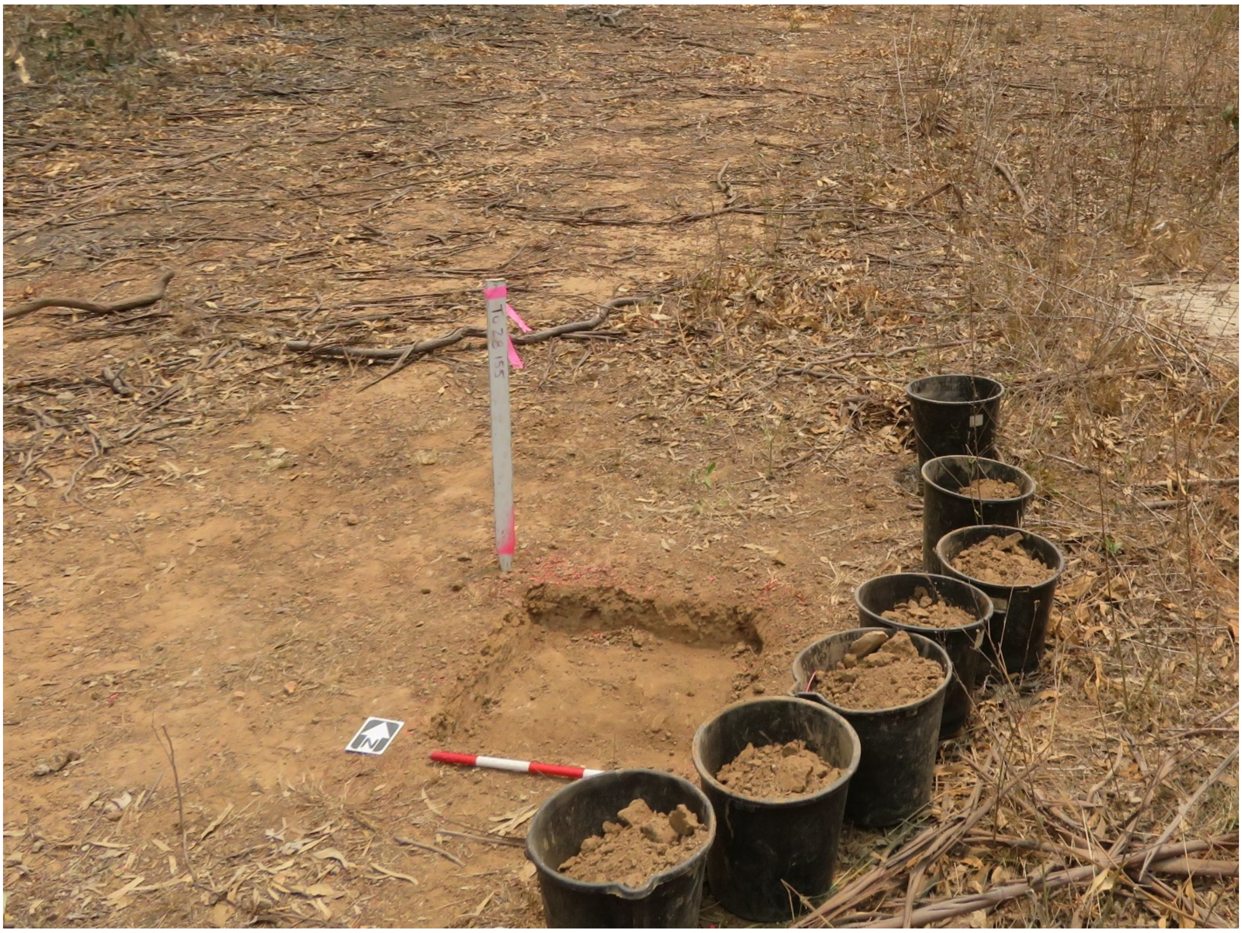
Regional Detention Basins C and V6, SMDS

Archaeological Technical Report

Report prepared for Maryland Development Company

October 2020



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Document Set ID: 9351105
Version: 1, Version Date: 27/10/2020

Report Register

The following report register documents the development and issue of the report entitled Regional Detention Basins C and V6, SMDS—Archaeological Technical Report, undertaken by GML Heritage Pty Ltd in accordance with its quality management system.

Job No.	Issue No.	Notes/Description	Issue Date
19-0397	1	Draft Report	31 March 2020
19-0397	2	Draft Report—revised, minor client comments	15 April 2020
19-0397	3	Final Report	20 October 2020

Quality Assurance

GML Heritage Pty Ltd operates under a quality management system which has been certified as complying with the Australian/New Zealand Standard for quality management systems AS/NZS ISO 9001:2016.

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

Contents Page

Executive Summary

GML Heritage Pty Ltd (GML) was engaged by Maryland Development Company Pty Ltd (MDC), on behalf of Lendlease, to undertake a program of Aboriginal archaeological test excavation for the Regional Detention Basins C and V6 project (the study area). This report presents the results of the Aboriginal archaeological test excavation undertaken in accordance with the NSW Office of Environment and Heritage (now Department of Planning, Industry and Environment) *Code of Practice for the Investigation of Aboriginal Objects in New South Wales.* It forms an appendix to the Aboriginal Cultural Heritage Assessment Report (ACHAR).

The study area overlies the Luddenham soil landscape and is characterised by flats and simple slopes intersected by and between two second order creeks. A pedestrian field survey of the study area identified nine Aboriginal surface artefact sites. The archaeological testing program, undertaken in January and February 2020, involved the excavation of 121 test units. A total of 200 Aboriginal artefacts were recovered. Analysis of the results identified one Aboriginal 'site': Basin V6 Artefact Site (AS) 2 (*to be registered*).

The whole Aboriginal artefact assemblage is assessed as having low scientific significance. The assemblage is considered to have low research potential based on the lack of variability in raw materials and technology exhibited within the assemblage, it is neither representative nor rare within the context of the wider St Marys Development Site (SMDS). The Basin C and Basin V6 assemblages are significant as part of the archaeological landscape of the SMDS. The Basin V6 assemblage is also considered to have educational potential.

The proposed development is for construction of two stormwater detention basins, construction of which would result in the total removal of all Aboriginal archaeological sites identified within the study area. Therefore, it is recommended that an Aboriginal Heritage Impact Permit (AHIP) is sought from the Department of Planning, Industry and Environment (DPIE) prior to the development commencing. Given the low scientific significance of the Aboriginal archaeological site Basin V6 AS2, no further archaeological work is recommended. An opportunity to undertake collection of surface artefacts prior to the works commencing should be made available to the Registered Aboriginal Parties (RAPs) for this project.

1.0 Project Background

1.1 Introduction

GML Heritage Pty Ltd (GML) was engaged by Maryland Development Company Pty Ltd (MDC), on behalf of Lendlease, to undertake a program of Aboriginal archaeological test excavation for the Regional Detention Basins C and V6 project (the study area). This report presents the results of the Aboriginal archaeological test excavation undertaken in accordance with the NSW Office of Environment and Heritage (OEH) (now Department of Planning, Industry and Environment) *Code of Practice for the Investigation of Aboriginal Objects in New South Wales.* It forms an appendix to the Aboriginal Cultural Heritage Assessment Report (ACHAR).

The purpose of this report is to identify whether the study area possesses or has the potential to possess Aboriginal heritage archaeological sites, places, objects, landscapes and/or values, in accordance with the OEH guidelines for Aboriginal heritage assessment (listed below). The results also include an assessment of the significance of the identified archaeological Aboriginal sites, places, landscapes and/or other values.[1] An impact assessment and management recommendations are provided to assist Maryland Development Company with its future responsibilities for the management of Aboriginal cultural heritage within the study area.

The ACHAR will be submitted to the NSW Department of Planning, Industry and Environment (DPIE) to support an application for an Aboriginal Heritage Impact Permit (AHIP) under Section 90 of the *National Parks and Wildlife Act 1974* (NSW) (NPW Act) for the study area. Three prior consents to destroy Aboriginal heritage sites (under Section 90 of the NPW Act) have been issued for Aboriginal sites near the study area. AHIP No. 10996059, C0000475 and C0000362 have been issued in the surrounding area. None of these AHIPs cover the proposed current development area.

1.2 Proposed Development

The proposal involves the construction of two detention basins (Basins C and V6) to detain, treat and attenuate stormwater runoff from Village 3 and Village 6 in the Jordan Springs development. The basins are located within the northwestern extent of the SMDS and within the Wianamatta Regional Park. Basins C and V6 will be constructed wetlands and act as water quality improvement basins with the provision for active stormwater detention during high flows.

Basin C will have a surface area of approximately 1.8ha and a notional depth of 1.7m, and Basin V6 will have a surface area of approximately 0.3ha and a notional depth of 1.6m.

Each basin is designed to contribute to the water quantity and quality management objectives under the Sydney Regional Environmental Plan No. 30—St Marys (SREP 30) and Penrith City Council's (Council) Water Sensitive Urban Design Policy (December 2013). The basins will incorporate the features for both water quality treatment and detention, including a drainage inlet point, low-level culvert outlet, spillway with erosion protection and vegetated slopes to provide effective nutrient removal. An access track along the side of each basin, with access ramps, will be constructed for regular inspection and maintenance access.

1.3 The Study Area

The project area is located in north St Marys, approximately 50km west of the Sydney CBD (Figure 1.1). It is situated in the northwest area of the SMDS (Figure 1.2). The site is bounded by Agnes Way and Delany Circuit to the north, and bushland to the south. It falls within the Penrith local government area and Londonderry parish (Figure 1.3) and covers parts of the following lots/DP:

- Lot 1/DP 1216994;
- Lot 4/DP 1216994; and
- Lot 5/DP 1216994.

1.4 Development Controls

Planning approval for new developments is managed under the *Environmental Planning and Assessment Act 1979* (NSW) (EPA Act). The project has been identified as a Designated Development under Section 78A of the *Environmental Planning and Assessment Act 1979* (NSW) (EPA Act). Environmental Assessment Requirements (SEAR No. 1360) were issued for the project, including the requirement for:

> *Identification and description of the Aboriginal cultural heritage values that exist across the whole area that will be affected by the proposal. This may include the need for surface survey and test excavation. The identification of cultural heritage values must be conducted in accordance with the Code of Practice for Archaeological Investigations of Aboriginal Objects in NSW (OEH 2010), and should be guided by the Guide to investigating, assessing and reporting on Aboriginal Cultural Heritage in NSW (DECCW 2011) and consultation with OEH regional branch officers.*

A development application (DA19/0810) was lodged with Penrith City Council on 22 November 2019. This included the submission of an Aboriginal Archaeological and Cultural Assessment Methodology (AACAM) prepared by GML. The AACAM contains a desktop assessment of the environmental and archaeological context of the study area to inform the potential for Aboriginal archaeological sites to be present. It also presented a methodology for consulting with Aboriginal people, including a field survey and program of archaeological test excavation in accordance with NSW DPIE guidelines.[2]

1.4.1 Aboriginal Heritage Legislation

In NSW, Aboriginal heritage is protected under the NPW Act. Aboriginal objects are protected from harm under Part 6 of the NPW Act. Aboriginal objects are defined under the act as any 'deposit, object or material evidence relating to the Aboriginal habitation of the area that comprises New South Wales'. To assist in the implementation of the NPW Act, the OEH developed a series of guidelines that determine how Aboriginal cultural values are managed. This report has been prepared as a requirement of the OEH guidelines.

1.4.2 Aboriginal Heritage Guidelines

The methodology presented in this report fulfils the requirements of the OEH *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW,* 2011. It is guided by the requirements of:

- the Department of Environment, Climate Change and Water (DECCW) *Aboriginal cultural heritage consultation requirements for proponents 2010* (April 2010);

- DECCW *Due Diligence Code of Practice for the Protection of Aboriginal Objects in NSW* (13 September 2010);
- DECCW *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (24 September 2010);
- OEH *Applying for an Aboriginal Heritage Impact Permit: Guide for applicants* (May 2011); and
- *The Burra Charter: the Australia ICOMOS Charter for Places of Cultural Significance 2013* (the Burra Charter).

1.5 Objectives for the Assessment

The objectives of this assessment were to:

- understand the number, extent, type, condition, integrity and archaeological potential of Aboriginal heritage sites and places within the study area;
- determine whether the identified Aboriginal sites and places are a component of a wider Aboriginal cultural landscape;
- understand how the physical Aboriginal sites relate to Aboriginal tradition within the wider area;
- undertake archaeological test excavation within the study area, in order to understand the nature and extent of archaeological deposits;
- prepare a scientific cultural values assessment for all identified aspects of Aboriginal cultural heritage, as identified within this report;
- determine how the proposed project may impact the identified Aboriginal cultural heritage;
- aim to minimise impacts to Aboriginal cultural heritage through sensible and pragmatic site and land management;
- determine where impacts are unavoidable and develop a series of impact mitigation strategies that benefit Aboriginal cultural heritage and the proponent; and
- provide clear recommendations for the conservation of archaeological values and mitigation of impacts to these values.

1.6 Reporting Approach

This ATR is an appendix to the ACHAR. This archaeological report is a standalone technical report which provides evidence about the material traces of Aboriginal land use that is integrated with the other findings from the assessment of Aboriginal heritage to support the conclusions and management recommendations in the ACHAR.

This report has been prepared following the requirements for reporting as established in DECCW *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales, 2010* (Code of Practice).

1.7 Investigators and Contributors

The project team's roles, qualifications and affiliations are detailed in Table 1.1. A number of Aboriginal community representatives have assisted in the archaeological assessment's field survey and test excavation activities and provided cultural input into the ACHAR and ATR. The list of contributors involved is specified below.

Table 1.1 Investigators and Contributors.

Person (Qualification)	Affiliation	Role
Sophie Jennings (BA [Hons])	GML	Project Manager, Excavation Director, Report Author
Hannah Morris (MA)	GML	Secondary Excavation Director
Dr Tim Owen (PhD)	GML	Project Director, Report Reviewer
Talei Holm (BA)	GML	Field Archaeologist
Shezani Nasoordeen	Subconsultant	Lithics Analyst
Elise Jakeman	N/A	Field Archaeologist
Yolanda Pavincich	N/A	Field Archaeologist
Rebecca Vartto	N/A	Field Archaeologist
Peter Woodley	N/A	Field Archaeologist
Raymond Adams	Kamilaroi-Yankuntjatjara Working Group	Registered Aboriginal Party
Tylah Blunden	Darug Custodian Aboriginal Corporation	Registered Aboriginal Party
Martin Bradshaw	Barking Owl Aboriginal Corporation	Registered Aboriginal Party
Krystle Carroll	Ginninderra Aboriginal Corporation	Registered Aboriginal Party
Amanda DeZwart	Amanda Hickey Cultural Services	Registered Aboriginal Party
Nicholas DeZwart	Amanda Hickey Cultural Services	Registered Aboriginal Party
Jamie Gibbs	Deerubbin Local Aboriginal Land Council	Registered Aboriginal Party
Adam Gunther	Kamilaroi-Yankuntjatjara Working Group	Registered Aboriginal Party
Steven Hickey	Widescope Indigenous Services	Registered Aboriginal Party
Paul Hunter	Kamilaroi-Yankuntjatjara Working Group	Registered Aboriginal Party
Belinda Jackson	Kamilaroi-Yankuntjatjara Working Group	Registered Aboriginal Party
Ryan Johnson	Murra Bidgee Mullangari Aboriginal Corporation	Registered Aboriginal Party
Adam King	Ginninderra Aboriginal Corporation	Registered Aboriginal Party
Steven Knight	Deerubbin Local Aboriginal Land Council	Registered Aboriginal Party
Jody Kulakowski	Barking Owl Aboriginal Corporation	Registered Aboriginal Party
Justin Lawlis	Kamilaroi-Yankuntjatjara Working Group	Registered Aboriginal Party
Brayden McDougall	A1 Indigenous Services	Registered Aboriginal Party

Person (Qualification)	Affiliation	Role
Storm McEwen-Gillespie	Deerubbin Local Aboriginal Land Council	Registered Aboriginal Party
Shelley Weldon	Deerubbin Local Aboriginal Land Council	Registered Aboriginal Party
David Whitten	Deerubbin Local Aboriginal Land Council	Registered Aboriginal Party
Jonathon Whitten	Deerubbin Local Aboriginal Land Council	Registered Aboriginal Party

Figure 1.1 Location of the project area within NSW. (Source: SIX Maps, with GML additions, 2019)

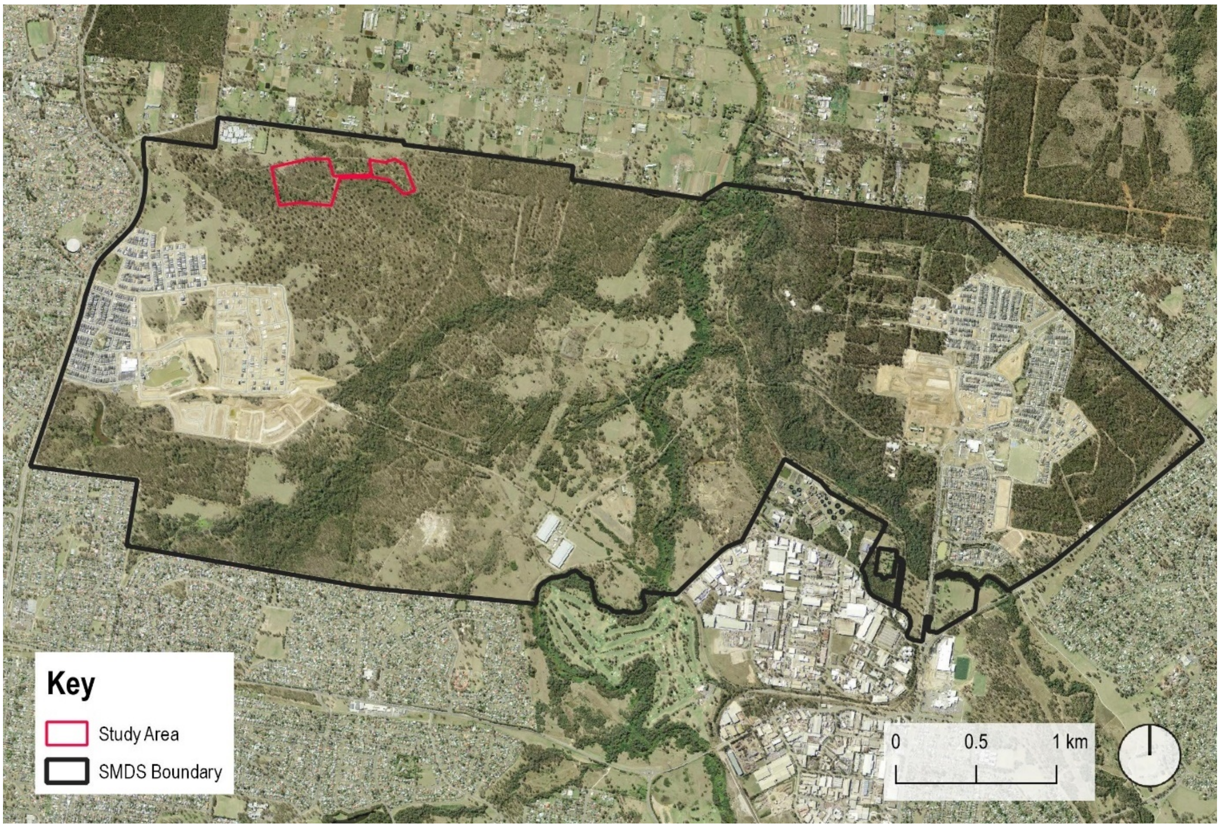

Figure 1.2 Location of the study area (outlined in red) in relation to the SMDS (outlined in black). (Source: NSW Land and Property Information [LPI] with GML additions, 2019)

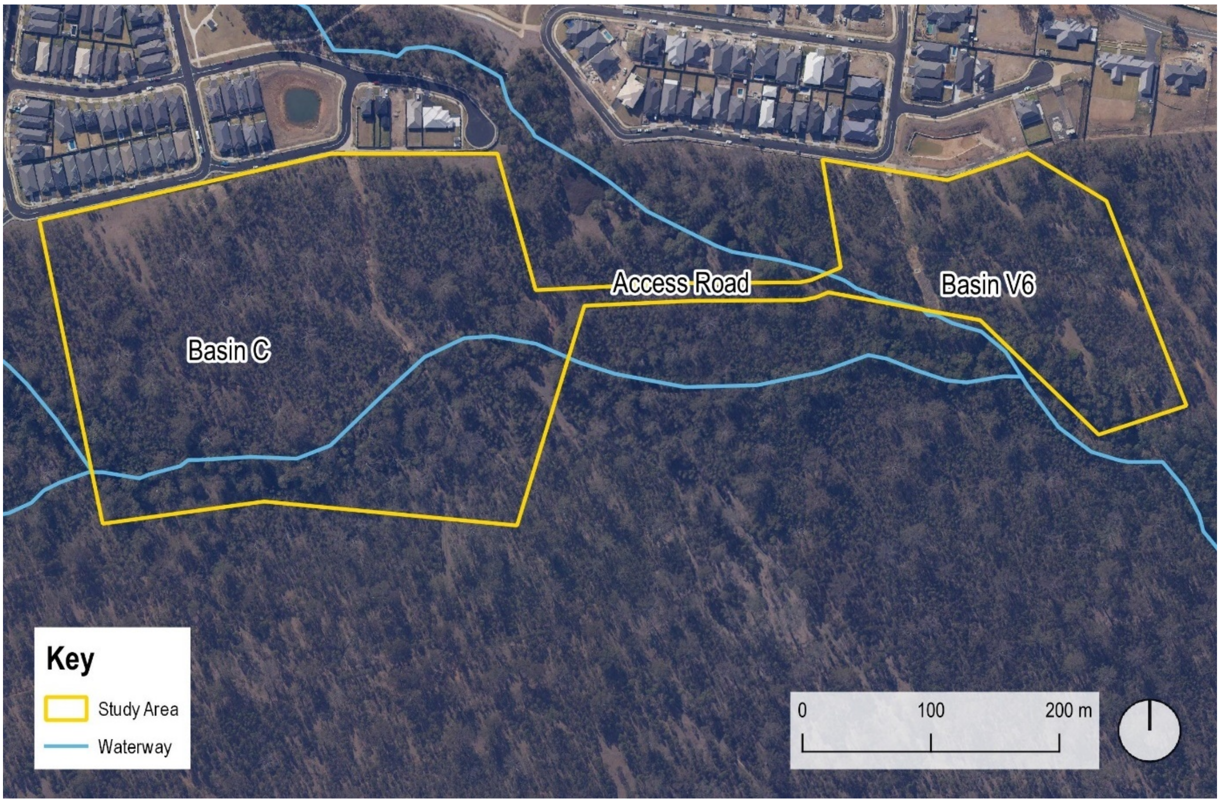

Figure 1.3 Plan showing the proposed AHIP boundary (outlined in yellow), with each basin site labelled. (Source: NSW LPI with GML additions 2019)

2.0 Archaeological and Environmental Context

In line with OEH/DPIE reporting requirements,[3] this section provides a review of previous archaeological work, the landscape context, regional character and an Aboriginal heritage predictive model.

2.1 Environmental Conditions

The project area's environment forms a component of the Darug peoples' traditional lands and Country. An understanding of the environment through the geology, soils, landforms, water and ecology is important to understand the context of long-term Aboriginal connections to the land. Combining basic environmental information with the history and contemporary connections starts to provide an understanding of the local and regional cultural landscape. Describing and mapping the landscape contextualises the physical data and underpins intangible connections inherent in most Aboriginal cultural landscapes. An overview of the baseline datasets for geology, soil, landforms, water and ecology is provided in this section.

2.1.1 Geology, Geomorphology and Soils

The SMDS overlies two main soil landscapes—Luddenham and South Creek (Figure 2.1). Basins C and V6 are both located on the Luddenham soil landscape,[4] a residual soil developed from in situ weathering of the underlying Wiananmatta Group shales, often associated with Minchinbury Sandstone. The Luddenham soils are highly prone to erosion. Soils of this landscape generally occur as a friable dark brown loam A_1 horizon, overlying a hard-setting brown clay loam to fine sandy clay loam (A_2 horizon). The B horizon comprises a reddish-brown to bright yellowish-brown medium clay, sometimes a silty clay or heavy clay.[5] Previous excavations across Western Sydney have demonstrated that in general B horizon soils do not contain Aboriginal artefacts. To the east of Basin V6, following the main watercourse, is the alluvial South Creek soil landscape. The mapped extent of the soil profile is representative of the creek's floodplains that bisect the SMDS. There is no expression of South Creek alluvium mapped within or near the study area.

2.1.2 Hydrology

The availability of water has significant implications for the range of resources available and the suitability of an area for human occupation. The study area is located west of South Creek, the major creek network on the Cumberland Plain, that bisects the SMDS. Around the study area there are a number of modern artificially created bodies of water that mostly relate to farming or the former use of the site as part of the St Marys Munitions Factory.

Figure 2.2 shows the proposed location of Basins C and V6 in relation to the waterways that form part of the South Creek network. A second-order creek, located within a very shallow, narrow valley, runs west to east outside the southern boundary of Basin C (but within the study area). Basin V6 is located 30m north of a second order creek that flows east towards South Creek. The creek also passes nearby the northern extent of Basin C. The two second order creeks confluence to the southeast of the study area, to form a third order creek, which eventually flows into South Creek as a fourth order creek.

2.1.3 Landform and Topography

The landforms associated with the Luddenham soil landscape typically consist of undulating to rolling hills. The local relief around the study area is between 28m to 52m above Australian Height Datum (AHD), and the slopes are shallow, ranging from less than 2% to 10% (Figure 2.3). The study area is located at the base of a series of hills to the west and south. To the east of the study area, the landscape flattens out into the floodplains associated with South Creek and Ropes Creek.

Basin C

Basin C is characterised by flats adjacent to the creek, with a small portion of the study area on the south side of the creek located on the lower slopes of a series of hills situated further south (Figure 2.3). The southern portion of Basin C is located within a shallow valley associated with the creek running through it. On the northern side of the creek, the landscape comprises an almost level plain that rises up very gradually to the west at a gradient of c2%. Directly on the southern side of the creek the landscape slopes more steeply, around 10%, into a series of low hills. The topographic map also reveals the location of a series of structures related to the Australian Defence Industries (ADI) site and munitions storage (see Section 2.5). They are visible on the mid-slope of the hill in the southeastern corner of Basin C (Figure 2.3).

Basin V6

Basin V6 falls into the valley associated with the creek to the south. The area is relatively flat, with a slight rise to the west. Directly to the north of the study area, low hills are present with a gradient of around 10%. They are similar to those on the southern side of Basin C.

2.1.4 Vegetation

The SMDS is located within the Cumberland Plain Woodlands. It would have originally comprised open woodland (eg Forest Red Gum), with closed woodland (eg Paperbark, Swamp Oak) along the creek margins. Today, the study area is within native Shale Plains Woodland vegetation, with freshwater wetland vegetation and introduced species along the creek margins.

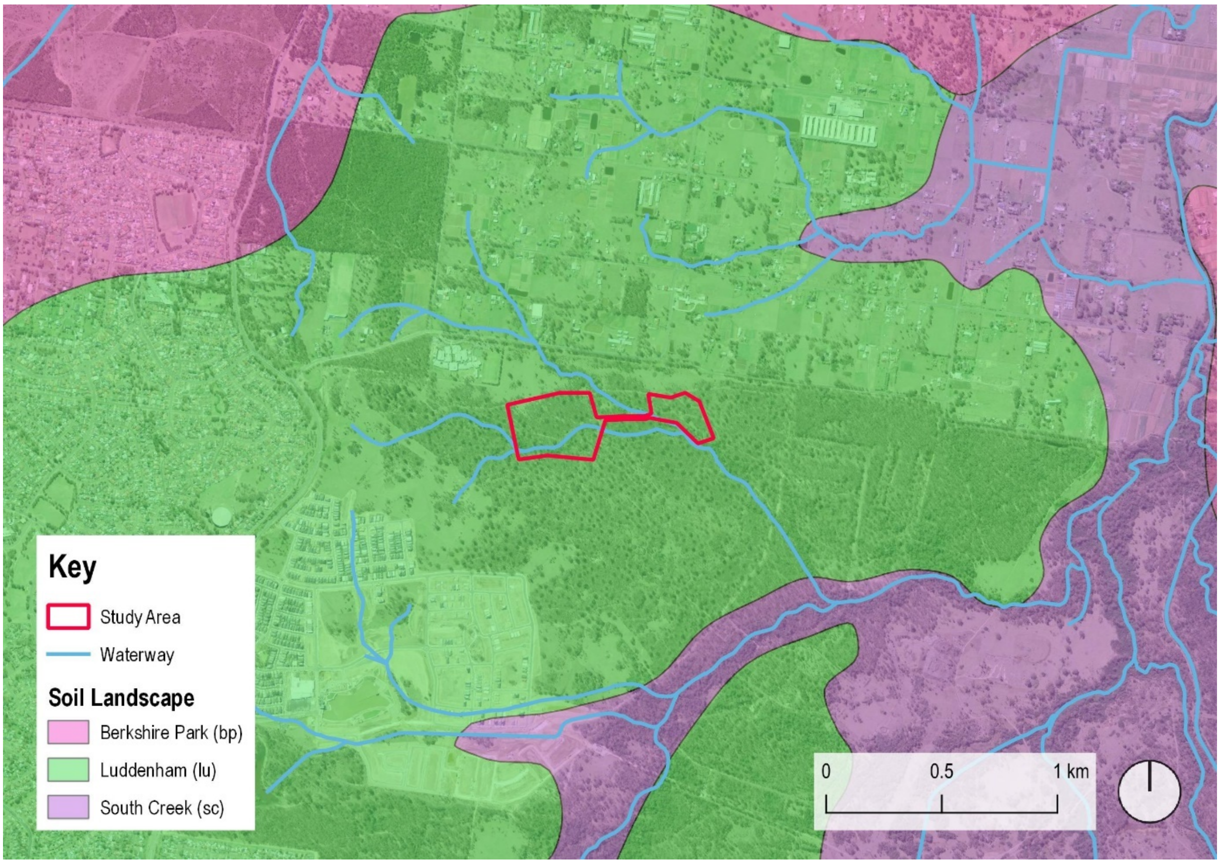

Figure 2.1 Soil landscape surrounding the study area. (Source: NSW LPI and NSW Spatial Services, with GML additions 2019)

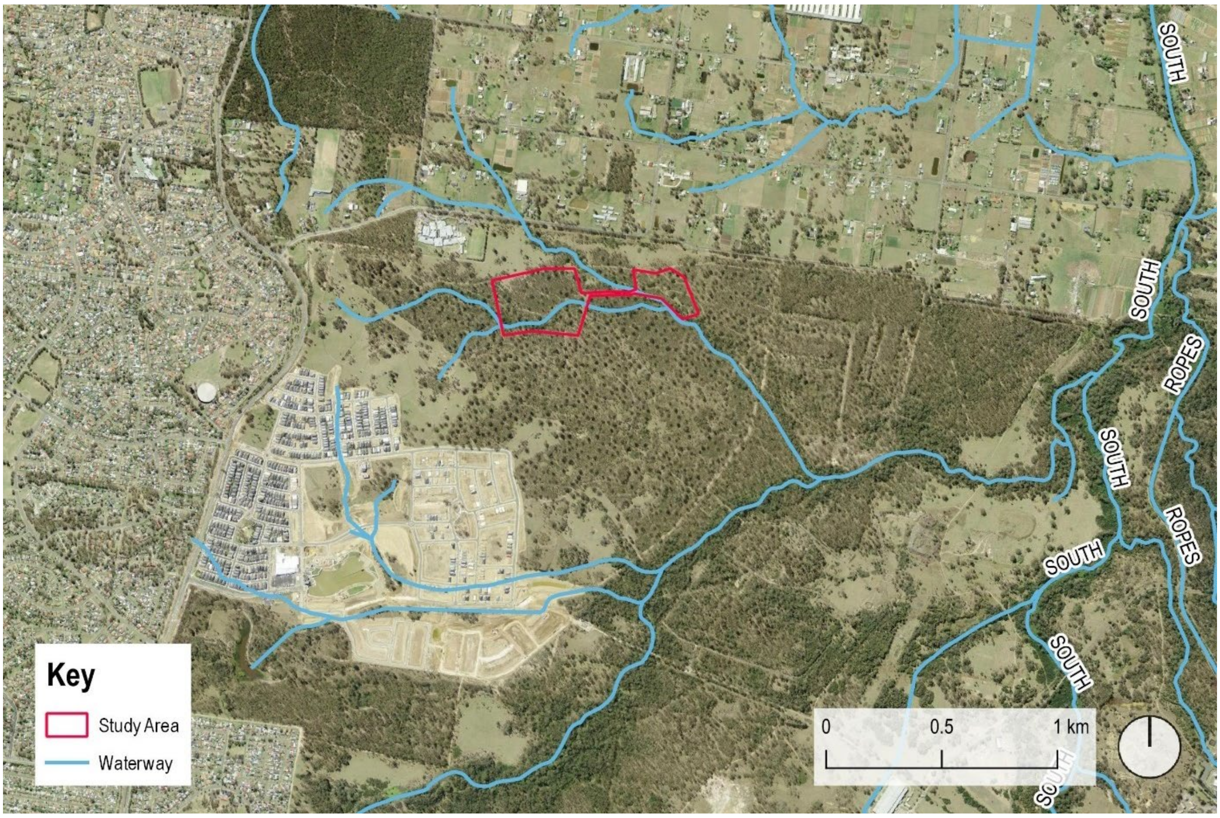

Figure 2.2 Natural hydrology, waterways and areas linked to the study area and wider landscape. (Source: GML 2019)

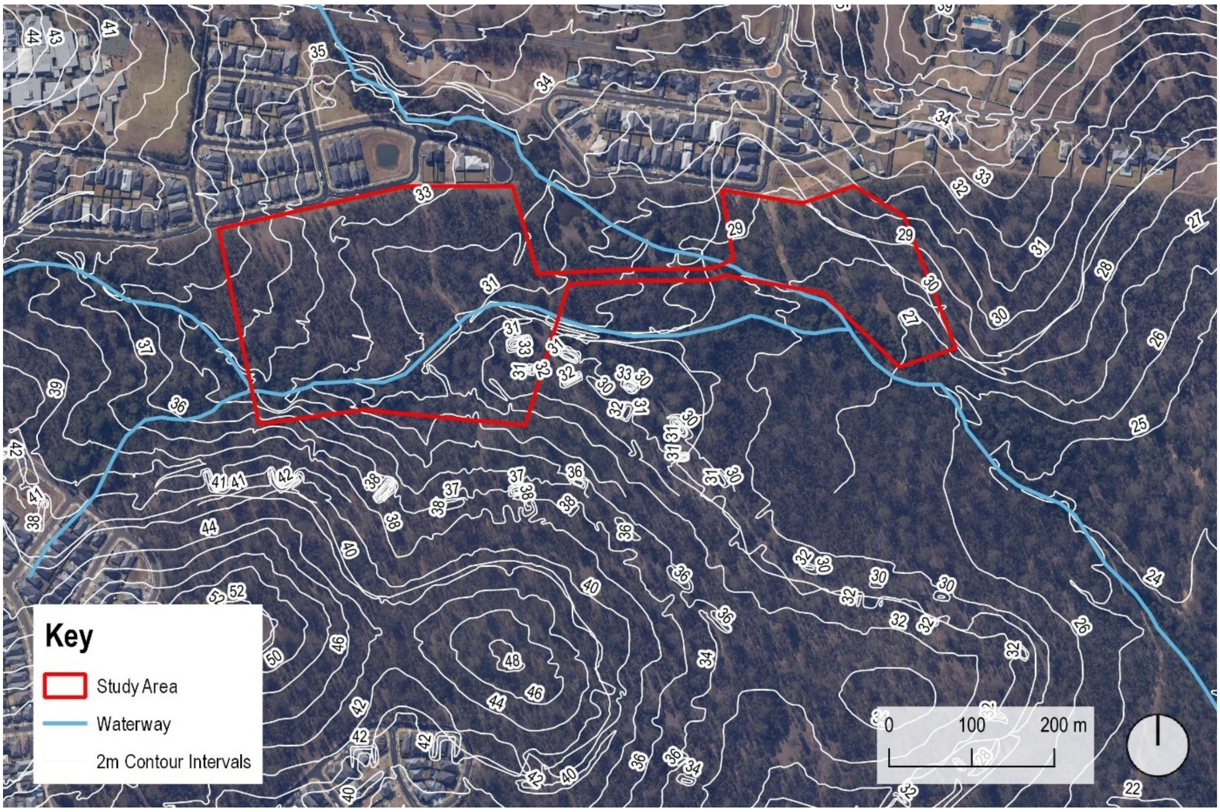

Figure 2.3 Contours at 2m intervals and their relationship to the waterways and study area. (Source: GML 2019)

2.1.5 Land Use Impact Analysis

The project area has been subject to a history of recent land use notably associated with the former ADI site. Prior land uses may affect the ability of the landscape to inform and relate its history of Aboriginal connections. Vegetation clearance, movement of creeks and waterways, cut and fill, and some Defence activities (notably construction) can change how the landscape appears. These activities can also affect and alter original soil profiles, which may have implications for the intactness of Aboriginal archaeological sites. Understanding the range and extent of prior land use allows a model of Aboriginal heritage sensitivity to be developed. To assess changes to the project area we have undertaken investigations of historical aerial images.

The entire SMDS was utilised for grazing and farming for approximately 150 years before the land was acquired in 1941 for the ADI site. Evidence of vegetation clearance and dirt roads (tracks) can be seen on the 1940s aerial (Figure 2.4). The development of the ADI site at St Marys saw the construction of factory and munitions storage complexes, which assembled and filled bombs, shells, fuses and pyrotechnics. A series of these buildings can be seen in the southeastern portion of the study area near Basin C, running along the edge of the plains. They can be faintly observed in the 1940s aerial (Figure 2.4) and the contour map as round shapes (Figure 2.3). None of these former structures fall within the study area. After World War II, many of the munition installations were disassembled, while others continued to be used by the Department of Defence.

During the Korean War (1950–1953), the St Marys Munitions Factory was re-established. The aerial from 1955 (Figure 2.5) shows that roads through the site have become more established. Again, no evidence of structures within the study area has been identified. Aerials from 1965 (Figure 2.5), 1978 (Figure 2.6), 2000 (Figure 2.7) and the present (Figure 1.3) show the progressive regrowth of woodland vegetation. The most recent aerial shows the establishment of the residential area at Jordan Springs, immediately north of the basin sites.

An inspection of the area on 30 October 2019 provided an opportunity to assess the extent of ground disturbance resulting from historic uses of the area. The site inspection focused on the footprint of the proposed basins. These are summarised below for each of the basin sites.

- Basin C—in the northern arm of Basin C, a large bund was located. Construction of the bund appears to be the result of pulling soil from the vicinity into a mound. The process removes the potential for intact, or in situ, artefact scatters on the surface or upper layers of earth. Drainage channels running beneath the haul road were identified in the eastern part of Basin C. These, too, removed any possible Aboriginal archaeological deposits in the area the works were undertaken.

- Basin V6—the northeastern portion of Basin V6 is heavily landscaped. An artificial slope, running upward to the east, leads to a second bund. The earthworks would have caused disturbance to the upper layers of soil. The eastern half of the study area is unlikely to yield intact archaeological deposits. The western portion of the basin has been disturbed by a number of drainage features. These include large, deep pits visible on the main clearer area, and smaller pits along the southern edge of the haul road. These drainage features have removed archaeological deposits from their footprints entirely.

- Access Road—drainage pits and channels running beneath and beside the haul road are present in the area between Basins C and V6.

In summary, Basin C has been subject to historical landscaping activities. These activities will have disturbed the upper layers of soil in the northern arm of the study area and along the haul road. As a result, the potential for intact archaeological deposits in these locations is nil to low.

Basin V6 has been heavily disturbed by landscaping and the construction of drainage systems. Landscaping in the eastern half of the study area has likely disturbed the upper layers of soil. The potential for intact archaeological deposits on the surface or upper layers of soil is nil to low. Moreover, the deep and extensive drainage pits along the western boundary of the study area will have entirely removed both surface and subsurface archaeological deposits.

The construction of the haul road also lowers the potential for archaeological deposits along the road between Basins C and V6. While some artefacts have been identified on the road surface, these will have been displaced from their original location due to the landscaping required to clear the road, and continued vehicular disturbance. While they are evidence of Aboriginal occupation in the vicinity, these deposits are not considered to be intact deposits. Artefacts recovered on either side of the road itself may represent intact archaeological deposits within buried contexts.

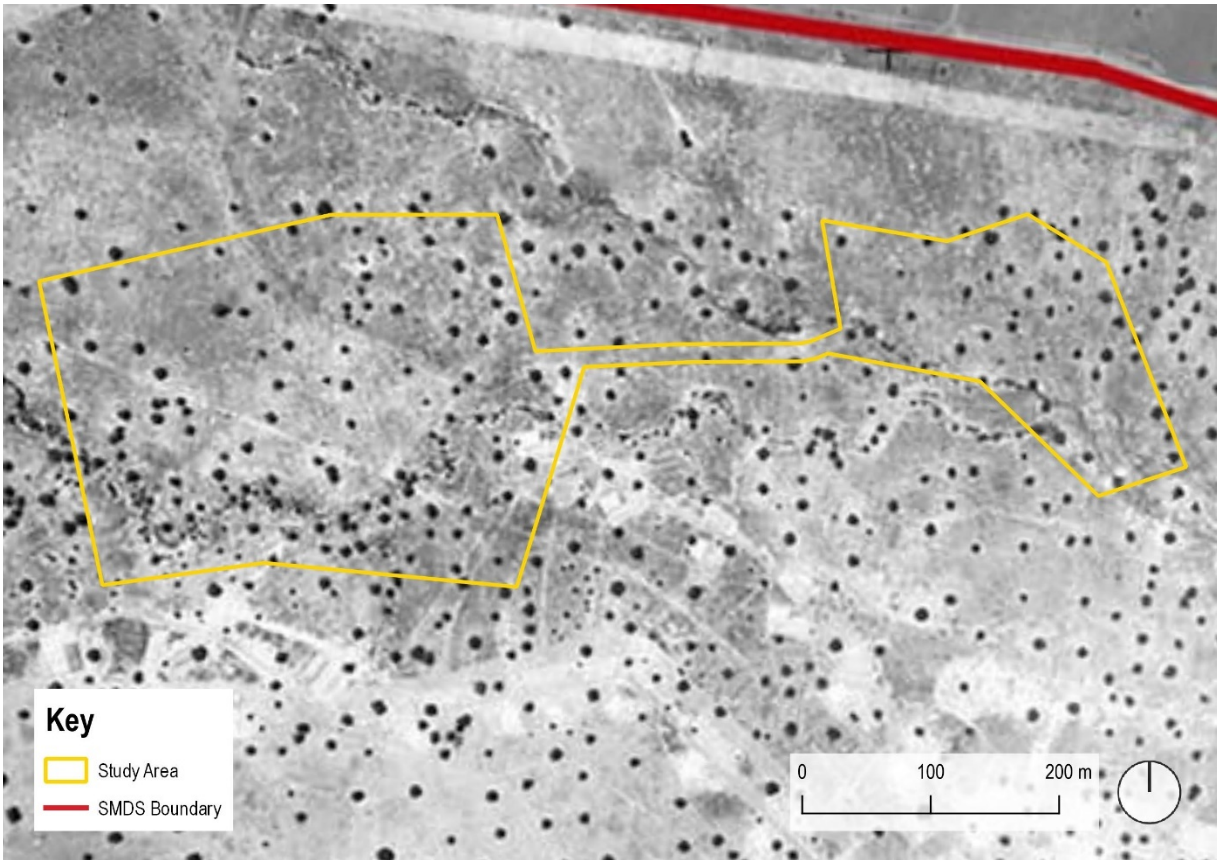

Figure 2.4 1940s aerial with ground disturbance from ploughing present. (Source: NSW LPI, with GML additions, 2019)

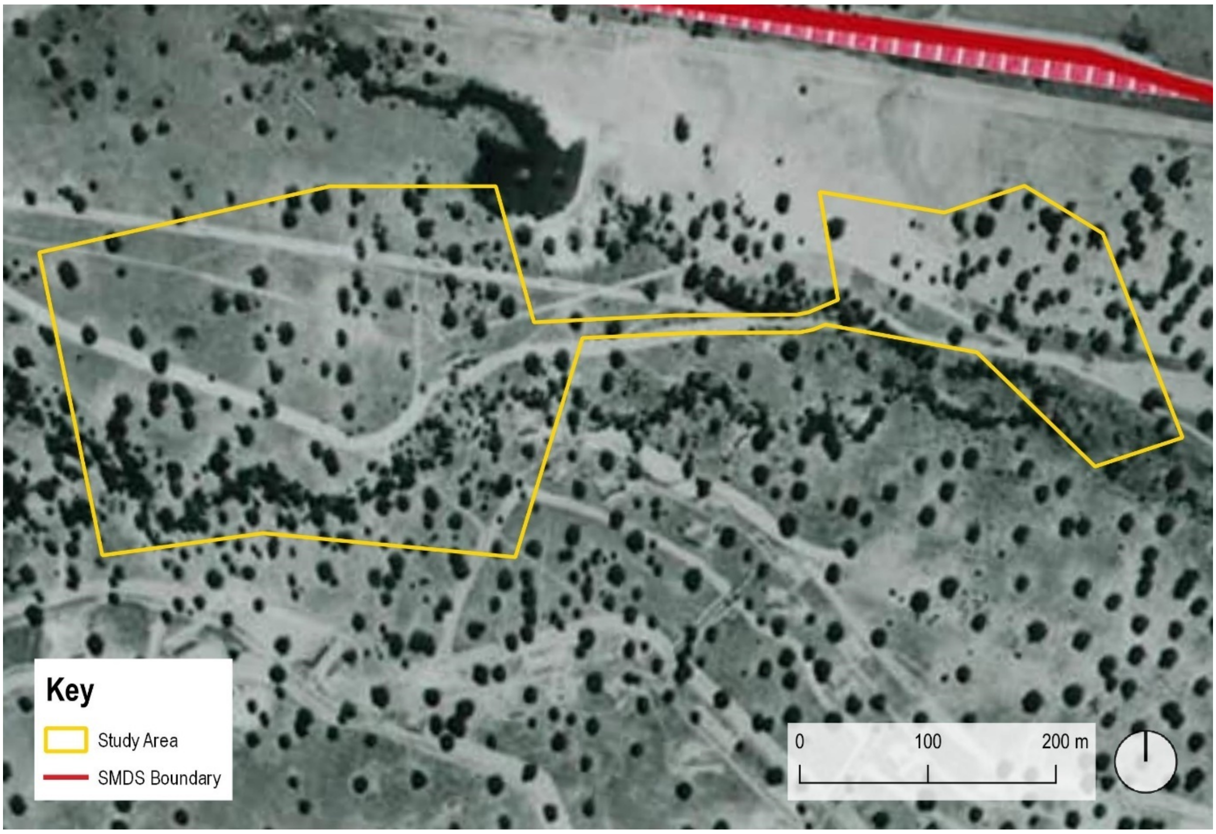

Figure 2.5 1955 aerial showing greater forestation of the land around the study area. (Source: NSW LPI, with GML additions, 2019)

Figure 2.6 1978 aerial showing greater forestation of the land around the study area. (Source: NSW LPI, with GML additions, 2019)

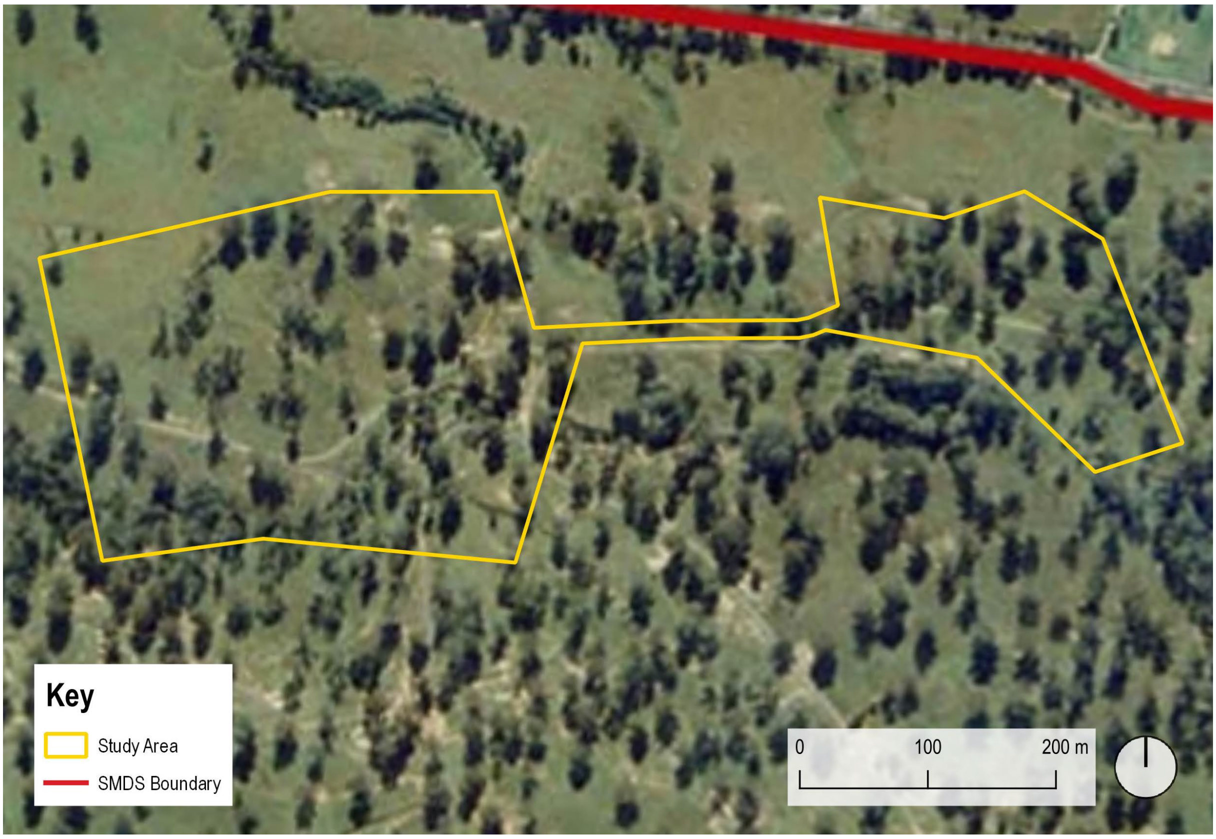

Figure 2.7 2000 aerial showing greater forestation of the land around the study area. (Source: NSW LPI, with GML additions, 2019)

2.2 Previous Archaeological Work

The purpose of this section is to synthesise available information from previous archaeological and historical research to provide a context and baseline for what is known about Aboriginal cultural heritage within the study area.

Over the past ~25 years a number of studies have taken place across the St Marys Development Site (SMDS). The majority of studies have been archaeological in nature, with the vast majority of sites recorded and excavated being stone artefact sites due to the preferential preservation of non-organic material. A Conservation Management Plan (CMP) prepared for the Wianamatta Regional Park includes discussions on the regional Aboriginal cultural landscape, cultural places and the significance of this area to Aboriginal people.[6]

2.2.1 Aboriginal Heritage Information Management System (AHIMS)

An extensive search of the AHIMS database was undertaken on 30 September 2019. The search included the study area, western half of the SMDS, and areas beyond the SMDS boundary.

The search returned 113 sites, falling into four categories—artefact sites (meaning multiple stone artefacts in a landscape location), isolated finds (single stone artefacts unconnected with a bigger site), Potential Archaeological Deposits (PADs) (locations with a yet to be proven subsurface archaeological expression), and PADs with isolated finds (Table 2.1). The majority of sites within the search area are classified as artefact sites, sometimes referred to as open camp sites in the AHIMS database and literature. The second most frequent type of site was isolated finds. Five of these isolated finds have been interpreted as being part of a PAD, meaning there is the potential for further artefacts to be recovered through archaeological investigation of subsurface deposits.

Table 2.1 Results of AHIMS Search.

Site Feature	Frequency	Percentage (%)
Artefact Site	70	62
Isolated Find	35	31
Isolated Find and PAD	5	4
PAD	3	3
Total	113	100

Basin C

The AHIMS search identified two sites registered within Basin C. The artefact site (AHIMS No. 45-5-3610) was recorded as an open artefact scatter containing eight lithics (Figure 2.9). As a result, more artefacts will be potentially located on the surface of the area within the Basin C footprint. This site is positioned in approximately the location of the access road, visible on the 1955 aerial (Figure 2.5). The presence of stone artefacts on the surface could be factors of erosion resulting from this period.

A second open artefact scatter (AHIMS No. 45-5-3609) is located in the southwest corner of Basin C. The open artefact scatter only contained two artefacts; however, the scatter may be considered in conjunction with an isolated find (AHIMS No. 45-5-3608) only 150m to the west and the aforementioned scatter within Basin C. These two sites are in locations that have been subject to minimal historical disturbance. They are located on the northern bank of the second order creek (Figure 2.2), and potentially relate to occupation activities on flats adjacent to the creek.

The landscape position of these three sites are within the 50m zone that Jo McDonald Cultural Heritage Management (JMcDCHM) suggested contains higher potential for archaeological evidence.[7] In summary, it is likely that the 50m zone on either side of the creek will retain archaeological evidence of Aboriginal activities.

Basin V6

No archaeological sites have been recorded within the Basin V6 boundary. However, the location of the second order tributary river is only approximately 35m to the south of the southern boundary of the study area. As a result, the potential for archaeological sites such as open artefact scatters is highest in the southern half of the Basin V6 boundary. The closest recorded artefact site (AHIMS 45-5-3587) was subject to archaeological test and salvage excavation in 2014 as part of the Jordan Springs redevelopment (WP1), the results of which are discussed further below.

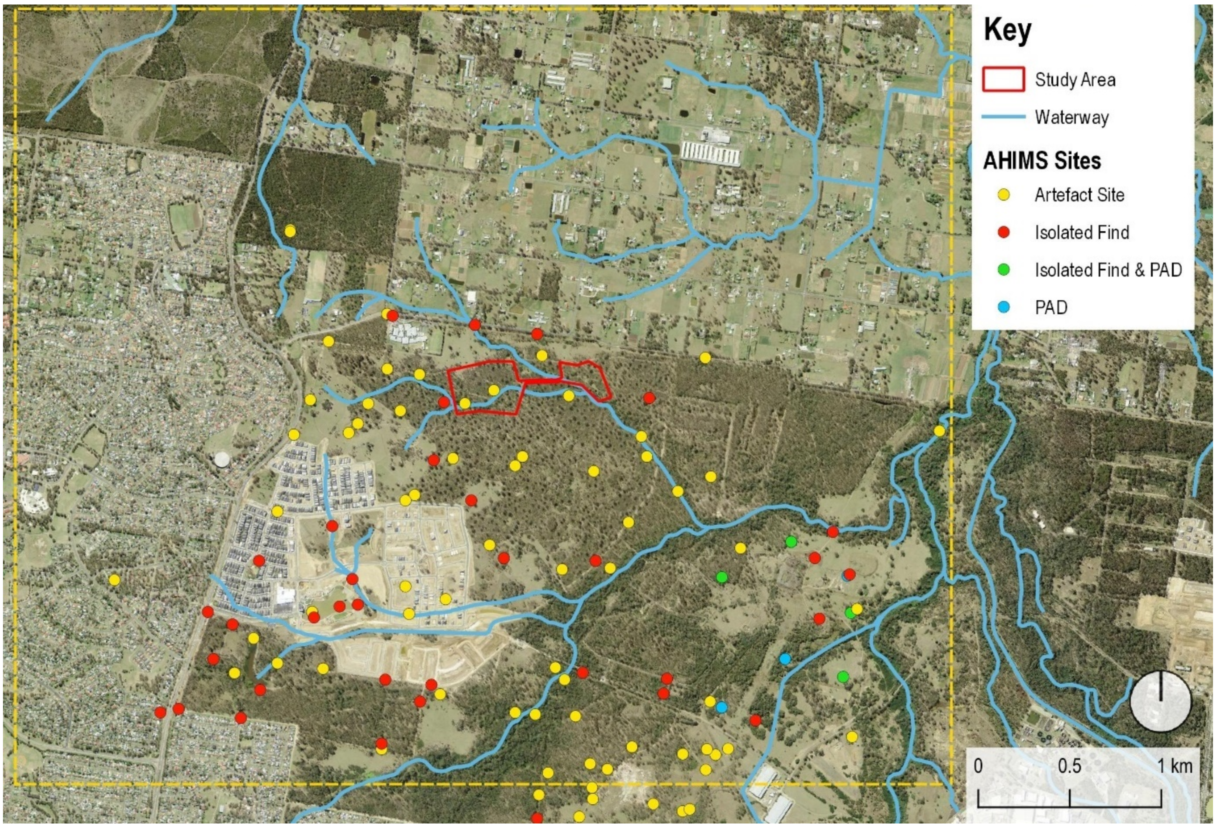

Figure 2.8 Sites identified through an extensive AHIMS search. The yellow dashed line marks the approximate extent of the search area. (Source: NSW LPI and DPIE, with GML additions 2019)

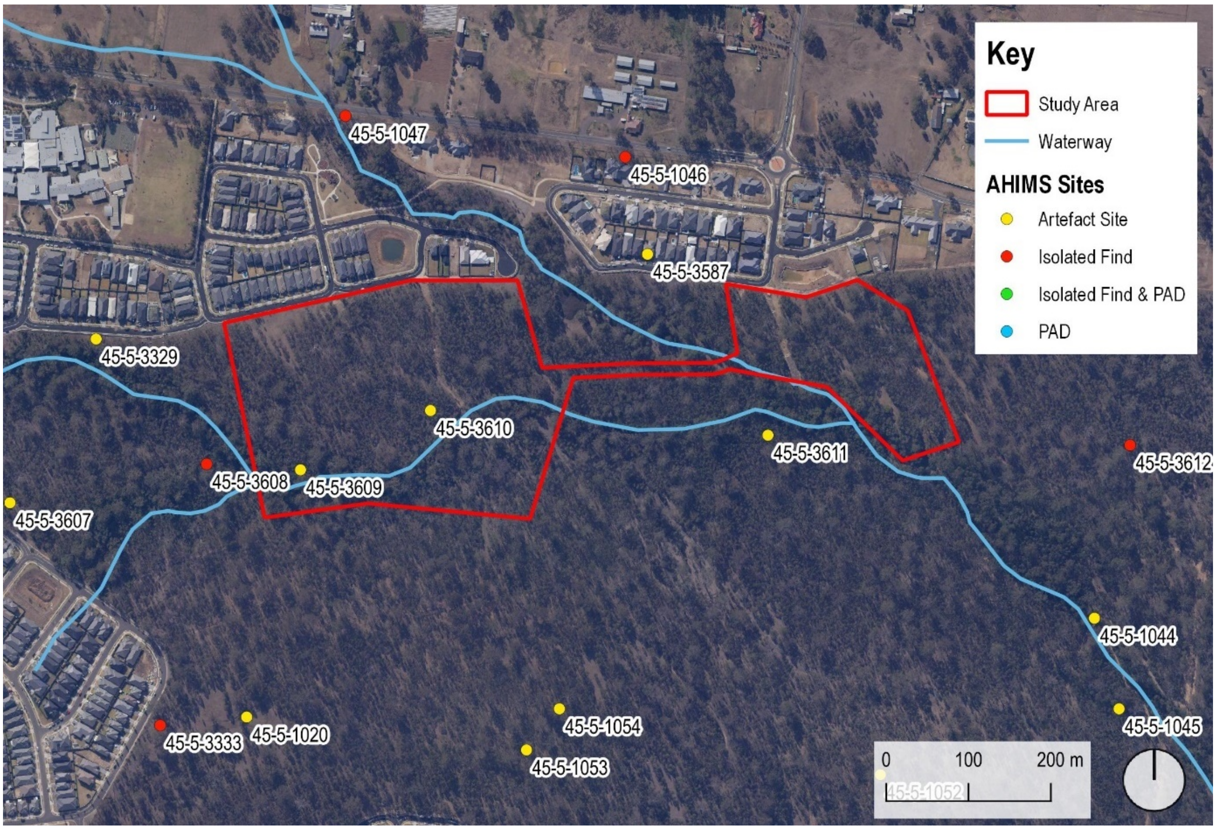

Figure 2.9 Registered AHIMS sites located directly around the study area. (Source: DPIE, with GML additions, 2019)

2.2.2 Previous Archaeological Investigations

A literature review of previous archaeological investigations within the SMDS was undertaken to understand the broader region's archaeological patterning. This review targeted reports relevant to the study area, focusing only on those archaeological investigations undertaken within the SMDS on the Luddenham soil landscape. Excavations along South Creek within alluvial deposits, notably the Central Precinct, have been excluded from this discussion.

The purpose of this section is to synthesise available information from previous archaeological and historical research to provide a context and baseline for what is known about Aboriginal cultural heritage within the study area.

SMDS Strategic Management Model

Between 1994 and 2000 Jo McDonald Cultural Heritage Management (JMcDCHM) developed a Strategic Management Model (SMM) to manage Aboriginal cultural heritage across the entire SMDS (now Jordan Springs, Ropes Crossing, North Dunheved, and the Wianamatta Regional Park).[8] The SMM identified four zones across the SMDS based on their archaeological potential. Each zone was designated specific management outcomes. These management zones assisted in the delineation of the developable areas within the SMDS (now Jordan Springs and Ropes Crossing), as opposed to areas of conservation (the area now zoned as Wianamatta Regional Park). The SMDS Strategic Management Model further informed the approach to archaeological investigations that have been completed as part of the redevelopment of the SMDS.

JMcDCHM 1997a—Interim Heritage Management Report[9]

JMcDCHM identified locations within the SMDS where silcrete, a raw material that can be manufactured into stone artefacts, could have been obtained.[10] Silcrete formed a major part of artefact assemblages collected in SMDS (see below). For example, as identified by the WS4&PAD test and salvage excavations,[11] the vast majority of artefacts collected from the area to the southeast of Basins C and V6 were manufactured from silcrete. The location of the silcrete raw materials are only 2km to 3km northeast of WS4&PAD, and 4km to 5km southeast of the present study area. Another location of silcrete cobble is directly east of the study area, on the eastern side of Ropes Creek, only 2.5km from Basin V6.

JMcDCHM 1997b—St Marys ADI Test Excavation[12]

In September 1997, JMcDCHM excavated 113 test pits (1m by 1m) across five sample areas, with members of the Deerubbin Local Aboriginal Land Council (DLALC). Open artefact scatters were identified in each of the areas, and a total of 3,461 Aboriginal stone artefacts were recovered. The closest to the present study area was Area 5 (AHIMS No. 45-5-1044), located on the Luddenham soils and situated 700m southeast of Basin C and 500m from Basin V6. A total of 33 test units were excavated along two transects, with a total of 321 lithics recovered.

The aims of the test excavation were to investigate the designation of conservation areas within the ADI site. JMcDCHM did so by assessing potential conflicts between the proposed works (filling of the floodplain) and heritage management requirements. JMcDCHM concluded that there was 'minimal conflict' between the proposed works and Aboriginal heritage management requirements as the areas of works are located in areas zoned as containing 'low or no archaeological potential'.[13]

Importantly, the conclusions from the report suggested that there is a moderate potential for archaeology around the study area. JMcDCHM designated the area on which proposed Basins C and V6 are located as Management Zone 3, defined as:

> *Moderate disturbance – land which has been cleared and grazed, and on which there is evidence of at least one phase of ploughing. Aboriginal sites may be found in these areas but they will have been disturbed to a depth of about 20 to 30cm.*[14]

JMcDCHM furthermore redefined the boundaries of the conservation zone corridors, adding that its testing works 'indicated that a conservation corridor width of 50m either side of the creekline would be inadequate to encompass areas of archaeological significance' and therefore suggested a conservation corridor of 150m on either side of the creek channel.[15] As there are creek lines running through and beside the study area, the results of this report would suggests that the current areas being assessed possess potential for intact archaeological evidence.

JMcDCHM 2004,[16] 2005,[17] 2006[18]—Fauna Fence Survey

JMcDCHM undertook several field surveys between 2004 and 2006 along the route of a proposed fauna fence constructed across the SMDS. The purpose of the fauna fence was to mark the boundary of the regional park and to manage macrofauna (ie kangaroos and emus) during the construction phase of residential and industrial precincts. As such, an area of the fence line (referred to as Section B to C) which defines the edge of Jordan Springs is located directly to the north of the study area.

The field surveys focused on the centre line of the proposed fence route with a 5m corridor to either side (a 10m corridor in total). Field surveys subsequent to the first survey were undertaken due to adjustments of the proposed path of the fence.

Along Section B to C, six open artefact scatters, three isolated finds, one open artefact scatter and PAD, and one PAD were recorded.[19] Three are notable for being close to the present study area. Firstly, ADI/FF9 (AHIMS No. 45-5-3609), an open artefact scatter and PAD, is located less than 25 metres from the southwestern extent of Basin C. The PAD was designated as containing moderate to high potential for further archaeological remains. Moreover, as it is a PAD, it is possible that the extent of the PAD covers the footprint of Basin C. Secondly, ADI/FF10 (AHIMS No. 45-5-3610), an open artefact scatter, is located directly within the boundary of Basin C. The scatter is potentially an extension of ADI/FF9 to the west. JMcDCHM notes that the area around it has been cleared and possibly graded for dam banks and therefore has low to moderate potential for intact deposits due to the disturbance. The third site within the vicinity of the study area is ADI/FF12 (AHIMS No. 45-5-3611), another open artefact scatter, located approximately 120m to the south of Basin V6. The report stated that there is moderate to high potential for intact archaeological deposits in the area.

JMcDCHM 2009—WP3 and WP4 Salvage Excavation[20]

Assessment of the SMDS Western Precinct (Jordan Springs)[21] identified seven target areas to be subject to salvage excavation prior to development taking place in these areas. A precinct-wide AHIP was applied for and granted for Jordan Springs (AHIP No. 10996059).

Archaeological excavation of WP3 and WP4 in 2009 was the first phase of salvage excavation with the AHIP. A combined total of 80 1m^2 test squares and 154m^2 of open area (OA) excavation was completed from the WP3 and WP4 excavations. A total of 2,355 cultural lithics were recovered from this excavation, with 1,967 meeting technical criteria to be classified as artefacts. Artefact density and distribution from both excavated sites generally conformed to distributions identified for first order streams in other areas of the Cumberland Plain (ie low discontinuous distribution, consistent with infrequently used or one-off sites).

The excavation at WP3 demonstrated sparse distribution of artefacts, as well as small-scale flaking and discard events. The excavation of this landform, in combination with its close proximity to a source of silicified tuff and quartz (Mount Pleasant), provided the opportunity to investigate raw material preference within a discrete location. This allowed some investigation into the way in which lithic material procurement may have influenced broader trends in silcrete use (ie possibly influencing an increase in artefact discard as opposed to that common in other first order landscapes). Evidence for a silcrete heat treatment area was present within OA A of WP3.

The artefact assemblage from dispersed testing at WP4 included raw material types of silcrete, silicified tuff and quartz in almost equal proportions (silcrete=37%, silicified tuff=33% and quartz=29%). Artefact density and distribution was similar to WP3.

The investigation confirmed that artefact bearing deposits can remain relatively intact even with the low to moderate disturbance associated with historic ploughing, and the more recent impacts related to the use of the SMDS as a munitions storage area by ADI.[22] Excavation of both sites also provided an insight into the nature of raw material procurement in association with distance from sources.

GML + JMcDCHM 2012—Jordan Springs WP5 Salvage Excavation[23]

Salvage excavation of WP5 within the Jordan Springs development area was undertaken in August and September 2012 in accordance with AHIP No. 10996059. A total of 42 1m^2 test squares and 59m^2 of open area excavation was completed from excavation within WP5. A total of 1,835 cultural lithics were recovered from this excavation program.

Excavation at WP5 demonstrated a low density, discontinuous lithic distribution across the landform, with occasional artefact clusters. The artefact densities were slightly lower than predicted by the application of the Cumberland Plain predictive model for landforms associated with second order streams. Following test excavation, three squares were selected for expansion. The expansion of two of these three squares demonstrated evidence for on-site production of backed artefacts. One OA (Area B) presented with possible evidence for a circular cultural burning feature; however, charcoal recovered from this feature has not yet been dated. However, artefact heat shatter and breakage surrounding the burning feature does not point to a higher percentage of artefacts demonstrating breakage through heat.

GML + JMcDCHM 2014—Jordan Springs WP1[24]

A program of archaeological test and salvage excavation was undertaken at WP1 during January and February 2014. This involved the excavation of 41 TUs, with six TUs expanded into OA excavations. The excavation took place across two lower hill slopes on the Luddenham soil landscape, bisected by a north–south orientated open depression/first order drainage creek. Remains of a paleochannel were also discovered on the western slope of WP1. The area of excavation is situated immediately north of Basin V6.

The purpose of the excavation was to investigate a lower hill slope on shale geology. The excavation encountered low density artefact concentrations (ie a maximum of 25 artefacts in a single metre squared), with some evidence for repeated occupation or use of areas within the landscape. The excavation on the slope east of the creek encountered mainly shallow, eroded or stripped soil profiles with very few artefacts. The slightly steeper slope across this area, coupled with the flatter area on the western slope opposite, were identified as possible factors for the lack of Aboriginal artefacts.

In comparison, several stone artefact concentrations and cultural burning features (interpreted as possible ovens) were identified on the western slope. The artefact concentrations ranged from 22 artefacts recovered from $11m^2$ at TU15 to a total of 259 artefacts recovered from $45m^2$ at TU1. The results of comparative analysis to other sites excavated across the northern Cumberland Plain showed that WP1 does not conform to the predictive modelling for archaeological sites associated with first order streams.

GML + JMcDCHM 2011—WP2 and WP6 Salvage Excavation[25]

Salvage excavation of WP2 and WP6 within the Jordan Springs development area was undertaken in late 2011. A combined total of 92 $1m^2$ test squares and $217m^2$ of open area excavation was completed from the WP2 and WP6 excavations, with a total of 4,282 cultural lithics recovered.

WP2 had an average density of five artefacts/m^2, which was much higher than other first order landscapes in the comparative area. In addition, WP2 displayed a low percentage of silcrete (51%), followed by quartz (35%) and silicified tuff (13%), compared with that expected. The artefact density encountered at WP2 was more consistent with predictions for locations further down the ridge (ie locations generally predicted to possess higher artefact densities). It was concluded that the ridge landscape of WP2 would have been occupied repeatedly over the Holocene, with the highest point of the ridge top a focus for activity.

WP6 was located in association with a third order stream, a landscape in which fewer excavations have been undertaken across the Cumberland Plain. Lithic assemblages from WP6 were expected to show less use of rationing strategies as people were less mobile, potentially staying in one camp for several days or even weeks. However, WP6 demonstrated relatively low and/or varying proportions of silcrete compared to sites with similar landform features from other locations across the Cumberland Plain.

Proximity to sources of silicified tuff and quartz within the gravels at Mount Pleasant and/or associated with the Nepean River may have influenced Aboriginal peoples' use of silcrete.

Potential explanations to account for the smaller than expected size of the lithic assemblage in association with a third order stream (WP6) include the possibility that sediments of the South Creek soil landscape may have been too sandy for the adjacent creeks to retain ponds for extended periods; alternatively, people may have preferred the open woodland of the adjacent shale slopes for residential occupation rather than the forest of the South Creek soil landscape.

The excavations undertaken at these salvage areas produced scientifically significant results and provided further information about the use and occupation of landscapes around tributaries and low hilltops in the former Western Precinct of the SMDS. As with the salvage excavations undertaken in WP3 and WP4 in 2009, the excavation of WP2 and WP6 confirmed that intact soil horizons do remain in association with landforms that have been identified as of low–moderate disturbance.

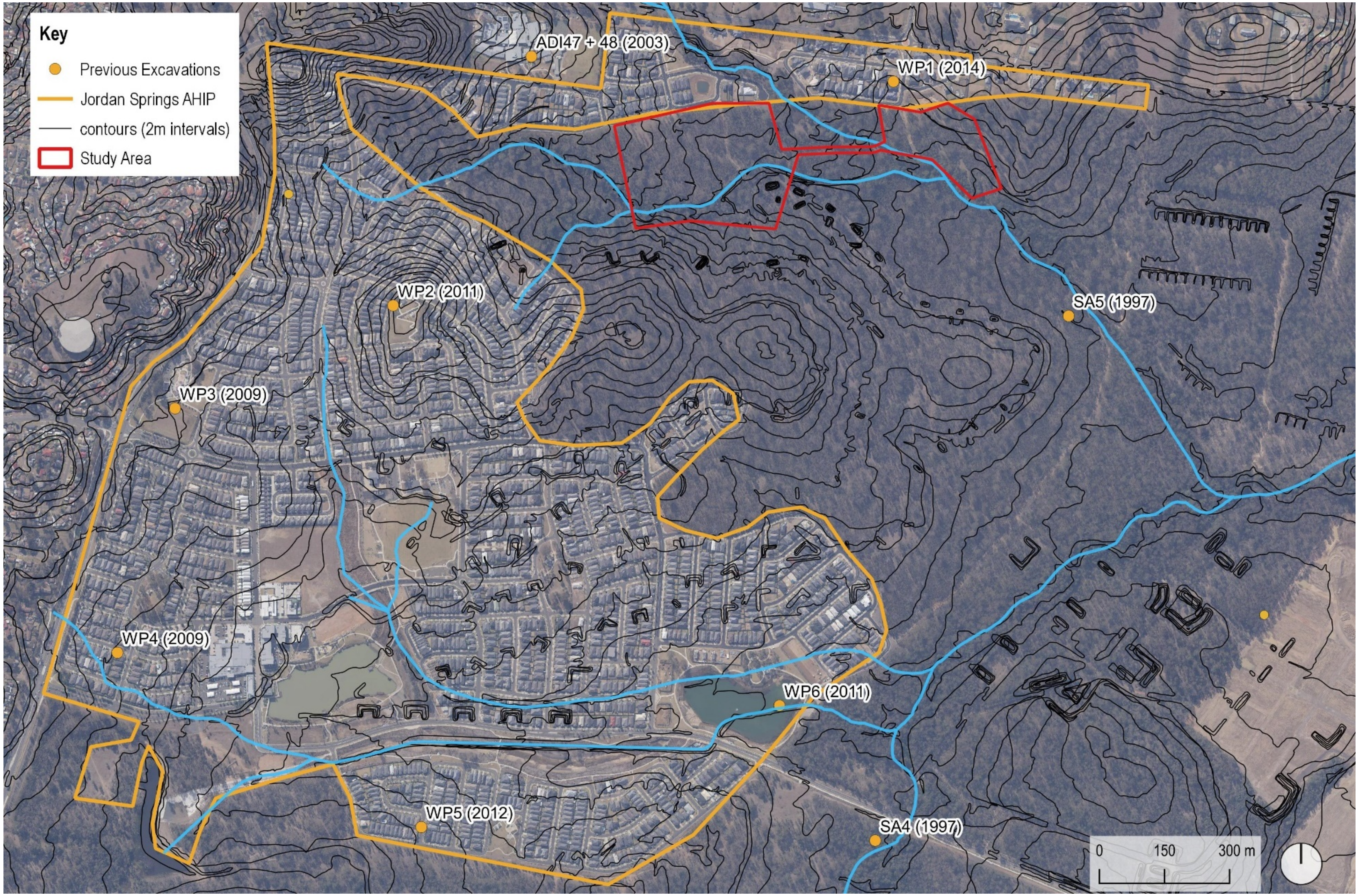

Figure 2.10 Association between prior heritage/archaeological investigations and the project area. (Source: NSW LPI with GML additions 2020)

2.3 Archaeological Predictive Model for the Study Area

The Cumberland Plain is one of Australia's most archaeologically excavated landscapes. Over the past 20 years hundreds of excavations have occurred here across many locations and landforms. A number of key Aboriginal heritage archaeological excavations have been undertaken that have informed the archaeological record and provided the basis for predictive modelling on the Cumberland Plain.[26]

Development of a predictive model for the archaeological landscape within the study area applies the stream order model. The stream order model posits that artefact sites of higher density and complexity are more likely to occur in association with higher-order streams, on lower slopes and terraces with a north or northeast-facing aspect.

On the basis of relevant archaeological research, a predictive model, referred to as the Cumberland Plain Predictive Model (CPPM), has been developed that suggests how the likely nature of sites across the Cumberland Plain can vary in terms of landforms and landscapes. Stream order is the basis for this model of Aboriginal site location, and assumes that people would have preferentially selected camping locations where the water supply was more permanent and predictable.[27] This model predicted that the size (density and complexity) and nature of archaeological features will vary according to the permanence of water (ie ascending stream order), landscape unit and proximity to lithic resources.

The key components of the CPPM regarding the potential for Aboriginal archaeological sites along second order creeks are as follows:

- In the middle reaches of minor tributaries (second order creeks) there will be archaeological evidence for sparse but focused activity (eg one-off camp locations, single episode knapping floors).
- Creek junctions may provide foci for site activity; the size of the confluence (in terms of stream ranking nodes) could be expected to influence the size of the site.

The CPPM also posits that in any landscape location there is a chance that a 'background scatter' of Aboriginal objects exists—that is, objects deposited as a consequence of one-off manufacture, use and/or discard use, where no correlation would be associated with a landform or a more permanent activity area. Such areas are unlikely to contain a subsurface archaeological deposit. Another major conclusion of the CPPM was that surface artefacts are not an accurate reflection of subsurface archaeological potential, as soils are largely aggrading across the Cumberland Plain and most artefacts are therefore buried.

2.3.1 Basin C and Basin V6 Predictive Model

Based on the CPPM and results of archaeological excavations at Jordan Springs, the following predictions are made regarding the potential for Aboriginal archaeological sites within the study area:

- Basin C—a 50m corridor along the creek that borders the southern edge of Basin C is the area most likely to retain higher densities of stone artefacts. This translates to the southernmost boundary of the study area, which is only 30m away from the creek line, and to the southwestern corner of the study area, where the creek crosses through the basin site. The northern half of the study area is expected to exhibit a lower density background scatter of surface and subsurface artefacts.
- Basin V6—this area has been heavily disturbed in the past and is not expected to retain in situ archaeological deposits. The results of the excavation at WP1 immediately north of Basin V6

indicated that this area had been subject to disturbance that had stripped the soil profile and very few artefacts were recovered. The northeastern area of Basin V6 is likely to contain no intact archaeological deposits, and minimal artefacts. The western half of Basin V6 is also considered heavily disturbed as a result of the drainage infrastructure.

- Haul Road—during the site visit it was observed that creation of the existing 4WD track/road required earthworks to build up the road surface, which will have disturbed the surrounding area. Additionally, the road is heavily eroded and unlikely to retain deposits containing in situ Aboriginal artefacts.

In summary, predictive modelling indicates that unfocused stone artefacts scatters and isolated finds are highly likely to be identified across the whole landscape. More focused Aboriginal activity culminating in potentially dense artefact concentrations may be found within a 50m buffer of the creeks running through the study area. The area has been heavily disturbed due to recent land use related to the SMDS. Landscaping activities have disturbed large parts of the study area and therefore the surface and subsurface archaeology.

The outcomes from the modelling, contrasted against the history of recent land use, provide an indication of locations and landforms that could be connected with physical (tangible) aspects of Aboriginal heritage. These locations are presented in Figure 2.11.

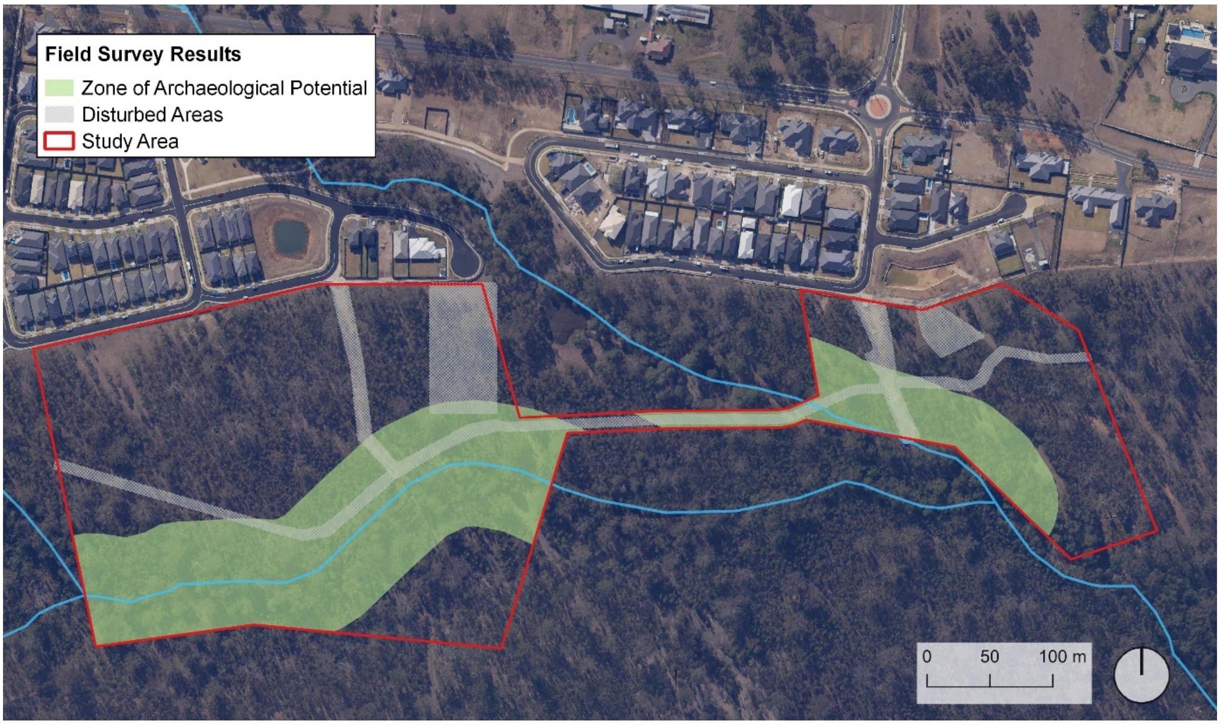

Figure 2.11 Summary of Aboriginal heritage predictive modelling for the project area. (Source: NSW LPI with GML additions 2020)

3.0 Aboriginal Heritage Field Survey

The background investigations have established the nature of the local environment, the extent of prior heritage works, and known Aboriginal connections into the project area. This section presents the results of preliminary investigations into the Aboriginal heritage of the project area. The outcomes combine to describe the overarching cultural landscape and provide the basis for the Aboriginal heritage values assessment.

3.1 Survey Sampling Strategy

Archaeological surveys are designed to allow for the identification of visible evidence of past Aboriginal occupation within the study area. The survey also assists in determining zones that will have buried, subsurface archaeological deposits. Together, this allows for the creation of an Archaeological Zoning Plan (AZP) that defines where Aboriginal evidence is likely to be located across the study area. In addition, consideration is given to locations within the study area that do not contain physical evidence from Aboriginal occupation, but would have been significant to Aboriginal use of the landscape, eg walking tracks, ceremonial areas, Dreaming trails etc. These should also be recorded, mapped and considered within the framework of assessment and management of Aboriginal heritage.

It must be noted that practically all archaeological survey is limited by several factors such as ground surface visibility and access restrictions, and is tempered by environmental factors during the period of survey. These influences will affect the outcome of any survey and introduce biases into the results.

The study area is 16.4ha. The area was surveyed on foot on 18 December 2019 by a single team comprising two archaeologists, two Aboriginal representatives and one representative from the client's project manager.

Given concerns regarding health and safety (namely snakes) and the lack of ground surface visibility, locations considered to have higher potential for archaeological sites were targeted. Transects around each of the basin sites was also undertaken to identify areas of previous impact that may not have been identified through desktop research. This approach was discussed and agreed to by the Aboriginal representatives as an appropriate method for this portion of the study area.

Newly identified 'sites' had their location recorded and their extent mapped on the aerial and/or topographic maps. They were photographed and AHIMS cards completed for them—these will be submitted to the DPIE. The landscape of the study area was characterised and areas with PAD were designated.

3.1.1 Recording Methods

In accordance with the DPIE guidelines,[28] the description of survey coverage includes landform units, the total area surveyed within that landform unit and a quantification of the level of exposure and visibility. The calculation of effective coverage provides a means with which to describe the proportion of the study area in which it is possible to assess the presence or absence of archaeological material. This measure is expressed as a percentage and can be calculated using different techniques. For this study, effective coverage was calculated by multiplying the area surveyed by the percentage of exposure and visibility within the survey unit. The area of effective coverage was then expressed as a percentage of the whole survey unit.

3.2 Results of the Survey

The study area was surveyed according to survey units, landforms and landscapes. These survey units were defined with reference to the *Australian Soil and Land Survey Field Handbook*.[29] Tables 4.1 and 4.2 present a description of the survey units and summarise the effective coverage and sampling of each landform.

Table 3.1 Description of Survey Units within the Study Area.

Landform	Survey Unit (SU)	Description
Flat	1	This area is located between two second order tributaries. The area is covered in open woodland affording good views across the area (Figure 4.1). The ground surface is covered in thick leaf litter, limiting surface visibility to <10% across the entire area. Thick scrub, including African olive, grows along the creek margins, limiting visibility and access. Areas of disturbance were localised—a stormwater opening was identified, and the area is crossed by several 4WD tracks.
Flat	2	This area is located immediately east of a second order creek and is covered in open woodland with low grass cover (Figure 4.2). A low earthen bund was identified in the northeast corner, and a stormwater drain runs through the centre of the area. Dense vegetation grows close to the creek margins, limiting visibility.
Simple slope	3	This area is situated at the base of a simple slope; beyond the survey unit the ground slopes upwards to the south into a series of low hills. The area is covered in open woodland, with ground surface visibility higher than on the flats at around 20%.

Table 3.2 Survey Units, Effective Survey Coverage and Summary of Sampled Areas by Landform.

Survey Unit	Landform	Landform Area (LA) (m^2)	Visibility (V)	Exposure (E) %	Effective Coverage Area (ECA) (m^2) (=SUA* V%*E%)	% Landform Effectively Surveyed (=ECA/LA *100)	Number of Aboriginal Sites Located in Survey
1, 2	Flat	150,886	10	10	1,508	1%	4
3	Simple slope	13,714	20	10	137	2%	1

Figure 3.1 Looking north across Survey Unit 1 towards the Jordan Springs residential area, just visible in the background. (Source: GML 2019)

Figure 3.2 Looking northwest across Survey Unit 2. (Source: GML 2019)

Figure 3.3 Looking north across the location of Basin C AS3 in Survey Unit 3. (Source: GML 2019)

Figure 3.4 Looking west along the creek that flows through the southern part of Basin C. (Source: GML 2019)

3.2.1 Aboriginal Archaeological Sites

Several Aboriginal archaeological artefacts and areas considered to have potential for intact archaeological deposits were identified during a preliminary site visit on 30 October 2019 and during the field survey on 18 December 2019. Aboriginal artefact deposits were identified during the test excavation completed in January 2020. AHIMS cards have been prepared for these sites, including photographs and location data; these are included in Appendix B. A summary overview of each new site is included in Table 4.3 below.

The locations of two existing Aboriginal artefact sites (AHIMS# 45-5-3609 and 45-5-3610) within the study area were inspected; however, the artefacts associated with these recorded sites were not relocated.

The outcomes of the pedestrian survey reflect both the predictive model for the study area and the locations where survey could occur. To that end the majority of Aboriginal stone objects observed within the study area were located in association with areas in proximity to the creek corridors.

Table 3.3 Summary of Aboriginal Archaeological Artefacts and Sites Identified within the Study Area.

AHIMS No.	Site Name	Site Type	Landform	Description
45-5-5276	Basin C AS1	Artefact site	Flat	Artefact scatter comprising four artefacts—three mudstone flakes and an IMSTC flake. The artefacts were located on a 4WD track in the middle of Basin C. The vehicle track has 100% visibility. The artefacts are located to the east of AHIMS site No. 45-5-3610 and may therefore relate to a larger PAD.
45-5-5275	Basin C AS2	Artefact site	Flat	Artefact site comprising one mudstone flake and two IMSTC flakes. The artefacts were located on a 4WD track in the middle of Basin C. The vehicle track has 100% visibility.
45-5-5368	Basin C AS3	Artefact site, PAD	Simple slope	This artefact site is located just outside the southern border of the study area. Seven artefacts were located across an area measuring 5m x 5m on a simple slope approximately 50m south of a second order creek. The artefacts comprise four mudstone flakes, including one backed blade, and three silcrete flakes. Surface visibility was 20% and 10% exposure. The site is located on the Luddenham soil landscape. The area of PAD is considered to extend across an area measuring 10m x 10m.
45-5-5366	Basin C AS4	Isolated artefact	Flat	Single silcrete artefact identified on a 4WD track. The vehicle track had 70% visibility, and 20% exposure.
45-5-5367	Basin C AS5	Isolated artefact	Flat	Single silcrete artefact identified on a 4WD track. The vehicle track had 90% visibility, and 20% exposure.
45-5-5362	Basin C AS6	Artefact site	Flat	Artefact site comprising one silcrete distal flake and one quartz flake. The artefacts were located in an area vegetated with open woodland and grass ground cover. The ground had 20% visibility and 5% exposure.
45-5-5361	Basin C AS7	Isolated artefact	Flat	Single silcrete broken flake identified near test pit TU46 in an area vegetated with open woodland and grass ground cover. The area had 20% surface visibility and 5% exposure.
45-5-5363	Basin C AS8	Isolated artefact	Flat	Single silcrete flake identified in open grassy area adjacent to graded 4WD track. The area had 10% surface visibility limited by dense leaf litter and 0% exposure.
45-5-5364	Basin C AS9	Artefact site	Simple slope	Artefact site comprising two silcrete flakes located approximately 3m southeast of TU64. The area is open woodland with low shrub, grasses and leaf litter limiting surface visibility to 10–20%.
45-5-5365	Basin V6 AS1	Isolated artefact	Flat	Quartz angular fragment located at the edge of a graded 4WD track. The vehicle track had 100% visibility and 20% exposure.

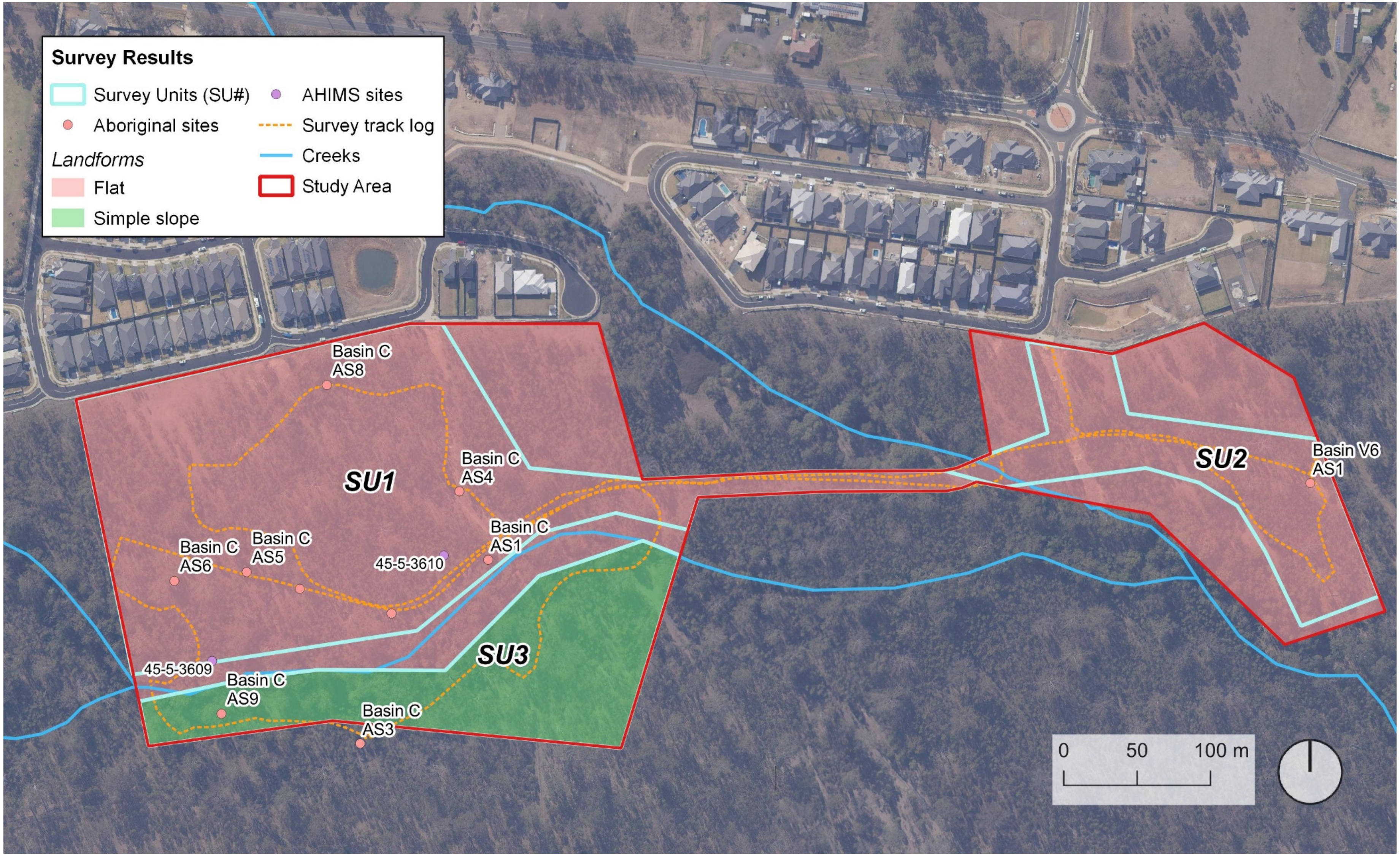

Figure 3.5 Location of new archaeological sites identified after a site visit, field survey and test excavation. (Source: NSW LPI with GML additions 2020)

3.2.2 Traditional Connections

A Conservation Management Plan (CMP) prepared for the Wianamatta Regional Park in 2011 included extensive consultation with the Aboriginal community.[30] The consultation identified a range of cultural connections and values attached to the regional park, including multiple specific sites shown in Figure 3.6.

The creeks that pass through the regional park, including those within the study area, were identified by the Aboriginal participants as travel routes. One of the participants discussed how he and his family and ancestors used the creeks to navigate through the area, and as places for fishing and recreation.[31]

During the December field survey, Aboriginal representatives also noted the significance of the creeks and noted their preference that these were not significantly altered or blocked by the development.

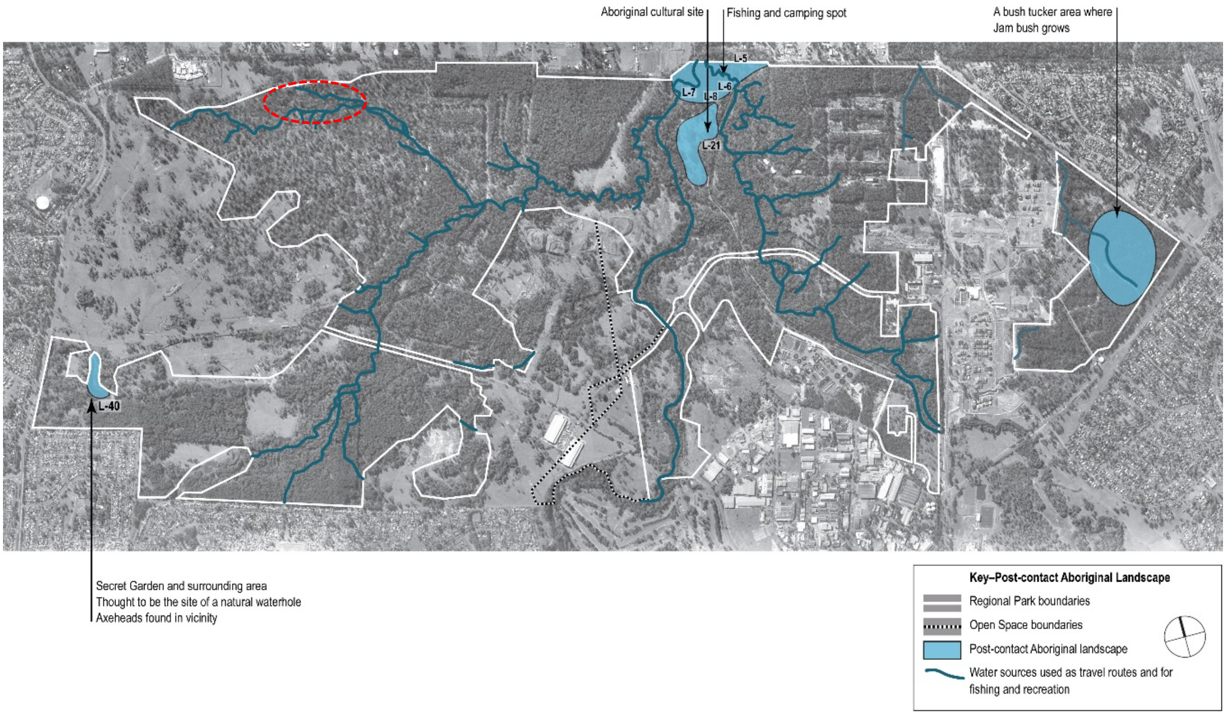

Figure 3.6 Post-contact Aboriginal sites identified within the Wianamatta Regional Park (outlined in white) as part of the Aboriginal community consultation conducted for the CMP. The approximate location of the study area is outlined in red. (Source: Wianamatta Regional Park CMP[32] with GML additions)

4.0 Archaeological Test Excavation—Methodology

4.1 Introduction

The excavation methodology was presented in GML's Aboriginal Archaeological and Cultural Heritage Assessment Methodology (AACHAM) (December 2019). The methodology was issued to RAPs for comment and a 28-day review period allowed in accordance with DPIE guidelines. Feedback on the methodology was received from several groups (discussed further in Section 4.3.2).

4.1.1 Testing under the Code of Practice[33]

Archaeological test excavation is permitted under the DPIE *Archaeological Code of Practice*[34] without the need for an AHIP under Section 90 of the NPW Act (ie archaeological test excavation is excluded from the definition of harm under the NPW Act), provided that the subsurface investigations are not carried out in the following areas:

- in or within 50m of an area where burial sites are known or are likely to exist;
- in or within 50m of a declared Aboriginal place;
- in or within 50m of a rock shelter, shell midden or earth mound; and/or
- in areas known or suspected to be Aboriginal missions or previous Aboriginal reserves or institutes.

As described by DPIE the purpose of test excavation is to:

> *collect information about the nature and extent of sub-surface Aboriginal objects, based on a sample derived from sub-surface investigations. Test excavations contribute to the understanding of site characteristics and local and regional prehistory and they can be used to inform conservation goals and harm mitigation measures for the proposed activity.*[35]

This section sets out the methodology for archaeological test excavation developed in accordance with DPIE guidelines. Aboriginal community consultation is being undertaken in accordance with NPW Regulation, subclause 80C (6), and was commenced prior to this proposed methodology being prepared and will continue throughout the project.

Existing knowledge has been gathered from register site data, previous reports of other investigations within the SMDS, the landscape context and known impacts to the study area (Section 2.0). The combination of these aspects defines the zones within the study area that are suitable for archaeological testing. A substantial body of work exists for previous archaeological excavations undertaken within the SMDS that has provided a good overall understanding of the nature and likely extent of archaeological deposits across the site in areas of good soil integrity and archaeological potential.

4.2 Archaeological Research Framework

While the requirement for undertaking the detailed Aboriginal archaeological works is statutory and designed to mitigate work impacts, the works and associated archaeology present the opportunity to address key research questions relating to our understanding of long-term Aboriginal occupation of the Cumberland Plain over the different soil landscapes.

The objective for the proposed excavations should be to gain further Aboriginal archaeological insight into the long-term Aboriginal use of this area, determining its values and contribution to the broader stories of Western Sydney. All proposed impacts to Aboriginal heritage sites should be driven by defined themed research questions, which culminate in sufficiently detailed excavation to allow the research questions to be answered. Developing an understanding of the long-term Aboriginal cultural landscape provides opportunities for connection with Aboriginal social and scientific values, which would provide significant benefit to the Aboriginal community and general public. The interpretation of these aspects should benefit future generations.

In order to achieve the objective, a series of research questions has to be established to guide the archaeological process and provide the basis for questioning the data collected. The results of excavations within the Jordan Springs Precinct (see WP1–6 in Section 2.0) found that the archaeological sites presented variables that were not consistent with the CPPM. This project presents an opportunity to collect additional data to expand on our understanding of past Aboriginal occupation and use of locations along lower stream-order waterways.

Broad research questions for the potential Aboriginal archaeological resource include:

1. What is the nature of the archaeological deposit and how can it be interpreted?
    a. What are the physical attributes of the deposit (stone, carbon, clay or other)?
    b. What, if any, evidence other than stone is present for Aboriginal occupation of this region?
    c. For stone deposits, what are the physical characteristics and do they indicate a specialised use? Is there a difference in stone tool types between the different locations tested?
    d. For other deposits (ie burning features), what are the physical characteristics and how do they compare to features identified at Jordan Springs (former Western Precinct)? Is it possible to identify relationships with concentrations of stone deposits?
    e. What are the spatial characteristics of the archaeological deposit at each location? Is the archaeological deposit consistent with depth? Were Aboriginal people utilising the same locations for thousands of years or was there considerable variation in landscape use and selection strategies? How does the archaeological deposit vary spatially within one site? Is there evidence for domiciliary areas within the deposit?
2. Can the archaeology be interpreted in a regional context?
    a. Where did the raw stone materials originate from? Have they been brought into the study area? From how far away has the stone been brought?
    b. Is there evidence of trade in connection to stone deposits? Within a single context, does one stone material exhibit a higher degree of ‘working’ than another? Does the level of working or percentages of stone change over time (ie across stratigraphical layers)? How do these differences relate to stone procurement strategies? What are the implications for the regional Aboriginal economy and possibly local tribal boundaries?
    c. How does the archaeological evidence compare with the results of Jordan Springs (former Western Precinct), which did not wholly conform to the CPPM in terms of the distance-decay to stream order model?
3. How is the archaeological deposit significant?

   a. What is the heritage value of the deposit, both scientifically and culturally?

   b. How does the Aboriginal community view and value the deposit identified?

   c. Does the deposit conform to the standard stream order model? Can the combined evidence from all the excavations across the SMDS be used to refine or describe a new model for Aboriginal occupation?

4. Is there a deposit worthy of future research? Is there a high scientific value archaeological deposit(s) worthy of extensive salvage excavation?

   a. Are chrono-stratified deposits (if present) located in a position that lends itself well to large scale open area excavation?

   b. What new research questions should be asked of open excavation? Are there benefits to undertaking larger scale investigations? Will we learn new information from bigger excavations? Or would it be better to 'window sample' very large landscape areas to obtain representative pockets of archaeological deposit?

4.3 Excavation Methodology

A methodology for archaeological test excavation has been defined by the OEH.[36] The sampling strategy for test excavation at Basins C and V6 has been developed following OEH guidelines, in response to the specific conditions of the study area and in accordance with the needs of the project.

The sampling framework for the test excavation has been developed in response to the CPPM and is based upon a 20m grid, where TUs will be excavated in transects, with 20m spacing between TUs. Further TUs will be placed outside the primary area with higher archaeological potential to confirm the lower density and/or absence of Aboriginal artefacts in that zone. These TUs will be placed at a 40m spacing.

For Basin C, transects are orientated roughly perpendicular to the alignment of the creek to ensure that the samples provide optimum coverage of the zones that have the greatest potential for containing a dense archaeological deposit. To confirm areas of low potential additional TUs have been placed on a 40m grid beyond the areas of predicted archaeological deposits.

For Basin V6, two transects have been placed to avoid previously disturbed areas and confirm whether the results of the excavation at WP1 also apply to this location eg if the area is highly disturbed, and does not retain an intact archaeological signature. As with Basin C, to confirm areas of low potential additional TUs have been placed on a 40m grid beyond the areas of predicted archaeological deposits.

For the roadway between the two Basins, a single transect has been placed along the route. Test pits were staggered along either side of an existing 4WD track to avoid areas that are highly disturbed and test zones that have potential to contain an archaeological deposit.

At both Basin C and V6, should a density of more than 24 artefacts/m^2 be identified in a TU (eg six artefacts in all excavated spits of a 0.5m by 0.5m test pit), additional TUs would be placed on a 10m grid to confirm the extent of the artefact expression.

In general, it is not proposed to expand TUs, unless features are identified. TUs may be expanded if the project's sampling parameters require verification of a density at a certain location, eg if all TUs return low densities, except for an isolated TU, expanding the TU would be warranted to confirm the extent and nature of the deposit. A maximum of $3m^2$ could be excavated in such a way.

The Aboriginal archaeological excavation will be undertaken by a team comprising an Excavation Director, between three to four field archaeologists and six Aboriginal representatives (from the RAPs).

4.3.1 Recording Methods

All TU locations will be set out by a surveyor, based upon the sample pattern developed in GIS software (with minor variation only where physical features on the ground necessitate this). Additional TUs, when required, will be set out in the field by hand using standard surveying techniques. Excavation of each spit will be determined by an archaeologist using a hand tape; the vertical control for excavating should be around 10mm.

Archaeological data sampling will require collection of information on standard archaeological excavation parameters, such as excavation location, landform, aspect, depth of each spit/context as excavated, number of stone objects, features, total number of objects, the identification of any features or inclusion (such as carbon), taphonomic factors (disturbance, bioturbation etc), soil characteristics, section and plan diagrams (especially where features are present). Cultural samples of carbon and clay will be retained and subject to dating. In order to complete this data sampling, archaeological excavation of sufficient extent and depth will be required.

4.3.2 Responses to the Archaeological Test Excavation Methodology

The AACHAM was issued to all RAPs for their review and comment in accordance with DPIE guidelines.[37] Responses to the proposed archaeological test excavation were received from six of the RAPs. The comments and GML's responses, including any modifications to the methodology, are discussed in Table 4.1 below.

Respondent	Comments	GML Response
A1 Indigenous Services	I have reviewed the document and support the Project Background Information, Methodology and Archaeological Research Design. A1 would like to be involved in any future field work.	Thank you for your feedback. We acknowledge your wish to be involved in the fieldwork and will consider this when organise the test excavation program.
Kamilaroi Yankuntjatjara Working Group	Thank you for your report, this area is highly significant to the Aboriginal people & I agree and support your methodology regarding St Marys Development Site, Basin.	Thank you for your feedback. We acknowledge the cultural significance of this place to Aboriginal people. Further discussion of the cultural values of the St Marys Development Site will be presented in the Interim ACHAR for the project.
Barking Owl Aboriginal Corporation	Myself and the members of Barking Owl Aboriginal Corporation have agreed and are satisfied with the proposed ACHA methodology and research design provided by GML Heritage and have no further comments or recommendations.	Thank you for your feedback on the methodology.
Aragung	I have read the Methodology Report and agree to the proposed Methodology and Archaeological Research Design in its entirety.	Thank you for your feedback on the methodology.
Widescope Indigenous Group	Thank you for providing me with the Methodology and research design proposed	Thank you for your feedback on the methodology.

Respondent	Comments	GML Response
	for the St Marys Development Site, Basin C + V6 project. I have reviewed and support the recommendations outlined in the Aboriginal Cultural Heritage Assessment (ACHA).	
Darug Custodian Aboriginal Corporation	Comments were received during the field survey regarding the test excavation methodology, particularly the use of 0.5m x 0.5m (0.25m^2) test units and 20m grid spacing, and the possibility of not intersecting archaeologist sites using this method. The use of 1m x 1m test pits was suggested as a better approach.	Thank you for your feedback on the methodology. We note your comments regarding the test pit size and grid spacing. Please note that the program of testing will be under the *Code of Practice for Archaeological Investigations*—requirement 16a defines the size of test units. In some instances, these can be expanded to 1m^2 units. We have allowed for some expansion in our methodology. The use of 0.25m^2 test units allows for horizontal and vertical stratigraphic control of the archaeological deposit during excavation and for a more detailed analysis of artefact distribution and patterning within and between artefact sites. The use of 20m grid spacing has taken into consideration the range of archaeological investigations completed to date across the SMDS, and has been used successfully for many archaeological excavation projects in Western Sydney. We do note that the spacing may not always intersect higher densities of stone artefacts. As such, our methodology outlined in Section 4.3.2 includes options for closer spacing of 10m or 5m. This allows for further assessment of areas with higher artefact densities, or if all test units return low densities, additional test units at a greater density may intersect an artefact site or confirm that the area does not contain high density artefact sites.

5.0 Archaeological Test Excavation—Results

5.1 Excavation Program

Test excavation was undertaken over a period of 12.5 days, between 13 January and 3 February 2020. Test excavation was undertaken by a team that included two GML personnel, three field archaeologists and representatives from the project RAPs.

DPIE was notified in writing on 30 December 2019 of the intent to commence test excavation in accordance with Requirement 15c of the *Code of Practice*.

Both basin sites and the connecting access road were subject to testing to identify areas of intact archaeological deposits. As per the methodology outlined in Section 4, test units were laid out by a surveyor on a 20m offset grid within a 50m-wide strip along the creek margins, and on a 40m off-set grid beyond these areas. Where necessary, TUs were offset slightly from their designated grid location as necessitated by the presence of trees, and obvious zones of high ground disturbance.

As the study area is entirely located within a single soil landscape, the first TU for the program was excavated in arbitrary 5cm spits. Based on the findings of this TU, the remainder of the TUs were excavated in 10cm spits. Excavation continued until basal clay (B-horizon) was reached. All soil excavated from each TU was wet-sieved by spit using 3mm wire-mesh sieves. Each TU was recorded in accordance with the methodology set out in Section 4.

Table 5.1 provides a summary of the test excavation units excavated across each area and landform. As TU110 contained a significantly higher number of artefacts compared with all other TUs excavated within Basin V6, it has been presented separately so as to allow a more accurate comparison of Basin V6 with the other testing areas.

Table 5.1 Synopsis of Archaeological Test Excavation.

PAD/ Testing Area	Landform	Soil Landscape	No. of TUs (50cm x 50cm)	Number of Artefacts	Artefact Density (/m^2)	Level of Disturbance	Revised Archaeological Potential
Basin C	Flat	Luddenham	57	20	0.55	Moderate	Low
	Simple slope	Luddenham	26	13	2.0	High	Low
Basin V6 (excluding TU110)	Flat	Luddenham	20	21	1.6[1]	Low	Low
Basin V6 TU110	Flat	Luddenham	4 [2]	137	137	Low	Low
Access Road	Flat	Luddenham	14	9	2.5	High	Low

[1] This artefact density excludes TU110.

[2] TU110 was expanded to 1m x 1m.

All images in this section were taken by GML unless indicated otherwise.

5.1.1 Basin C Area 1

A total of 58 TUs (TUs 1, 3–57, 92 and 93) were excavated on the northern side of the second order creek that bisects the Basin C study area (Figure 5.1). TUs 58, 59 and 60 were not excavated as they were inaccessible due to thick vegetation and not able to be offset. TU61 was located close to the creek and after heavy rains the location became flooded and inaccessible; it was not possible to offset this location.

A total of 20 artefacts were recovered from 13 TUs, with an average artefact density of 0.55m^2 (Figure 5.1). The highest number of artefacts was recovered from TUs 20 and 29 (n=3); all other TUs contained one or two artefacts. None of the TUs were expanded.

The landform at this location is a very gentle flat that slopes down (1.5% gradient) towards the east (Figure 5.2, Figure 5.3). The soils in this area are characterised as the Luddenham soil profile (Figure 5.4). The A_1 horizon was not observed in any of the TUs. A new A_1 layer was in the process of forming and contained frequent fine rootlets. The A_2 horizon comprised a heavily compacted greyish brown (10YR 6/3) or yellow brown (10YR 5/4) fine silty clay or silty loam, on average 300–400mm thick. This overlies a yellow brown waxy clay (7.5YR 4/4), or dull reddish-brown clay/silty clay B horizon. The A_2/B transition is gradual (50–100mm) (Figure 5.5). Evidence of bioturbation from insect burrows and tree roots was noted in many of the test pits.

Evidence for past ground disturbance was noted in multiple areas. TU11 contained 100mm of redeposited A_2 soil and 150mm of silty clay was identified overlying a truncated but intact A_2 horizon (Figure 5.6). This is likely associated with the creation of an access route across the study area that is visible on a 1955 aerial of the site (Figure 2.5). TU21, located 45m south of TU11, also showed evidence of disturbance, with 100mm of redeposited bright orange silty clay capping an intact soil profile (Figure 5.7). This also appears to relate to the grading of an access road visible on the 1955 aerial (Figure 2.5).

TUs 24, 27, 35, 36, and 39 are located within a few metres of the access road that runs through the Basin C study area. Evidence of disturbance associated with construction of the road was observed at these test pits. This generally consisted of 100–200mm of fill (redeposited or reworked A_2 soils) overlying a truncated but intact A_2 soil horizon (Figure 5.8).

TU46 was also heavily disturbed. The pit was excavated to a depth of 0.55m below the modern ground level, with the fill containing concrete, brick and redeposited clay. The pit was located in a depression that had been backfilled and may relate to an old stormwater drain or infilled creek (Figure 5.9).

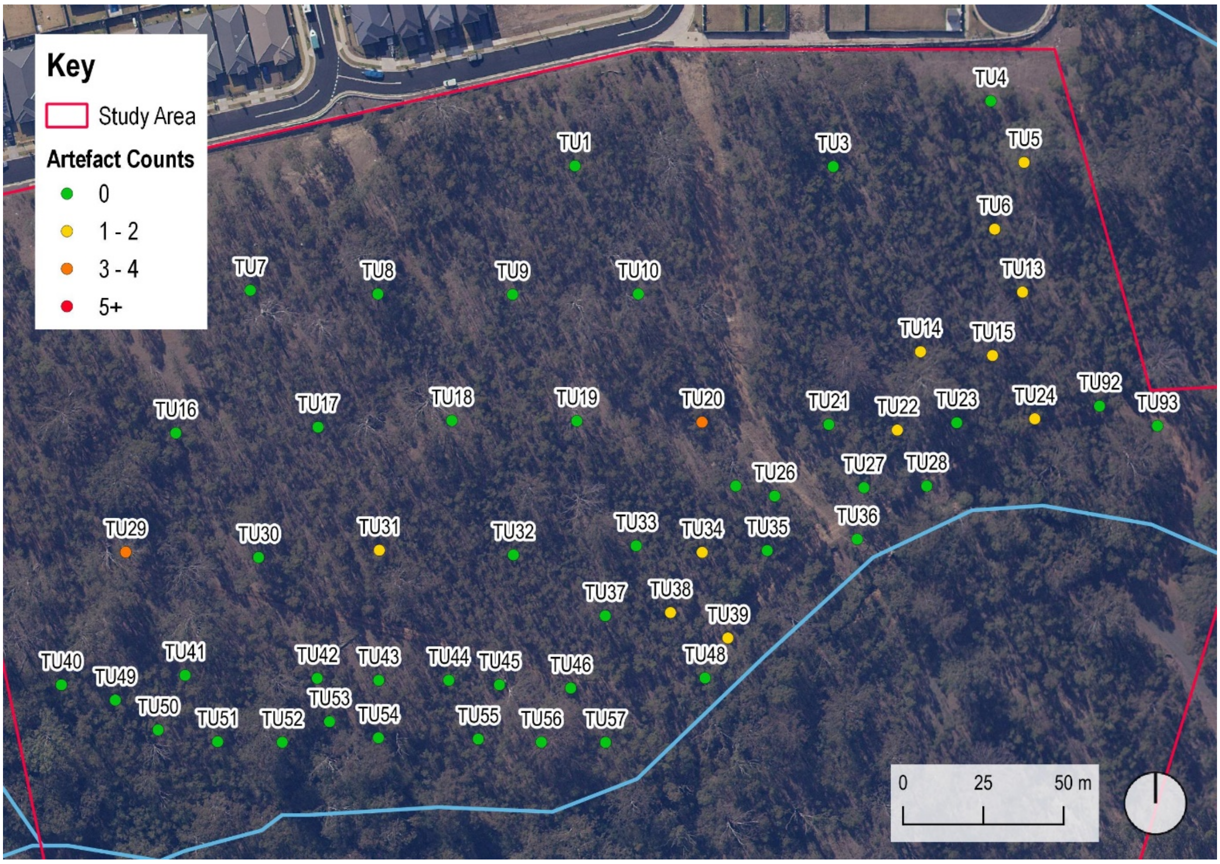

Figure 5.1 Plan of Basin C Area 1 showing density of artefacts recovered from each TU.

Figure 5.2 Looking south from TU28 into thick vegetation along the creek margin.

Figure 5.3 The typical landscape across much of Basin C Area 1 showing sparse tree regrowth and dense leaf litter covering the ground surface. As8

Figure 5.4 North wall of TU8 showing typical Luddenham soil profile encountered across Basin C Area 1, with truncated A_2.

Figure 5.5 North wall of TU34, showing gradual transition from A_2 to B horizon.

Figure 5.6 North and east walls of TU11 showing redeposited soil overlying an intact A_2 horizon (transition indicated by grey lines).

Figure 5.7 West wall of TU21 showing clay fills associated with road construction overlying intact A_2 horizon.

Figure 5.8 Wall of TU36 showing redeposited material overlying intact A_2 horizon.

Figure 5.9 Northern wall of TU46 showing fill to 500mm depth.

5.1.2 Basin C Area 2

A total of 26 TUs (TUs 62–66, 68–79, 83–91) were excavated across Basin C Area 2, located south of the second-order creek (Figure 5.10).

TU67 was not excavated as asbestos-containing material was identified across the ground surface at the location. A total of 13 artefacts was recovered from nine TUs, with an average artefact density of 2m^2.

The landform at this location is the base of a simple slope, with the ground level lying at 31m–36m AHD and a gradient of 6–7% (Figure 5.11). The soil in this area is also characterised as the Luddenham soil landscape. The A_1 horizon was not present in any of the TUs excavated. The A_2 horizon is typically a fine greyish brown (7.5YR 4/4 or 10YR 4/4) silty clay or silty loam grading to yellowish brown with depth. The TUs exhibited a similar soil profile to that observed across Basin C Area 1, although several TUs in Basin C Area 2 presented a deeper profile (500–700mm below ground level/bgl) compared with those further north.

At the eastern end of this area, evidence of extensive earthworks and other disturbances was noted in 10 TUs (Figure 5.11). This was also visible on the surrounding surface as banks, ditches and cuttings along the creek. In these TUs, a 200–500mm thick layer of imported fill overlay a truncated A_2 horizon. The fill generally comprised a mottled red/white/grey clay, although in places this was a reworked A_2. The fill layer covers an area approximately 100m north–south, and 120m east–west. Contour data and historic aerial imagery show two earthen mounds located east of TU83 and TU88 associated with the operation of the ADI site from the 1950s onwards (Figure 2.5). The presence of an intact A_2 profile below the imported clay fill in most of the TUs would suggest that the clay was introduced to level out the area for activities associated with the earthen mounds. The depth of the A_2 horizons in TUs 77 (400mm), 89 (350mm) and 91 (300mm), exhibiting a similar depth and profile to undisturbed soils on the north side of the creek, supports this conclusion.

At the western end of Basin C Area 2, the shallow profile noted in TUs 63 and 64 (<10mm) is likely the result of sheet erosion associated with historic land clearance (Figure 5.17).

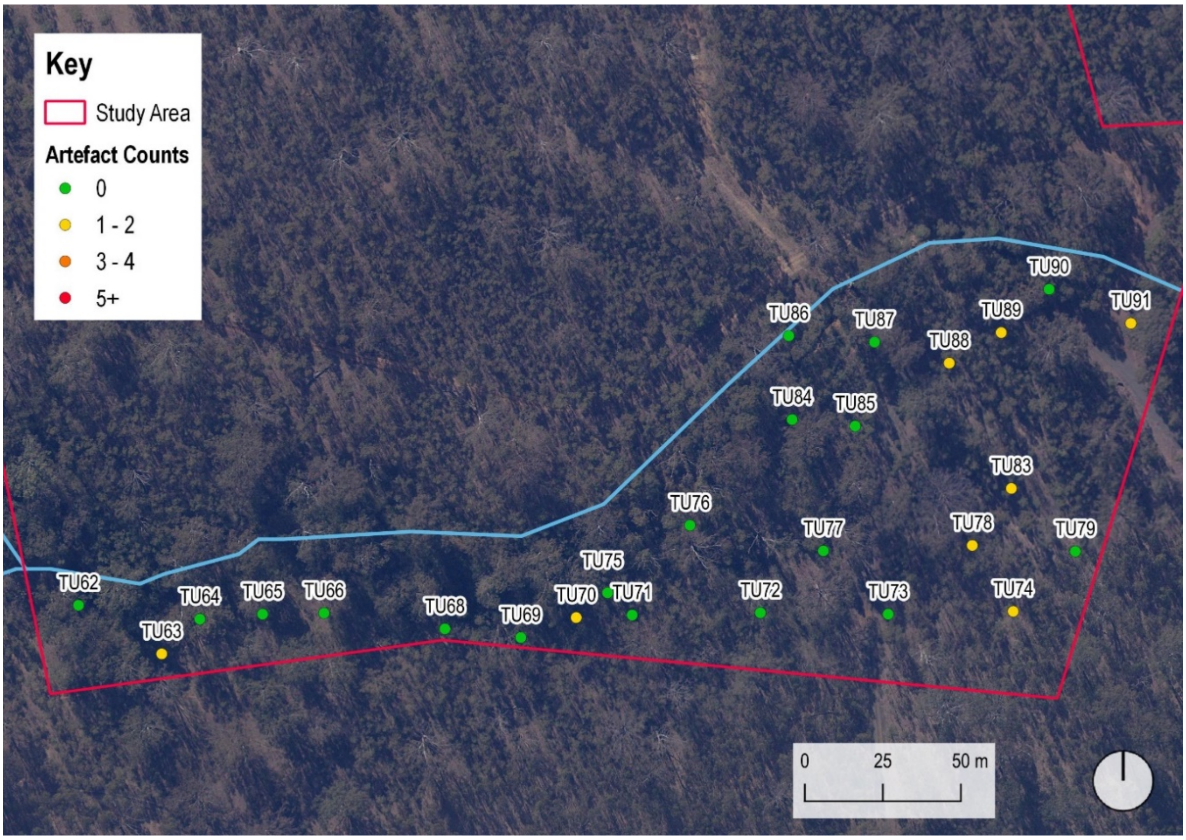

Figure 5.10 Plan of Basin C Area 2 showing the density of artefacts recovered from each TU. (Source: NSW LPI with GML additions 2020)

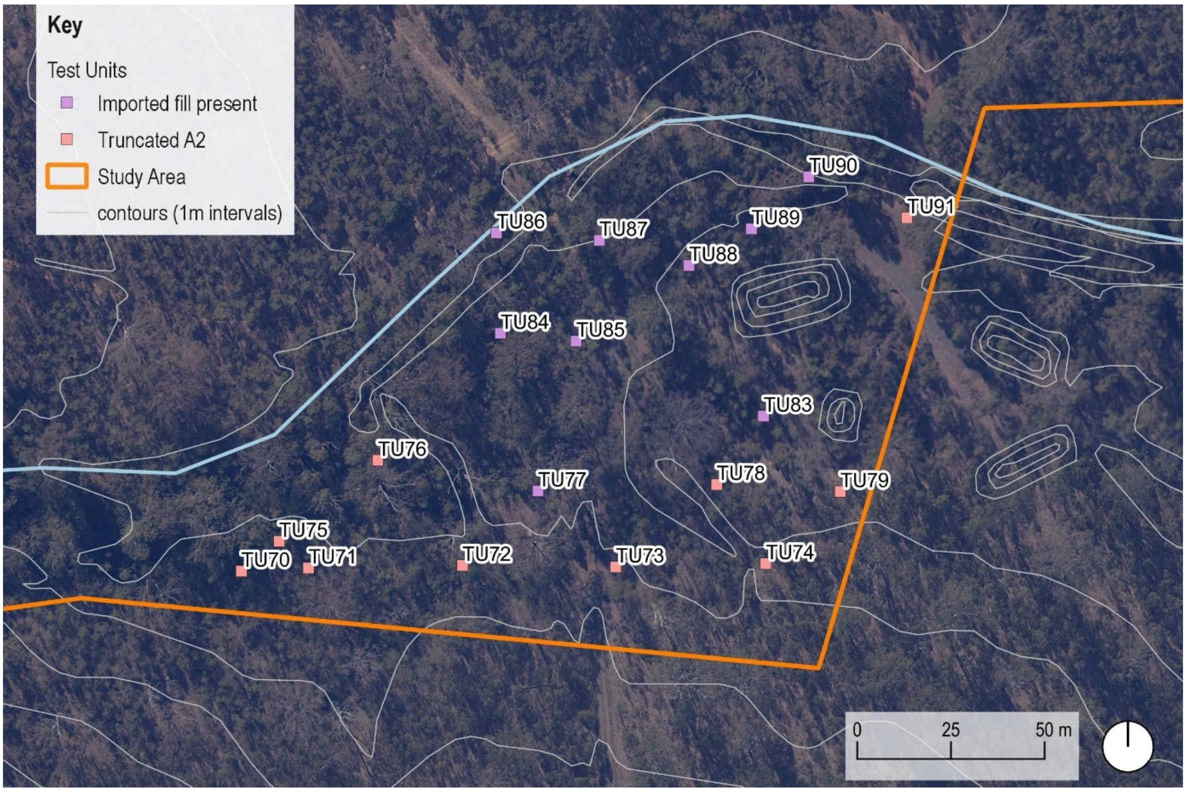

Figure 5.11 Plan showing TUs in Basin C Area 2. Those TUs containing fill are coloured purple. (Source: NSW LPI with GML additions 2020)

Figure 5.12 Wall of TU71 showing deeper soil profile encountered in this part of the study area.

Figure 5.13 Wall of TU83 showing 250mm of introduced clay fill overlying a truncated A_2 soil profile (arrow).

Figure 5.14 South wall of TU84 showing a deep layer (~500mm) of imported fill overlying a truncated A2 soil profile. The top of the A2 is indicated (arrow).

Figure 5.15 Wall of TU90 showing imported fill directly overlying the B horizon clay. The A_2 horizon was not present.

Figure 5.16 Looking north at TU88 showing a typical landscape across Basin C Area 2.

Figure 5.17 South wall of TU66 showing shallow soil profile found in TUs 62–66, 68–69.

5.1.3 Basin V6

A total of 21 TUs (108–129) were excavated across Basin V6. Thirteen TUs were laid out at 20m intervals along two transects orientated roughly parallel to a second order creek. An additional five TUs were placed at 40m intervals further east of the creek to test the area of low potential.

A total of 158 artefacts were recovered from seven of the TUs, with two TUs (TU110 and TU117) exhibiting a higher density compared to the surrounding area. Excluding TU110 and 117, the average artefact density was higher across Basin V6 at 3.9m^2.

TU117 contained a total of 13 artefacts, although further analysis of the artefacts determined that these represented only two complete flakes reduced through bipolar reduction from a single core. TU110 contained 33 artefacts, and the decision was made in the field to expand this to 1m^2. A total of 137 artefacts were recovered from the expanded test unit. This is discussed further below.

The landform at this location is a flat bordering the creek (Figure 5.19). TUs 112, 113 and 121 are located in an open depression adjacent to the creek. TUs 125 and 126 are located at the base of a simple slope that rises up towards the northeast. Local relief across the area is between 27m–29m AHD.

The TUs are characterised as the Luddenham soil profile, with the majority (TUs 109, 111, 114, 115, 117, 118, 119, 123, 124, 125, and 126) exhibiting a broadly similar profile to that encountered at Basin C Area 1, being a light greyish brown silty clay loam between 300–400mm deep overlying a mottled waxy yellow-brown clay (Figure 5.20). TUs 113 and 121 were located closer to the creek and contained a medium brown clayey silt (TU113) (Figure 5.21) or sandy silt (TU121) with increasing manganese gravels and clay content with depth. A clear transition (20–50mm) was observed in both pits onto a yellowish-brown sticky silty clay with grey mottling. No intact A_1 horizon was identified in the TUs, showing the entire area had been previously stripped of topsoil. This can be seen in historic aerials of the site and the near absence of mature trees.

Evidence of localised disturbance was noted at three of the TUs (TU112, 116, and 122). The disturbance observed in TUs 112 and 122 likely relates to the creation of an access track and land clearance observed on a 1955 aerial of the site (Figure 2.5). TU112 contained a truncated profile, with the pit only 170mm deep (Figure 5.22), while TU122 contained 200mm of fill overlying an intact truncated A_2 horizon. Evidence of redeposited material was also observed on the ground surface 1m north of TU122. TU116 appears to have been disturbed by construction of the existing access track that bisects Basin V6.

TU110A/B/C/D and TUs 127–129

At TU110 the testing recovered a concentration of artefacts. The initial TU (TU110B) yielded 34 artefacts, triggering the expansion to a 1m^2 pit. Due to the proximity of a tree to the southeast, the TU was expanded to the west and south. A letter was assigned to each of the four 50cm x 50cm units as shown in Figure 5.23. A total of 139 artefacts were recovered from the expanded TU110. Three additional pits were located to the east (TU128), south (TU127) and west (TU129) to identify the extent of the deposit (Figure 5.24). Two artefacts were recovered from TU128 and one from TU129. This would suggest that TU110 is the center of a discrete artefact site.

The soil profile at TU110 was not consistent with the surrounding area, extending to a depth of 780mm. Spit 1 consisted of a redeposited clay, likely resulting from construction of the adjacent access track (2m north). Below this, Spits 2–5 were a medium greyish brown (7.5YR 4/3) clayey silt with fire ironstone gravel inclusions and consistent with other TUs excavated across Basin V6. Spits 6–8 were a dark brown (10YR 3/2) silty clay with manganese and frequent ironstone inclusions. A layer of ironstone gravels in a silty clay matrix was present at the base of Spit 8 with a sharp (10–20mm) transition onto the B horizon, a pale orange waxy clay (Figure 5.25). The archaeological excavation at WP1 noted the presence of a paleochannel (remains of a former water course) approximately 150m to the north and the soil profile in TU110 may be a continuation of this feature (Figure 5.26).

TUs 127, 128 and 129 were considerably shallower in comparison to TU110. TU127 contained a grey brown silty loam 350mm deep, overlying a waxy yellowish-brown clay. Spit 1 in both TUs 128 and 129 comprised a reworked A_2 overlying an intact A_2 horizon from Spit 2 with a gradual transition onto the B horizon clay.

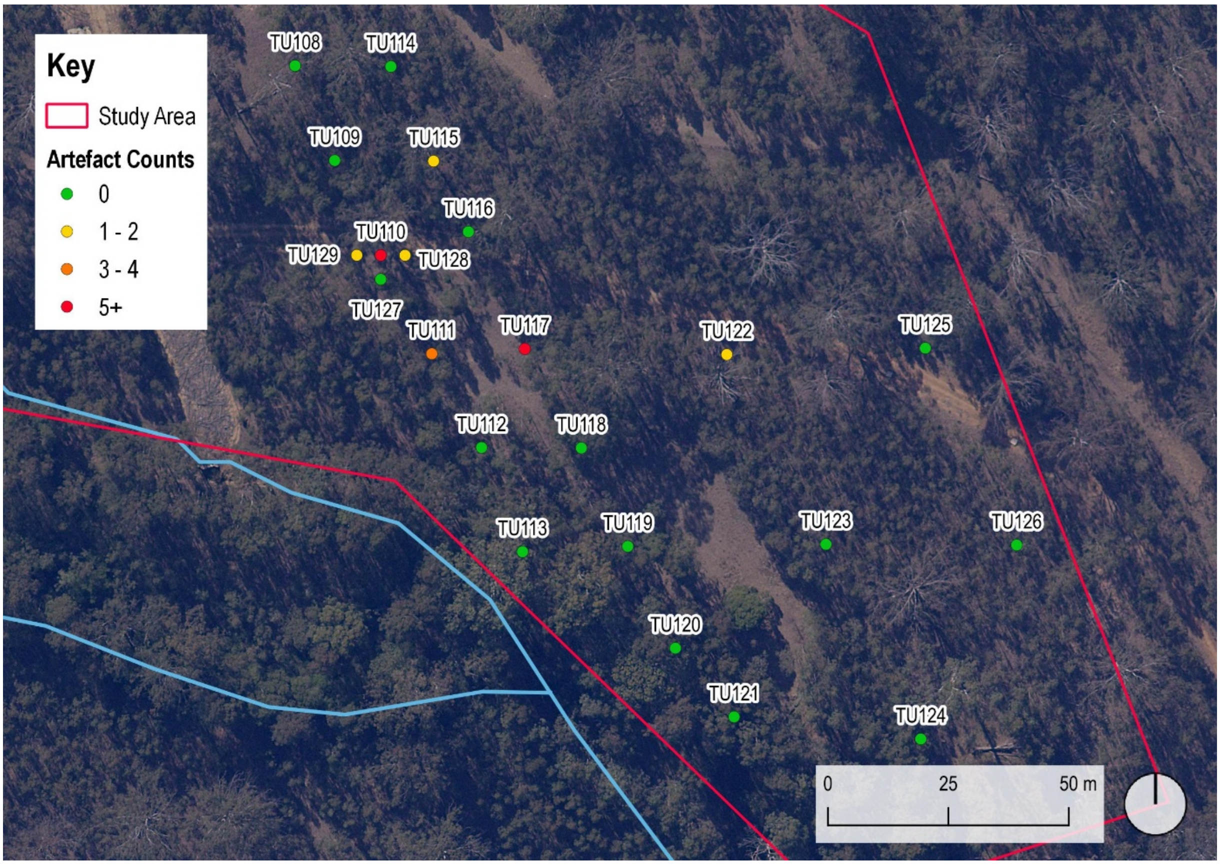

Figure 5.18 Plan of Basin V6 showing density of artefacts recovered from each TU. (Source: NSW LPI with GML additions 2020)

Figure 5.19 Looking northwest from the centre of Basin V6 showing typical vegetation cover.

Figure 5.20 Wall of TU111 showing Luddenham soil profile consistent with Basin C. Scale is 0.1m increments.

Figure 5.21 Wall of TU113, located in an open depression adjacent to the creek. TU113 and TU121 exhibited more clayey soil profiles.

Figure 5.22 TU112 showing shallow profile, likely truncated by road construction in the mid-twentieth century. Scale is 0.1m increments.

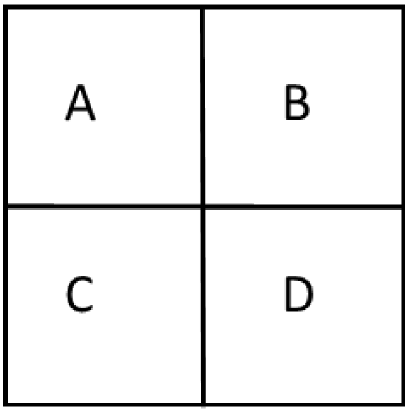

Figure 5.23 Layout of expanded TU110 showing sequence of letters used to identify individual 50cm x 50cm squares.

Figure 5.24 Looking east at TU129 (foreground) and TU110 (background), with the excavation team in action.

Figure 5.25 East-facing section in TU110 showing the depth of fill capping the intact soil profile, and lower spits (6–8) from which the artefact assemblage was recovered.

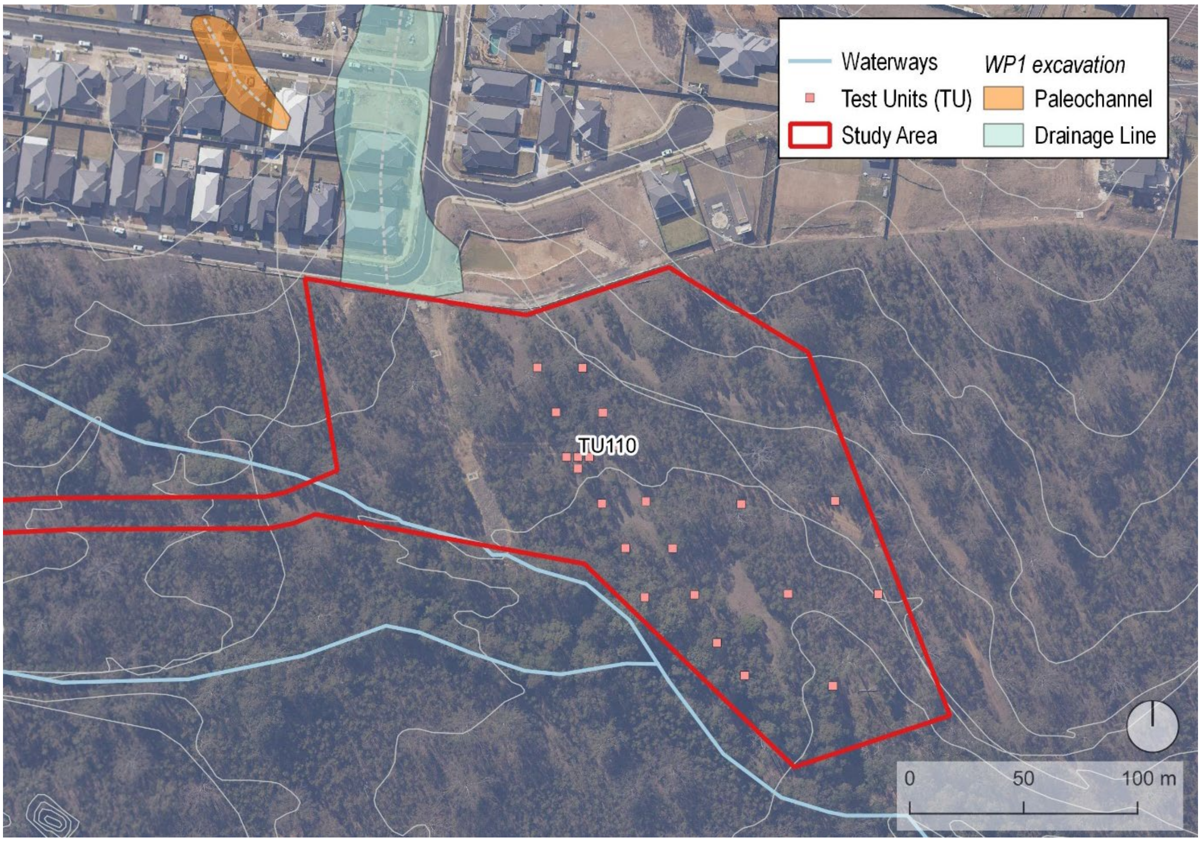

Figure 5.26 Plan of Basin V6 showing location of paleochannel and drainage channel in the WP1 excavation area in relation to TU110.

5.1.4 Access Road

A total of 14 TUs (TU94–107) were excavated along the access route between Basins C and V6, placed on alternating sides of the road. The TUs were placed to confirm the depth and extent of disturbance caused by construction of the access road and to identify if intact soil profiles with artefact bearing deposits were present. Nine artefacts were recovered from six TUs, giving an average artefact density of 2.5/m^2.

The landform at this location is a continuation of the gentle flat within Basin C Area 1. The majority of TUs exhibited a similar profile consisting of ~100mm of a sandy silt overburden/fill overlying a truncated A_2 horizon 300mm deep, becoming shallower at the eastern end of the transect. Evidence of an earlier road surface was identified in six TUs (TUs 92, 94, 95, 102, 104 and 106). This consisted of a yellow sandy clay with high gravel content, up to 100mm thick (Figure 5.28). The surface was generally found approximately 100mm below the modern ground surface, covered by a silty sand fill with bluestone gravel inclusions.

The access road crosses a second order creek that runs through the eastern part of the study area and a culvert was constructed at this location. Evidence for raising of the ground surface associated with construction of the culvert was identified in TUs 105 and 106. TU105 contained a 300mm-thick fill layer, consisting of a compact mid-greyish brown silty clay with frequent large gravel inclusions overlying a thin layer of greyish yellow silty clay at 300mm below the current ground surface. This overlay an intact, albeit truncated, A_2 horizon (clayey silt). TU106 had a similar, although shallower, profile with a 200mm-thick gravelly mid-greyish brown sandy silt layer overlying 100mm of moderately compact mid-greyish brown silty clay (A_2 horizon) (Figure 5.29).

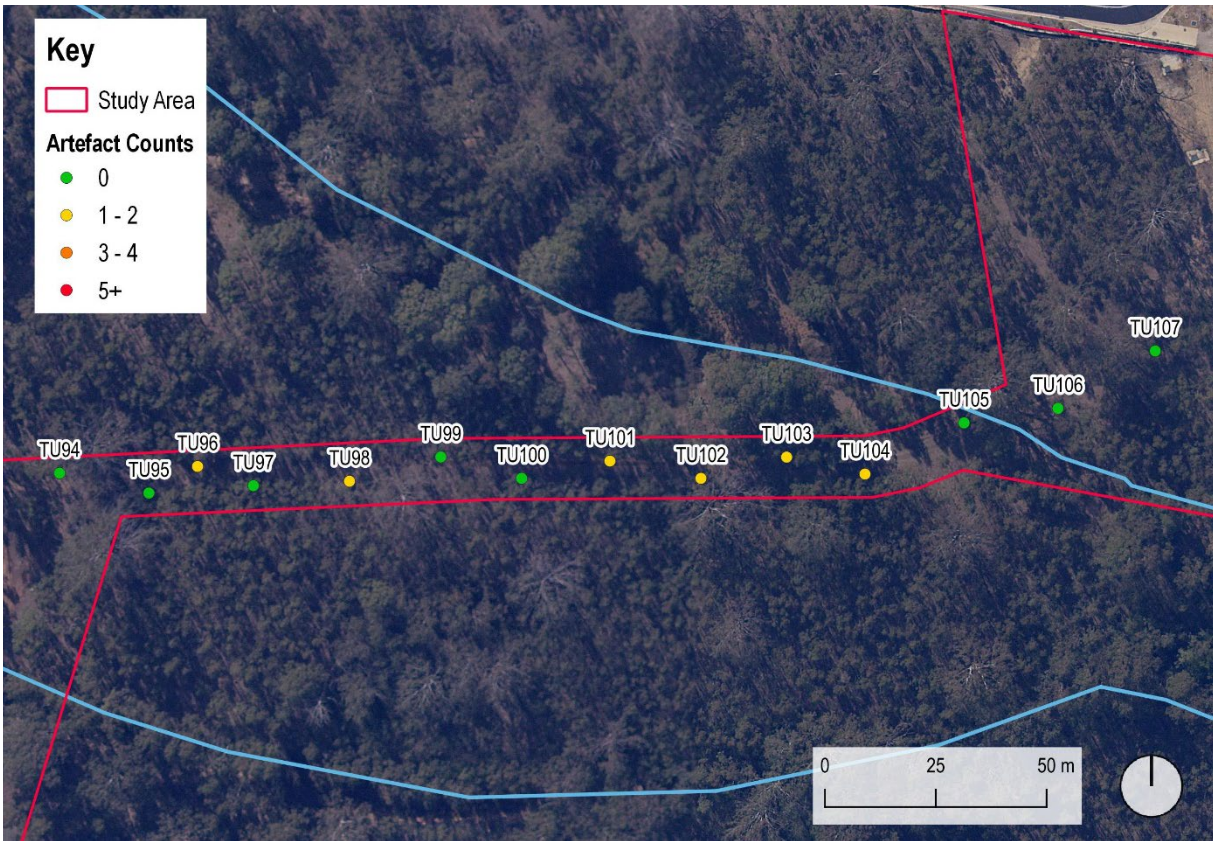

Figure 5.27 Plan of the Access Road showing the density of artefacts recovered from each TU. (Source: NSW LPI with GML additions 2020)

Figure 5.28 Wall of TU94 with the former road base layer indicated (arrow).

Figure 5.29 Wall of TU106 gravel-rich fill overlying a truncated A_2 horizon.

5.2 Analysis and Discussion

Overall, the test excavation program has demonstrated that the study area is characterised by a low density 'background scatter' of Aboriginal artefacts and is consistent with the predictions of the CPPM. While two locations at Basin V6 exhibited a higher density of artefacts, TUs 110 and 117, these assemblages are likely the result of single occupation events focused on the bipolar reduction of silcrete and mudstone cores. This is supported by the results of salvage excavation at WP1, 200m north of Basin V6 (Figure 2.10) where several low-density artefact scatters were investigated. The results of salvage excavation at WP1 found that where individual TUs exhibited a higher density of artefacts, the excavation of adjacent TUs showed a significant drop in artefact numbers. [38] This is consistent with the findings at TU110 where additional TUs placed at 5m distance recovered very few artefacts (n=3).

The following discussion of the artefact assemblage has been reproduced from the analysis prepared by Shezani Nasoordeen, and presented in Appendix A.

> *The classic bases for comparison in an assemblage involve the proportion of raw material representation and the representation of technological components. The Basin C, Access Road and Basin V6 testing areas have yielded neither a wide variety of stone raw materials across the testing areas, nor the varied assemblage representative of activities consistent with artefact manufacture, maintenance or discard. Raw materials are clearly being sourced from gravels; however, there is also a strong terrestrial source component (ie an eroding outcrop) evident in the silcrete at the site. The study area, in general, apart from TU110, has a very low background scatter density of less than five artefacts per square metre. TU110 expansions revealed higher densities, yet these perhaps over-represent the breakage patterns associated both post depositionally and through bipolar reduction.*
>
> *Bipolar reduction and the use of silcrete in the area is well understood. TU110 did not yield a statistically viable assemblage to assess any changing raw materials with depth. For these reasons, scientifically, the archaeological information potential of expanding this test unit is considered to be low. The low potential rating comes from the lack of potentially statistically significant results, the commonplace nature of materials and techniques across the Cumberland Plain sequence, and the lack of conclusion about the temporal sequencing within the mid to late Holocene. If a larger assemblage of cores, or complete flakes were excavated, this would have warranted further excavation.*
>
> *TU117 also exhibited a higher number of artefacts (n=13) compared to the surrounding TUs. However, similar to TU110, the lithic analysis identified that these represent a minimum of two flakes only, reduced from a single bipolar core. This TU likely also intercepted a one-off event and is not considered to warrant further excavation.*

The testing program also provided evidence of extensive land clearance, involving the stripping of the topsoil horizon across the entire study area. This is consistent with historic aerials showing that the entire site had been cleared of vegetation in the late nineteenth or early twentieth century. This is likely related to the use of the area for farming, prior to the establishment of the ADI site in the 1940s. Further modification of the landscape relating to the ADI site was identified in Basin C Areas 1 and 2. This included grading of multiple access roads, and significant earthworks in the eastern part of Basin C Area 2.

5.2.1 Identified Aboriginal Sites

One area containing Aboriginal objects has been registered in the AHIMS.

- Basin V6 AS2 (AHIMS #45-5-5369).

Figure 5.30 Location of Aboriginal site Basin V6 AS2. (Source: NSW LPI with GML additions)

5.2.2 Addressing the Research Questions

The research questions posed in the AACHAM[39] are addressed to understand the potential significance of the archaeological evidence recovered during the test excavation program across the study area.

1. What is the nature of the archaeological deposit and how can it be interpreted?

a. What are the physical attributes of the deposit (stone, carbon, clay or other)?

b. What, if any, evidence other than stone is present for Aboriginal occupation of this region?

c. For stone deposits, what are the physical characteristics and do they indicate a specialised use? Is there a difference in stone tool types between the different locations tested?

d. For other deposits (ie burning features), what are the physical characteristics and how do they compare to features identified at Jordan Springs (former Western Precinct)? Is it possible to identify relationships with concentrations of stone deposits?

e. What are the spatial characteristics of the archaeological deposit at each location? Is the archaeological deposit consistent with depth? Were Aboriginal people utilising the same locations for thousands of years or was there considerable variation in landscape use and selection strategies? How does the archaeological deposit vary spatially within one site? Is there evidence for domiciliary areas within the deposit?

The archaeological deposit identified at Basins C and V6 consisted entirely of stone artefacts, manufactured using bipolar reduction. No evidence for other cultural features (ie ovens) was identified during the test excavation program. The assemblage consists predominantly of artefacts manufactured from silcrete (56%), with lesser amounts of mudstone (25%), chert (14%), quartz (1%), and other materials (2%). The higher proportion of silcrete is consistent with other sites excavated across the SMDS and broader Cumberland Plain. The assemblage consists of 262 cultural lithics, of which 60 are heat shatter. Broken flakes and angular fragments make up a large proportion of the artefact assemblage (19% and 23%), with complete flakes representing 15% of the assemblage. A small number of cores (n=8) and tools (n=7) were also found.

5. *Can the archaeology be interpreted in a regional context?*

d. Where did the raw stone materials originate from? Have they been brought into the study area? From how far away has the stone been brought?

e. Is there evidence of trade in connection to stone deposits? Within a single context, does one stone material exhibit a higher degree of 'working' than another? Does the level of working or percentages of stone change over time (ie across stratigraphical layers)? How do these differences relate to stone procurement strategies? What are the implications for regional Aboriginal economy and possibly local tribal boundaries?

f. How does the archaeological evidence compare with the results of Jordan Springs (former Western Precinct), which did not wholly conform to the CPPM in terms of the distance-decay to stream order model?

The assemblage does not exhibit characteristics that would be able to address these research questions and is broadly similar to many other assemblages excavated across the SMDS. The location and composition of the assemblage does not strictly conform to the CPPM. Notably, at Basin C a high proportion of TUs excavated within 50m of the creek did not contain Aboriginal artefacts, with the bulk of the artefact assemblage recovered from TUs located at a distance of 50m–100m from the creek.

Basin V6 was more consistent with the CPPM. TUs 110 and 117 are located approximately 50m from a creek and close to the junction of two creeks, an area identified as likely exhibiting a higher variability in resources. The artefact assemblage recovered from TU110 is interpreted as a one-off event, a pattern also identified for sites associated with second order streams.

6. *How is the archaeological deposit significant?*

d. What is the heritage value of the deposit, both scientifically and culturally?

e. How does the Aboriginal community view and value the deposit identified?

f. *Does the deposit conform to the standard stream order model? Can the combined evidence from all the excavations across the SMDS be used to refine or describe a new model for Aboriginal occupation?*

The value of the assemblage to the Aboriginal community has yet to be determined. This report will be issued to all RAPs, along with the ACHAR, for feedback. The assemblage is considered to have low scientific value on the basis of the statistically small assemblage size, low proportion of formal tools, and its conformity with the composition and manufacture techniques known for the Cumberland Plain.

7. *Is there a deposit worthy of future research? Is there a high scientific value archaeological deposit(s) worthy of extensive salvage excavation?*

c. *Are chrono-stratified deposits (if present) located in a position that lends itself well to large scale open area excavation?*

d. *What new research questions should be asked of open excavation? Are there benefits to undertaking larger scale investigations? Will we learn new information from bigger excavations? Or would it be better to 'window sample' very large landscape areas to obtain representative pockets of archaeological deposit?*

No evidence for stratification of the soil profile was identified across the study area. Evidence of extensive modification of the upper layer of the soil profile that was identified across most of the study area reduces the overall integrity of the archaeological deposits. An increase in the proportion of artefacts manufactured from mudstone compared with silcrete has been identified at other Cumberland Plain sites as representative of Pleistocene occupation (ie >10,000 years before present [BP]). However, analysis of the assemblage has demonstrated a statistically weak correlation in the change of raw materials with depth from silcrete to mudstone with depth. As such the assemblage is considered unlikely to yield new information regarding variations in occupation and use of the landscape by Aboriginal people over time.

6.0 Scientific Values and Significance Assessment

6.1 Introduction

Aboriginal heritage sites, objects and places hold value for communities in many different ways. The nature of those heritage values is an important consideration when deciding how to manage a heritage site, object or place, and balance competing land use options.

The approach to the Aboriginal heritage assessment is based upon identifying the key Aboriginal heritage values—values that are likely to be both tangible and intangible. This approach needs to consider the values assessment from the scientific and Aboriginal community perspectives, in accordance with Australian best practice documents.

This assessment concerns itself with scientific values only. Aspects of social value, historic value and aesthetic value are assessed in the ACHAR, to which this report is an appendix.[40]

The primary guide to management of heritage places is the Burra Charter,[41] which defines cultural significance as:

> *Cultural significance means aesthetic, historic, scientific, social or spiritual value for past, present or future generations.*
>
> *Cultural significance is embodied in the place itself, its fabric, setting, use, associations, meanings, records, related places and related objects.*
>
> *Places may have a range of values for different individuals or groups.*

6.1.1 Assessment Criteria

This assessment has sought to identify Aboriginal heritage objects and sites within the study area and obtain sufficient information to allow the values of those objects and sites to be determined. Following OEH guidelines for assessing scientific value,[42] five key criteria have been considered during the examination of the scientific value/significance of the identified sites and places within the subject area. These criteria are:

- Research potential—does the evidence suggest any potential to contribute to an understanding of the area and/or region and/or state's natural and cultural history?
  - Integrity and condition—integrity refers to the level of modification a site has been subject to (the cultural and natural formation process) and whether the site could yield intact archaeological deposits, which could be spatially meaningful. Condition takes into account the state of the material, which is especially relevant for organic materials.
  - Complexity—the demonstrated or potential ability of a site to yield a complex assemblage (stone, bone and/or shell) and/or features (hearths, fire pits, activity areas).
  - Archaeological potential—the potential to yield information (from subsurface materials which retain integrity, stratigraphical or not) that will contribute to an understanding of contemporary archaeological interest, or which could be saved for future research potential.
  - Connectedness—whether the site can be connected to other sites at the local or regional level through aspects such as type, chronology, content (ie materials present, manufacturing processes), spatial patterning or ethnohistorical information.

- Representativeness—how much variability (outside and/or inside the study area) exists, what is already conserved, how much connectivity is there?
- Rarity—is the study area important in demonstrating a distinctive way of life, custom, process, land use, function or design no longer practised? Is it in danger of being lost or of exceptional interest?
- Educational potential—does the study area contain teaching sites or sites that might have teaching potential?
- Archaeological landscapes—the study of the cultural sites relating to Aboriginal peoples within the context of their interactions in the wider social and natural environment they inhabited. Landscapes can be large or small depending upon specific contexts (ie local or regional conditions); they may also be influenced by Aboriginal social and demographic factors (which may no longer be apparent).

A statement of Aboriginal scientific significance has been prepared that summarises the salient values as drawn from the above criteria.

Table 6.1 Discussion against Assessment Criteria.

Criterion	Discussion
Research Potential	The stone artefact assemblages are assessed as having low research potential. The Basin V6 PAD exhibited neither a wide variety of raw materials, nor variation in manufacture techniques nor a high proportion of tools that may contribute new information about how Aboriginal people lived and used this space. Excluding TU110, the density of artefacts recovered across the study area is low and is consistent with people moving across the landscape rather than occupying a site for extended periods of time. This 'background scatter' is typical of the wider Cumberland Plain landscape. While TU110 yielded a higher density of artefacts, analysis of the assemblage indicates that the minimum number of complete flakes, cores and tools is much lower. Excavations at other sites has demonstrated that artefact concentrations similar to that from TU110 usually only cover an area 1–2m^2 and expansion of TU110 is unlikely to yield a significantly greater number of artefacts that would be statistically significant.
Representativeness	The stone artefact assemblages are not considered to be representative of the wider SMDS. The development of the entire SMDS allowed for conservation of areas identified as having high archaeological significance, particularly along South Creek. These areas form the Wianamatta Regional Park (see Section 2.2). As noted above, comparison of the Basin C and Basin V6 assemblages to other sites across the SMDS demonstrates that it is similar to many other small sites excavated across the Luddenham soil landscape. The assemblages exhibit limited variability between areas excavated across the study area.
Rarity	The artefact assemblages are not considered to be rare within the context of the SMDS or the wider Cumberland Plain. The Basin C and Basin V6 artefact assemblages are characterised by artefacts manufactured from silcrete, mudstone, chert and quartz, with a low proportion of formal tools, that is consistent with other sites excavated adjacent to second order streams within the Cumberland Plain.
Education Potential	The Basin V6 artefacts are considered to have potential as an educational or teaching assemblage. The Basin V6 assemblage is characterised by a high proportion of bipolar reduction on heat treated silcrete, including five artefacts refitted to a single core. Other cores reduced using unifacial reduction

Criterion	Discussion
	were also able to be refitted. The combination of both bipolar and unifacial reduction in a single assemblage is considered to have value in assisting others in the identification of reduction techniques used in Cumberland Plain assemblages.
Archaeological Landscapes	The artefact assemblage has moderate significance as part of the archaeological landscape of the SMDS. The archaeological excavation of many sites across the SMDS since the mid-1990s has provided a large sample of sites excavated across differing landforms, soil landscapes and stream orders/sizes. As part of this larger collection of sites, the combined Basin C and V6 assemblage can contribute to our understanding of past Aboriginal occupation and use of this place through comparative analysis despite its limited archaeological value in and of itself.

6.1.2 Statement of Scientific Heritage Significance

The Aboriginal artefact assemblage recovered during the test excavation program is assessed as having low scientific significance. The assemblage is considered to have low research potential based on the lack of variability in raw materials and technology exhibited within the assemblage and is neither representative nor rare within the context of the SMDS. The Luddenham soil landscape has been extensively excavated within Jordan Springs and the results from Basin C and V6 do not contribute new information to our understanding of past Aboriginal occupation of the SMDS and broader Cumberland Plain.

The Basin C and Basin V6 assemblages have significance as part of the archaeological landscape of the SMDS. The Basin V6 assemblage is also considered to have educational potential.

7.0 Impact Assessment

7.1 Description of the Proposed Development

7.1.1 Construction

Lendlease proposes to construct two stormwater detention basins within the study area. The proposed activity is shown in Figure 7.1. The proposed activity will involve excavation of the two basins (C and V6) and ancillary works, including localised excavation for stormwater outlets, modification of existing creek alignments to create inflow and outflow channels, and construction of access tracks for long-term maintenance.

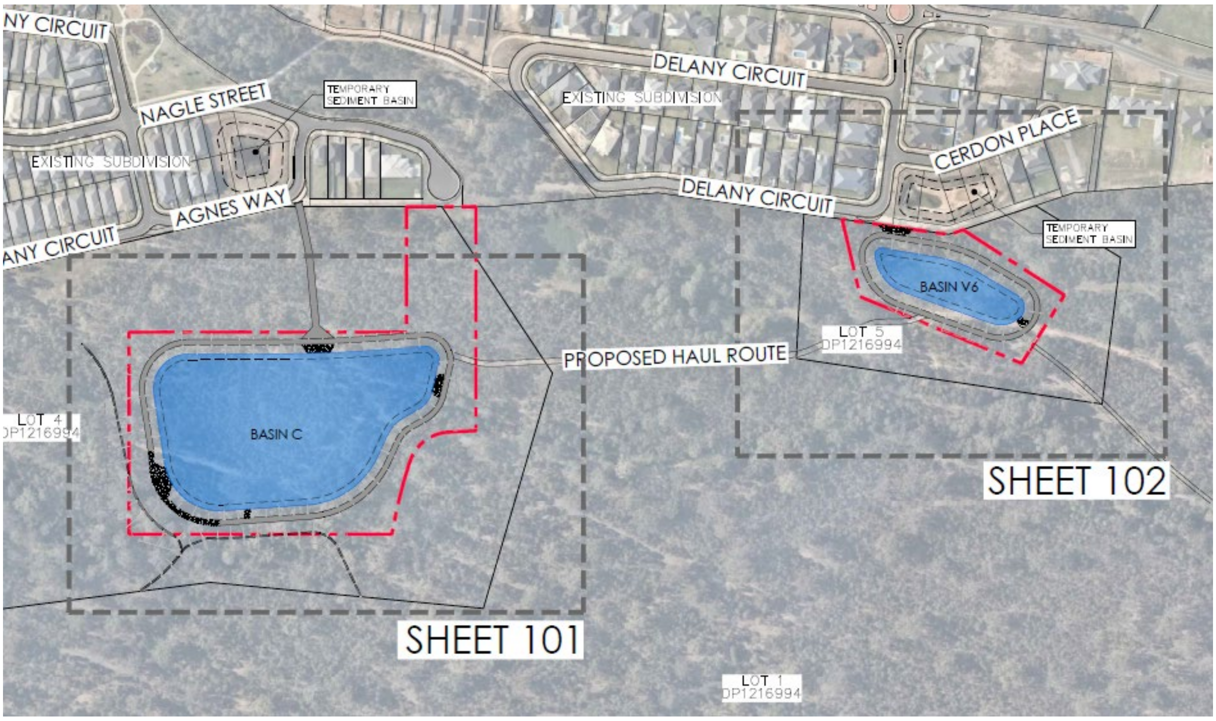

Figure 7.1 Plan of the proposed layout of the stormwater detention Basin C (at left) and Basin V6 (at right). (Source: ADW Johnson, dwg. 300225-CENG-003 Rev. A, 18 November 2019)

7.1.2 Contamination Remediation

The Remediation Action Plan (RAP)[43] prepared for the study area identified two locations in Basin C requiring remediation. Hydrocarbon contamination was identified at the eastern end of Basin C, near TU24, with asbestos containing material (ACM) identified at the western end of Basin C along the existing access track, near TUs 42–44 (Figure 7.2). Remediation at these locations will involve excavation of the contaminated soils to a depth of 0.3–0.5m below the existing ground surface. The excavated material will either be re-used in a suitable location on site as appropriate or disposed of off-site.

In addition to the locations above, ACM was identified by the test excavation team, between TUs 66 and 68, and in TU84 on the south side of the creek (Figure 7.2). Lendlease has advised that these areas would be assessed following the Unexpected Finds Procedure set out in the Remedial Action Plan.[44]

This involves assessment by an environmental consultant/field scientist, and remediation (involving excavation of contaminated materials and soils) as required.[45]

Figure 7.2 Location of known contaminants identified within the Basin C study area, based on the RAP[46] and visual identification during the test excavation program. (Source: NSW LPI with GML additions)

7.2 Impacts of the Proposed Development

Test excavation within the study area identified one additional Aboriginal archaeological site, in addition to the 10 surface artefact sites identified during the field survey, and the previously registered AHIMS sites.

The proposed development involves subsurface excavation and modification along existing creeks for the construction of two stormwater detention basins. These activities will result in the removal of any potential Aboriginal archaeological deposits within the basin footprints and access roads, and along the creek margins. Outside of these locations, ancillary works associated with construction, such as establishment of temporary site offices, stockpile locations, and temporary access routes, will have a localised impact on isolated subsurface Aboriginal archaeological objects. As such, these impacts are considered to result in total harm to all potential Aboriginal archaeological deposits and objects within the Basin C and V6 study area.

The activities of the proposed development, the degree of impacts and harm they may cause to Aboriginal sites are summarised in Table 7.1 below.

Table 7.1 Proposed Development Activity and Type, Degree and Consequence of Harm.

Activity	Type of Harm	Degree of Harm	Consequence of Harm
Excavation with Basins C and V6 footprint	Direct impact on Aboriginal objects within the footprint of each basin, including Basin C AS1, Basin C AS2, Basin C AS4, Basin C AS5, Basin C AS7, and Basin V6 AS2.	Total removal of Aboriginal objects and associated archaeological deposits within each basin footprint.	Potential for total loss of value within footprint of basin(s).
Modification of existing creek alignment flows	Direct impact on Aboriginal objects identified through test excavation program.	Total removal of Aboriginal objects and associated archaeological deposits at these locations.	Potential for total loss of value.
Excavation of outflow channel for Basin V6	Direct impact on Aboriginal objects identified through test excavation program.	Total removal of Aboriginal objects and associated archaeological deposits within this location.	Potential for total loss of value.
Contamination remediation	Near TUs 30, 31, 42, 43, 44, and 84—no artefacts identified in these Tus.	Total removal of surface or subsurface Aboriginal objects within each area to be remediated.	Potential for total loss of value.
Establishment of site compound and other ancillary works	Potential direct impact to isolated surface and subsurface Aboriginal objects, including Basin C AS6, Basin C AS8, Basin C AS9, and Basin V6 AS2.	Potential for total removal of Aboriginal objects across the study area.	Potential for total loss of value.

8.0 Management, Mitigation and Recommendations

The following management and mitigation statements are made in light of the findings of the study area inspection, background research, predictive modelling, heritage significance assessment, relevant NSW legislation protecting Aboriginal heritage, the DPIE Aboriginal Cultural Heritage Assessment Guidelines and consultation with local Aboriginal stakeholders.

The following Aboriginal sites would be impacted by the proposed development:

- Basin V6 AS2 (AHIMS #45-5-5369);
- ADI–FF09 (AHIMS #45-5-3609);
- ADI–FF10 (AHIMS #45-5-3610);
- Basin C AS1 (AHIMS #45-5-5276);
- Basin C AS2 (AHIMS #45-5-5275);
- Basin C AS3 (AHIMS #45-5-5368);
- Basin C AS4 (AHIMS #45-5-5366);
- Basin C AS5 (AHIMS #45-5-5367);
- Basin C AS6 (AHIMS #45-5-5362);
- Basin C AS7 (AHIMS #45-5-5361);
- Basin C AS8 (AHIMS #45-5-5363);
- Basin C AS9 (AHIMS #45-5-5364); and
- Basin V6 AS1 (AHIMS #45-5-5365).

8.1 Potential Management and Mitigation Strategies

8.1.1 Policy—Community Collection

The RAPs should be presented with an opportunity to collect surface Aboriginal objects that were identified within the study area during the field survey and test excavation. This should be undertaken prior to the start of construction activities.

8.1.2 Policy—Aboriginal Heritage Impact Permit

Given the low densities of Aboriginal objects that occur across the study area, and the low research potential of the Aboriginal objects which were excavated from the study area, no further archaeological investigation is recommended. An AHIP under Section 90 of the NPW Act should be sought for the development.

8.2 Recommendations

1. This ATR should be provided to the RAPs for this project for comment, and their comments recorded and addressed in the final ACHAR.

2. An AHIP under Section 90 of the NPW Act (without salvage excavation) should be sought prior to the construction program commencing. This development cannot commence until an AHIP is issued by the DPIE. The conditions of the AHIP will guide the development process.

3. An approved development application (DA) must be in place for DPIE to consider the AHIP application.

4. An Aboriginal Site Recording Impact Form must be submitted to AHIMS once the activity is complete.

5. An opportunity for the collection of surface artefacts by members of the Aboriginal community who registered an interest in this project should be arranged prior to the proposed works occurring.

6. The stone objects recovered during the test excavation, and any artefacts from the community collection, should be reburied on Country. A location which will be part of the Wianamatta Regional Park has been identified. The location is not associated with any Aboriginal objects. The location is identified in Figure 8.1 (and Figure 5.1 with reference to other test units and recovered Aboriginal object density). The location is TU1; it was excavated during the testing phase and contained no Aboriginal artefacts. The test units surrounding the reburial location also contained zero artefacts. The coordinates of the location are: 290324E, 6267034N (MGA Zone 56).

7. The Aboriginal objects excavated will need to be securely stored in the proponent’s office at Level 14, Tower Three, International Towers Sydney, Exchange Place, 300 Barangaroo Avenue, Barangaroo NSW 2000, until reburial can occur.

8. This report will be provided to relevant members of the Aboriginal community who registered an interest in this project for their comment and Aboriginal social assessment. All comments will be incorporated into this report.

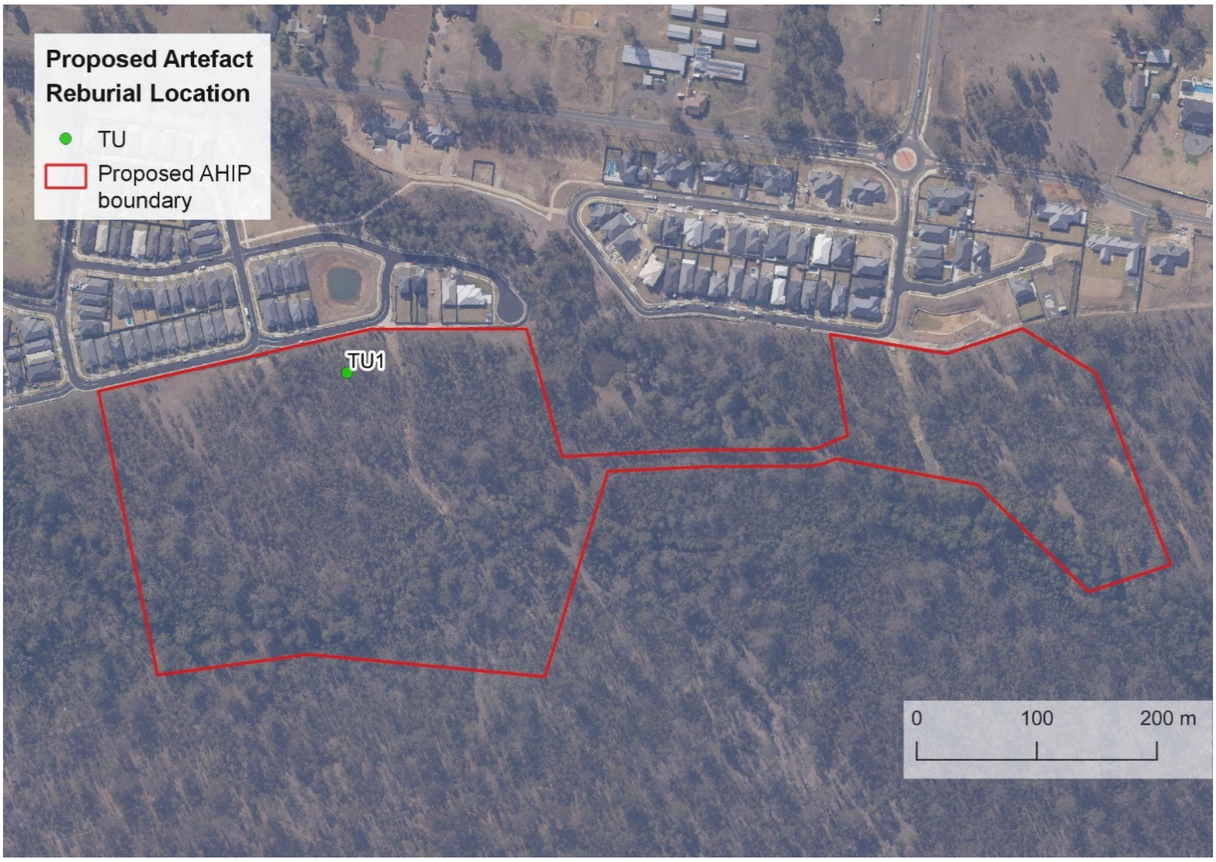

Figure 8.1 Proposed location for the reburial of Aboriginal objects.

9.0 Endnotes

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10.0 Appendices

Appendix A

Lithic Analysis

1.0 Lithic Analysis

1.1 Lithic Assemblage Description

In total, 262 cultural lithics (that is, stone artefacts and other potentially anthropogenic stone items, such as fire cracked rock, known as heat shatter) were excavated during the test excavation program. Included within this total are 202 stone artefacts and 60 heat shattered pieces of stone.

The overall flaked assemblage appears to have a strong emphasis on the use of silcrete, of which at least two individual nodules can be easily identified through their ability to be pieced back together. Bipolar reduction (that is, when stone is rested on a flat surface or other stone surface, to compress and extract a lot of material from smaller stone cobbles) characterises the assemblage, with many angular fragments and broken flakes as well as very crushed platforms characterising much of the flaked assemblage. The bipolar reduction technique is clearest within TU110, which was expanded to $1m^2$.

The nature of bipolar reduction is that it can be very hard to distinguish from natural breaks along flaw fracture planes in stone material (this is especially true for silcrete) and other post-depositionally broken surfaces. A strict visual classification process was undertaken for the process of identified heat damaged artefacts for the presence of either:

- a heat induced non-conchoidal fracture (HINC);[1]
- potlid; and/or
- heat crenated surface, similar to a potlid surface.

The relationship between these heated surfaces and whether they are truncated by flaking after heating is difficult to determine, but few potentially heat-treated silcretes were identified using a basic visual classification, and piece-by-piece comparison method.[2] This visual classification is not a complete assessment of potentially heat-treated artefacts, as knowing the sources and their specific behaviour through heating is required to make any conclusive scientific archaeological interpretations.

1.1.1 Stone Artefact Flake Class Components

There are 262 cultural lithics in the assemblage, which includes 202 stone artefacts (77.1%) and 60 heat shattered stone pieces (22.9%). The breakage ratio appears relatively high with a minimum number of eight cores, 51.5 flakes, and seven retouched flakes/tools constituted from the 262 pieces of cultural lithic material.

Broken flakes, heat shatter and angular fragments dominate the assemblage (n=61, n=60, n=51, respectively, Table 1). If we compare the ratio of complete to broken flakes, the result is a very low representation of complete flakes (0.62 complete flakes to one flake fragment). This is partly owing to the bipolar stone artefact reduction technology. Bipolar reduction involves the breaking of material by using compressing forces of a hammer and anvil to break the rock, and produces many irregular fracture patterns.

Table 1 Flake Class Frequency, Average Artefact Length and Minimum Number of Artefacts.

Stone Artefact Class	Count (n)	Percentage of the Assemblage (%)	Average Length of Artefact (mm)	Minimum Number of Cores (MNC)	Minimum Number of Flakes (MNF)	Minimum Number of Tools/ Retouched Flakes (MNT)
Angular fragment	51	19.5	13.7+ 6.1			
Angular fragment of a tool (Utilised)	1	0.4	9.0			
Broken flake	61	23.3	11.2+ 4.3			
Broken longitudinal split	3	1.1	8.3+0.6			
Complete flake	39	14.9	14.5+5.8		39	
Complete longitudinal split flake	7	2.7	14.4+8.5		3.5	
Complete tool/retouched flake	5	1.9	23.0+6.9			5
Core	8	3.1	31.1+7.7	8		
Distal flake	5	1.9	11.6+4.8			
Distal tool/retouched flake	1	0.4	23.0			
Heat shatter	60	22.9	10.9+6.0			
Medial flake fragment	7	2.7	15.4+6.8			
Medial tool fragment	2	0.8	6.0+5.2			
Proximal flake fragment	9	3.4	11.1+3.2		9	
Proximal tool	2	0.8	27.5+16.3			2
Modern glass (not an Aboriginal artefact)	1	0.4	30			
Total	**262**			**8**	**51.5**	**7**

The majority of the stone artefacts were excavated from the Basin V6 testing area, with extensions undertaken on TU110. The highest minimum number of artefacts (that is, the value that predicts the intensity of breakage and reduction) comes from TU110 (MNF=35.5, MNC=5 and MNT=5, Table 2).

Table 2 Spatial Distribution amongst Basin C, Basin V6 and the Access Road Testing Areas.

Testing Areas	TUs	Count of Stone Artefacts (excluding heat shatter)	Sum of MNF	Sum of MNC	Sum of MNT
Basin C	5	1			
	6	1	1		
	13	1			
	14	2	1		
	15	1			
	20	3			1

Testing Areas	TUs	Count of Stone Artefacts (excluding heat shatter)	Sum of MNF	Sum of MNC	Sum of MNT
	22	1	1		
	24	1			
	29	3	1		
Basin C	31	2	1	1	
	34	1			
	38	1	0.5		
	39	2			1
	63	1	1		
	70	2	0.5		
	74	1	1		
	78	2			
	82	2			
	83	1	1		
	88	1	1		
	89	2			
	91	1	1		
Access Road	96	1			
	98	1			
	101	1			
	102	2	1	1	
	103	2	1		
	104	2			
Basin V6	110	137	35.5	5	5
	111	3			
	115	1			
	117	13	2	1	
	122	1			
	128	2	1		
	129	1			
	Total	200	51.5	8	7

1.1.2 Stone Artefact Raw Material

The archaeological predictive model known as the Cumberland Plain Predictive Model (CPPM) posits that the proportion of materials used to make stone artefacts at an artefact site is influenced by the distance that Aboriginal people travelled on the landscape to collect that stone. The further people travel, the greater the degree of material conservation, and the less material overall that should be seen furthest from the sources or quarries.

As such, studying these proportions can prove information either of previously unknown or underutilised sources, or the mobility of groups in the area. Silcrete, a siliceous quartz based sedimentary rock, is used most frequently and discarded within the study area (n=148, Table 3). Mudstone, a fine sedimentary rock, is second most frequent (n=67), followed by a siliceous sedimentary rock, chert (n=38). Very small quantities of quartz and quartzite were also found within the study area (n=3 and 4 respectively).

The cultural sequence of stone artefacts also describes varying proportions of stone artefact raw materials as they vary through time. There is a clear increase of stone artefacts of all raw materials at a depth of 50cm to 60cm (spit 5 and 6). Apart from the clear low representation of quartz, silcrete forms between 47% and 77% of the assemblages by spit depth. In comparison to mudstone and chert, there does not appear to be a clear pattern of silcrete increase in relation to chert and quartz that can constitute a temporal change of material use by Aboriginal people. While there is a general decrease in silcrete with depth, and increase in mudstone, this inverse relationship is very weak and cannot be considered statistically significant (Table 4).

Table 3 Stone Artefact Raw Material By Spit Depth.

Spit Depth	Chert	Glass	Mudstone	Quartz	Quartzite	Silcrete	Silicified Tuff	Total
0			3		1	1		5
1	6	1	7	1	3	18		36
2	4		4	2		27		37
3	2		3			5		10
4	2		2			14		18
5	3		11			22		36
6	15		26			44		85
7	5		5			10	1	21
8	1		6			7		14
Total	**38**	**1**	**67**	**3**	**4**	**148**	**1**	**262**

Table 4 Key Raw Material Types By Percentage of Spit Assemblage.

Spit	Silcrete	Mudstone	Chert
1	50.0	19.4	16.7
2	73.0	10.8	10.8
3	50.0	30.0	20.0
4	77.8	11.1	11.1
5	61.1	30.6	8.3
6	51.8	30.6	17.6
7	47.6	23.8	23.8
8	50.0	42.9	7.1
Total	56.5	25.6	14.5

1.1.3 Cortex Representation

The assemblage retained very little cortex, with an overwhelming percentage of stone artefacts retaining no cortex (n=175, 87%).

Table 5 Cortex Coverage of Stone Artefacts By Raw Material.

Cortex Coverage	Chert	Mudstone	Quartz	Quartzite	Silcrete	Silicified Tuff	Total
1–25%	5	4			10		19
25–50%		2			3		5
50–99%					1		1
COMPLETE					1		1
NONE	16	44	3	4	107	1	175
Total	21	50	3	4	122	1	201

1.1.4 Flake Assemblage

The minimal presence of facetted and trim platforms indicates that backed artefact production is unlikely to have been the focus of the activity at this location. This is consistent with the low frequency of complete flakes.

Table 6 Platform Types of Complete and Proximal Flakes By Raw Material.

Platform Types	Chert	Mudstone	Quartz	Quartzite	Silcrete	Silicified Tuff	Total
Cortical	1	1					2
Crushed	3	3			6		12
Facetted	1				1		2
N/A	1	1	1	1	12		16
Trim					1		1

Platform Types	Chert	Mudstone	Quartz	Quartzite	Silcrete	Silicified Tuff	Total
Unifacial	2	1	1		10	1	15
Total	8	6	2	1	30	1	48

1.2 Basin C (TUs 1–93)

1.2.1 Stone Artefact Assemblage Description

Silcrete forms 64% of the Basin C assemblage (n=27, Table 7). Very few complete flakes are represented, indicating minimal flaking actions undertaken in this area. The discard of a bipolar core, and a fragment of a backed blade, and a very small (c. <10mm) asymmetric backed geometric crescent microlith does not represent significant artefact maintenance, or site complexity and temporal sequencing. Bipolar flakes and angular fragments identify that raw material may have been further exploited at smaller sizes and thus at the end of the potential use life of available raw material; however, the numbers are inconclusive.

Table 7 Flake Classes Represented in Basin C by Raw Material.

Flake Class	Chert	Glass	Mudstone	Quartz	Quartzite	Silcrete	Total
Angular fragment	2		2		1	3	8
Broken flake	1		1			7	9
Complete flake	1			2		6	9
Complete longitudinal split					1	1	2
Complete tool						1	1
Core						1	1
Distal flake						1	1
Heat shatter	2		1			4	7
Medial flake						1	1
Proximal flake						1	1
Proximal tool						1	1
Void (Glass)		1					1
Total	6	1	4	2	2	27	42

1.1 Access Road (TUs 94–107)

1.2 Stone Artefact Assemblage description

The stone artefacts in this testing area represent a very low density scatter. A total of nine stone artefacts were identified, with an MNF of 2.5 and an MNC of 1. A very broken assemblage is evident, with only one core with potential flaking post heat-exploded surfaces. However, it is difficult to pinpoint the temporal sequencing (ie when this post heated surface flaking may have occurred). Artefact 172 is a bipolar core, with heat exploded surfaces characterised by heat-induced non-conchoidal fracture, and roughness contrasts, which may indicate pre and post heating surface roughness contrasts

(Figure 1). The core has been struck twice and rotated along a single plane of initiation (ie rotated 180 degrees for the second strike).

Table 7 Flake Classes Represented in Access Road Testing Area By Raw Material.

Flake Class	Chert	Glass	Mudstone	Quartz	Quartzite	Silcrete	Total
Angular fragment					1	1	
Broken flake			1			1	
Broken longitudinal split						1	
Complete flake						1	
Complete longitudinal split							
Complete tool							
Core						1	
Distal flake							
Heat shatter							
Medial flake						1	
Proximal flake						1	

Table 8 Stone Artefacts from Access Road Testing Area.

TU	Spit	ID	Material	Colour	Observations	Flake class	Comment
98	1	33	Silcrete	Red brown	N/A	Broken longitudinal split	
96	1	35	Silcrete	Pink red	N/A	Medial flake	
101	1	182	Quartzite	Light yellow	N/A	Angular fragment	
102	2	32	Silcrete	Pink brown	N/A	Complete flake	
102	3	15	Silcrete	Red brown	N/A	Core	Potentially heat treated, r/c and HINC crosscut
103	1	16	Silcrete	Pink brown	HEAT DAMAGE	Broken flake	
103	2	17	Silcrete	Pink brown	N/A	Proximal flake	Very fine material
104	1	28	Silcrete	Red brown	N/A	Angular fragment	Very fine material
104	1	29	Mudstone	Brown	N/A	Broken flake	

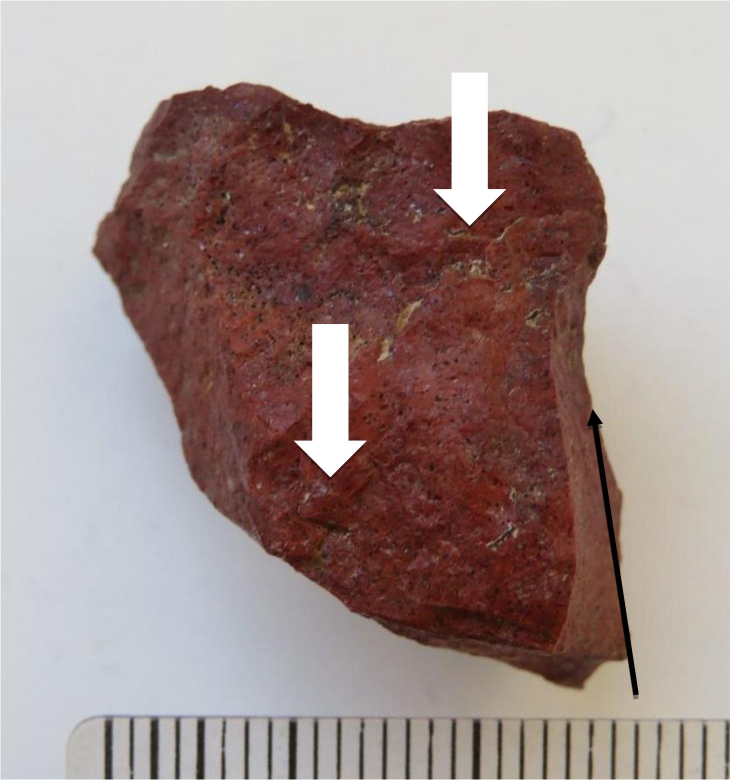

Figure 1 Artefact 172, TU31, spit 2, silcrete bipolar core, the only core in the Access Road assemblage. White arrows indicate potential HINCs, and the smooth potential post heat treated crosscutting this surface. Blue arrow indicates direction flaking and bipolar shear force. (Source: Nasoordeen 2020)

1.3 Basin V6 (TUs 108–129)

1.4 Stone Artefact Assemblage Description

The strongest stone artefact signature occurs within the Basin V6 testing area. A total of 211 cultural lithics were excavated, including 53 heat shattered pieces, 50 broken flakes, and 41 angular fragments, with only 29 flakes, six cores and at least five tools. The total number of stone artefacts without heat shatters is 158. Overall this assemblage is characterised of both bipolar and unifacial reduction, with minor components of alternating flaking in minimal quantities (Artefact #96), and the discard of a small number of tools (MNT=5).

1.4.1 Raw Material Type

Silcrete dominates the Basin V6 assemblage, with a number of individual cores able to be refitted—one due to bipolar reduction refitting (Artefact #233), the other through conjoining of post-depositionally broken surfaces (Artefact #136). Mudstone and chert are lesser raw materials represented in the assemblage, with quartz notable in its absence.

Table 9 Flake Classes Represented in Basin V6 Testing Area By Raw Material.

Flake Class	Chert	Mudstone	Quartz	Quartzite	Silcrete	Silicified Tuff	Total
Angular fragment	1	10			30		41
Angular fragment of a tool					1		1

Flake Class	Chert	Mudstone	Quartz	Quartzite	Silcrete	Silicified Tuff	Total
Broken flake	6	18	1		25		50
Broken longitudinal split	1				1		2
Complete flake	5	6		1	16	1	29
Complete longitudinal split	1	1			3		5
Complete tool	1	3					4
Core		2			4		6
Distal flake		2			2		4
Distal tool		1					1
Heat shatter	15	16			22		53
Medial flake		2			3		5
Medial tool					2		2
Proximal flake	2				5		7
Proximal tool		1					1
Total	32	62	1	1	114	1	211

1.4.2 Cores

Two of the six cores have potentially heat treated surfaces which have later been selected for further reduction. The difficulty with identifying intentional and opportunistic use of heat exploded or heat treated silcrete is problematic and the subject of much discussion. Artefacts 233 to 237 represent one nodule which is visually distinct in the assemblage with post heat exploded surfaces flaked in a bipolar reduction sequence. Three unifacial cores are also present in the Basin V6 assemblage. One alternate flaking core was identified on mudstone, which may indicate the targeting of the removal of larger (c20mm) flakes from this core.

Table 10 Cores Recorded in Basin V6 Testing Area.

TU	Quadrant	Spit	ID	Raw Material	Colour	Observation	Core Type	Comments	Cortex
110	C	7	41	Silcrete	Pink brown	Heat damage	Unifacial	HINC surface post flaked	None
110	C	5	123	Mudstone	Banded grey	Heat damage	Bipolar	Broken bipolar core	25–50%
110	D	8	96	Mudstone	Banded light brown	N/A	Bifacial (Alternating)	Bipolar chunk, later reduced as alternating bifacial core reduction	None
110	D	8	97	Silcrete	Grey to pink	Heat damage	Unifacial	Broken core	None
110	N/A	6	136	Silcrete	Brown	N/A	Unifacial	Broken core conjoin two pieces recorded	50–99%

TU	Quadrant	Spit	ID	Raw Material	Colour	Observation	Core Type	Comments	Cortex
								as one	
117	N/A	2	233	Silcrete	Pink brown	Potlid	Bipolar	Two rotations, flaking post heating refit 233 to 237, very fine material. Bipolar reduction occurs post heating surface. Potential heat treated—however, potlid indicates temperature control is not required.	None

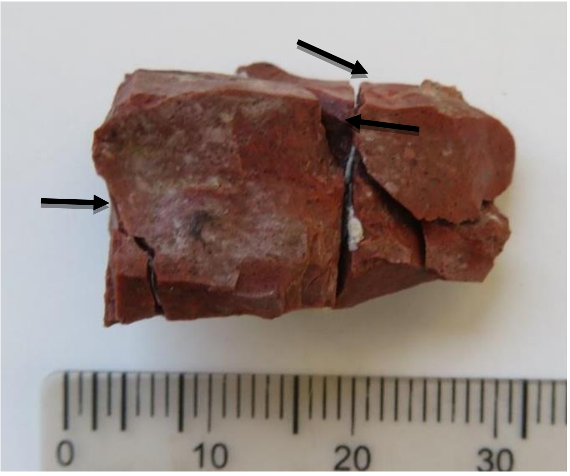

Figure 2 Artefacts 233 to 237 refit from bipolar percussion. Left to right: core is largest piece #233.

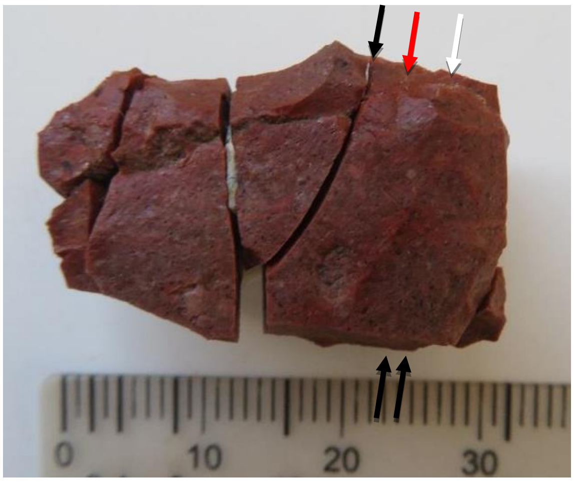

Figure 3 Artefacts 233 to 237 refit from bipolar percussion. Left to right: core is largest piece #233. Red arrow shows fracture along internal flaw plane, and white arrow shows potlid heat exploded feature.

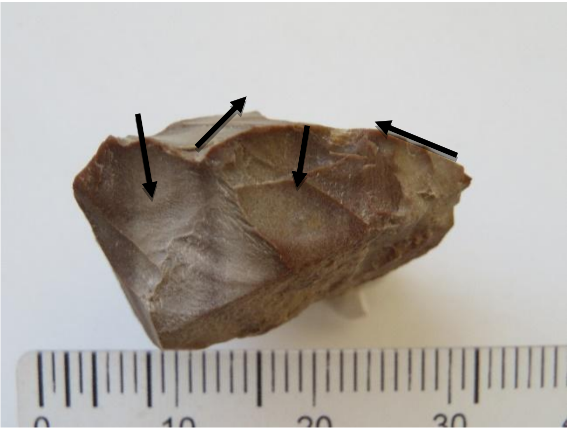

Figure 4 Mudstone banded core Artefact 96. Arrows indicate alternating flaking direction producing bifacial core type.

Figure 5 Mudstone banded core Artefact 123, gravels.

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Figure 6 Mudstone banded core Artefact 123. Arrows indicate alternating flaking direction producing bifacial core type.

1.4.3 Retouched Artefacts

A total of one scraper, two backed blades, one conjoined notch, and another complete notch tool and two fragments of backed artefacts were excavated from TU110. The frequency of these tools, as well as the high number of broken tools, indicate that these were unlikely to have spent a major part of their use life at the site. In concert with the low frequency of active flaking or maintenance of artefacts on site demonstrated by low unifacial reduction, but somewhat moderate bipolar flaking, these artefacts tend to indicate the area was used for a short time, resulting in a small archaeological stone artefact signature. If this were used more than intermittently, we would see more of the production of waste flakes and a significant increase in backed artefacts and cores.

Table 11 Retouched Artefacts from Basin V6 Testing Area.

TU	Quad	Spit	ID	Material	Colour	Flake Class	Comment	Tool Description
110	D	7	47	Mudstone	White (patina?)	Complete tool		Scraper
110	A	7	102	Silcrete	Red brown	Medial tool	Backed blade	Backed blade
110	A	5	109	Mudstone	Light brown	Proximal tool	Conjoins with 110 complex notch	Notch
110	A	5	110	Mudstone	Light brown	Distal tool	Conjoins 109	Notch
110	D	4	115	Silcrete	Yellow to brown	Medial tool	Backed	Backed blade
110	D	6	205	Chert	Red brown grey	Complete tool	Angular red brown cortex	Backed blade
110	C	8	206	Mudstone	White	Complete tool	One complex notch, utilised to step retouch on q4	Notch
110	C	8	211	Mudstone	Yellow	Complete tool	Broken into three analysed as one piece,	Backed blade

TU	Quad	Spit	ID	Material	Colour	Flake Class	Comment	Tool Description
							bidirectional backing	
110	A	8	247	Silcrete	Red brown	Angular fragment tool	Retouched edge on broken ventral, utilised retouch	Utilised

Figure 7 Notch tool, Artefact 206 dorsal.

Figure 8 Notch tool, Artefact 206 ventral.

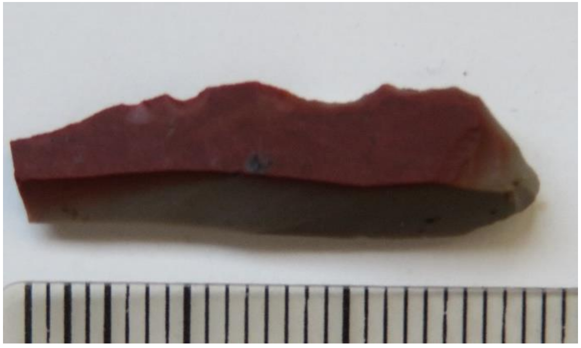

Figure 9 Backed blade on chert, Artefact 205 dorsal.

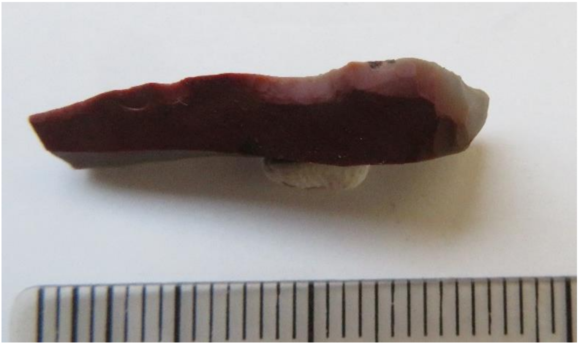

Figure 10 Backed blade on chert, Artefact 205 ventral.

1.4.4 TU110

Overall, the density of stone artefacts within TU110 in the Basin V6 area is 139/m^2. However, when we look at the minimum number of artefact values, we see that flake production of 35.5 flakes is quite low and focalised within the square. The surrounding squares placed at a 5m offset do not contain similar densities. Similarly, the core and tool discard is more evident of opportunistic use and discard or loss of material.

Table 12 TU110 Artefact Count and Minimum Number of Artefacts.

Expansion Unit	Flake Class (N)	Sum of MNF	Sum of MNC	Sum of MNT
A	35	11		1
B	1	0.5		
C	47	11	2	2
D	18	5	2	2

Expansion Unit	Flake Class (N)	Sum of MNF	Sum of MNC	Sum of MNT
N/A	36	8	1	
Total	139	35.5	5	5

1.5 Discussion

The classic bases for comparison in an assemblage involve the proportion of raw material representation and the representation of technological components. The Basin C, Access Road and Basin V6 testing areas have yielded neither a wide variety of stone raw materials across the testing areas, nor the varied assemblage representative of activities consistent with artefact manufacture, maintenance or discard. Raw materials are clearly being sourced from gravels; however, there is also a strong terrestrial source component (ie an eroding outcrop) evident in the silcrete at the site. The study area, in general, apart from TU110 has a very low background scatter density of less than five artefacts per square metre. TU110 expansions revealed higher densities; however, these perhaps over-represent the breakage patterns associated with both post-deposition and through bipolar reduction.

Bipolar reduction and the use of silcrete in the area is well understood. TU110 did not yield a statistically viable assemblage to assess any changing raw materials with depth. It is for these reasons that scientifically the archaeological information potential of expanding this test unit is considered to be low. The low potential rating comes from the lack of potentially statistically significant results, the commonplace nature of materials and techniques across the Cumberland Plain sequence, and the lack of conclusion about the temporal sequencing within the mid to late Holocene. If a larger assemblage of cores, or complete flakes were excavated, this would have warranted further excavation.

Table 4.13 Distribution of Artefacts in TUs in the ADI/SMDS. (Does not include expansion squares)

Area	Numbers of Artefacts in Each 50x50cm TU							Total 50x50cm TUs	Total Artefacts	Mean Density Artefacts/m^2
	0	1–2	3–5	6–9	10–15	16–20	>20			
BI/Area 4	7	2						**9**	2	0.9
BI/Area 5	12	1						**13**	1	0.3
BI/Area 6	10	1	2					**13**	7	2.2
BI/Area 7	15	1						**16**	1	0.3
BI/Area 8	21	5	1		1			**28**	23	3.3
BI/PAD1	11	2						**13**	3	0.9
BI/PAD2	2	4	1					**7**	10	5.7
BI/PAD3	36	30	11	3				**80**	104	5.2
BI/Area 9	10	1						**11**	1	0.4
CP1	6	4		1			1	**12**	34	11.3
CP2	2	4	2					**8**	12	6.0
CP3.1	19	13	13	1				**46**	73	6.4
CP4	11	17	3	2	1			**34**	56	6.6

Area	Numbers of Artefacts in Each 50x50cm TU							Total 50x50cm TUs	Total Artefacts	Mean Density Artefacts/m^2
	0	1–2	3–5	6–9	10–15	16–20	>20			
CP6	11	20	9					**40**	61	6.1
ND1	11	5	1	1				18	20	4.4
ND2	8	7	2	5	2			24	75	12.5
Basin C	84	7	2					93	14	0.15
Access Road	7	6						13	9	0.69
Basin V6	14	4	1		1		1	18	71	3.9

Endnotes

[1] Schmidt, P, Bellot-Gurlet, Parkington Nickel 2015, 'A previously undescribed organic residue sheds', *Journal of Human Evolution,* pp 22–35.

[2] Schmidt, P 2017, 'How reliable is the visual classification of heat treatment?', *Archaeological Anthropological Science*, pp 1–15.