney Freight Line Aboriginal Archaeological Assessment. Prepared by Vanessa Hardy for Parsons Brinkerhoff.

Dallas, M. and D. Steele 2004 Aboriginal Archaeological Survey of Department of Defence Lands at Moorebank. Report to GHD Pty Ltd on behalf of the Department of Defence.

Dames and Moore 1996 Environmental Management Plan for Liverpool Base Administrative Support Centre and School of Military Engineering.

Davidson, D.A. and Simpson, I.A. 2001 Archaeology and Soil Micromorphology. In Brothwell, D.R. and Pollard, A.M. (eds) *Handbook of Archaeological Science*, 167-177. Wiley Interscience: Chichester.

van Dijk, D.C. 1959 Soil Features in relation to erosional history in the vicinity of Canberra. CSIRO Australian Soil Publication No 13.

Department of Environment and Climate Change and Water (DECCW) 2005 *Interim* Guidelines *for Aboriginal Consultation.*

Department of Environment, Climate Change & Water (DECCW) 2010 *Aboriginal cultural heritage consultation requirements for proponents 2010, Part 6 National Parks and Wildlife Act 1974.* NWS Department of Environment, Climate Change & Water, Sydney.

Department of Infrastructure, Planning and Natural Resources (DIPNR) 2004 *Georges River Catchment: Guidelines for Better Practice in Foreshore works.* Department of Infrastructure, Planning and Natural Resources: Sydney.

Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) 2011 Australian Government website http://www.environment.gov.au/heritage/about/commonwealth/criteria.html

Dunston, D.J. 1990 Some early environmental problems and guidelines in New South Wales estuaries. *Wetlands (Australia)* 9 (1); 1-6.

Eades, D. 1976 The Dharawal and Dhurga Languages of the New South Wales South Coast. Australian Aboriginal Studies Research and Regional Studies No. 8. AIAS, Canberra.

Erskine, W, 1994 Late Quaternary alluvial history of Nowlands Creek, Hunter Valley, NSW Australian Geographer 25(1): 50-60.

Field, R.J.and Humphreys, G.S. 2002 The development of a Podzol using stratigraphic-age relationships and a mass balance approach. Pp 28-32 In Roach,I.C. (eds) Regolith and landscapes in Eastern Australia. CRC LEME: Perth.

Field, J. and Little, D. Regolith and Biota. Pp 175-217 In Scott, K.M. and Pain,C.F (eds). Regolith Science. Springer CSIRO: Dordrecht.

Fitzhardinge, L.F. (1961). Notes to Expedition to Botany Bay (in) Sydney's First Four Years. Angus and Robertson.

Folk, R.L. 1954 The distinction between grain size and mineral composition in sedimentary-rock nomenclature. *The Journal of Geology* 62, 344-359.

Fritz, W.J. and Moore,J.N, 1988 *Basics of Physical Stratigraphy and Sedimentology*. John Wiley: Chichester.

Gale, S.J., Haworth, R.J., Cook, D.E. and Williams, N.J. 2004 Human impact on the natural environment in early colonial Australia. *Archaeology in Oceania* 39, 148-156.

Gale, S.J. and Hoare, P.G. 1991 *Quaternary Sediments. Petrographic Methods for the Study of Unlithified Rocks*. Belhaven Press: New York.

Gray, M. 2003. *Geodiversity. Valuing and Conserving Abiotic Nature*. John Wiley & Sons: Chichester.

Haglund, L. 1984 Archaeological Survey at Glenfield, near Liverpool, NSW. Report to Don Fox Planning Pty Ltd.

Haglund, L. 1994 Current Options for the M5 Motorway (Beverly Hills to St Peters and Padstow to Botany/Mascot) in relation to Aboriginal Heritage Potential - Working Paper. Report to Manidis Roberts and the RTA.

Howarth, R. 2002 Changes in mangrove/salt-marsh distribution in the Georges River Estuary, Southern Sydney 1930-1970. *Wetlands (Australia)* 20 (2): 80-103.

Hunter, J. (1968). An Historical Journal of the Transactions at Port Jackson and Norfolk Island. Angus and Robertson, Sydney.

Humphries, G.S., Hesse, P.P; Kamper, S. and Field, R.J. 2002 The development of Earthy Fabric in sandy palaeochannels and source bordering dunes in the Pilliga. Pp 74-75 In: Roach, I.C. (ed.) *Regolith and Landscapes in Eastern Australia*. CRC LEME: Bentley.

Koettig, M. and P. J. Hughes 1983 An Archaeological survey of the route of the proposed rail link between East Hills and Glenfield, NSW. Report to Dames and Moore Pty Ltd.

Kemp, R.A. 1985 *Soil Micromorphology and the Quaternary*. Quaternary Research Association Technical Guide No. 2. QRA: Cambridge.

Kohen, J. (1986). Prehistoric Settlement in the Western Cumberland Plain: Resources, Environment and Technology. Unpublished PhD Thesis Macquarie University.

Kohen, J. (1988). “The Dharug of the western Cumberland Plain: Ethnography and Demography” in Meehan B and Jones R (eds) Archaeology with Ethnography: An Australian Perspective. Department of Prehistory RSPacS ANU Canberra.

Kohen, J., J. Stockton and M. A .J Williams 1984 “Shaws Creek II Rock Shelter: A Prehistoric Occupation Site in the Blue Mountains Piedmont, Eastern New South Wales” in *Australian Archaeology* 13:63-68.

Long, A. 2005 Aboriginal Scarred Trees in New South Wales: A Field Manual. Department of Environment and Conservation (NSW).

Lourandos, H. 1985 Intensification and Australian Prehistory. In T. D. Price and J. A. Browns (eds) *Prehistoric Hunter Gatherer: the Emergence of Cultural Complexity*. pp. 385-423 Academic Press.

Maddocks, J. 2001 Have we forgotten about flooding on the Georges River? Unpublished manuscript for 2001 Floodplain Authorities Conference – Wentworth Shire Council. Bewsher Consulting Pty Ltd CNF33-1 doc.

Mathews, R.H. and M.M. Everitt (1900). “The Organisation, Language and Initiation Ceremonies of the Aborigines of the South East Coast of NSW” in *Journal and Proceedings of the Royal Society of NSW*. 34:262-281.

Mathews, R.H. (1895). Australian Rock Pictures in *The American Anthropologist* July 1895.

Mathews, R.H. (1898) “Initiation Ceremonies of Australian Tribes” in *Proceedings of the American Philosophical Society* 38:54-73.

Mathews, R.H. (1901a). “The Thurrawal Language” in *Journal and Proceedings of the Royal Society of NSW* 35:127-160.

Mathews, R.H. (1901b) “Thurrawal Grammar Part 1" in *Languages No. 3*. Australian Institute of Aboriginal Studies.

Mathews, R.H. (1901c). Rock Holes Used by the Aborigines for Warming Water. *Journal of the Royal Society of NSW* Vol 35 pp213-216.

Mathews, R.H. (1904). “Ethnological Notes on the Aboriginal Tribes of NSW and Victoria” in *Journal and Proceedings of the Royal Society of NSW* 38:203-381.

Mathews, R.H. (1908). “Some Mythology of the Gundungarra Tribe, New South Wales” in *Zeit f Ethnologia* 40:291-310.

McDonald, J. (1994). *Dreamtime Superhighway: An Analysis of Sydney Basin Rock Art and Prehistoric Information Exchange*. Unpublished PhD thesis, Department of Prehistory and Anthropology, Australian National University, Canberra.

McDonald, J. and E. Rich 1993 Archaeological Investigations for Rouse Hill Infrastructure Project [Stage 1] Works along Caddies, Smalls and Second Ponds Creek, Rouse Hill and Parklea, NSW. Final Report on Test Excavation Programme. Volumes I and II. Report to the Rouse Hill Joint Venture.

Mitchell McCotter 1995 Report on Proposed International Shooting Centre at Holsworthy

Munsell Colour 1992 *Munsell Soil Color Charts*. Revised Edition. Macbeth: New York.

Nanson, G.C., Cohen, T.J., Doyle, C.J., and Price, D.M. 2003 Alluvial evidence of major Late-Quaternary climate and flow-regime changes on the coastal rivers of New South Wales, Australia. Pp. 233-258 In: Gregory, K.J. and Benito, G. (eds), *Palaeohydrology : Understanding Global Change*. John Wiley & Sons: Chichester.

Navin Officer Heritage Consultants (NOHC) 1997 Aboriginal Cultural Heritage, Technical Paper 11, Proposal for a Second Sydney Airport at Badgerys Creek or Holsworthy Military Area. Report to PPK Environment and Infrastructure for the Commonwealth Department of Transport and Regional Development.

Navin Officer Heritage Consultants 1998 Archaeological Subsurface Testing Program - Proposed Industrial Development, The Crossroads, Liverpool, NSW. Report to Multiplex Constructions (NSW) Pty Ltd.

Navin Officer Heritage Consultants 2011 Moorebank Intermodal Freight Terminal Scoping Study, Cultural Heritage Desktop Review, Summary compilation of known and potential constraints. An interim report to Parsons Brinckerhoff, Sydney.

Navin Officer Heritage Consultants 2012 Research Design and Proposed Methodology - Archaeological Test Excavation Program Aboriginal Heritage: Moorebank Intermodal Terminal.

Navin Officer Heritage Consultants 2014a Moorebank Intermodal Terminal – Liverpool City Council Northern Powerhouse Land; Aboriginal Subsurface Testing. Report to Parsons Brinckerhoff on behalf of Department of Finance and Deregulation.

Navin Officer Heritage Consultants 2014b Moorebank Intermodal Terminal; European Heritage Assessment. Report to Parsons Brinckerhoff.

New South Wales Government 2005 *Floodplain Development Manual : the management of flood liable land*. Department of Infrastructure, Planning and Resources: Sydney.

Nott, J.F. 1990 *Cainozoic landform evolution on the Shoalhaven Plain, NSW with special reference to the alluvial and aeolian history of the last 45 million years*. Unpublished Phd thesis, Department of Geography, University of Wollongong. 247pp.

Nichol, S.L. and Murray-Wallace, C.V. 1992 A partially preserved last interglacial estuarine fill: Narrawallee Inlet, New South Wales. *Australian Journal of Earth Sciences* 39: 545-553.

Officer, K.L.C.1984 From Tuggerah to Dharawal: Variation and Function within a Regional Art Style. Unpublished BA Hons thesis. Department of Prehistory and Anthropology, Australian National University, Canberra.

Officer, K. 1997 Archaeological Survey Proposed Bulk Storage Facility The Crossroads, Liverpool, NSW. Report To Multiplex Constructions (NSW) Pty Ltd.

Ollier, C.D. 1978 Tectonics and Geomorphology of the Eastern Highlands. Pp.5-47, In: Davies, J.L. and Williams, M.A.J., (eds), *Landform Evolution in Australasia*. ANU Press: Canberra.

Ollier, C. and Pain, C. 1996 *Regolith, Soils and Landforms*. John Wiley and Sons : Chichester

Phillip, A. (1789). The Voyage of Governor Phillip to Botany Bay: with Contributions from other Officers of the First Fleet and Observations on Affairs of the Time by Lord Auckland. John Stockdale, London. Reprinted 1970, Angus and Robertson.

Pickett, J.W. 2002 Stratigraphic relationships of laterite at Little Bay, near Maroubra, New South Wales. *Australian Journal of Earth Sciences* 50(1): 63-68.

Pickett, J.W., Macphail, M.K., Partridge, A.D. and Pole, M.S. 1997 Middle Miocene palaeotopography at Little Bay, near Maroubra, New South Wales. *Australian Journal of Earth Sciences* 44: 509-518.

Ross, A. (1988). “Tribal and Linguistic Boundaries: A Reassessment of the Evidence” in Aplin G (ed) (1988) A Difficult Infant: Sydney before

Roy and Thom 1981 Late Quaternary marine deposition in New South Wales and southern Queensland – an evolutionary model. *Journal of the Geological Society of Australia* 28: 471-489.

Roy, P.S., Thom, B.G. and Wright L.D. 1980 Holocene sequences on an embayed high-energy coast : an evolutionary model. *Sedimentary Geology* 26 (1-3): 1-19.

Sefton, C. 1994 Archaeological Survey of Proposed Drill Sites P1 and P2, Holsworthy Military Training Area, Punchbowl. Report (letter) to Kembla Coal and Coke Pty Ltd.

Sharp, R. G. 1994 Cultural Heritage Potential of Army Training Areas in Australia. Undergraduate Report, Charles Sturt University.

Simmons, S. 1977 Hume Freeway - Seymour to Avenel Section; Archaeological Survey Report. Victoria Archaeological Survey, Ministry of Conservation, Melbourne.

Smith, L. J. 1989 Final Report: Site Survey and Site Analysis on the Northern Cumberland Plain. Report to National Parks and Wildlife Service.

Steele, D. and Dallas, M. 2001 *Aboriginal archaeological survey of Department of Defence Lands at Moorebank.* Unpublished report to Egis Consulting.

Stockton, E. D. and W. Holland 1974 “Cultural Sites and their Environment in the Blue Mountains” in *Archaeology and Physical Anthropology in Oceania* 9(1):36-65.

Sydney Prehistory Group 1983 *In Search of Cobrakall: A survey of Aboriginal sites in the Campbelltown area south of Sydney*, Parts 1 and 2, NSW National Parks and Wildlife Service.

Taylor, G. 2008 Landscape and regolith. Pp 31-43 In Scott, K.M. and Pain,C.F (eds). *Regolith Science*. Springer CSIRO: Dordrecht. .

Taylor, G. and Eggleton, R.A. 2001 *Regolith Geology and Geomorphology*. John Wiley and Sons: Chichester.

Tench, W. (1961). *1789 - 1793 Sydney's First Four Years: being a reprint of A Narrative of the Expedition to Botany Bay and A Complete Account of the Settlement at Port Jackson*. Reprinted in 1961 by Angus and Robertson. Sydney.

Tench, W. (1789). *A Narrative of the Expedition to Botany Bay...* London: Debrett.

Tench, W. (1793). *A Complete Account of the Settlement at Port Jackson. in Sydney's First Four Years*. Angus and Robertson.

Tindale, N.B. (1974). *Aboriginal Tribes of Australia*, Australian National University Press. Canberra.

Turbet, (1989). The Aborigines of the Sydney District Before 1788. Kangaroo Press. Kenthurst.

Walters, I. 1988 “Fish hooks: Evidence for Dual Social Systems in South-eastern Australia” in *Australian Archaeology* 27:98-114.

Wentworth, C.K. 1922 A scale of grade and class terms for clastic sediments. *The Journal of Geology* 30, 377-392.

White, J. (1790). *Journal of a Voyage to New South Wales*. London. Reprinted 1962 (ed. A.H. Chisolm). Angus and Robertson, Sydney.

Young, R.W. and Bryant, E.A. 1993 Coastal rock platforms and ramps of Pleistocene and Tertiary age in southern New South Wales, Australia. *Zeitschrift für Geomorphologie N.F. Band* 37 (3): 257-272.

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