Plains, Plants and Planning.

An analysis of Indigenous Earth Mounds at Calperum Nature Reserve, Riverland, South Australia

Robert Jones

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Robert Jones RFD, BA, BArch.

A thesis submitted in fulfilment of the requirements of the degree of Master of Archaeology and Heritage Management, Department of Archaeology, Flinders University of South Australia.

6 November 2016

Declaration of Candidate

I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

Signature: Robert Jones

Date: 6th November 2016

Abstract

Previous archaeological surveys and research within the section of the of the Murray River valley between the townships of Renmark and Mildura have identified a late Quaternary sequence of burials, artefact scatters, quarries, earth mounds, middens and scarred trees. This study adds to previous work on Indigenous earth mounds in the Riverland region of South Australia. The research focusses on place, and the influence of local geomorphology on the expression of new ideas and innovation as key drivers of adaptations to environmental variability through a consideration of earth mound morphology, distribution and surface contents. Thus, providing an insight into Indigenous landscape use, gender roles and the responses of local Indigenous people to seasonal environmental variability.

Oven mounds constituted a reusable asset which were utilised on a cyclical basis, possibly by family groups, and potentially subject to socio-economic and cultural criteria. Within this interpretation, women likely occupied an important role in the operation and maintenance of oven mounds and the supply of critical nutritional resources to family and clan groups. The archaeological record on the Calperum floodplain, including the location, distribution and surface content of earth mounds and occupation sites, suggests an intimate causal relationship with the local geomorphology. An argument has been advanced, to suggest that this has influenced the placement of oven mounds and the adoption of a system of active management of aquatic plant resources to maximise outcomes over the annual subsistence cycle and to mitigate risk.

The inability of this study, to provide radiocarbon ages for oven mounds contained within the Calperum floodplain, precludes assessment of the local human response to long term change during the mid to late Holocene. However, the Calperum oven mounds do provide a

useful case study for the response of late Holocene Aboriginal people, in active riverine systems, to local environmental variability.

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Cover page photograph: Reny Island Billabong. Photograph M. Morrison September 2015.

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1. Introduction

The research conducted for this thesis is situated within a wider research program that aims to investigate past and contemporary Aboriginal connections to country at the Calperum[1] Station Environmental Reserve. The station is located 15 kilometres north of Renmark[2] in the Riverland region of South Australia, and more broadly within the wider Murray Darling Basin (Figures 1.1, 1.2). The wider project is a collaborative venture between the River Murray and Mallee Aboriginal Corporation (RMMAC) and Flinders University Archaeology staff. The study outlined here, is one of several student research projects which have been initiated within this broader research project. The study represents an opportunity to expand on previous regional studies on Indigenous earth mounds and the models which have been advanced to explain their function during the mid to late Holocene (see later sections).

The Murray Darling Basin is a prominent and iconic geomorphic feature of the Australian continent and is of environmental, economic, recreational, political and social importance. The region is renowned for its history, archaeology, palaeontology and geomorphology and consequently figures prominently in the story of Indigenous peoples, following their initial entry into Greater Australia during the Pleistocene. Figure 1.1 outlines the geographic extent of the Murray Darling Basin. It is bound in the north and east by the Carnarvon Range and Great Dividing Range respectively, covering 1,059,000 square kilometres or 14% of the area of the Australian continent (Murray Darling Basin Authority 2015). For the purposes of

[1] A word derived from the local Indigenous language said to mean 'a branch road or short-cut' (Tindale c.1934-c.1991)
[2] A place name associated with a source of chert stone (Tindale c.1934-c.1991).

this study, the use of the term Murray Darling Basin is intended to also include the closely associated earth mound regions of the northern Adelaide Plains and the Western Districts of Victoria, which are not technically part of the Basin.

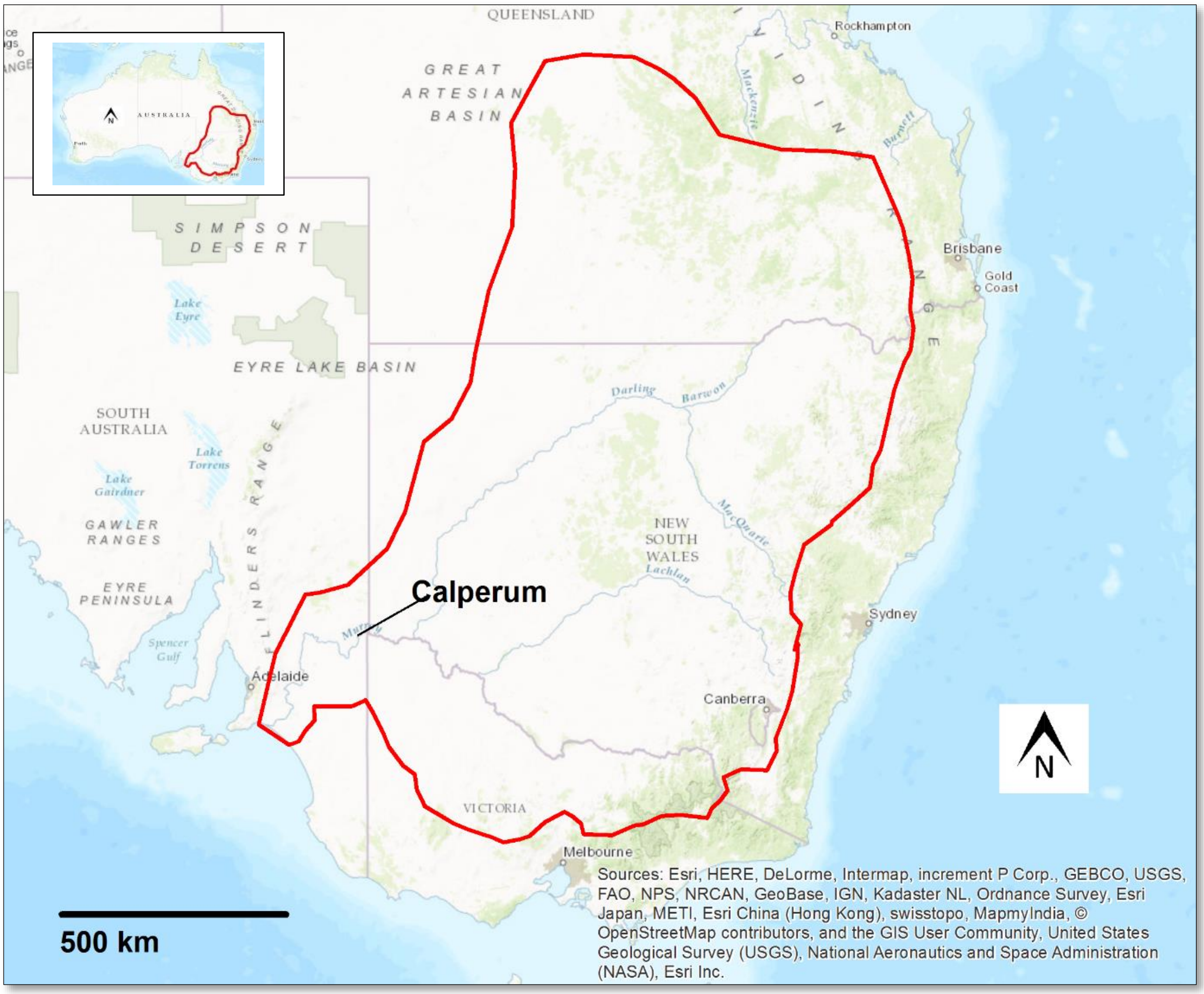

Figure 1.1: Murray Darling Basin and location of the Calperum study area.

Earth Mounds in Australia

Earth mounds are found both in the north, and in the south-east of Australia (Figure 2.1) (Brockwell 2006:47). Brockwell (2006:47) defined earth mounds as:

> ...those which are composed mostly of soil and sand. Depending on their location they may also contain stone artefacts and faunal remains, including shell. (Brockwell 2006:47; see also Westell and Wood 2014).

In the context of the Hay Plain, Martin (2006: 9) observed that:

> The 'earth' or mound matrix is full of archaeological material such as heat retainers, ash, charcoal, faunal remains, stone tools, and occasionally burials. Even the word mound is unsatisfactory, as the end result of erosion is a scatter of heat retainers and other erosion resistant material on what may be termed a claypan.

The observations above indicate a diversity in the expression of this type of feature, both over time and within different geomorphological and environmental contexts. The archaeological study of the remains of earth mounds has the potential to provide considerable information on the economic systems, social and cultural systems, chronologies, and environments of the past (Brockwell 2001:1–23).

The earth mounds of the Murray Darling Basin constitute visible evidence of the Indigenous past, reflecting economic practices (e.g. cooking of animal foods and the management, harvesting, preparation and preservation of plant foods), cultural expression (style and landscape modification), changes in social organisation, including gender relationships and the exchange of ideas and innovation (Coutts et al. 1979:4–5; Klaver 1998:31–34; Martin 2006:304–306). The archaeological study of earth mounds within the Murray Darling Basin has been conducted in the context of both academic research and heritage studies, focussing on two broad themes:

- Regional studies of earth mound sites from the perspective of spatial distribution, morphology, chronology, function, and seasonality; and

- Wider research questions about Indigenous societies, economies and cultures; and associated environmental factors. Including the formulation of explanatory models associated with:
    - Settlement strategies and function;
    - Economic intensification;
    - Social organisation;
    - Climate change; and
    - Cultural expression.

Prior to the initiation of the collaborative Flinders/RMMAC research project, earth mounds on the Calperum Station floodplain had not been systematically surveyed and recorded. This gap in knowledge sits in contrast to the more detailed research conducted in other regions of the Murray Darling Basin over the past 40 years (Balme and Beck 1996; Berryman and Frankel 1984; Coutts et al. 1976, 1979; Godfrey et al. 1996; Johnston 2004; Klaver 1998; Lane 1980; Martin 2006; Sullivan 1980; Westell and Wood 2014; Williams 1988).

The literature indicates that earth mounds, within the Murray Darling Basin, exhibit morphological diversity across the region, in response to economic, cultural and environmental factors. They have potentially served several local functions over time and space. Their structure and contents, particularly burnt clay, and a general association with wetlands, have been interpreted as evidence of the repetitive processing of high energy plant species for food and fibre (Martin 2006:291–293). In some instances, in the wider region, their rounded and elevated structure and location in flood prone areas infers their use during periods of inundation as convenient living spaces (Coutts 1979:85). In addition, the apparent sudden emergence of earth mounds in the mid Holocene, supported by numerous and robust age determinations (Berryman and Frankel 1984; Coutts et al 1979; Godfrey et al. 1996; Johnston 2004; Klaver 1998; Martin 2006; Williams et al. 2008; Williams et al. 2015a; Williams et al. 2015b), and their subsequent wide and rapid distribution, suggests the spread of innovative ideas through regional populations. This potentially supported the growth of new, more intensive forms of intensive food production, restricted home ranges and consequent changes in economic and social systems (Williams et al. 2015b).

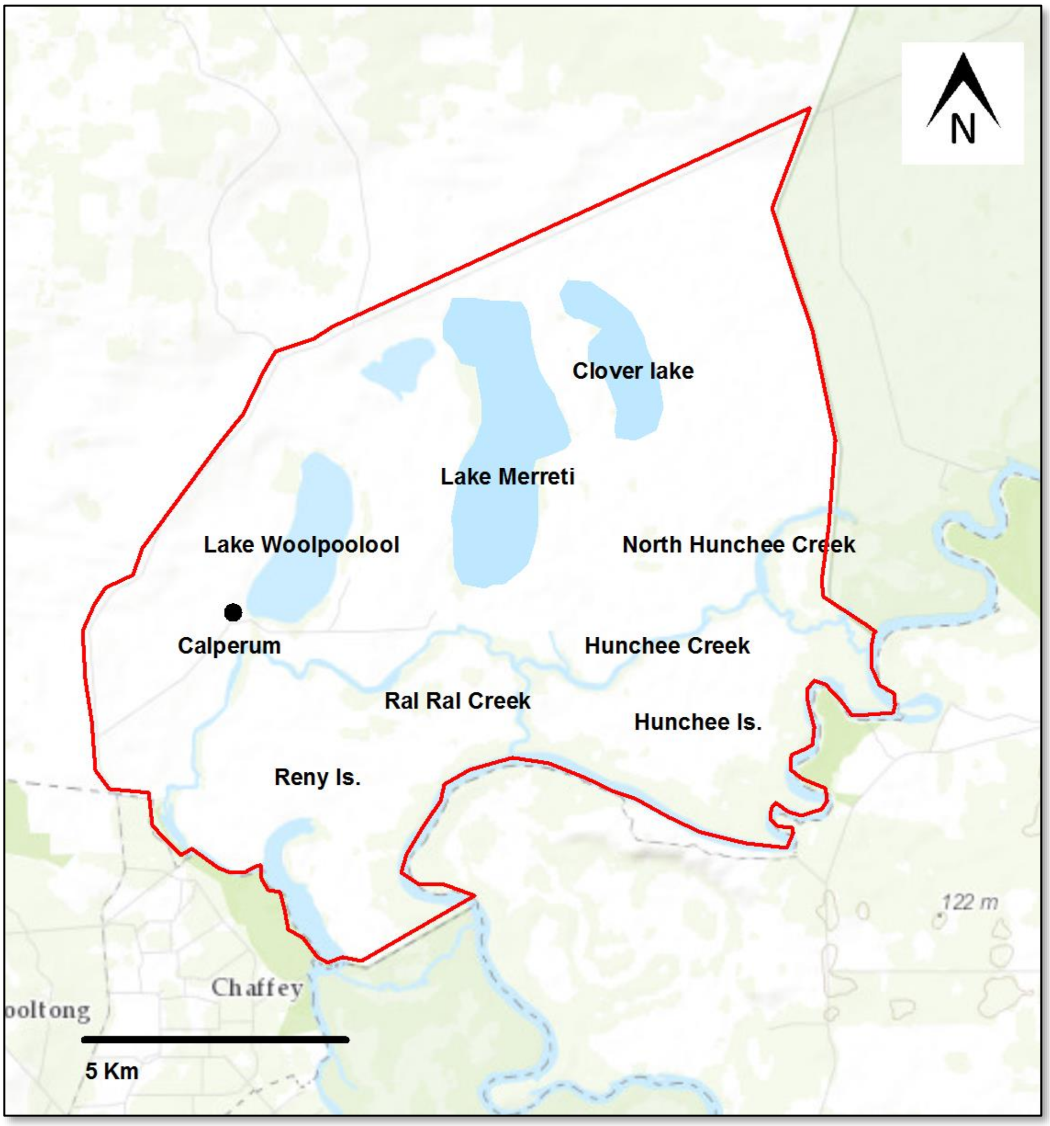

Figure 1.2: The Calperum floodplain study area.

Research Question

This study focuses on a survey and analysis of a sample of Indigenous earth mound features within an 86 km^2 portion of the Calperum floodplain, which is contained within the boundary of the Renmark-Wentworth road and the Murray River (see Figure 1.2). I have adopted Klaver's (1998:132–135) system for the classification of earth mounds, which is outlined in Chapter Two and will be used to characterise the earth features recorded within the Calperum floodplain and seek to use this to address the research question which is posed below.

The research aims to test the hypothesis that the Indigenous earth mounds located on the Calperum floodplain, represent similar adaptations to environmental variability as proposed for other regions of the Murray Darling Basin during the late Holocene.

The research question being investigated is:

> What does ethno-history, the archaeological remains of earth mounds and a comparison with the regional earth mound dataset, reveal about demography, economic settlement patterns, resource utilisation, site selection and function, on the Calperum floodplain?

The aims of the study are:

- In the absence of a local age profile for Calperum earth mounds, to provide a regional chronological context through a synthesis of published ages for earth mounds of the wider Murray Darling Basin.

- To survey and record a range of earth mound features within the Calperum floodplain, and to examine these within the local geomorphological and hydrological contexts.
- To quantify deposits of burnt clay nodules and mussel shell fragments on mound surfaces where possible, in order to generate new insights into site function and local socio-economic structure.
- To compare the dimensional and morphological characteristics of the earth mounds with those of the other major precincts of the Murray Darling Basin where mounds occur.
- To consider spatial and elevation data, and seasonal resource availability, to provide an insight into resource utilisation, site selection, site function and the impact of seasonal flooding regimes.
- To construct a parsimonious demographic and settlement model for the Calperum floodplain.
- To examine the potential role of earth mounds as socio-economic/cultural markers of territory on the Calperum floodplain.

Significance

The research outlined here, is significant for several reasons. The study adds to previous work by Westell and Wood (2014), by systematically recording and analysing a representative sample of the Indigenous earth mounds within the South Australian portion of the Murray Darling Basin. Secondly it adds to the comparative data about earth mounds, within the Murray Darling Basin, contributing to an understanding of the characteristics and diversity of this iconic Indigenous landform, both within the wider region and nationally. In addition, as a regional case study, this research contributes to important debates regarding the adaptations made by Indigenous societies to environmental variability during the mid to late Holocene.

The study is significant to the traditional owners of the region as represented by the River Murray and Mallee Aboriginal Corporation (RMMAC), as part of a wider archaeological investigations into Indigenous economic systems and possible social and cultural changes in the local region.

Thesis Outline

Chapter Two provides a review of relevant archaeological research, theories and models associated with Indigenous earth mounds and Indigenous societies within the Murray Darling Basin and closely associated regions. The research literature is firstly viewed via temporal and geographic contexts to establish a regional perspective, and then considered in respect of various explanatory models and wider debates. These include cultural, social and functional models for the use of earth mounds.

Chapter Three provides an overview of the study area, including the geographical and geomorphological contexts of the Riverland region of South Australia and north-western Victoria, which incorporates the Calperum floodplain. In addition, I examine prior archaeological research, ethno-history, demography and resource availability within the floodplain context.

Chapter Four outlines the methodology utilised for this research. This includes the community and Flinders University processes for ethical approval. The chapter also outlines survey and field methodology, including GIS recording, GPS point recording, photography, dimensional and surface recording and height profiles for selected features.

Chapter Five presents the data obtained for each earth mound recorded, including its physical setting, surface analysis, relationship to other mounds, water sources and the archaeological context.

Chapter Six examines and discusses the data derived from the sample of earth mounds recorded on the Calperum floodplain. It also compares the earth mounds of the Calperum floodplain with the mounds of the wider region, addressing each research aim listed above.

Chapter Seven outlines the conclusions derived from this research in respect of the initial aims and the potential for further research.

2. Earth Mounds in South-eastern Australia

Introduction

Indigenous earth mounds are an archaeological feature on some coastal plains of northern Australia, the northern Adelaide Plains and in some riverine environments of the south-eastern portion of the continent (Brockwell 2001:1–10, 2006:47). This chapter aims to contextualise Indigenous earth mounds at Calperum in relation to the earth mounds of the wider Murray Darling Basin.

What are earth mounds?

Earth mounds containing ash, burnt clay, mussel shell[3] and occasional animal bone within the Murray Darling Basin, exhibit significant diversity in dimensions, morphology and contents (Klaver 1998:122–135). In this sense, the general term ‘earth mound’ is an inadequate descriptor for the range of features which contain these materials and are found in several different environments across the Murray Darling Basin. Such diversity renders the simple definition of Brockwell (2006:47) and the tripartite typology employed by Coutts et al. (1976, 1979) and later researchers, as potentially too simplistic when applied to earth oven deposits in south-eastern Australia. Instead, it suggests greater complexity in site development and function over time, including complex taphonomic processes within diverse and often dynamic environments.

[3] Two types of mussel are found in archaeological contexts within the Murray Darling Basin, these are *Velesunio ambiguous* and *Alathyria jacksonii*, from lacustrine and riverine environments respectively (Garvey 2013:121; Walker 1981:1241; Walker 1990:309–314).

Klaver (1998:122–135) has produced a useful classification for the assessment of diverse earth features as part of a general classification of site components (Table 2.1). These include earth ovens, excavation pits, above ground hearth and oven structures, areas of ashy sediment and mounded structures. Klaver (1998:135) notes that there are issues with the nomenclature of earth features but concedes that the use of the word mound at the first level of analysis is useful, due to the difficulties of initial classification of often indeterminate earth features. This terminology and the classification system serves as the basis of analysis for this study and will be discussed further in Chapter Six.

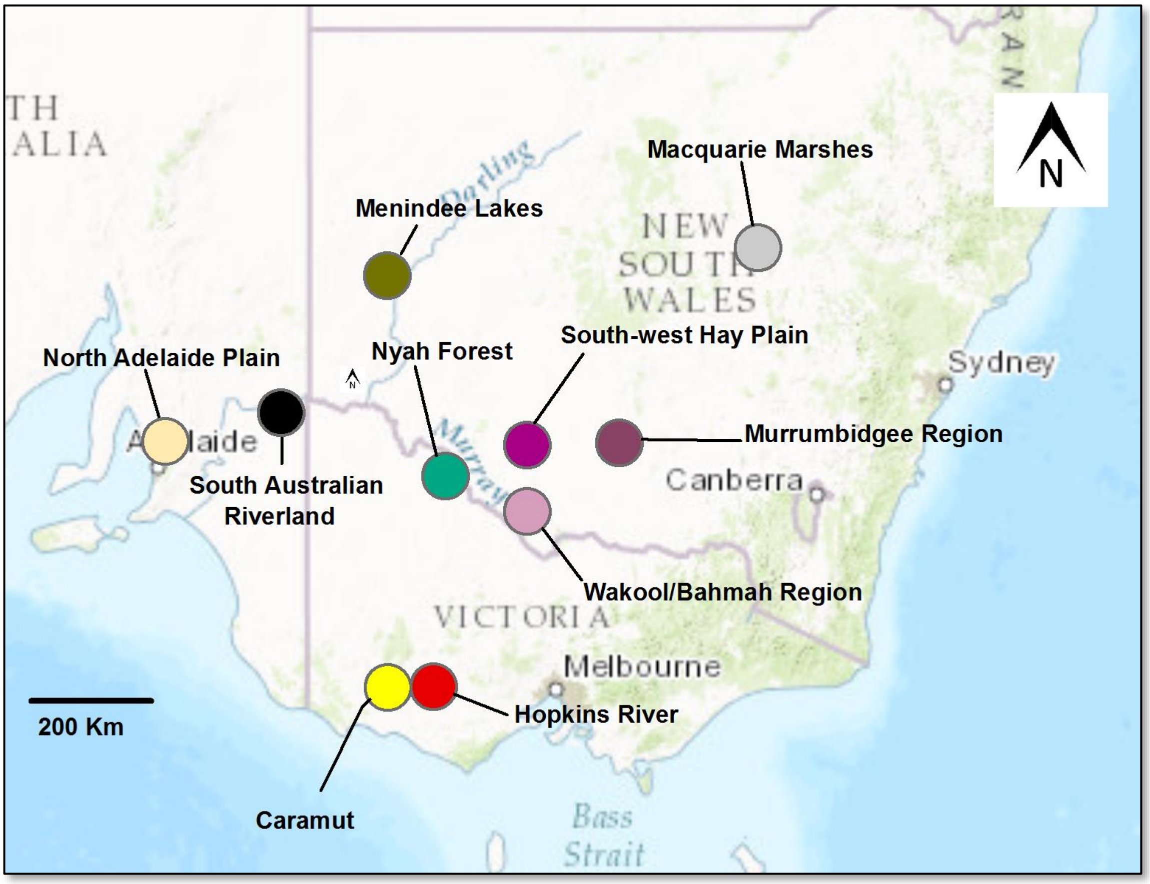

Figure 2.1: The major locations of earth mounds in south-eastern Australia (adapted from Westell and Wood 2014:32; see also Pardoe 2003:43).

Table 2.1: Earth feature characteristics, derived from Klaver (1998).

Site Component	Size	Features	Description	Site size	Activity	Comment	Source
Ashy sediment accumulation	Fine grain	Occupation floors/ General camping.	Mixed deposits of soil and ash.	Large/ Irregular.	Campsite.	Mixed surface. May be disturbed oven mound site.	Ethnography
		Open hearth camp fire.	Charcoal/soil and ash.	Less than 1 metre.	Campsite.	Continued use may evolve into mounded structure – occupation mound.	Archaeology
Excavated pit		Small oven pit.	Burnt clay present.	Less than 1 metre.	General camping.	Other artefacts and material present.	Ethnography
		Large oven pit.	Depression.	Up to several metres diameter.	Processing large quantities of materials or food.	Association with plant resource zone.	Ethnography

Site Component	Size	Features	Description	Site size	Activity	Comment	Source
Fired clay heat retainer	Range from 0.5cm to 15cm	Small pit ovens.	Rake-out piles.	1 metre diameter.	Cooking.		Archaeology
		Multiple Pit ovens.			Cooking.		Archaeology
		Above ground oven structures.	Aggregations without in-ground pits.	Variable.	Reuse for cooking	Grouped aggregations over large surface. Incipient mounds.	Archaeology
		Oven mound.	Discrete, mounded, many burnt clay lumps.	Variable.	Repetitive use of small pit ovens.	Mussel shell and artefacts. Compact or soft.	Ethnography
		Occupation earth mound.	Discrete and mounded few burnt clay lumps.	Variable.	Camping.	Few artefacts and other materials.	Ethnography
		Pit ovens within midden deposits	Matrix dominated by shell fragments.		Cooking within midden deposits.		Archaeology
		Utilised natural mounds.	Natural rises, animal activity, tree fires.		Natural processes.		Archaeology

Earth mound purpose

The origin and/or purpose of earth mounds within south-eastern Australia has been suggested to be associated with the construction of earth ovens for food preparation and plant processing, as living spaces (particularly during floods), as potential cultural markers and the accumulation of lifestyle debris, including mussel shells, and occasional burials (Coutts et al. 1979:86; Westell and Wood 2014:30–65; Williams 1988:213). Martin (2006:54–100) provides a detailed overview of heat retainer technology and the use of earth ovens in the Australian context, differentiating earth ovens from simple hearths and indicating the innovation associated with their use. Martin (2006) argues that the technology enables access to additional calories from plant based complex carbohydrates, through the application of heat and moisture whilst conserving fuel.

In summary, earth mounds frequently contain burnt clay, shell and faunal remains, though not always together, and in varying ratios. They occur in floodplain environments in close association with economically important wetland plants, which, with archaeological evidence of earth oven technology, indicates cooking and processing occurred within such sites. These environments are subject to flooding, thus potentially indicating a settlement choice to cope with seasonal inundation in some instances. Table 2.2 identifies key regional earth mound datasets for the south east of the Australian continent, including morphological data for comparison with the Calperum dataset compiled as an outcome of this study (see Appendix 13).

Table 2.2: Key regional datasets by mound precinct including author's names and reference.

Earth mound precinct	Study area	Citation
South Australia	Northern Adelaide Plains	Westell and Wood (2014); Draper (1992); Littleton et al. (2013)
	SA Riverland	Westell and Wood (2014)
North Central Victoria	Swan Hill	Coutts et al. (1979)
	Wakool/Barmah	Buchan (1980); Berryman and Frankel (1984); Frankel (1991); Simmons (1980)
Macquarie Marsh N.S.W.	Macquarie River	Balme and Beck (1996)
Western Victoria	Hopkins River	Coutts et al. (1976)
	Caramut	Williams (1988)
Western NSW	Menindee Lakes	Pardoe (2003)
South Central NSW	Hay Plain	Martin (2006)
	Murrumbidgee	Klaver (1998)

Regional chronology

The oldest ages[4] for all sites in the Murray-Darling Basin are associated with the Willandra and Menindee lakes at 46,000 BP (Bowler et al. 2003). The oldest age associated with any site type, in a riverine environment, is 20,420 BP (Edmonds 1998). From available data, older sites, prior to 20,000 BP, would appear to be absent from active riverine environments (Williams et al. 2008).

The numbers of ages, and relative age ranges, of earth mounds by sub-region, are shown in Table 2.3 (see Appendix 1 for additional detail). Of the 64 ages for mounds listed, 59 are from the last 3,000 years and five range between 3,501 BP and 4,500 BP. Thus, from current evidence, earth mounds in the Murray Darling Basin are essentially late Holocene in age with 78% of ages less than 2,000 years BP (Table 2.3). All ages prior to 3,000 BP are from sites in the Hay Plain and Wakool regions. Ages for the north-west and north of Victoria, south of the Murray River, are significantly younger with only one from Lake Boort exceeding 2,000 BP. The age progressively increases, north of the Murray River through the Wakool region, with the oldest located in the south west area of the Hay Plain. To the north of this area, the age profile of mounds in the Murrumbidgee River region is again significantly reduced, the oldest age estimates at 2,940 BP (Appendix 1). In the western districts of Victoria, the maximum age recorded is 2,350 BP; this is comparable with the oldest age of 2,480 BP, recorded in the northern Adelaide Plains.

[4] Note: All determinations discussed are uncalibrated.

The data indicates that the earth mounds which occur on the floodplains of active riverine environments and/or seasonal floodplains are younger than 3,000 BP, whilst those located in more morphologically stable environments are considerably older. The older ages recorded for the Hay Plain, does not necessarily indicate that earth mounds originated in this region, as this does not preclude the possibility that older structures were destroyed by taphonomic processes and the lateral movement of river channels in active riverine environments.

Table 2.3: Available uncalibrated earth mound C^{14} ages by precinct in 500 year periods. Note: Lake Boort ages were not included as they were derived from the same mound.

	Uncalibrated Radiocarbon Age BP									
Precinct	0-500	501-1,000	1,001-1,500	1,501-2,000	2,001-2,500	2,501-3,000	3,001-3,500	3,501-4,000	4,001-4,500	Total
Western Victoria	1	2	3	2	1	0	0	0	0	**9**
Nyah	2	6	8	1	0	0	0	0	0	**17**
North Adelaide	0	2	1	0	1	0	0	0	0	**4**
Hay Plain	0	0	0	0	0	0	0	2	2	**4**
Murrumbidgee	7	12	0	0	0	4	0	0	0	**23**
Wakool	0	0	0	0	2	1	0	0	1	**4**
Goulbourn River	2	0	0	0	0	0	0	0	0	**2**
M. Marsh	0	1	0	0	0	0	0	0	0	**1**
Total	**12**	**23**	**12**	**3**	**4**	**5**	**0**	**2**	**3**	**64**

An analysis of the age ranges of the Nyah Forrest mounds (Appendix 1), demonstrates potential contemporaneity of a group of mounds, which are located within 1,200 m of each other, potentially demonstrating a satellite grouping which was periodically active for the period 800 to 1,200 BP. This spatial and chronological association possibly suggests a semi-sedentary lifestyle in a resource rich environment oriented around a mix of larger and smaller mounds representing occupation and processing sites respectively.

Regional Studies of Mounds in the Murray Darling Basin

South Australia

Westell and Wood (2014) synthesise previous work on Indigenous earth mounds in South Australia, outlining their distribution, typology, regional characteristics, potential function, formation processes and associated artefact assemblages. The authors identify 31 mounds located within the river floodplains of the Northern Adelaide Plains (Figure 2.1), between Gepps Cross and the township of Two Wells and cite early historical evidence of mounds associated with the Torrens and Sturt Rivers in the central and southern Adelaide regions respectively (Westell and Wood 2014:35-44). Mound characteristics in the Adelaide region are difficult to determine due to damage caused by agricultural activity since European colonisation, however, Westell and Wood (2014) cite earlier work by Draper (1992), which indicated diameters of 10–57 metres and a height range between 0.1–1.3 metres and evidence of at least two types of mound. The majority were low, circular, homogeneous accumulations of burnt clay pellets, in a silt matrix with ash and charcoal (Westell and Wood 2014:40). The second type is less common, but larger with a more diverse assemblage of materials, including burials in some instances (Littleton et al. 2013; Westell and Wood 2014:41–42).

Littleton et al. (2013) re-examined the “Gillman mound”, in the Port Adelaide region of the north Adelaide plain, which was originally excavated in 1970 by Hodges (1973). At the time of excavation, the mound was less than half its original size, which was estimated as greater than 24 metres in diameter and over three metres high. The excavation revealed a top layer of 2 –3 metres of calcareous sand, with the upper-most deposits stained with dark ashy occupation debris, and a lower layer of red sand extending below the surrounding ground level. The authors concluded that the site had been used episodically but not casually (Littleton 2013:38, 49).

Owen and Pate (2014:48–51) conducted stable isotope analyses of skeletal material from an individual burial dated to the late Holocene. The burial was recovered from a site in Salisbury, north of Adelaide, which was interred in a landscape containing numerous mounds. The isotopic evidence indicated a diet dominated by terrestrial sources of protein and an absence of seafood in the long-term diet. This was unexpected given the bioregion of the Adelaide Plains and indicated a different diet from other regional groups (Owen and Pate 2014:50). Following a reanalysis of both chronological and ethnographic data, they concluded that shifts to more local food sources in the late Holocene, potentially indicated sedentism and territoriality (Owen and Pate 2014: 51).

Westell and Wood (2014:45) identified 147 mounds along the Murray River from Wellington to the New South Wales border, with the heaviest concentration along the section of the river between the township of Loxton and the NSW/Vic Border (Figure 2.1). In the northern Riverland region (within which the Calperum floodplain is situated), earth mounds are relatively consistent in morphology, being generally circular with diameters between 3–50 metres and 0.2–0.7 metres in height, consisting of burnt clay pellets, ash and charcoal in a fine silt matrix (Westell and Wood 2014:46). Mussel shell has been found on 44% and 50% of the Chowilla[5] and Katarapko[6] mounds respectively indicating extensive use of river

[5] A word derived from the local Indigenous language said to mean 'a place of spirits or ghosts' (Tindale c.1934-c.1991).
[6] A word derived from the local Indigenous language said to mean 'home for rock crystal' (Tindale c.1934-c.1991).

mussel as a food source and their potential preparation within or near earth ovens. Westell and Wood (2014:48) observe that mounds in this region occur predominantly in lower, more regularly flooded parts of the floodplain, along major channels and around the margins of lagoons coincidently associated with the occurrence of water flora such as *Typha* and *Phragmites* spp. (See Figure 2.2). The authors' inference, from mound morphology and distribution, is that mounds in this region originated through the accumulation of earth oven material used for the processing of aquatic vegetation for food and fibre, and were separated from habitation and other activity areas (Westell and Wood 2014:48). This represents the key explanatory model for mound formation in the South Australian Riverland.

Figure 2.2: Stand of *Phragmites* spp. in Ral Ral Creek. Photograph: M. Morrison September 2015.

Western and North-Western Victoria

Through excavation and subsequent analysis of mounds in the central, western and the Murrayland regions of Victoria, Coutts et al. (1976:42–43; 1979) concluded that the mounds that they studied in the Hopkins River region of Western Victoria (Figure 2.1b), were the remains of seasonal camps located close to water and were not function-specific, instead representing a diversity of activities. They identified 207 mounds, generally circular in shape, 75% of which were located on natural rises, with 45% grouped in pairs, contained in larger groupings of six within a radius of 500 metres (Coutts et al. 1976:12–13, 19–20). Two mounds were excavated and found to contain stone hearth arrangements, burials, stone artefacts, faunal remains of freshwater shellfish and crustaceans, mammals and reptiles (Coutts et al. 1976:20–38). In a previous study, they noted differences in mounds located along the Murray River, which, in contrast to those of western and central Victoria, contained large quantities of burnt clay, mussel shell and animal bones (Coutts et al. 1976). Coutts et al. (1979:1) identified at least three types of earth mound in Victoria:

- Type A – Consisting of a single layer of clay containing only charcoal and burnt clay pellets.
- Type B – Homogenous in composition and containing large amounts of burnt clay, mussel shell and animal bone.
- Type C – Occupation sites containing pits, hearths, ovens, faunal remains including molluscs and eggshell, stone flakes and stone tools.

These broad classifications are not necessarily present in any one region and individual mounds can differ in morphology, potentially reflecting a developmental continuum over time (Coutts et al. 1979:1, 85–86).

Williams (1988:72–75) defined three types of mound in the Caramut area of the western District of Victoria (Figure 2.1), encompassing sites for shelter, oven sites and general living areas, although she noted that these functions could be combined in one locality. She concluded from the ethno-history, archaeological excavation and soil chemistry that the mounds investigated at Caramut represented base camps and that the mound cluster studied was likely to represent a village (Williams 1988:67). Her research indicated that earth mounds in south-western Victoria not only constituted an adaptation to wetland environments, but were also associated with a more intensive settlement of the region, indicating a more sedentary lifestyle (Williams 1988:216–222). Williams (1988:215) argued that large mounds indicated a continuum of construction which represented, 'a change in the organisation and structure of a campsite', indicating potential long term occupancy, and 'a change in the use of labour', that reflected a concentration on large durable structures expressed as large fish trap complexes as well as mounds. Williams (1988:220–221) concluded that the appearance of such structures was related to changes in alliance and redistributive networks which created a demand for increases in food production and discounted the influence of climate change in this context.

Central Murray

In 1977, the Victorian Archaeological Survey conducted a comprehensive field programme in which one of the principle aims was to methodically record and study earth mounds to the north-west of Swan Hill, and along the Lodden, Avoca, Little Murray and Murray rivers (Figure 2.1), with a view to determine type and variety, chronology, functions, cultural relationships and future research potential (Coutts et al. 1979; Lane 1980). A total of 122 mounds were recorded in the Nyah Forest, which were generally less than 20 metres in diameter, and which were often located in groups (Coutts et al. 1979:15–17). Coutts et al. (1979:15, 54) identified two types of mound, the first containing burnt clay, charcoal and sediment, whilst the second type additionally contained freshwater mussel shell and other faunal remains. After the excavation of one mound (DP/1), the authors concluded the site had developed from a cooking mound and constituted a seasonal occupation space utilised on occasions other than during floods, suggesting increased efficiency in resource acquisition through better access to abundant wetland areas and a potentially semi-sedentary lifestyle (Coutts et al. 1979:82, 86).

The excavation of two smaller mounds (DP/2 and DP/3) indicated their origin and use as earth oven sites with a satellite relationship to the larger occupational mound (Coutts et al. 1979:84–85). Coutts (1980:36) later identified a third type of mound which appeared similar to the second type outlined above, except that it contained extensive faunal remains and some artefacts, and was interpreted to have been used during periods of flooding.

Lane (1980) surveyed Indigenous archaeological sites along the Little Murray River, an anabranch system of the Murray River, near Swan Hill in north Western Victoria (Figure 2.1). Eighty-three mounds were recorded, but they had been significantly disturbed by European agricultural activity (Lane 1980:113–117). The mounds were similar in composition, containing burnt clay pellets, charcoal, sediment and fragments of shell and bone, from which Lane concluded that two mound types were present (Lane 1980:115).

Sullivan (1980) examined mounds in the nearby Nyah Forest region (Figure 2.1), reporting that two types of mound were present, the first constituting “compact” mounds containing burnt clay with little cultural material and located on small rises along small tributaries of the river within the floodplain. The second, larger and less numerous, type were described as “soft” mounds, often constructed over the top of the first type outlined above. Sediment pH testing indicated a 5.5 to 6.5 range and 8.0 to 9.0 for the small and larger mounds respectively (Sullivan 1980:49–51). This contrast was interpreted as due to differences in construction rather than post-depositional changes within them (Sullivan 1980:50).

Western and Southern New South Wales

Simmons (1980:57–86) surveyed two areas of the central Murray River floodplain, Lake Jilleroo to Tooley Landing, and a system of lakes and channels between Nyah, on the River Murray, and the Wakool River in New South Wales (Figure 2.1). The author examined 75 mound sites over both areas providing a detailed analysis of their appearance and structure, contents and the geomorphology of the immediate region (Simmons 1980:63). The first area contained two types of mounds. The first comprising large isolated mounds 30–40 metres in diameter and up to 0.75 metres high, located on levees along the main stream (Simmons 1980:64–65). These were like the 'Type two' described by Coutts et al. (1979:15) at Nyah Forest. The second type was smaller and found in clusters near the edge of the floodplain. The second area between Nyah and the Wakool River exhibited small mounds containing burnt clay pellets, which were associated with lake margins and alluvial flats (Simmons 1980:69–70). Simmons (1980:83) concluded that the mounds represented seasonal base camps, and reflected the importance of aquatic resources to the local Indigenous economy.

Buchan (1980) found two types of mound in the Lake Coomeroop region of the Murray Valley, in southern New South Wales (Figure 2.1). The larger type contained dark silty soil with burnt clay pellets, charcoal, mussel shell and faunal remains. The second, smaller type, were low and circular with burnt clay pellets and occasional shell (Buchan 1980:46–47). Some difficulty was encountered in distinguishing between natural mounds formed around burnt tree stumps, and culturally derived mounds containing only burnt clay and charcoal. Sullivan and Buchan (1980:96) explored this issue, concluding that, whilst a continuum existed between natural and cultural mounds, the latter were potentially distinguishable through morphology, being steep sided and flat bottomed with dark and compact soil. Elliott (1980:108) conducted a magnometer survey of two small mounds in the Nyah Forest, concluding that the methodology could be of use in distinguishing Aboriginal mounds from those occurring naturally.

Frankel (1991) outlines a survey and excavation in the Wakool River region, and a further study at Caramut in central Victoria (Figure 2.1) (Berryman and Frankel 1984; Frankel 1991:77–82, 82–84). Mounds were closely associated with the availability of water within the floodplain. Berryman and Frankel (1984:25–28) identified 95 mounds and were in general agreement with the typology of Coutts et al. (1979), but did flag the potential for minor modification. Frankel (1991:82) concluded that mound placement is strongly related to the harvesting of aquatic resources during flood.

Klaver (1998:132–135) recorded 311 mounds, closely associated with water sources in the central Murrumbidgee floodplain, identifying ovens, heat retainer components, hearths and occupation sites (Figure 2.1). The excavation of four mounds and two earth ovens provided mainly burnt clay with some faunal remains (Klaver 1998:172–181). Klaver (1998:279–284) concluded that the mounds originated as ovens with some later development into larger occupation sites which were used on a seasonal basis. She argued that the evidence did not support population increases or increased sedentism but indicated social and technological innovation and increased flexibility in resource utilisation (Klaver 1998:4).

Pardoe (2003:44–46) recorded 270 ashy deposits within the Menindee Lakes region, located in the far west of New South wales (Figure 2.1) and when combined with previously identified deposits increased the total for the region to 286. He postulated that these developed from earth ovens, classifying them as ‘focal points where dense occupation occurred over extended periods of time’, and were associated with the cooking of meat, tubers, rhizomes and fibrous vegetables; and the production of twine for netting (Pardoe 2003:45). In support of this argument, Pardoe (2003) cites Brock (1844[1988]:52) in respect of the use of earth ovens to produce twine, and Howitt (1904:717) for the importance of twine and nets within the local economy and in regional trade.

Northern New South Wales

Balme and Beck (1996:39–49) collected spatial, dimensional and compositional information for 63 mounds within the Macquarie Marshes (Figure 2.1) and compared them with earth mounds from elsewhere in south-eastern Australia. They noted that earth mounds are not contiguous in their distribution (see Figure 2.1 for a regional perspective) suggesting regional diversity between neighbouring regions (Balme and Beck 1996:48). The mounds were situated on seasonally flooded areas and were determined to contain burnt clay pieces 5–25 millimetres in diameter in accumulations of greater than 10 square metres (Balme and Beck 1996:40–42).

Hay Plain

The Hay Plain, in south western New South Wales, covers an area of approximately 20,000 square kilometres, and is dominated by earth mounds (Witter 1992:141). Martin (1996a, 1996b) reported very large mounds, and mound complexes, burial clusters, and micro-blade technology to the west of the Hay Plain, as well as earth ovens along paleo-channels to the east and smaller mounds, ovens, middens and ashy archaeological deposits along the modern Lachlan and Murrumbidgee rivers (Figure 2.1).

For her research on the archaeological significance of earth mounds on the Hay Plain, Martin (2006:45–46) sought to determine whether a "fundamental factor" could be linked to the emergence of mounds. This led her to investigate the dynamics of behavioural change and to examine the interaction of human agency and historical processes on the natural and cultural landscape of the region.

Martin (2006:292–293) concluded from ethno-history and archaeological analysis, that heat retainer ovens were extensively utilised on the Hay Plain for the cooking and processing of plant material, which allowed the conversion of complex carbohydrates into more easily digested carbohydrates and sugars. The excavation of the Ravensworth 3 and Tchelery 1 mounds provided direct evidence of the use of heat retainer ovens through the presence of clay heat retainer pieces, fused silica, charcoal, lenses of ash, pits and hearths (Martin 2006:293). Repeated use of the sites was indicated by carbonised faunal remains and an absence of definite stratigraphical relationships through thorough mixing of mound contents over time. Magnetic susceptibility and particle analyses indicated that the finer sediment present resulted from the breakdown of clay heat retainer material. Macroscopic charcoal, pollen and plant imprints from mounds indicated the presence of large amounts of wetland plants including *Typha* and *Cyperaceae* spp.; this, together with the small amounts of shell and bone present, indicated that plant food was the principal material processed (Martin 2006:294, 2011:162–172).

Martin (2006:296–299) also found that earth mounds are concentrated in the western portion of the region in association with '...larger, richer, more predictable and permanent wetland features' but discounts that ovens were always incipient mounds or that they were necessarily a conscious strategy to remain dry during flooding.

Interpretations of Mound Sites

The Intensification debate

Lourandos (1983:86–87, 1997:216–218) hypothesised that earth mounds reflected strategies enabling the utilisation of marginal wetlands and consequently population growth and increased sedentism in the western districts of Victoria, constituting a regional example of a continent wide social transition which he termed intensification. Social agency was favoured as a key driver of change, and was manifested as increased intergroup ceremonial and alliance network activity, as the key factor in mobilising resources to satisfy existing, and changing, social requirements in an increasingly challenging environment (Lourandos 1980:256; McNiven et al. 2006:9). Williams (1988:67, 220–221) added to this perspective through her identification of western Victorian earth mound clusters as the remains of villages representing intensified levels of production and greater social complexity, interpreting this to be primarily due to social developments rather than climate change.

In contrast, Hiscock (2008:253) argues against the possibility of earth mounds as the remains of 'villages' which indicate a highly sedentary population in the region, as proposed by some researchers (Flood 2001; Williams 1985). Opponents of social hypotheses for the origins of earth mounds in the Murray Darling Basin have argued that contemporaneity between mounds has not been established and consequently, more evidence of complexity and social change is required (Frankel 1991:85; Head 1990:85; Hiscock 2008:253; Holdaway et al. 2008). Frankel (1991:85) favours a simpler explanation involving repeated accumulation of earth oven material over time. In this interpretation, these features subsequently served as occupation sites, in a region which was characterised by poor drainage and a climate which became progressively wetter and more variable after 2,500 BP (Frankel 1991:85).

Bird and Frankel (1991:189–190) and Hiscock (2008:188–189) make the distinction between cumulative directional change (intensification) and short term adjustments in response to changing circumstances, concluding that the archaeological evidence from western Victoria and south-eastern South Australia reflects hunter-gatherer societies responding to external and internal influences, but not in a directional way.

Domiculture

Hynes and Chase (1982:38) define domiculture as '…hearth-based parcels of knowledge, strategies and actions applied to each 'domus', where 'domus*'* refers to a '…specific area where selective environmental knowledge and resource strategies are applied at a specific time'. Gott (1982:65) describes the Aboriginal practice of 'firing, gathering and digging' as a form of 'natural cultivation' which potentially increased production of natural stocks of carbohydrate bearing tubers in Southern Australia. Indigenous use of *Typha* spp., as recorded by Eyre (1845:269), Grey (1841:292) and Mitchell (1839:60) indicates management of an important source of food and fibre which borders on cultivation.

Balme and Beck (1996:45) highlight the inconsistency in content of earth mounds, and stress the absence of an agreed single and original function. They propose the practice of a form of domiculture as a possible explanation (Balme and Beck 1996:45). They suggest that domiculture is the only common function which is potentially consistent with the regional presence of baked clay, charcoal and burnt sediment found within mounds (Balme and Beck 1996:45). In addition, Balme and Beck (1996:47) explain discontinuity of mound use through the adoption of an intermittent strategy to address seasonal variation in the natural growth of high carbohydrate tubers. In this scenario, deliberate planting increases the availability of resources during relatively sedentary periods (Balme and Beck 1996:47). Whilst a lack of evidence for deliberate cultivation of plants on mounds is an issue for this hypothesis, a modified argument can be made in respect of the potential management of *Typha* spp*.* and other tuberous plants associated with, but not necessarily cultivated on or near mounds

(Martin 2006:278–282). The intensive use of earth oven technology, as expressed in the high presence of earth mounds in the Murray-Darling Basin, indicates the adoption of more intense strategies in the use of plant resources from the mid Holocene.

Cultural Landscapes

In addition to the potential functions as outlined above, mounds have also been suggested to be prominent symbolic features in past cultural landscapes, and as cultural markers of territory and ownership (Frankel 1991:82; Martin 2006; Westell and Wood 2014:57). Frankel (1991) commented on the regular spacing of mounds within the Murray Valley as potential indicators of territorial and resource ownership. This is a theme that correlates to the cultural model of exclusion, as developed by Pardoe (1988; see also Pate 1997:112), in respect of the potential function of cemeteries as symbols of territorial ownership, derived predominantly from archaeological evidence in the Murray Darling Basin. This is discussed further below.

From her research on the Hay Plain, Martin (2006:300–306) has constructed an encompassing model incorporating the physical processes of earth mound construction (earth oven building and use) and the formation of a cultural and social landscape with significant implications for the social positioning of women and their role in society. Martin (2006:282–286) cites ethnographic and archaeological evidence in support of the premise that women exercised considerable social influence in the riverine environments of the Hay Plain through the management, harvesting, processing and cooking of large quantities of plant foods, particularly *Typha* spp. This work led to the formation and development of mounds associated with co-operation between individuals, the development of leadership by women and the creation of new social relationships (Martin 2006:286–287).

Martin's (2006) proposal transcends simplistic models of earth mound use and purpose and is consistent with the intensification model proposed by Lourandos (1980, 1983, 1997) in respect to his argument for greater compartmentalisation of relations between people and land, and new territorial structures. Martin (2006:308–312) argues for social change and new and reduced territories during the Holocene, underpinned by the processing of high energy wetland plants through the introduction and wide scale use of heat retainer cooking technology.

The Climatic Context

Williams et al. (2015a:106) uses the dates for data methodology as a reliable proxy for changes in past human activity on a continental level, drawing on 5,044 radiocarbon dates from 1,750 Australian archaeological sites. By correlating human–climate relationships, they indicate that '...there is evidence of increasing populations with the establishment of home-range strategies, initiation of new corporate identity and development of more complex technological procurement strategies'. Williams et al. (2015b:1) argue that the Holocene climatic optimum (9–6 ka) was associated with a ... 'rapid expansion, growth and establishment of regional populations across approximately seventy percent of Australia, including much of the arid zone'. This period also saw the spread of Pama-Nyungan languages, Panaramitee art, backed artefacts and a move to more sedentary lifestyles, signalling innovation in social, cultural and economic practices (Williams et al. 2015b:1). The period 4.5–2 ka experienced an extended EL Nino-Southern Oscillation and increased aridity, population fragmentation and decreased territoriality (Williams et al. 2015b:12). The period post 2 ka, experienced a climatic amelioration with the onset of La Nina climate conditions and an '...intensification of mobility strategies and technological innovations that were developed in the early-to mid-Holocene' leading to increased population, increased territoriality, and the development of complex religious and social systems, in order to control resources (Williams et al. 2015b:1, 12).

The Population Context

The presence of large Indigenous cemeteries in the Murray-Darling Basin has been hypothesised to signal a major cultural change within the region from the early Holocene, indicating the development of large populations, sedentism, increasing territoriality and exclusion (Lourandos 1997:233; Pardoe 1995:705–706, Owen 2004, Pate and Owen 2014:91–92). In this context, Pardoe (1988:12–14) argues that the archaeological record, over the period 2,000 BP to the present, potentially indicates social status by descent, the emergence of hierarchical authority structures associated with sex and age; and the rise of a new social order. The skeletal record also indicates a possible increase in skeletal trauma which was potentially associated with organised conflict (Pardoe 1995:711).

Hiscock (2008:257–259) provides a critique of this hypothesis, indicating that other explanations may be deduced from the skeletal evidence. For instance, the cemetery at Roonka demonstrates an average burial rate of one individual every two or three generations and may not necessarily reflect exclusive or continuous use by a single sedentary group (Hiscock 2008:259; see also Littleton and Allen 2007:283–298).

Pate (1998a, 1998b, 2006:232, 240) and Pate and Owen (2014) have demonstrated, through isotopic analysis of skeletal remains found at Roonka Flat, near Blanchetown, and Swanport near Murray Bridge, on the banks of the River Murray in South Australia, that adult males had a significantly different diet from that of adult females and children. Pate (2006:239) concluded, from mortuary practices, that social differentiation was indicated for sex (related to subsistence activity), and age but was not indicative of social stratification as associated with hereditary decent. Women and younger children depended on a much higher proportion of aquatic and terrestrial plants and freshwater shellfish in their diet (Pate 2006:232). Patterns of dental wear indicate heavy reliance on coarse and gritty plant foods, possibly from cooking in earth ovens and the processing of fibre for netting; and potentially associated with the intensification of food procurement strategies, social change and/or population growth (Pardoe 1995:710–711).

Webb (1984) indicates that the skeletal record for Murray River populations from the late Pleistocene to the period of European contact, demonstrates a high incidence of chronic and acute stress including cribra orbitalia (anemia) and dental enamel hypoplasia. He argues that this health pattern reflects a large sedentary population with a high instance of malnutrition, parasitism, infection, endemic treponematoses and mechanical stress through heavy physical activity, reflecting potential change in economic strategies within the region (see also Pardoe 1995).

Pardoe (1995:710–711) notes that on the evidence available, the physical characteristics outlined above were confined to populations in the Murray/Murrumbidgee/Macquarie/Hay Plain regions and were not evident in the Darling River and Willandra regions.

Summary

This review indicates that the earth mounds of the Murray Darling Basin occur in diverse environments including the mobile riverine environments of the Darling, Murray, Murrumbidgee and Macquarie River floodplains; the seasonal wetlands of the north

Adelaide Plains and the western districts of Victoria; and the tectonically stable Hay Plain. In respect to developmental processes, structure, morphology and function, the mounds exhibit strong similarities within sub-regions but considerable diversity across the wider Murray Darling Basin. Ecological diversity, significant variations in earth mound morphology, and differences in levels of physical stress and other pathologies in populations across the region during the mid to late Holocene, suggests different adaptations to local geomorphic and climatic conditions, and potentially different demographic and social contexts.

The regional overview and intensive debate provided by the literature to date is reasonably robust for some regions but gaps remain and potential for further research exists, particularly in the southern areas of the Murray Darling Basin in South Australia and north-western Victoria. The latter region is known to contain earth mounds which have had little systematic analysis and comparison with other areas of the region (Westell and Wood 2014).

3 The Study Area

Introduction

The study area lies within the Riverland region of South Australia (Figure 1.2) and comprises an area of floodplain on the Murray River which lies within the boundaries of the Calperum Nature Reserve. Constituting a local component of a sinuous riverine environment lying within a semi-arid, relatively flat region with a contrasting complex floodplain geomorphology (Gill 1973:1–97). The River Murray is the dominant component in the landscape and is the source of this complexity. The annual rainfall for the region is of the order of 200–500mm with evaporation of 1,500-2,400mm (Walker and Thoms 1993:105). The greater River Murray floodplain in this area exhibits a complex of anabranches, lakes, dry pans, billabongs and paleo-channels which represent a geological history which extends at least five hundred thousand years into the past (Bowler 1990:100–101; Page and Nanson 1996:930; Walker and Thoms 1993:105).

This chapter synthesises current knowledge relating to the geography, geomorphology, archaeology and ethno-history for the Calperum study area, as they relate to this research. Due to limited previous research near Renmark, information has been derived from both up and downstream locations within the Murray Darling Basin. The study aims to address gaps in our understanding of pre-contact Aboriginal societies in the Riverland region of South Australia. It involves an overview of the chronological, geomorphic, environmental and local archaeological contexts, and a morphological comparison of regional earth mound datasets. In addition, it aims to establish a demographic model for Calperum and investigate a seasonal model of resource availability and group mobility, with emphasis on site selection and function, and resource utilisation.

This will provide an opportunity to test the basic hypothesis outlined in Chapter One through addressing the research question posed. In addition, depending on the information derived from the study, it may be possible to comment on the applicability of the various models proposed for the response of Indigenous peoples to environmental challenge during the late Holocene.

Fluvial History and Geomorphology

The Murray River is a remnant of an extensive riverine system which originated in the Tertiary because of the uplift of the Great Dividing Range to the east of the Murray Darling Basin (Walker and Thoms 1993:105). A marine ingress occurred from six million to four million years ago, followed by the formation of a very large freshwater lake, Lake Bunggunnia, that remained for two million years (Bowler 1990:95–109; Walker and Thoms 1993:105). The period since the retreat of this lake was characterised by a sequence of river regimes determined by climate and precipitation levels and which left characteristic depositional patterns over many kilometres in the riverine landscape east of the South Australian/Victorian border and which extends to the Great Dividing Range (Page et al. 1991:14; Page and Nanson 1996). Immediately to the west of the South Australian/Victorian Border (Figure 3.1) the river is contained within the Chowilla and Calperum floodplains which vary up to 10 kilometres in width. From their research in the Ned's Corner area of the Murray River in north eastern Victoria, Prendergast et al. (2009:58–60) identified and named four land systems within the floodplain. These are the Murray, Mulcra, Lindsay and Ned's Corner systems, dating from the present to 40,000 BP, with the fifth (Woorinen) representing the older landscape which contains the floodplain itself (see Figure 3.2 and Table 3.1).

Gill (1973:11) provides an overview of the episodic nature of the drought/flood regime which has dominated the recent fluvial history of the Murray River and the “biotic complex” which has adapted to it. He indicates the existence of a rich and complex economic resource available to pre-contact Indigenous populations in an environment characterised by “…a mass of meanders…and oxbow lakes” (Gill 1973:11).

A systematic geomorphic analysis of the Calperum floodplain does not exist at this time, however, the landform analysis of Prendergast et al. (2009) and the nomenclature established by them for the local landscape at Ned’s Corner, provides a comparative framework for the evaluation of specific landforms within the floodplains of the South Australian Riverland. Calperum lies 50 kilometres to the west of Ned’s Corner and is a continuation of the same floodplain complex. Figure 3.2 and Table 3.1 provide a useful basis for comparison of landform type and a potential broad chronological profile based on the morphologies expressed in Table 3.1, resulting in a proposed preliminary landform profile (Figure 3.3) for the Calperum floodplain based on Prendergast et al. (2009).

The study area constitutes a mosaic of geomorphic features, including the main stream of the Murray River, periodic flooding lakes, sand sheets, billabongs and an anabranch system comprising the Ral Ral[7] and Hunchee Creeks which contain Reny and Hunchee islands, and a portion of Little Hunchee Island (Figure 3.3). The Murray River makes an abrupt turn to the south near the Calperum floodplain and enters a choke point below Renmark township. This, in conjunction with the periodic flooding regime has potentially created the

[7] Named after a prominent member of an Aboriginal group in the district (Manning 1990:259).

characteristic meander floodplain at Calperum, which extends east as the Chowilla floodplain into New South Wales.

Whilst a geomorphic study is not available for this immediate region a preliminary assessment of landforms can be attempted, based on the information contained in Table 3.1 which has been compiled for the closely related geomorphic context at Ned's Corner in north-western Victoria (Prendergast et al 2009). Morphological similarities, foliage, sediment profile and dominant formation processes indicate that the Reny and Hunchee Island landforms (Figure 3.3) potentially conform to the Mulcra Land System identified at Ned's Corner. The northern banks of the Ral Ral and Hunchee Creeks potentially signal a change of landform to the Lindsay Land System and a slight rise in elevation. This is speculative until a specialist study has been completed but serves to provide a preliminary geomorphic context for this study. The late Pleistocene (post 15,000 years ago) chronology assigned to the Mulcra land system by Prendergast et al. (2009) is of no practical use in respect of the archaeology contained on its surface beyond noting a potential maximum age. The active riverine environment, prior to the building of locks and weirs, would have had significant influence on the age profile of the archaeology present on the floodplain. This is demonstrated by the available radiocarbon ages for active riverine sites in the Murray Darling Basin, detailed in Appendix 1, which indicates that 78 percent of available ages associated with earth mounds in the region are less than 2,000 BP.

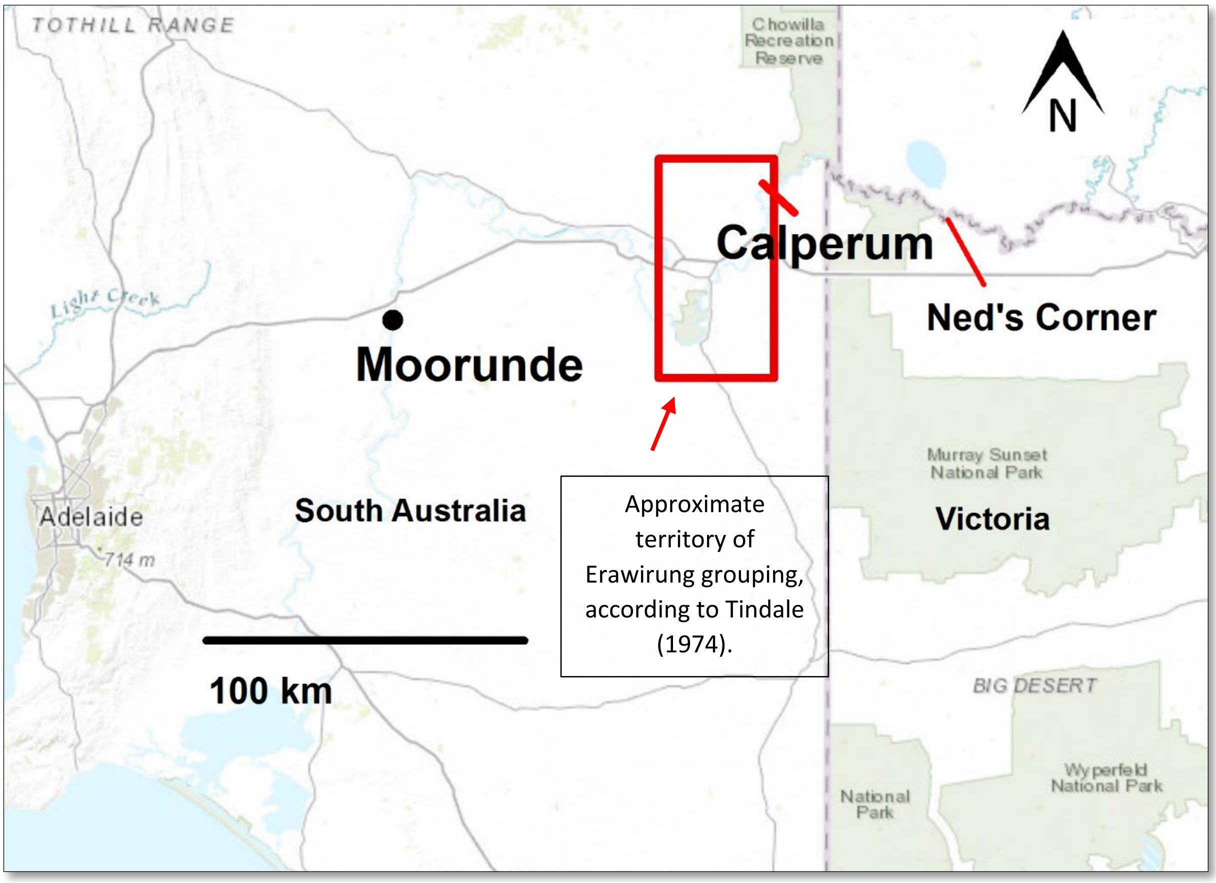

Figure 3.1: Map of the River Murray in South Australia and north-western Victoria indicating the proximal territorial boundaries of the Erawirung tribal group and locations of the Calperum floodplain and Ned's Corner. Erawirung territorial extent derived from Tindale (1974).

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Figure 3.2: Plan and cross section of land systems at Ned's Corner north-eastern Victoria (from Prendergast et al. 2009).

Table 3.1: Land systems of the River Murray Floodplain in northwest Victoria (from Prendergast et al. 2009).

Land System	Land Units	Dominant Process	Surface Expression	Sediments	Soils / Degree of Pedogenesis	Dominant Vegetation	Archaeology	Age
Murray Land System	Floodplains, billabongs and river channels	Fluvial	Mildly undulating surface with some flooding channels	Compacted light grey medium clay	Very little soil development	River Red Gum	Surface scatters of artefacts	Holocene (~10 ka to present)
Mulcra Land System	Floodplain and paleo-meander scrolls	Fluvial	Mildly undulating channel floodplain sequences	Medium grey gilgai clay	Mild pedal development	Black Box with some grasses and Lignum	Midden deposits on floodplain surface	Late Pleistocene (post 15 ka)
	Billabongs	Fluvial	Arcuate depression sometimes filled with water	Fine medium grey overbank clays	Mild pedal development	Black Box and Red Gum	Not observed	Late Pleistocene (Post 15 ka)
Lindsay Land System	Floodplain and paleo-meander scrolls	Fluvial	Mildly undulating channel floodplain sequences	Dark grey gilgai clay and sandy bedload	Mild pedal development	Lignum with some Black Box	Not observed	LGM (Pre 15 ka)
	LLS source-bordering dunes	Aeolian	Red sandy rises	Fine to medium, well-sorted red sand	Carbonate pedogenesis below 30 cm	Various chenopod species	Middens, stone artefacts, burials and hearths	LGM (Pre 15 ka)
Neds Corner Land System	Floodplain and paleo-channels	Fluvial	Predominately flat surface	Fine red silty sand	Secondary carbonate duplex soils	Chenopod shrub land	Hearth stone and stone artefacts on surface	>40 ka
	NCLS Source-bordering dunes	Aeolian	Irregularly shaped sandy rises	Fine, well sorted red brown sand	Clay cutan development. Carbonate at depth	Blue bush, old man saltbush	Middens, burials, hearth stones and stone artefacts on surface	>40 ka
	Lunette lakes	Aeolian/ lacustrine	Ovoid depressions, 4-5 m blow surrounding plains flanked by arcuate dunes on eastern margins	Pelletal clay, gypseous grey-brown sandy clay	Some carbonate and gypsum, weak pedal development	Blue Bush, Dillon Bush, native grasses	Grinding stones, hearth stones, burials and stone artefacts on surface	LGM? (~20 ka?)
Woorinen Land System	Linear dunes and swales	Aeolian	Regular rises with rounded crests	Fine red brown sand	Paleosols and carbonate development	Mallee eucalypts	Not observed	Active throughout last and previous glacial cycles

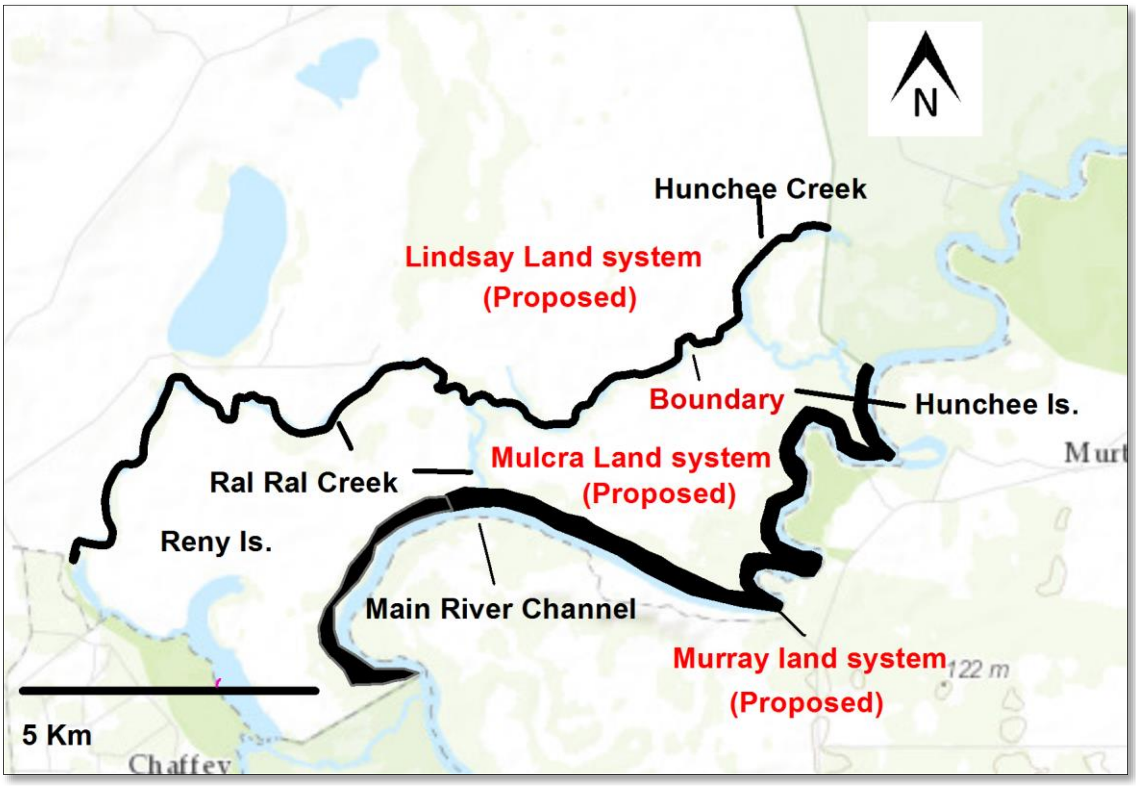

Figure 3.3: Map of the Calperum floodplain and survey area showing the location of projected land systems for Reny and Hunchee Islands.

Previous Archaeological Research

As Previously noted, archaeological surveys and research within the section of the of the Murray River valley between the townships of Renmark and Mildura have identified a late Quaternary sequence of burials, artefact scatters, quarries, earth mounds, middens and scarred trees with major scope for further studies (Caldwell 2014; Garvey 2013:120; Westell and Wood 2014). Garvey (2013) has initiated a research project with emphasis on determining the chronology of occupation of the Murray Valley immediately adjacent to the south of the Darling River and Willandra Lakes regions at Ned's Corner in north-western Victoria. She indicates an emphasis on shell midden archaeology and the use of freshwater shellfish as a food resource by late Pleistocene/early Holocene populations, to provide a comparison with earlier work along the Darling River and Willandra lakes (Garvey 2013:120–121; Murray Darling Basin Authority 2014).

Caldwell (2014) completed an unpublished preliminary synthesis of recorded Indigenous archaeology within the Calperum Nature Reserve by an analysis of the archival material held by the South Australian Government's Aboriginal Affairs and Reconciliation Division, obtained with permission of RMMAC for the broader project. This identified thirteen sites including burials, open sites, quarries and scarred trees generally associated with water sources. Of these, nine were associated with the Calperum Floodplain and four from inland locations away from the river (See Table 3.2). The inland sites included a stone quarry, scarred tree, burials and a campsite. Opportunities for additional research were identified, particularly in the southern portion of the reserve contained within the Murray River floodplain (Caldwell 2014:17). There are no archaeological surveys of the study area that are publicly available at this time, however a general archaeological survey of a portion of the Calperum floodplain was completed during the 2015 Flinders University Field School. In addition, several Flinders University student research projects, concurrent and separate to this study, have been initiated. These involve lithic studies and geophysics techniques, but results are not yet fully available.

Table 3.2: Calperum Indigenous sites from the South Australian Aboriginal Affairs and Reconciliation Division (AARD) in the Department of Premier and Cabinet, derived from Caldwell (2014).

No.	Location	Type	Date recorded	Description
1	Floodplain	Campsite	12 July 2011	Artefacts, hearth and faunal material
2	Floodplain	Campsite	18 January 2012	Hearth, shell midden, grind stone and stone flakes
3	Floodplain	Burial	6 March 1970	Double burial
4	Floodplain	Scarred Tree	6 March 1970	Canoe tree
5	Floodplain	Burial	13 May 1969	Burial ground
6	Floodplain	Scarred Tree	13 may 1969	Canoe tree
7	Floodplain	Burial	13 may 1969	Extensive burial ground
8	Floodplain	Campsite	13 May 1969	Extensive camping ground
9	Floodplain	Scarred Tree	13 May 1969	Live Red River Gum
10	Inland	Quarry	28 Feb 1973	Stone quarry for tools west of Stony pitch dam
11	Inland	Burial	31 July 2011	Location not identified
12	Inland	Scarred tree	12 July 2011	Location not identified
13	Inland	Campsite	1 May 1997	Tilmy dam evaporation basin

Classical Societies

Tindale (1974:211) identified the Calperum floodplain to be part of the territory of the Erawirung tribal group, extending approximately 20 kilometres north of the main river channel at Calperum, south and west with an eastern boundary along the eastern bank of the River Murray from Paringa to Loxton then a further 40 kilometres south of the river (Figure 3.1).[8] This group controlled the resources contained within their territory, including sources of tool grade stone (Tindale 1974:211; Woolmer 1974:21). Here, key insights into the economy, demography and settlement patterns of pre-contact groups are generated by a review of ethnographic information and early colonial accounts.

[8] The geographic outline for the territory of the Erawirung group is indicative only as it is understood that other ethno-historical boundaries exist in addition to those provided by Tindale (1974). A full synthesis would require a detailed analysis of ethno-historical and anthropological accounts such as Berndt and Berndt 1993; Curr 1886; Eyre 1845; Horton 1994; Howitt 1904; Taplin 1878 and Tindale 1940 and is beyond the scope of this study.

There is a considerable body of ethnographic research available for the Murrayland and other regions of South Australia. For instance, Berndt and Berndt (1974, 1993) provide a detailed account of the social, economic and cultural aspects of Indigenous societies based on personal accounts, which provide valuable insights into past practices. These include socio-economic issues such as the division of labour within groups, the management of resources (Berndt and Berndt 1974:42–43, 1993:77) and the use of technologies such as canoes, nets, traps and earth ovens (Berndt and Berndt 1974:41, 1993:87–95, 104, 572; see Beveridge 1889:32–34 for an eye-witness account of the construction and use of earth ovens by Indigenous Australian people; see Black and Thoms 2014 for a North American perspective). However, apart from details on earth oven cookery, this work is silent about the earth mound features which may result from hunter-gatherer subsistence activity as outlined in Chapter Two.

In the southeast of the continent there is a distinct lack of current ethnographic information, in contrast to the north (for instance, see Meehan 1982, 1988); however, significant detail can be derived from the accounts by early explorers, settlers and naturalists. Early contacts with Indigenous peoples in the Murray Darling Basin were described by several prominent colonists, including Sturt (1833), Mitchell (1839), Eyre (1845), Beveridge (1865, 1883, 1889), Bonney (1884), Gregory (1884) and Taplin (1878). However, Balme and Beck (1996:43–45) question the uncritical use of ethno-historical sources by some researchers when investigating earth mound formation and use, since many of the original accounts were based on third party information rather than direct observation. In many instances, early records reflect personal interpretations of mound contents and have no more validity than observations in the present (Balme and Beck

1996:45). These concerns are valid and require the use of appropriate caution when considering this type of information.

Economic resources

The earliest observations indicate that earth mounds were a frequent artefact created by pre-contact Indigenous populations in freshwater riverine and lacustrine environments of the Murray Darling Basin and the wetland systems of the western districts of Victoria; and were used for several purposes (Kenyon 1912:98). This included seasonal occupation during times of inundation and the processing of wetland plants and other food items using earth oven technology.

References were made regarding earth mounds, and the construction of earth ovens for cooking meat and plant material for both food and fibre. Beveridge (1889:32–34) provides a detailed account of the construction and use of earth ovens along the River Murray in the Swan Hill region of north-western Victoria. Mitchell (1839 2:53, 60, 80–81, 134) notes the significance of bulrush-root (*Typha* spp.) as a source of a staple food to the local peoples along the Lachlan and Murrumbidgee, describing the use of earth ovens for their preparation. Kenyon (1912:102) argued that the mounds of the western districts of Victoria were occupation sites and that the mounds of the Murray valley were specifically derived from the use of earth ovens for cooking. Beveridge (1889:34–35) observed the use of mounds as occupation sites, by Indigenous people, during flood periods in the Swan Hill district. In contrast, information, provided to Dawson (1881:103) by Indigenous people of the western districts of Victoria, indicated that mounds were never used for ovens in that region, suggesting specific and different responses to local geomorphic, environmental and climatic conditions.

Floodplain environments of the Murray River in South Australia provided a rich resource for Indigenous populations prior to contact with Europeans (Angus 1847 [1969]; Eyre 1845). These resources included animal, bird, reptile, fish, shell-fish, crustaceans and plant resources often accessed on a seasonal basis using technologies derived from local and externally traded materials (Angas 1847 [1969]:90–94; Eyre 1845 2:251–255, 259–291). Fibre derived from the roots of *Typha* spp*.* as a by-product of cooking and consumption, were particularly important resources for the manufacture of nets for catching fish, birds and animals (Angus 1847 [1969]:90; Eyre 1845 2:286–288). Earth ovens and the mounds, which resulted from their construction and continued use, were integral and essential to this subsistence activity as well as the roasting and steam cooking of animal and plant foods (Angas 1847 [1969]:99–101).

Eyre's (1845 2:291) description of the communal use of a single earth oven between three or four families, is of interest in the context of settlement and land use patterns. Eyre (1845 2:291) observed that women were the gatherers and preparers of vegetable foods within the group. This suggests that the harvesting of tubers, the operation of earth ovens, and the mounds and ashy features, which arise from this use, constituted a social focus for the women of the group, particularly since they managed and operated this system on a communal basis (Eyre 1845 2:291). In contrast, the business of cooking larger animals was the responsibility of the men (Eyre 1845 2:291). This is discussed later in relation to dietary differences between men and women.

The Calperum floodplain constitutes a classic riverine environment, as described by Eyre (1845 2:244–295) as typically rich in the economic resources underpinning Indigenous societies along the Murray River. Such environments supported semi-sedentary populations and occasional aggregations for up to 600 individuals for socio-cultural interaction (Eyre 1845 2:252, 372). Eyre (1845 2:253) emphasises the seasonal nature of subsistence activities linked to the flow patterns of the river, and indicates that an adequate diet was maintained throughout the year but which was characterised by seasonal availability and various social strictures as to who could consume what and when (Eyre 1845 2:250, 293–295).

The observations of Eyre (1845 2: 293–295) indicates a semi-sedentary riverine based population with a complex social and cultural framework anchored by seasonal, and flexible, resource procurement strategies. In addition, mobility for hunting and family groups beyond the floodplain and its water resources were possible in sandy country with an underlying layer of clay following heavy rain (Gill 1973:89). The latter provided seasonal pools of water accessible in the sand even after disappearing from the surface, providing a water supply for 'pool-campers' and allowing access to additional resources within the territorial limits of the tribal group, away from the wetlands associated with the main river channel (Gill 1973:89). Local groups were not necessarily restricted to the river and its floodplain but had territorial access to a portion of the hinterland for both subsistence and technology assets such as quality stone for tool making (Tindale 1974:211; Woolmer 1974:21). Whilst noting the indicative nature of Tindale's (1974) tribal boundaries and the absence of a dated context for the archaeology of the Calperum area, I suggest that mobility and space provided at least some seasonal flexibility in resource procurement, in the recent past at least, and constituted insurance against nutritional and social stress in a highly variable seasonal environment, subject to a cyclical flooding regime. Whist limited, the existing archaeology (Table 3.2) lends some support to this land use and settlement model indicating activity both within the floodplain and the nearby hinterland, but predominantly in the former.

Demography

Pre-contact population patterns of Indigenous groups within the Murray Darling Basin and specifically the Calperum floodplain, are difficult to assess, because of limited records as well as the impact of disease on population levels immediately prior to contact with Europeans (Butlin 1983; Pardoe 1990:59). For instance, Bonney (1884:123–124) describes the impact of an epidemic on the Bungyarlee and Parungi tribes in the Lower Darling River, indicating a contemporary instance of the loss of one third of a regional Indigenous population in one event. However, it is useful to attempt such an analysis from early first-hand accounts, to provide some insight into the economic capacity of the floodplain, consequent resource utilisation, and the socio-economic context which was supported. This has relevance to the archaeology of the region and to the number and distribution of Indigenous earth mounds in the context of this study.

Sturt observed Indigenous groups which provide some basis for an assessment of population densities in riverine environments. Shortly after leaving the Murrumbidgee and entering the Murray on the 17th of January 1830, he encountered a group of 83 individuals including men, women and children, again on the 19th another group of 150, and again on the 23rd, a group of 600 at the confluence of the Murray and Darling Rivers (Sturt 1833 2:91–107). On the 24th Sturt (1833 2:120–126) encountered a group of 80 individuals, leading him to observe that the population appeared to increase as they travelled west, communicating with groups of 200 to 250 daily. Prior to the river taking a southward direction, Sturt (1833 2:135) described encountering a tribe which was '…one of the most numerous on the banks of the Murray'. The first contact was with a group of 270 people but which also was associated with '…detached families for many miles below the place where we had parted from the main body' (Sturt 1833 2:135). From Sturt's description, the location of this last encounter appears to be in the vicinity of the Calperum floodplain where the river takes a distinct southward direction (see Figure 3.3).

The settlement pattern described by Sturt (1833) appears to indicate that he encountered both a large aggregation and smaller family groups along the river which derived from the one social entity. This indicates some fluidity in spatial arrangement or at least the ability to come together at relatively short notice, suggesting a localised geographic context and a potentially high population density.

Settlement patterns

The settlement patterns and resource utilisation of the pre-contact population of the Calperum floodplain would be expected to reflect the annual hydrological cycle of the Murray River as indicated by Wood et al. (2005) in their assessment of the archaeological record associated with the adjacent Chowilla Anabranch system. Wood and Westell (2010:4), in a report on the Katfish Reach Project Area in the Katarapko – Eckert Creek anabranch system, expressed this as:

- A yearly contraction of people to higher ground during flood periods, including the floodplain margins and elevated land within the floodplain;
- A settlement focussed on areas immediate to the river or around more permanent water bodies during late summer to winter; and
- Intense periods of settlement around targeted seasonal resource areas, such as seasonal wetlands.

Wood and Westell (2010:7) found that archaeological sites within the region occur close to water sources (channels, creeks and billabongs) with a rapid decline with distance from these features. An association was also found between site location and a flood inundation model based on a river flow of 100 Gigalitres (Wood and Westell 2010:7), indicating the influence of flooding at this level of flow. In this context, Wood et al. (2005:68) found a concentration of sites at the margins of landforms representing the extent of various flooding scenarios. Larger trees were also associated with these locations indicating a resource focus for occupation (Wood and Westell 2010:7). Interestingly, in this context, the relic meander plain demonstrated the highest number of sites, though higher site densities occurred around sandy highland rises bounding floodplain margins, as well as dunes, levees and lunettes within the floodplain (Wood et al. 2005:66).

Summary

This overview of the Calperum study area prior to contact with Europeans describes a region of high, but seasonal, resource productivity with a potentially high population density capable of large seasonal aggregations of 500–600 individuals. The geomorphology indicates an evolving and very active riverine environment as the key driver of this pattern of productivity and consequently a major influence on the lives of the individuals who lived within it. This is supported by a review of ethno-historical accounts and the ethnographic research conducted in similar environments within the Murray Darling Basin. Earth mounds associated with subsistence activities are a major expression of the Indigenous presence and occupation of riverine environments within the wider region. A survey and an analysis of their morphology, function, locations and relationships to each other and key resource zones within the Calperum floodplain constitutes an opportunity to address the lack of knowledge about pre-contact Indigenous societies in this area as well as to contribute to wider debates about Indigenous settlement practices, socio-cultural and economic strategies during the late Holocene.

4 Methods

Chapter Four serves to outline the methods adopted for this study within the context of the wider project. The initial activity conducted was a general survey of a north-south portion of floodplain adjacent to the Murray River, in October 2015 as part of a Flinders University field school for post-graduate students. A detailed survey of areas associated with water sources was undertaken, by the author, to locate and record samples of Indigenous earth mound features for this analysis. Further field surveys were also conducted in April and September 2016 to add to this work.

Flinders University Ethics Approval

The study is part of a Flinders University archaeological investigation into past and contemporary Indigenous connections to country which has the active support and participation of the River Murray and Mallee Aboriginal Corporation (RMMAC) which represents the Indigenous groups of the South Australian Riverland.

Flinders University research projects that may impact Indigenous communities requires approval from the Flinders University Social and Behavioural Research Ethics Committee (SBREC). This approval was granted on 3rd September 2014, as project number 6,618. RMMAC cultural advisors were present during all field activities to ensure all work was culturally appropriate and that protocols (as agreed prior to field work) were followed. In accordance with the wishes of RMMAC, and due to the provisions of the *Aboriginal Heritage Act (1988)*, all field research conducted as part of this project was non-invasive. In addition, no archaeological site co-ordinates were to be disclosed in any resulting publication, including this thesis.

Survey methods

General survey

Field work included pedestrian survey, preliminary site recording, photography, and the use of field journals for the documentation of data (see Burke and Smith 2004). The general surveys conducted by field school students and staff, during field schools in September 2015 and 2016, included north-south pedestrian transects of the easternmost portion of Reny Island, the western margin of Lake Woolpoolool[9] and the northern extremities of Lake Merreti[10] and Clover Lake. Archaeological data derived from these transects were recorded on electronic tablets and uploaded to a database for further analysis. During these surveys, any features which were identified as possible earth mounds were noted for further analysis as part of this study.

Earth mound survey

The method adopted for field sampling, was influenced by the limited time available and the nature of the sites targeted. The literature concerning earth mound locations in the Murray Darling Basin and closely related areas, indicates their close relationship with water sources and wetlands, particularly their distribution in floodplain environments (Coutts et al. 1976; Coutts et al. 1979; Downey and Frankel 1992; Elliott 1980; Frankel 1991; Klaver 1998; Lane 1980; Littleton et al. 2013; Martin 2006; Westell and Wood 2014; Williams 1988). In view of this distribution, probability survey methodology was deemed inappropriate. Locations

[9] A word derived from the local Indigenous language said to mean 'a place of milk like mud' (Manning 1990:345)

[10] A word derived from the local Indigenous language said to mean 'a pool of water' (Manning 1990:202)

likely to contain mounds were identified from previous research and pedestrian surveys by field school students and the author, conducted over three short field sessions totalling fourteen days. These local environments included:

- A section of riverbank of the main stream of the River Murray;
- The area surrounding two ephemeral billabongs situated in the Reny and Hunchee Island sections of the floodplain;
- The east and west banks of a section of the Ral Ral Creek;
- Sections of the northern and southern banks of the Hunchee Creek;
- A section of the eastern margin of Lake Merreti;
- Sections of the eastern and western margins of Clover Lake; and
- The western margin of lake Woolpoolool.

The surveyed features were designated per location (Table 4.1), and numbered sequentially.

Table 4.1: Mound location designations.

Mound Designation	Location
MRC	Main river channel
RIBB	Reny Island Billabong
RRCW	Ral Ral Creek west
RRCE/ HCS	Ral Ral Creek east /Hunchee Creek south
HIBB	Hunchee Island Billabong
HCN	Hunchee Creek north
MLE	Lake Merreti east

The intention was to find and record a representative sample of earth mounds to allow an examination of location and typology. Statistical sampling was not utilised for this exercise due to the specific nature of this site type and its non-random distribution relating to a close association with water features. The general survey of the area subsequently justified this, since no aggregated earth features were discovered in localities not close to water sources.

Recording

After the survey process, the co-ordinates, as well as dimensional, morphological and surface data were compiled and tabulated (see Appendix 3 for a sample recording sheet).

The following characteristics of earth mound features were recorded following their discovery:

1. Co-ordinates for the centre of each site recorded using a Garmin 62 GPS device;
2. Physical dimensions, including width, length, and height above the surrounding surface, were estimated by sight and tape measure;
3. Surface composition including a sample count of heat effected clay nodules (derived from clay heat retainers) and shell fragments, if accessible and not obscured by foliage and excessive ground litter (see below);
4. The presence of ashy deposit;
5. The presence of artefacts, shell and animal remains;
6. The presence of diagnostic plant species;
7. Evidence of burials;
8. Distance to water; and
9. Distance between individual features.

River pool levels at Lock 6 and Lock 5, upstream and downstream of the Calperum floodplain were noted during the periods that the measurement of distances between mounds and the closest water were made to provide a relative framework for comparison.

In September 2016, a Real Time Kinetic (RTK) device (Leica Icon GPS60) was used to record several mound elevation profiles. The exercise was restricted to several mounds from Hunchee Creek North and one from the east side of Lake Merreti because of flooding within the anabranch floodplain at the time. Measurements provided surface profiles against the Australian Height Datum (1994) and were used to evaluate previous height estimations. Elevation readings were taken at 0.5 m intervals across the centre of each mound except for HCN24 where two profiles were taken at right angles. Data was saved as a text file and exported to Microsoft Excel for analysis and generation of profile graphs.

Earth mound surface recording of burnt clay and shell fragments

The surface distribution and size range of burnt clay nodules and mussel shell fragments was hypothesised to be of use in the assessment of mound attributes and consequent identification of the earth feature types present on the Calperum floodplain. The individual earth mounds which were recorded demonstrated some variation in surface condition, soil type, vegetation and access. A non-random sampling strategy was adopted due to access issues associated with vegetation and tree debris, and surface disturbance by rabbits. Where possible a larger sample was taken across the mound to assess size distribution for both clay nodules and shell fragments and improve the assessment of density per square metre. The assessment of the distribution and number of burnt clay nodules and shell fragments present on the surface of those mounds which were sufficiently clear of foliage and tree debris, was conducted using a one metre square counting frame divided into 20 centimetre-wide, grids to assist counting. The mounds were selected for accessibility and represented a cross section of the typologies found during the survey. The frame was placed sequentially either side of a centre line at three or four locations, depending on the diameter of the feature and surface cover.

A simple specimen count of mussel shell fragments was conducted in three size categories, less than 1 centimetre, 1–2 centimetre and greater than 2 centimetres if present. Counts of individual shells (MNI) was not possible due to the high degree of fragmentation that was encountered, and lack of preservation of diagnostic features (i.e. hinge).

Burnt clay nodules were counted in 3 size categories, these were 1–2 centimetres, 2–5 centimetres and greater than 5 centimetres in size. Counting was conducted manually from a vertical perspective over the frame. Each count was duplicated and averaged to minimise error. The data was recorded on recording sheets for analysis (see Appendices 3-9 for recorded data). Artefacts and faunal remains were noted but not further classified or counted as part of this study, although a separate study contemporaneously examined lithic material associated with the mounds recorded and listed here (Threadgold in prep).

Spatial analysis

An analysis was conducted of feature locations, their spatial relationship to each other, the River Murray and local water sources. This type of analysis is potentially useful in identifying patterns within the landscape which relate to land use and settlement strategies and potentially will allow interpretation of past behaviour (Klaver 1998:120). Since this study is concerned with behaviours at the local level, site positioning relative to one another and resources within the local environment are of interest in respect of social patterns and the use of space within the landscape. The distance between features was calculated using GPS co-ordinates and simple trigonometry. The distance between individual features and the nearest water source was measured using a tape measure, this was rounded to the nearest metre due to access and safety issues.

A simple elevation map was developed to provide a context for the annual flood cycle for the Calperum meander floodplain. This was created using ArcGIS for the provision of elevation data outlining points of height change within the landscape and potential areas of inundation in the study area. The Prendergast et al. (2009) landform system was provisionally applied to the study area through the consideration of elevation data, landscape typology and vegetation type.

Calperum settlement patterns and demography

An examination of ethno-historic and previous research was conducted to develop a preliminary environmental, demographic and seasonal resource model for Indigenous settlement patterns within the Calperum floodplain. This was then evaluated in conjunction with the data derived by field survey. The model outlined in Chapter Three predicts a seasonal settlement pattern in accordance with environmental resource zones and flooding cycles. Where settlement patterns are not in accordance with this model other potential explanations, such as social and cultural factors, may apply. Of course, this approach assumes that a survey of such sites will provide sufficient insight into resource utilisation, site selection and site function on the Calperum floodplain.

Regional comparison

This study places emphasis on reviewing and comparing dimensions, morphology, placement and potential functionality. Consequently, strict site definitions (Table 2.1) were utilised as a basis for comparison and interpretation between regions to contextualise the earth features of the Calperum floodplain with the range of diversity exhibited by this range of landform features within the wider region (Klaver 1998:130–132). Following compilation of the Calperum data, a comparison was made with data derived from research literature describing other major earth mound precincts of the Murray Darling Basin, and closely associated regions.

Research limitations

The research conducted for this study was subject to number of limitations. Soil and charcoal samples were unable to be taken due to the extended timeframe required for an excavation permit under the South Australian *Aboriginal Heritage Act (1988)*. This was in excess of the timeframe for submission of this thesis. Further, RMMAC requested only non-invasive methodology to be used during the field work conducted for this study. Limited access to the study area and consequently the amount of time available for survey, necessitated the use of basic measurement methods and the adoption of targeted sampling rather than the compilation of a detailed record of the entire floodplain. Also, the quantification of shell fragments and/or burnt clay nodules on earth features was precluded, in some instances, by vegetation cover, surface disturbance by rabbits or a cover of alluvium. Vegetation removal was not an option as the study area is in a nature reserve.

Summary

The methods and processes outlined above were adopted to address the aims expressed in Chapter One. In the first instance, a field survey was conducted to obtain data about earth features within the Calperum floodplain and to make a comparison with similar features in other regions of the Murray Darling Basin. This was then used to gain an understanding of the typologies present, their distribution within the floodplain, and an insight into the use and management of the landscape by the local Aboriginal population.

5 Results

Introduction

This chapter presents results of the research conducted as part of this study. It first outlines a brief overview of the general archaeological context of the study area, followed by the results of the earth mound field surveys, including dimensional, morphological, surface, and spatial data. This comprises data for 32 features which were identified and recorded for the study. Individual features were identified based on the criteria outlined in Table 2.1, as derived from Klaver (1998).

Calperum archaeological context

The field surveys conducted during September 2015, April 2016 and September 2016 encompassed 9.9 square kilometres or 11.5 percent of the floodplain between the Renmark-Wentworth road and the Murray River (Figure 5.1). This work identified a considerable quantity of archaeological material, including earth mounds as well as shell middens, isolated hearths of varying size, burials, scarred trees, lithic scatters, and isolated lithic material including flakes, small cores, grindstones, mullers and occasional larger pieces of heat-effected silcrete. Mussel shell was frequently, but not uniformly, found on the surface of earth mounds. Where possible the sub-surface presence of shell was determined through visual examination of rabbit burrows and surface erosion.

In the northern portion of the floodplain, north of the Ral Ral/Hunchee anabranch system, archaeological sites were associated with the margins of Woolpoolool, Merreti and Clover Lakes and associated elevated sandy areas. On Reny and Hunchee Islands, south of the anabranch, sites were concentrated in elevated sandy areas, around the margins of the creeks and billabongs and along the main river channel.

An isolated mound was recorded on the north-east margin of Lake Merreti. An extensive survey of the vicinity did not detect further examples.

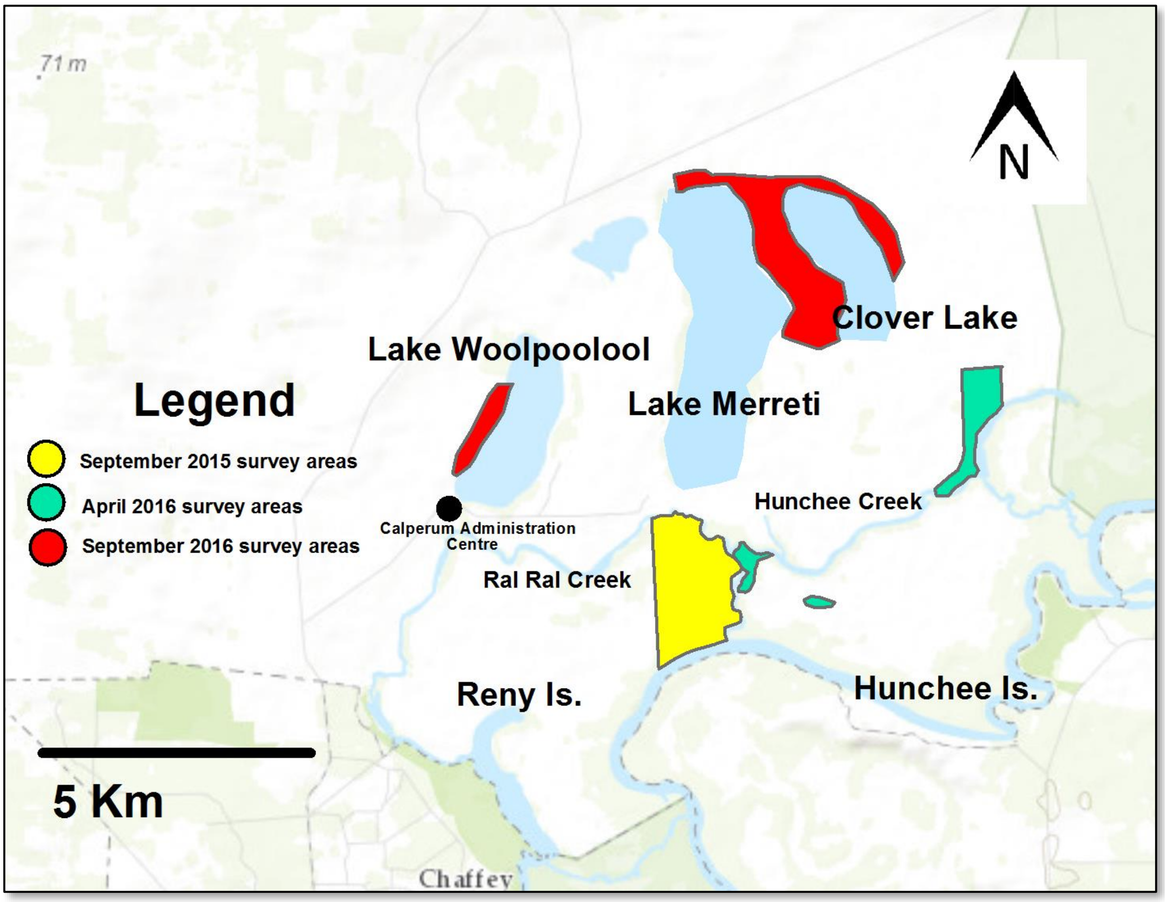

Figure 5.1: Survey coverage.

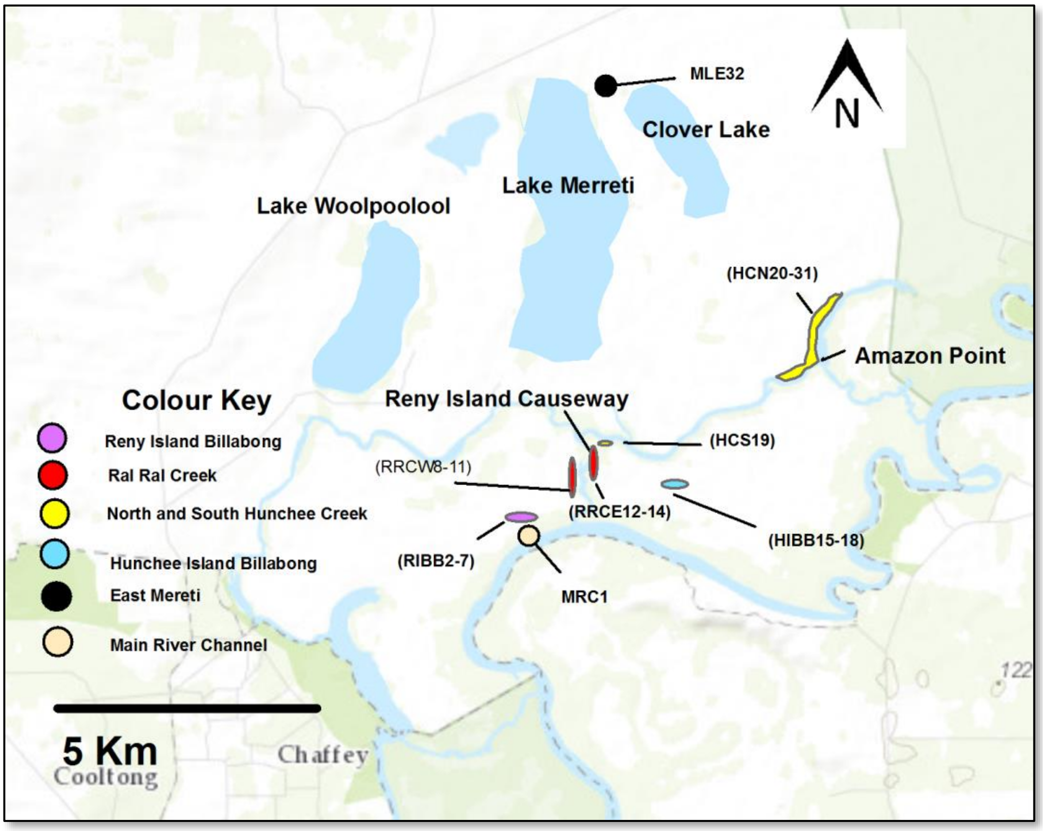

Figure 5.2: Locations within the survey area containing earth mounds and associated features.

Calperum earth mound precincts

The survey data for all earth mounds surveyed on the Calperum floodplain is contained in Appendices 3–10. This includes copies of the recording sheets outlining burnt clay nodule and shell fragment frequencies for those features which were sufficiently clear of debris for sampling, as well as location co-ordinates, sketch maps and descriptions of individual features. Appendix 12 contains a selection of photographs of Calperum earth mounds, and miscellaneous archaeological material representative of the locations outlined below.

Main river channel: MRC1

Landscape setting

A single earth mound feature (MRC1) was recorded (Table 5.1) along the section of main river bank which was contained within the general survey outlined in Figure 5.2. It was located on the bank of the river, one metre from the edge of the water and was adjacent to a drainage channel which entered the river upstream from the feature.

Local archaeological context

The mound was located upstream of a shell midden which extended two hundred metres along the river bank to the south-west. Stone flakes, charcoal and bone fragments were present on, and near the mound and the associated midden.

Earth mound morphology and data

Surface material included high amounts of shell fragments and burnt clay nodules (Table 5.2). A ring of burnt nodules of clay were imbedded in sediments near the centre of the mound. The edge had been partly eroded by the river, exposing a partial section of the deposit. This did not exhibit any ashy soil in the strata exposed. From the morphology demonstrated, the feature was classified as a utilised natural mound, potentially resulting from the remains of a tree which had been burnt in the past and which was indicated by the central ring of burnt clay. The surface presence of stone artefacts, charcoal and mussel shell fragments indicates its use in the past by Aboriginal people, however, it was not included in the oven mound database for further analysis.

Table 5.1: Summary table of the main river channel mound.

No.	Length (m)	Width (m)	Height/Depth (m)	Distance of closest edge to water (m)	Feature type
MRC1	17	16	0.300	1	Utilised natural mound

Table 5.2: Burnt clay nodule and shell fragment count for MRC1.

Location	Feature	Mound area	Sample area (m^2)	Sample size (%)	Burnt clay nodules count			Burnt clay nodules per m^2			Shell fragments count			Shell fragments per m^2		
					1-2 cm	2-5 cm	>5 cm	1-2 cm	2-5 cm	>5 cm	<1 cm	1-2 cm	2-5 cm	<1 cm	1-2 cm	2-5 cm
MRC	MRC1	854.5	6	0.7%	1301	97	19	217	16	3	636	22	0	106	4	0

Reny Island Billabong precinct: RBB2-RIBB7

Landscape setting

This area contained six earth mounds, circular to elliptical in shape, grouped around the Reny Island Billabong (Table 5.3, Figure 5.2). The billabong is located within the Reny Island floodplain which is characterised by a pattern of paleo-meander scrolls and is subject to periodic flooding. This occurred naturally in September 2016 because of high river levels. Local vegetation was predominantly Black Box, lignum, grasses and two dominant salt tolerant ground covers (*Disphyma crassifolium* and *Mesembryanthemum* spp.).

Local archaeological context

Small numbers of lithic fragments, including small flakes and cores and small pieces of irregular heat shattered silcrete, were observed either on the surface of RIBB3-RIBB6 and/or in the immediate vicinity. RIBB7 displayed no lithic material on its surface but three fragments, including a small core, were noted within 50 metres. RIBB5 was associated with a small shell midden located 20 metres to the south.

Earth mound morphology and data

RIBB2 contained burnt clay nodules but no ashy soil, shell, or lithic artefacts. RIBB 3-6 contained ashy humic soil, burnt clay nodules but no observable shell fragments on the surface (Table 5.4). A growth of a *Mesembryanthemum* spp. (ice plant) with white flowers was present on each of these features (Figure 5.3). This contrasted with the surrounding floodplain, which had a dominant growth of pink flowering *Disphyma crassifolium,* commonly named pigface (Figure 5.4). RIBB7 was located on the northern levy bank of the billabong and was covered by alluvium with no *Mesembryanthemum* or *Disphyma* present, no ashy soil was observed on the surface or from the eroding edge of the levy. Burnt clay nodules were thinly distributed across the mound (Table 5.4), a single proximal section of a tibia from a small mammal was noted but no shell fragments were observed on the surface.

From the characteristics outlined above, RIBB2 was identified as a large above ground hearth/proto-oven. RIBB3, RRIB4, RIBB5 and RIBB6 were identified as oven mounds, and RIBB7 as a utilised natural mound.

The interval distance between features is listed in Table 5.5 with an average separation of 134 metres. Figure 5.3 presents this data graphically. Apart from RIBB2, each of these features were located within 3 metres of the water's edge.

Table 5.3: Summary table for Reny Island Billabong.

No.	Length (m)	Width (m)	Height/Depth (m)	Distance to water (m)	Feature Type
RIBB2	17	5	0.150	6	Above ground hearth/oven
RIBB3	20	20	0.200	2	Oven mound
RIBB4	11	11	0.200	2	Oven mound
RIBB5	9	9	0.150	3	Oven mound
RIBB6	10	7	0.200	3	Oven mound
RIBB7	23	23	0.200	2	Natural mound/edge of levy

Figure 5.3: Species of *Mesembryanthemum* spp. (ice plant) growing on humic soils often associated with mounds on the Calperum floodplain (CSIRO 2004). Photograph: R. Jones September 2015.

Figure 5.4: *Disphyma crassifolium* (pigface) growing on non-humic floodplain soils. (Moore 2005:387). Photograph: R. Jones September 2015.

Table 5.4: Burnt clay nodule and shell fragment count for Reny Island Billabong mounds.

Location	Feature	Mound area	Sample area (m^2)	Sample size (%)	Burnt clay nodules count			Burnt clay nodules per m^2			Shell fragments count			Shell fragments per m^2		
					1-2 cm	2-5 cm	>5 cm	**1-2 cm**	**2-5 cm**	**>5 cm**	<1 cm	1-2 cm	2-5 cm	**<1 cm**	**1-2 cm**	**2-5 cm**
Reny Island Billabong	RIBB2	267.0	10	3.7%	744	47	4	74	5	0	0	0	0	0	0	0
	RIBB3	314.2	10	3.2%	1622	49	10	162	5	1	0	0	0	0	0	0
	RIBB4	95.0	6	6.3%	498	2	2	83	0	0	0	0	0	0	0	0
	RIBB5	63.6	6	9.4%	78	0	0	13	0	0	0	0	0	0	0	0
	RIBB6	219.9	4	1.8%	275	25	0	69	6	0	0	0	0	0	0	0
	RIBB7	415.5	14	3.4%	123	4	6	9	0	0	0	0	0	0	0	0

Table 5.5: Distance between oven/oven mound sites surrounding the Reny Island Billabong.

Feature	Distance to nearest Site/mound (m)	Site Type
RIBB2	-	Isol. Oven Feature
RIBB3	64	Oven Mound
RIBB4	322	Oven Mound
RIBB5	53	Oven Mound
RIBB6	168	Oven Mound
Total distance	**607**	
Average distance	**152**	

Ral Ral Creek west precinct: RRCW8 – RRCW11

Landscape setting

This area contained four aggregated features, circular to slightly elliptical in shape, located in a north-south linear pattern along the levy bank on the west side of Ral Ral Creek (Table 5.6, Figure 5.2). Vegetation was dominated by large River Red Gums, Black Box, grasses and salt tolerant groundcovers. Small stands of *Typha* spp. (bulrush) were noted in the creek next to the earth mound precinct.

Local archaeological context

Small numbers of lithic fragments were observed either on the surface of these features or in the immediate vicinity. A small hearth was noted close to Ral Ral Creek and adjacent to RRCW10. RRCW11 was closely associated with a shell midden which extended 12 metres to the north (Appendix 6).

Earth mound morphology and distribution

Features RRW8–10 contained white flowers of *Mesembryanthemum* and burnt clay nodules but no shell fragments. RRW11 was covered in alluvium which obscured the surface with few clay nodules visible, however shell fragments (90% less than 1 centimetre) were present, in contrast to other mounds in this location (Table 5.7). RRW9 and RRW10 were both damaged by rabbit activity.

All features were identified as oven mounds. The interval distance between features is 167 metres. Distance to the edge of the creek ranged from 36 to 80 metres with an average of 60 metres.

Table 5.6: Summary table for Ral Ral Creek west oven mounds.

No.	Length (m)	Width (m)	Height/Depth (m)	Distance to water (m)	Feature shape
RRCW8	19	17	0.250	60	Oven mound
RRCW9	24.5	20	0.500	36	Oven mound
RRCW10	16	16	0.400	60	Oven mound
RRCW11	9	9	0.100	80	Oven mound

Table 5.7: Burnt clay nodule and shell fragment count for Ral Ral west oven mounds.

Location	Feature	Mound area	Sample area (m^2)	Sample size (%)	Burnt clay nodules count			Burnt clay nodules per m^2			Shell fragments count			Shell fragments per m^2		
					1-2 cm	2-5 cm	>5 cm	**1-2 cm**	**2-5 cm**	**>5 cm**	<1 cm	1-2 cm	2-5 cm	**<1 cm**	**1-2 cm**	**2-5 cm**
Ral Ral Creek	RRCW8	1014.7	6	0.6%	249	9	3	42	2	1	0	0	0	0	0	0
	RRCW9	1539.4	6	0.4%	367	11	4	61	2	1	2	0	0	0	0	0
	RRCW10	201.1	6	3.0%	755	62	18	126	10	3	0	0	0	0	0	0
	RRCW11	63.6	6	9.4%	24	0	3	4	0	1	28	2	0	5	0	0

Table 5.8: Distance between oven mounds surveyed along the north-south section of Ral Ral creek west.

Feature	Distance to nearest site/mound (m)	Site Type
RRCW8	-	Oven Mound
RRCW9	82	Oven Mound
RRCW10	286	Oven Mound
RRCW11	134	Oven Mound
Total distance	**502**	
Average distance	**167**	

Ral Ral Creek east and Hunchee Creek south precinct: RRCE12 –RRCE14, HCS19

Landscape setting

This precinct contained three circular earth mounds, and a pit, located on the eastern levy bank of the north-south section of Ral Ral Creek, and south of Hunchee Creek (Table 5.9, Figure 5.2). HCS19 was included because of its proximity to the Ral Ral Creek east area. The pit (RRCE13) was classified as a proto-oven site and was included in calculations of relative separation but was excluded from further discussion, as no further information could be derived. RRCE12 was adjacent to a drainage channel which entered the creek from the east and was covered in alluvium with ashy, humic soil was visible because of animal activity. Local vegetation included River Red Gum, Lignum and grasses.

Local archaeological context

Small numbers of lithic fragments as well as occasional larger pieces of silcrete were observed either on the surface of these features or in the immediate vicinity. A small hearth was observed 15 metres to the north along the bank of the creek from RRCE12. A scarred tree was recorded on the south bank of Hunchee Creek near HCS19.

Earth mound morphology and data

Some burnt clay nodules were eroding from the edge nearest the water. RRE14 was located adjacent to the edge of the levy, north of the Reny Island causeway. It had a large tree located centrally, was badly deflated and significantly damaged by rabbit activity. Mussel shell was eroding from a rabbit hole at the base of the tree. Large nodules of burnt clay were eroding from the edges of the feature. HCS19 was situated south of Hunchee Creek and east of its junction with Ral Ral Creek (Figure 5.2). It contained ashy, humic soil, a heavy overgrowth of metre high vegetation and was badly disrupted by rabbits.

The presence of alluvium, dense vegetation and rabbit disruption precluded the quantification of burnt clay and shell fragments on the surface of these features.

RRE12, RRE14 and HSC19 were identified as oven mounds. RRE13 was identified as an isolated oven pit, however no burnt clay was present and on this basis, was excluded from further analysis. The interval distance between features is listed in Table 5.10, with an average of 338 metres. Distance to the edge of the creek ranged from two to 80 metres.

Table 5.9: Summary table for Ral Ral Creek east oven mounds and pit.

No.	Length (m)	Width (m)	Height/Depth (m)	Distance to water (m)	Feature shape
RRCE12	15	15	0.200	2	Oven mound
RRCE13	1	1	0.500 (depth)	2	Pit
RRCE14	20	20	0.300	80	Oven mound
HCS19	20	20	0.200	30	Oven mound

Table 5.10: Distance between oven mounds and the pit surveyed at Ral Ral creek east and Hunchee Creek south (includes HCS19).

Feature	Distance to nearest site/mound (m)	Site Type
RRCE13	-	Pit
RRCE12	50	Oven Mound
RRCE14	578	Oven Mound
HCS19	387	Oven Mound
Total distance	**1015**	
Average distance	**338**	

Hunchee Island Billabong precinct: HIBB15 – HIBB18

Landscape setting

This precinct contained four circular aggregated features distributed around the billabong, with HIBB15 and HIBB16 on the north side and HIBB17 and HIBB18 to the south (Table 5.11,

Figure 5.2). The billabong is located within the Hunchee Island floodplain which is characterised by a pattern of paleo-meander scrolls and is subject to periodic flooding (Figure 5.11). Vegetation was predominantly Black Box, Lignum and grasses. An area of elevated sand was located immediately to the north of the billabong.

Sketch maps: Appendix 8.

Local Archaeological context

Small numbers of lithic fragments were observed either on the surface of these features and in the immediate vicinity.

Earth mounds morphology and data

HIBB15 was a large feature with some shell fragments and nodules of burnt clay, ashy, humic soil and was badly disrupted by rabbits. HIBB16 was smaller but with similar characteristics. HIBB17 and HIBB18 were small ashy features obscured by vegetation and tree debris with some small clay nodules but no visible shell fragments.

Photographs: Appendix 12.

All features were identified as oven mounds. The interval distance between features is listed in Table 5.12, with an average of 73 metres. Distance to the edge of the creek ranged from two to 30 metres with an average of 11 metres.

Table 5.11: Summary table for Hunchee Island Billabong oven mounds.

No.	Length (m)	Width (m)	Height/Depth (m)	Distance to water (m)	Feature Type
HIBB15	21	20	0.500	3	Oven mound
HIBB16	10	10	0.100	2	Oven mound
HIBB17	10	10	0.100	10	Oven mound
HIBB18	15	15	0.100	30	Oven mound

Table 5.12: Distance between all oven mound sites surveyed in the vicinity of the Hunchee Island Billabong.

Feature	Distance to nearest site/mound (m)	Site Type
HIBB15	-	Oven Mound
HIBB16	66	Oven Mound
HIBB17	130	Oven Mound
HIBB18	24	Oven Mound
	220	**Total distance**
	73	**Average distance**

Hunchee Creek north precinct: HCN20 – HCN31

Landscape setting

This area contained 11 oven mounds, circular to elliptical in shape, and a circular above ground hearth located on the northern levy bank of Hunchee Creek (Table 5.13, Figure 5.2). The predominate vegetation is River Red Gum, Black Box and Lignum. Elevated sandy areas extend three kilometres north-easterly, up to and around Lake Merreti and Clover Lake. During September 2016, high river levels and the consequential filling of both Lake Woolpoolool and Lake Merreti prevented access to Hunchee Creek north via the east-west track from the Calperum administration centre.

Local archaeological context

Small numbers of lithic fragments as well as occasional larger pieces of silcrete were observed either on the surface of these features or in the immediate vicinity. Features HCN22 to HCN24 were interspersed with scatters of shell fragments, lithic debris and burnt clay, and contained a variety of small stone artefacts with occasional larger pieces of silcrete. A concentration of stone flakes was located 60 metres to the south of HCN28 on the bank of Hunchee Creek at Amazon Point (Figure 5.2). A 40 metre by 10 metre surface of white alluvium, located 100 metres to the north of HCN31, contained a scatter of chert flakes.

Earth mound morphology and data

Mounds HCN22 to HCN24 consisted of an ashy soil matrix containing shell fragments and small to large burnt clay nodules. HCN24 was extensively covered with tree debris. HCN25 was an ashy feature severely degraded by ripping. HCN26 was a small feature with a cover of small burnt clay nodules with no ashy material or shell fragments visible. HCN27 and HCN28 were ashy features displaying burnt clay nodules with extensive tree debris and ground covering vegetation. HCN29 was a raised feature, at the junction of the entrance track to Amazon Point (Figure 5.2), which displayed some rabbit activity. Small to large nodules of burnt clay were present, with shell fragments eroding from the side of a rabbit burrow. HCN30 and HCN31 were ashy features south of Amazon Point, with burnt clay nodules, some shell fragments and obscured with tree debris.

HCN26 was identified as an above ground hearth and the remainder as oven mounds. The interval distance between features is listed in Table 5.12, with an average distance of 203 metres. Distance to the edge of the creek ranged from 30 to 63 metres with an average of 47 metres.

Table 5.13: Summary table for Hunchee Creek north oven/oven mounds.

No.	Length (m)	Width (m)	Height/Depth (m)	Distance to water (m)	Feature Type
HCN20	20	14	0.200	62	Oven mound
HCN21	40	23	0.500	42	Oven mound
HCN22	25	25	0.500	40	Oven mound
HCN23	22	22	0.250	40	Oven mound
HCN24	16	16	0.400	40	Oven mound
HCN25	20	20	0.200	63	Oven mound
HCN26	3	3	0.010	59	Above ground hearth/oven
HCN27	30	30	0.200	42	Oven mound

HCN28	20	20	0.200	30	Oven mound
HCN29	20	15	0.600	52	Oven mound
HCN30	20	20	0.100	62	Oven mound
HCN31	25	20	0.500	35	Oven mound

Table 5.14: Burnt clay nodule and shell fragment counts for accessible Hunchee creek north features.

Location	Feature	Mound area	Sample area (m^2)	Sample size (%)	Burnt clay nodules count			Burnt clay nodules per m^2			Shell fragments count			Shell fragments per m^2		
					1-2 cm	2-5 cm	>5 cm	1-2 cm	2-5 cm	>5 cm	<1 cm	1-2 cm	2-5 cm	<1 cm	1-2 cm	2-5 cm
Hunchee Creek north	HCN20	879.6	6	0.7%	221	25	9	37	4	2	87	0	0	15	0	0
	HCN21	2890.3	4	0.1%	231	42	7	58	11	2	114	0	0	29	0	0
	HCN22	1727.9	6	0.3%	106	9	25	18	2	4	144	0	0	24	0	0
	HCN23	380.1	6	1.6%	508	54	17	85	9	3	30	0	0	5	0	0
	HCN24	201.1	6	3.0%	226	30	5	38	5	1	1	0	0	0	0	0
	HCN25	314.2	2	0.6%	407	11	0	204	6	0	0	0	0	0	0	0
	HCN28	314.2	4	1.3%	111	17	6	28	4	2	0	0	0	0	0	0
	HCN29	942.5	4	0.4%	620	38	5	155	10	1	0	0	0	0	0	0
	HCN31	1570.8	2	0.1%	267	10	2	134	5	1	0	0	0	0	0	0

Table 5.15: Distance between all oven/oven mounds surveyed along Hunchee Creek north.

Feature	Distance to nearest site/mound (m)	Site Type
HCN20	-	Oven Mound
HCN21	434	Oven Mound
HCN22	80	Oven Mound
HCN23	82	Oven Mound
HCN24	91	Oven Mound
HCN25	220	Oven Mound
HCN26	185	Isolated Oven feature
HCN27	148	Oven Mound
HCN28	267	Oven Mound
HCN29	122	Oven Mound
HCN30	268	Oven Mound
HCN31	335	Oven Mound
Total distance	**2231**	
Average distance	**203**	

Lake Merreti east precinct: MLE32

Landscape setting

The mound was located on a sand base between Lake Merreti and Clover Lake in a local landscape characterised by slightly rounded features covered in sand and/or alluvium, which indicated the cyclical depositional processes at work in this area (Table 5.16, Figure 5.2). Predominant vegetation was Black Box, grass and low chenopod shrubs. A Black Box tree occurred in the centre of the mound.

Local archaeological context

A complex of archaeological sites, which included hearths, burials, dispersed lithic scatters, shell middens and scarred trees were associated with slightly elevated sandy areas within 200 metres of the lake margins.

Earth mound morphology and data

This mound was atypical in comparison with other mounds of the Calperum floodplain. It was located 200 metres from the current eastern edge of Lake Merreti, which was expanding in September 2016 due to high river levels. It was located on a sand base rather than the clay base of the lower floodplain defined by the Ral Ral/Hunchee anabranch system. The feature was extensively covered in tree debris and contained a dense stand of bushy vegetation which covered approximately 25% of the total area. The mound consisted of an ashy soil matrix with burnt clay nodules eroding from the edge. No shell fragments were visible.

The mound was classified as an oven mound. An extensive survey of the surrounding area failed to identify further examples in the vicinity.

Table 5.16: Summary Lake Merreti oven mound.

No.	Length m	Width m	Height/Depth m	Distance of closest edge to water m	Feature type
MLE32	16	16	0.5	200	Oven mound

Summary of field survey data

A summary of the survey data for the earth mounds outlined in the previous section is shown in Table 5.17. Burnt clay nodules and shell fragment counts were summarised and presented in Table 5.18. Table 5.19 provides a comparison of mound height estimates and measurements made with the Leica Icon GPS60.

This will be discussed in Chapter Six, in comparison with the regional dataset which has been derived from the literature and included as Appendix 13.

Table 5.17: Dimensional summary of Calperum floodplain oven mounds.

Sub-Region	Sample Size	Mean Length	Mean Width	Mean Height	Median Length	Median Width	Median Height	Max Length	Min Length	Max Width	Min Width	Max Height	Min Height
Calperum Floodplain	27	18.9	17.0	0.28	20	17	0.2	40	9	30	7	0.6	0.1

Table 5.18: Burnt clay and shell fragment counts for selected oven mounds which provided an unobscured surface. Mound area was calculated as either a simple circle or ellipse.

Location	Feature	Mound area	Sample area (m^2)	Sample size (%)	Burnt clay nodules count			Burnt clay nodules per m^2			Shell fragments count			Shell fragments per m^2		
					1-2 cm	2-5 cm	>5 cm	**1-2 cm**	**2-5 cm**	**>5 cm**	<1 cm	1-2 cm	2-5 cm	**<1 cm**	**1-2 cm**	**2-5 cm**
	MRC1	854.5	6	0.7%	1301	97	19	217	16	3	636	22	0	106	4	0
Reny Island Billabong	RIBB2	267.0	10	3.7%	744	47	4	74	5	0	0	0	0	0	0	0
	RIBB3	314.2	10	3.2%	1622	49	10	162	5	1	0	0	0	0	0	0
	RIBB4	95.0	6	6.3%	498	2	2	83	0	0	0	0	0	0	0	0
	RIBB5	63.6	6	9.4%	78	0	0	13	0	0	0	0	0	0	0	0
	RIBB6	219.9	4	1.8%	275	25	0	69	6	0	0	0	0	0	0	0
	RIBB7	415.5	14	3.4%	123	4	6	9	0	0	0	0	0	0	0	0
Ral Ral Creek	RRCW8	1014.7	6	0.6%	249	9	3	42	2	1	0	0	0	0	0	0
	RRCW9	1539.4	6	0.4%	367	11	4	61	2	1	2	0	0	0	0	0
	RRCW10	201.1	6	3.0%	755	62	18	126	10	3	0	0	0	0	0	0
	RRCW11	63.6	6	9.4%	24	0	3	4	0	1	28	2	0	5	0	0
Hunchee Creek north	HCN20	879.6	6	0.7%	221	25	9	37	4	2	87	0	0	15	0	0
	HCN21	2890.3	4	0.1%	231	42	7	58	11	2	114	0	0	29	0	0
	HCN22	1727.9	6	0.3%	106	9	25	18	2	4	144	0	0	24	0	0
	HCN23	380.1	6	1.6%	508	54	17	85	9	3	30	0	0	5	0	0
	HCN24	201.1	6	3.0%	226	30	5	38	5	1	1	0	0	0	0	0
	HCN25	314.2	2	0.6%	407	11	0	204	6	0	0	0	0	0	0	0
	HCN28	314.2	4	1.3%	111	17	6	28	4	2	0	0	0	0	0	0
	HCN29	942.5	4	0.4%	620	38	5	155	10	1	0	0	0	0	0	0
	HCN31	1570.8	2	0.1%	267	10	2	134	5	1	0	0	0	0	0	0

Mound profile measurement

In September 2016, a Leica Icon gps60 was used to map the surface profiles of seven oven mounds along Hunchee creek. The opportunity was also taken to check mound height estimations made previously by tape measure and sight.

Height comparisons for eight oven mounds in the Hunchee creek north precinct are presented in Table 5.20. Where satellite and 3G signal strengths were maintained for the Leica Icon gps60, comparable results were similar to those obtained by tape measure, except when disrupted by tree canopies. Data for HCN22, HCN25 and HCN28 were not included for further analysis due to issues with signal interference by tree canopies. Issues were also experienced with 3G reception due to remoteness, which caused frequent periods of instrument downtime.

Appendix 11 contains surface profile graphs for the seven mounds recorded.

Table 5.19: Original height estimations versus RTK height measurements for eight mounds.

Mound	Original Height Estimation (m) (April/September 2015)	RTK Height (m) (September 2016)
MLE32	0.5	0.5
HCN20	0.2	0.2
HCN21	0.5	0.43
HCN22	0.5	0.02
HCN23	0.25	0.22
HCN24	0.4	0.39
HCN25	0.2	0.03
HCN27	0.2	0.24
HCN28	0.2	1.5

River level data

The relative river levels during the periods that the distance of mounds to water were measured are outlined in Table 5.20. Relative distance from the Murray river Mouth for Lock 6, Calperum floodplain and Lock 5 are 620, 590 and 562 kilometres respectively, indicating that he Calperum floodplain is located almost exactly at the midpoint between the two locks by river distance.

Table 5.20: A comparison of normal pool level and river levels, for Lock 6 (upstream of Calperum) and Lock 5 (downstream), during periods of field work at Calperum.

Date	Lock 5 (m) (AHD)	Lock 6 (m) (AHD)	Measurement Locations
Pool Level	16.2	19.25	N/A
25/09/2015	16.55	19.29	Reny island Billabong and Ral Ral Creek west
15/04/2016	16.31	19.25	Hunchee Island Billabong, Ral Ral Creek east and Hunchee Creek
28/09/2016	16.72	19.83	None

The differences in level between September 2015 and April 2016, at Lock 5 and Lock 6, are 0.24 and 0.04 metres respectively, indicating an estimated level difference at Calperum (at the midpoint between the locks) of approximately 0.1 metres which is considered to have a negligible effect on distances between mounds and the nearest water feature.

Elevation data

Figure 5.5 shows elevation points for the study area outlining low lying areas subject to inundation from higher river flow, and potential refuge areas from flood. Figure 5.6 and 5.7 provide topographic views of the Calperum floodplain showing recent areas of inundation and light brown areas of elevated sand. There is a lower elevation profile (red points on

Figure 5.5) south of the Ral Ral and Hunchee creek anabranch and three low lying areas to the north, outlined in Figures 5.5, 5.6 and 5.7, which constitute the ephemeral lakes of Clover, Merreti and Woolpoolool. Elevated areas are indicated to the east and west of Woolpoolool, east and west of Merreti and to the east of Clover.

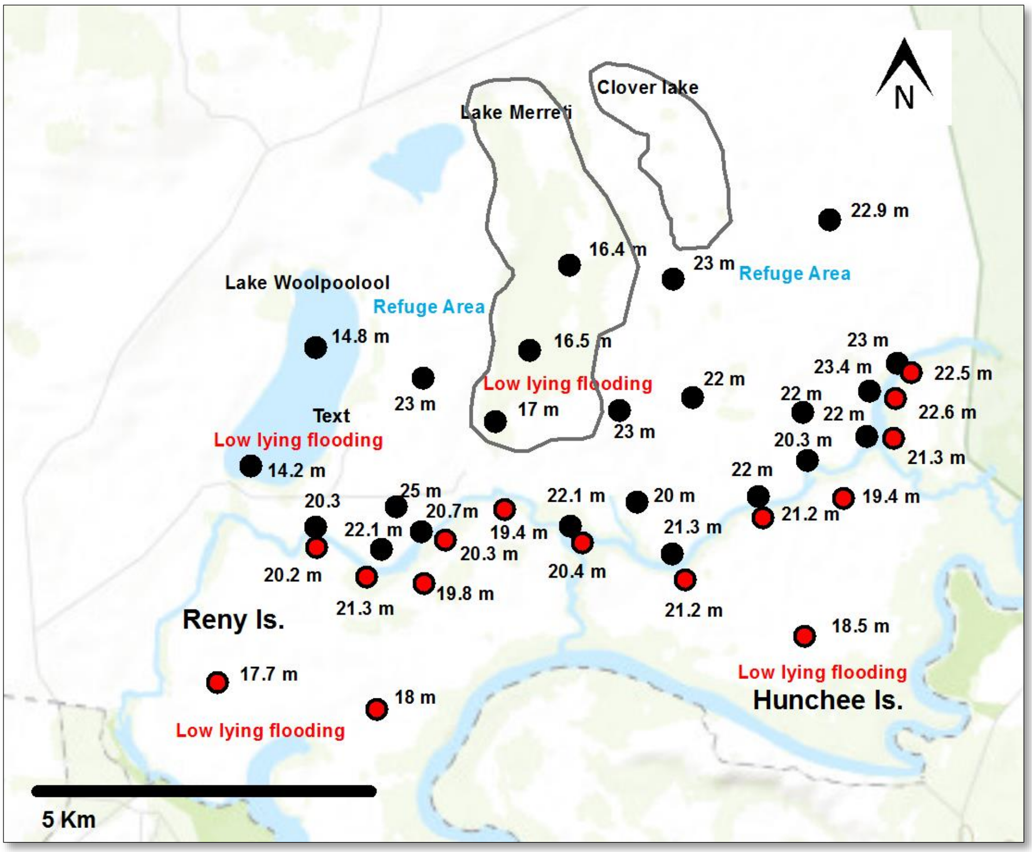

Figure 5.5: Elevation profile north and south of Ral Ral and Hunchee Creeks.

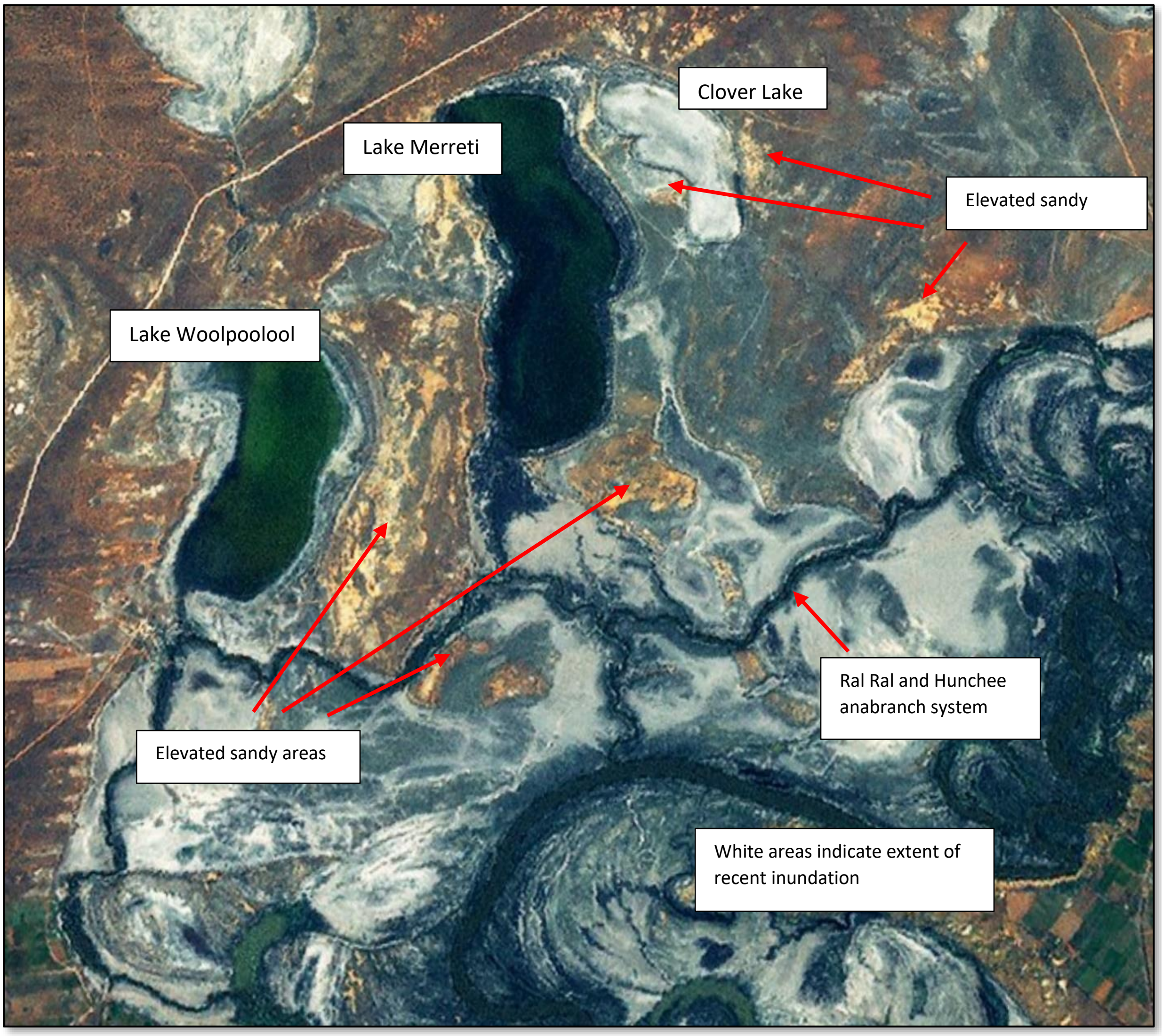

Figure 5.6: Topographic view of the Calperum floodplain showing recent areas of inundation (white) and elevated sandy areas (light brown).

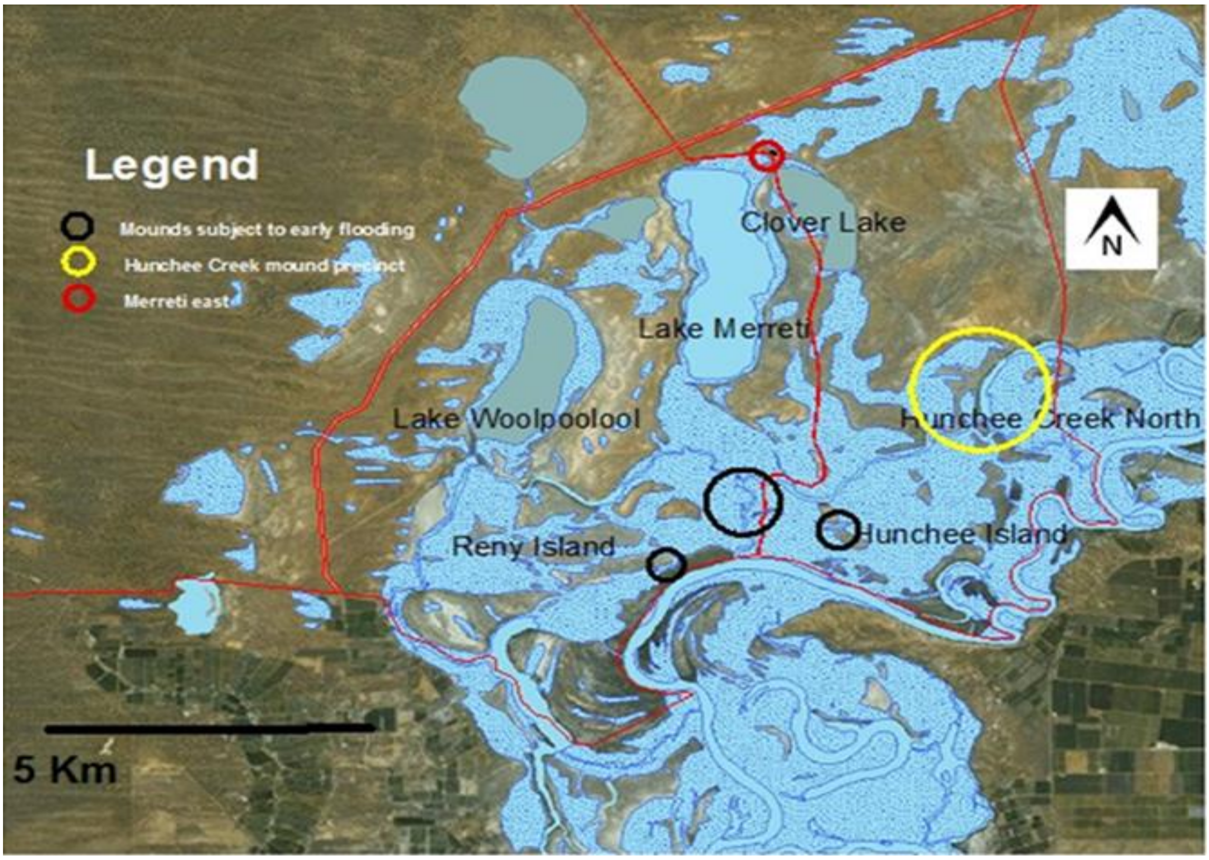

Figure 5.7: Topographic view showing flood extent at which lower floodplain mound precincts flood and Hunchee Creek north and Lake Merreti east precincts remain accessible.

Summary

Thirty-two earth mounds and related features were surveyed on the Calperum floodplain, during the research for this project. Of these, 27 were identified as oven mounds, two as natural mounds, two as isolated above ground hearth/ovens and one as a pit. The data derived from this survey and the analysis of both physical and chronological data from 1,112 regional earth mounds as outlined above, serves as the basis from which I will develop the discussion to address the research aims and question outlined in Chapter One.

6 Discussion

This chapter discusses the study results, outlined in Chapter Five, in the context of the question and research aims listed on pages six and seven in Chapter One. In the first instance, I provide a synthesis of the key physical attributes for the discussion which follows, the discussion is then ordered to address the research aims outlined in Chapter One.

Earth mounds are generally located along creeks, seasonally inundated floodplain, rivers and lakes and tend to form groups or clusters (Coutts et al. 1976, 1978; Martin 2006; Westell and Wood 2014). As outlined previously, mounds within the region are generally oval to roughly circular with a diameter up to 200 metres and a height range of up to two metres, with the largest and oldest (to date), located in the Hay Plain region. The least developed, in an aggregative sense, are the ashy deposits in the Menindee Lakes region, which Pardoe (2003:45) attributes to the same formation processes as the earth mounds of the Riverine Plain (see also Martin 2006).

Previous research indicates considerable variation in size, contents, prevalence and distribution, but analyses of this data reveals the presence of four broad types of oven mound deposit found across the six earth mound precincts of the Basin, these are:

1. An accumulation of an ash and soil matrix;
2. A single layer of clay containing only charcoal and burnt clay pellets (potentially indicating an early stage deposit of type 3 below);
3. A homogenous deposit, containing soil, ash, burnt clay, mussel shell and animal bone; and

4. Occupation sites containing pits, hearths, ovens, faunal remains including molluscs and eggshell, stone flakes, occasional burials and stone tools. Such sites are hypothesised to have developed from the type 3 listed previously.

For most regions, the composition of earth mounds indicates sequential use of earth oven technology as a primary mechanism of development over time (Coutts et al. 1976, 1979; Martin 2006; Westell and Wood 2014). This suggests a common and continuous developmental process at play, supplemented by general occupational debris in some instances (Balme and Beck 1996; Coutts et al. 1979; Martin 2006; Westell and Wood 2014).

Within the riverine environments of the Murray Darling Basin, the widespread cooking and processing of the rhizomes of wetland plants suggests a reason for the greater presence of the third type of deposit, outlined above, within wetland, floodplain and anabranch river systems, in contrast to the less numerous and larger occupation deposits (Martin 2006; Westell and Wood 2014).

The dimensional data recorded from the survey of the Calperum floodplain, was derived from a sample of 27 oven mounds, this compares with a total of 144 reported by Westell and Wood (2014) for their South Australian Riverland dataset, and a total of 2,029 for the wider region (Appendix 13). Calperum data lies within the length/diameter and height ranges for the region (Figure 6.1), however, the Calperum sample does not exhibit the lateral extremes of the larger Riverland dataset; and is at the lower end of the height range recorded for the wider region (Figure 6.2). Within the riverine environments of the Murray Darling Basin, only the ashy features of the Menindee Lakes in western New South Wales have a smaller height range. Despite the lower height profile of the Calperum sample, the length/diameter to height range ratio suggests a more rounded profile, although this is most likely to be a distortion due to the smaller sample size and is discounted for further discussion.

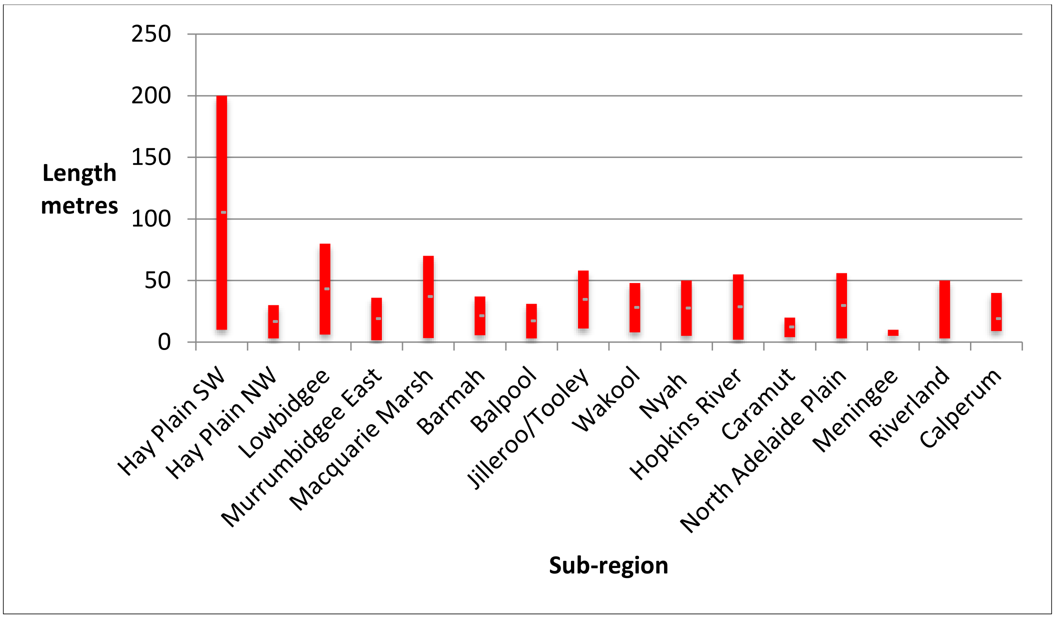

Figure 6.1: Graph of mound length range by sub-region. Derived from Balme and Beck 1996, Berryman and Frankel 1984, Coutts et al. 1976, Coutts et al. 1979, Martin 2006, Simmons 1980, Westell and Wood 2014, Williams 1988.

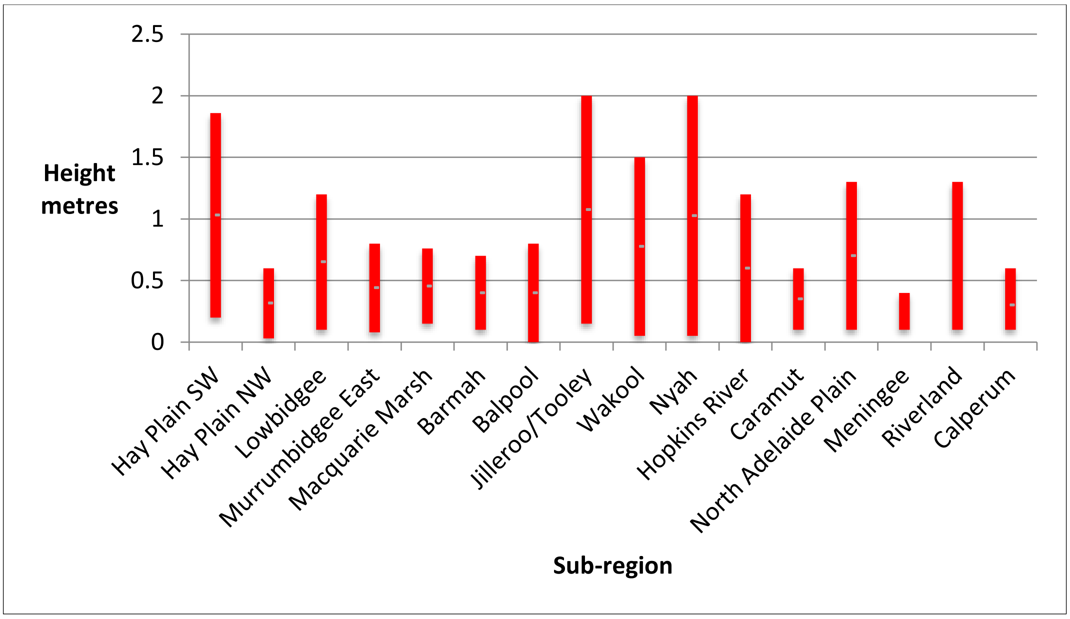

Figure 6.2: Graph of mound height range by sub-region. Derived from Balme and Beck 1996, Berryman and Frankel 1984, Coutts et al. 1976, Coutts et al. 1979, Martin 2006, Simmons 1980, Westell and Wood 2014, Williams 1988.

Chronology

Indigenous earth oven mounds in the Murray Darling Basin are a phenomenon of the mid to late Holocene, as indicated by the age ranges outlined in Figure 6.3 (See Appendices 1 and 2 for additional detail). The concentration of the largest and oldest mounds in the Hay Plain region suggests a correlation between age and size in a tectonically stable environment. Martin (2006:114) indicates that the Ravensworth 3 mound, on the Hay Plain, was built during a narrow time frame of 300 years about 4,000 BP. The Tchelery 1 mound, 6.5 kilometres, south of Ravensworth 3, was dated to 4,300 BP and was constructed over 700–800 years, after which it ceased to be used as an aggregating heat retainer cookery site, but was potentially used for living space (Martin 2006:138). Both the Ravensworth and Tchelery mounds were located on lake lunettes, on the tectonically stable Hay Plain (Martin 2006:52). This most likely explains their survival to a greater age, and size, in contrast to mounds located within highly mobile riverine environments, characterised by cyclical deposition and erosion, such as the Calperum floodplain.

A preliminary analysis of current chronological data for earth mound in the Murray Darling Basin, indicate that 78% of ages are less than 2,000 years BP (Table 2.3). Also, this data indicates that all recoded ages prior to 3,000 BP are from sites in the Hay Plain and Wakool regions of New South Wales. Thus, on current evidence, earth mounds found in riverine environments subject to erosional and depositional processes, are likely to be late Holocene in age. As such, the typology demonstrated by the Calperum sample and the environment within which they are located suggests that they are likely to be late Holocene in age. Evidence of older features would have been compromised through erosion and deposition due to regular seasonal flooding.

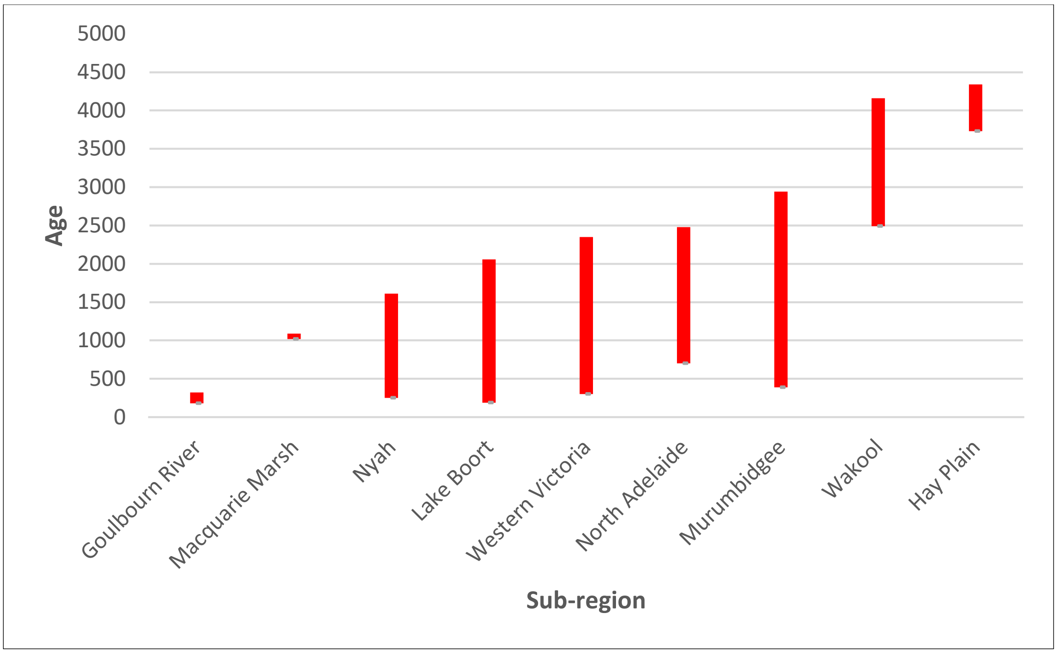

Figure 6.3: Uncalibrated earth mound radiocarbon age range by sub-region in the Murray-Darling Basin. Derived from Balme and Beck 1996; Coutts et al. 1977; Godfrey et al. 1996; Johnson 2004; Klaver 1998; Martin 2006; Berryman and Frankel 1984, Westell and Wood 2014.

The Calperum oven mounds were classified in accordance with Klaver's (1998:122–135) criteria for oven mounds listed as type three above (See Chapter Five and Appendices 3–9 for further detail). This included the presence of all or most of the following criteria:

- A discrete mounded shape;
- The presence of burnt nodules of clay;
- An association with shell and/or artefacts; and
- A compact or soft ashy soil matrix.

This parallels the characteristics reported by previous researchers in similar environments within the Murray Darling Basin (Balme and Beck 1998; Coutts et al. 1979; Westell and Wood 2014).

In summary, the Calperum oven mounds are situated toward the smaller end of the regional dimensional spectrum and exhibit dimensional, spatial and other morphological similarities with type 3 earth mounds (as defined and listed above) located within similar riverine environments of the Murray Darling Basin.

Mound Distribution

The Calperum oven mounds which were recorded for this study were all located near water and positioned on natural levies. The only exception was the atypical isolated mound recorded near Lake Merreti (MLE32). Oven mounds were present in five distinct locations within the floodplain (Figure 5.2), these were:

- Reny island Billabong (south of the anabranch);
- Hunchee Island Billabong (south of the anabranch);
- Ral Ral Creek/Hunchee creek south (anabranch);
- Hunchee creek north (anabranch); and
- Lake Merreti east (north of the anabranch).

The averaged dimensional data for each of these locations indicates that the mounds associated with billabongs exhibit smaller lateral and height dimensions than those associated with the anabranch creeks (Table 6.1). Distance to the nearest water was also significantly less at the time of measurement, which was during a non-flood period. Anabranch levies are generally positioned further from the water than are billabong levies, reflecting different flow characteristics during flood.

Table 6.1: Average of Calperum oven mound dimensions by environmental zone. Note that lake Merreti was filling and expanding at the time of recording.

Environmental Zone	Sample Size	Average Length (m)	Average Width (m)	Average Height (m)	Average dist. to water (m)
Ral Ral Island oven mounds (Billabong)	4	12.50	11.75	0.19	2.5
Ral Ral Creek oven mounds (Anabranch)	6	17.25	16.17	0.29	53
Hunchee Island oven mounds (Billabong)	4	14.00	13.75	0.20	13.3
Hunchee Creek oven mounds (Anabranch)	12	23.17	20.42	0.33	42.3
Lake Merreti oven mound (Northern floodplain)	1	16	16	.50	200

The very close spatial grouping between the Hunchee north mounds, HCN21-HCN23 (average 84 m lateral distance) (Table 5.15; Figures 6.7, 6.8), indicates a focussed and regular use of this area. Focussed use is also indicated by close association of mounds around the Reny island Billabong (average of 152 m), along Ral Ral Creek west (average of 167 m) and around Hunchee Island Billabong (average of 73 m) (Tables 5.5, 5.8, 5.12). The concentration of oven mounds in locations with a close association with water, is suggestive of an economic focus on aquatic ecosystems. This is consistent with ethno-historic reports for the use of *Typha* spp. These provide evidence of the importance of aquatic plant rhizomes, within the Aboriginal economies of the Murray Darling Basin, as a source of carbohydrate and fibre. This, of course, does not discount the exploitation of other plant and animal foods in these localities.

The oven mounds with the largest lateral and height dimensions are associated with the northern levy bank of the Hunchee Creek anabranch. This is potentially explained by their higher elevation than the mounds of the Reny and Hunchee Island floodplain, which would suggest less frequent flooding except in exceptional flood years (Figures 5.5, 5.6, 5.7). This would result in oven mounds which would be available for use throughout most years with less scouring of deposits, resulting in larger mounds than those around the floodplain billabongs. The latter would be subject to more frequent inundation and a consequently reduced period of use. The sample of height profiles (Appendix 11) obtained for the mounds along Hunchee Creek north indicates these features would remain dry until water levels rose above 20 m (AHD). Under this scenario, the southern portion of the floodplain containing the billabong mounds would become harder to access as the water level levels exceeded 19 m (AHD) and the floodplain surface became progressively water-logged. The northern bank of Hunchee Creek, lake lunettes and the elevated sand country to the immediate north (Figure 6.4, 6.5) would constitute a refuge area during the annual flooding cycle, with progressive restriction by flooding over 20 m (AHD) (Figure 5.5). This pattern of flooding was observed in September 2016 when Reny and Hunchee Islands became inaccessible as Lakes Woolpoolool and Merreti commenced filling and expanding. The mounds along the northern portion of Hunchee Creek remained free of flood water and were accessible from the north.

The dispersed distribution of oven mounds south of the anabranch, along the northern bank of the Hunchee creek anabranch and at least one oven mound near Lake Merreti, suggests a south/north, seasonally mitigated and deliberate pattern of establishment. The availability of *Typha* spp. rhizomes, from plants located on the lower floodplain, would be disrupted during the flood period between September and January (see Tables 6.2, 6.3). Oven mounds located north of the anabranch system would have extended access to the calorific and fibre resources of aquatic plant communities and other foods, as the resources of the southern portion of the floodplain, and the associated oven mounds, became less accessible due to inundation.

In summary, the Calperum oven mounds demonstrate a separation in distribution between the southern meander floodplain and the northern bank of the anabranch system. This is most likely related to the location of plant resources, particularly *Typha* spp., but also reflects the influence of the annual inundation cycle and an intention by the local population to maintain continuous access to this resource type. This may have included differential management of wet-land plant resources of the southern and northern parts of the floodplain so that harvesting occurred at different times, in different areas, as outlined by Klaver (1998:87) for the Murrumbidgee region. This would have tempered the effect of seasonal inundation and maximised the resource over the subsistence cycle. This is discussed further below.

Figure 6.4: A sandy and elevated site north of the Hunchee Creek anabranch system, demonstrating mussel shell fragments. Photograph C. Westell April 2016.

Figure 6.5: Typical sandy country north of the Ral Ral and Hunchee Creek anabranch system. Photograph: M. Morrison April 2016.

Mound Function

Burnt clay nodules and shell fragments predominantly cluster toward the smallest size categories (1-2 centimetre and <1 centimetres respectively) on all features assessed (Table 5.18; Figure 6.6, 6.7). The absence of large pieces of clay heat retainer material on the surfaces of mound features is possibly related to the time since previous use (approximately 165–175 years) and taphonomic processes leading to size reduction during that time. It was apparent that larger nodules were present within some individual mounds as they had eroded out of the edge onto surrounding surfaces. The ubiquitous presence of burnt clay nodules on and around the mounds at Calperum and the morphology outlined above, provides preliminary support for the interpretation that they were formed from the accumulation of heat retainer material resulting from the repeated use of earth ovens.

Significant surface deposits of mussel shell were recorded at the main river channel (MRC1 – natural mound), one mound on Ral Ral creek west (RRCW11 – oven mound), and several oven mounds (HCN20–HCN23) located on the north side of Hunchee creek. In the case of MRC1 and RRCW11 their respective close association with shell middens suggests an explanation for a significant presence of shell in these instances. In the case of the Hunchee Creek oven mounds (HCN20, HCN21, HCN22 and HCN23) there was a general scatter of shell fragments on and around these sites. RIBB5 was associated with a small deposit of shell, which was 20 metres to its south. Other mound features, including those located at the Hunchee Island Billabong, displayed some evidence of shell eroding from the sides of rabbit burrows, but which was unable to be quantified due to surface disruption. The quantified surface evidence and sub-surface observations of the presence of shell, indicates that 40% of the Calperum sample of 27 oven mounds, two utilised natural mounds and two above ground hearth/ovens, which were surveyed for shell fragments, were associated with the local consumption of mussels. This figure is comparable with the levels of 44% and 54%, as reported by Westell and Wood (2014:46) for earth mounds on the Chowilla and Katarapko floodplains respectively. This pattern suggests multiple instances where mussels were available and consumed during the time of mound formation and use. The frequent and dispersed presence of shell fragments on mound surfaces, and in rabbit burrows when present, indicates that this material is likely to be ubiquitous in this context.

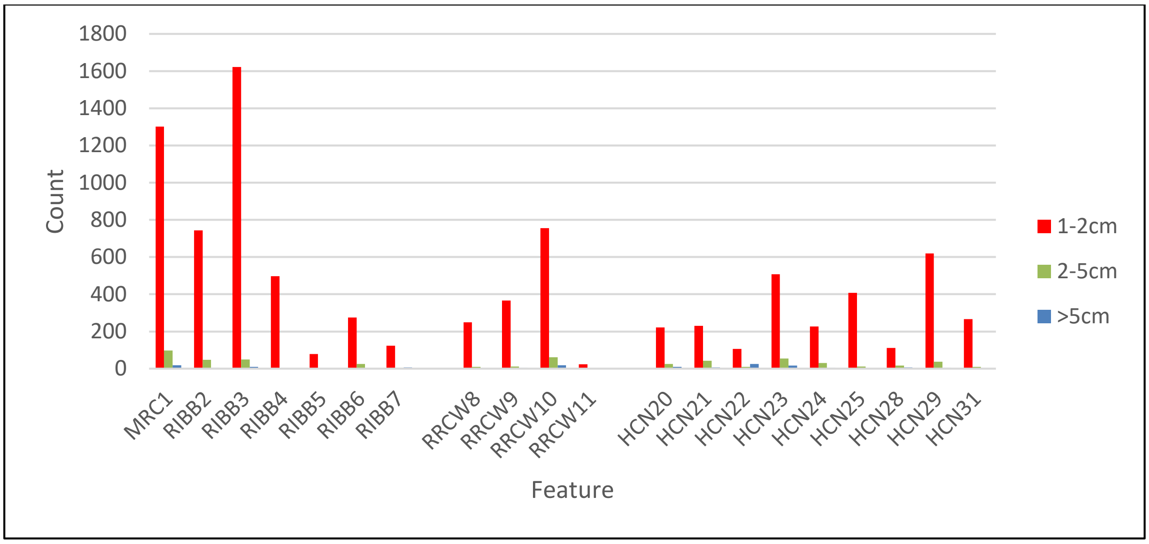

Figure 6.6: Frequency of burnt clay nodules per size class.

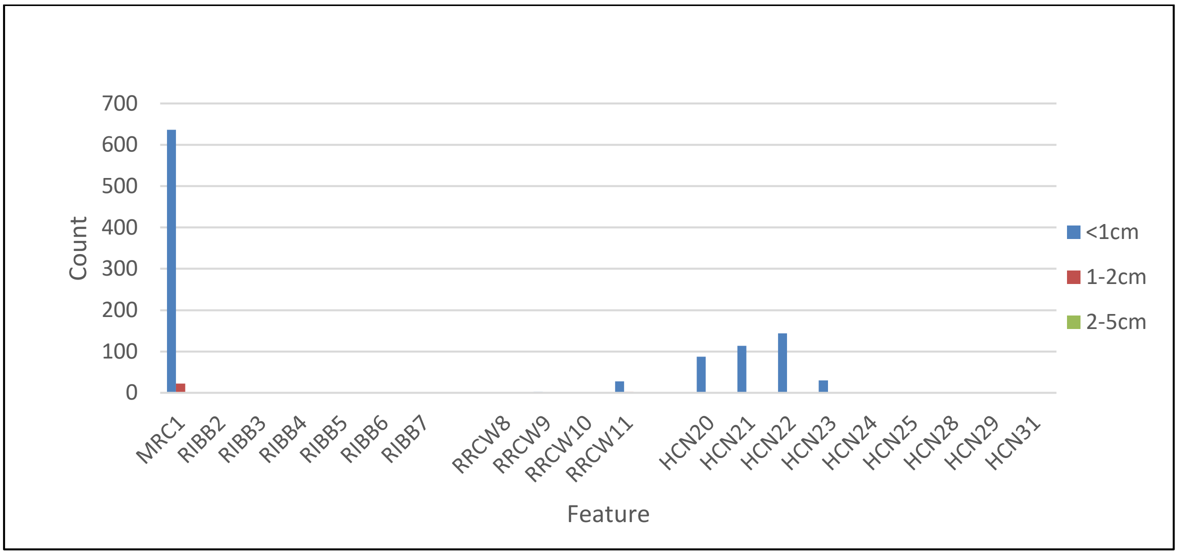

Figure 6.7: Frequency of shell fragments per size class.

Demography

Reconstructing past demography, settlement and land use patterns of Indigenous groups within the floodplain is difficult, complicated by the potential impact of European disease on Aboriginal communities prior to and at the time of contact with Europeans; and concerns over the accuracy of early European accounts (Balme and Beck 1996:44–45). However, a broad estimate of minimum population levels can be made from the first-hand accounts of

Sturt (1833) and Eyre (1845), which can contribute to an understanding of demography and settlement patterns, and landscape use. Subsistence activity can be deduced, in some part, by assessment of seasonal flood cycles and the annual growth patterns of plant communities. This approach has been used by Allen (1972) and Klaver (1998), in their research along the Darling and Murrumbidgee Rivers, and is followed here.

From the observations of Sturt (1833), social groupings along the Murray were of the order of at least 80 to 250 individuals within a territory defined by a day's travel by boat. Two hundred and sixty-six kilometres from the confluence of the Murray and Darling were travelled by Sturt in eight days (22nd–29th January 1830). This represents approximately 33 kilometres travelled per day. From population estimates by Sturt, this represents a territorial span of approximately 30 kilometres of river frontage per tribal grouping. Sturt's (833 2:135) estimate of a group size of 250, represents a density of at least eight persons per kilometre of river, but is obviously fluid in respect of both subsistence activity and periodic social aggregation. Eyre (1845 2:372) estimated a level of three to four individuals per mile (approximately three per kilometre) of river frontage at Moorunde, near Blanchetown in South Australia. This section of river at Moorunde has a much narrower floodplain (1.5 kilometres) than at Calperum Nature Reserve (6–7 kilometres) and would reasonably be expected to have a lower productive capacity and to consequently to support a lower population in relation to the length of river frontage than at Calperum.

The Calperum floodplain has a river length of 18 kilometres, which, from Sturt's observation, potentially represents a population estimate of approximately 150 individuals within the 86 square kilometres of floodplain contained between the Renmark-Wentworth road and the River Murray. This represents slightly less than two individuals per square kilometre and whilst a very coarse estimate due to the sinuous nature of the river, the depth and productivity of the associated floodplain provides some validation. It fits with the observations of Eyre (1845), as it is relative to population densities (slightly less than four individuals per kilometre of river) along the narrower resource zone at Moorunde, and Pardoe's (2003:50) estimate along the much poorer resource zone along the Darling River. Allen (1974:313) indicates that aggregations of 45 individuals occurred along the Darling during summer following higher spring river flows, in contrast to groups of 13 which were dispersed throughout the entire region during other times of the year (see also Keen 2004:112–114). Klaver (1998:282) estimated a slightly higher population density for the Murrumbidgee, than the Darling, based on the availability of higher calorific value foods, with an aggregation level of forty to sixty individuals and smaller groups of up to fifteen at other times. Her conclusion was that this represented seasonal sedentism for periods of up to a month (Klaver 1998:284). The observations by Sturt (1833) and the evidence cited by Allen (1974), Klaver (1998), Keen (2004) and Pardoe (2003) supports the premise that seasonal fluidity in settlement density would have existed within the Calperum floodplain population in response to the flood cycle, associated resource availability and seasonally scheduled social aggregations. Klaver (1998:98–102) indicates that the period for aggregation appears to be during the summer period following the seasonal spring flood and ebb cycle, contemporaneous with a spike in available resources necessary to support large gatherings.

A semi-sedentary lifestyle in concert with the river flood regime, governed by the seasonal availability and geographic distribution of subsistence resources, would be expected at Calperum. Ethno-historical evidence and previous research suggests a population of the order of at least 150 individuals divided into approximately ten family groups could be a relevant group structure for the floodplain at Calperum. This translates to approximately nine square kilometres per group. These groups would constitute part of a wider regional population which could be as large as four to five hundred (Eyre 1845 2:372) which would come together periodically, potentially during the summer following annual flooding, for ceremonial, ritual and social purposes.

Interestingly, the Calperum survey provided a sample of 15 oven mounds in the southern and 12 in the northern portions of the floodplain, suggesting a relatively even distribution between the two areas and a near correlation with the estimate for the number of family groups postulated above. However, a larger sample representative of the entire floodplain, a determination of the contemporaneity of oven mounds and a consideration of taphonomy, are required to test this association

Resource use, settlement patterns and mobility

As outlined above, the use of oven mounds within the floodplain will most likely have a seasonal basis to their location and operation, largely determined by access before and after flooding and the availability of plant root stock for cooking and processing (Klaver 1998:87, 100). Klaver (1998:77–102) and Keen (2004:44) have provided analyses of the various environments and plant communities available to groups along the Murrumbidgee and Darling Rivers which would have supported the seasonal cycle of subsistence. This includes an analysis of food availability by month of the year (Keen 2004:42–44; Klaver 1998:100). In this context, it is possible to postulate a yearly mobility and activity cycle for the Calperum population, with groups moving progressively from the floodplain to higher ground with the advent of flooding after winter, in accordance with landscape accessibility, ease of movement and the availability of resources (Tables 6.2, 6.3). The degree of movement and the timeframe, in any one year, would of course be determined by the extent of flooding, and the surface condition of the landscape. This can be modelled by a simple elevation model that indicates the areas that would have been subject to inundation during flood cycles as well as those that have remained habitable (Figure 5.5). Figure 5.6 provides a topographical view which indicates current floodplain patterns generated by the present river system of weirs and locks. This view is relevant to the analysis of past landscape use since flood patterns are determined by landscape contours, and these have not changed because of weir construction. In addition, the locations of archaeological evidence recorded as part of the wider Calperum project, indicates that elevated areas that provided refuge from flooding in the past still demonstrate this capacity today.

The model being proposed here, is that groups would have utilised both animal, aquatic and plant resources in more elevated areas as they moved in response to rising water levels (Lawrence 1969:96). This would have been a normal response to an expected change in circumstances, assisted by watercraft, nets, fire and other technologies commonly deployed in support of traditional subsistence strategies (Lawrence 1969:92–104). When the floods receded, this process would have been reversed, likely incorporating, amongst other activities, the trapping of fish, plant harvesting and deliberate plant management activities (Gott 1983, 1999:42; Hallam 1986; Klaver 1998:92, 102; Wood et al. 2005; Wood and Westell 2010:4).

Table 6.2: Food staples availability by month, derived from Keen (2004:42–44). Note: Red depicts resource availability, brown indicates seasonal restriction and yellow the annual period of flooding.

Vegetable Foods	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Typha/Phragmites spp.												
Water Ribbons												
Geranium spp.												
Picris, Cucumis spp.												
Thistle Top												
Grass seeds												
Native millet												
Love grass												
Brittle grass												
Aristida spp.												
Nadoo												
Shrubs												
Pigweed												
saltbush												
Goosefoot												
Flax Plant												
Mulga												
Amaranthus spp.												
Pittasporum spp.												
Fruits/leaves												
Portulaca spp.												
Sonchus spp.												
Nitraria spp.												
Pigface												
Warrigal cabbage												
Nasturtium spp.												
Fish/Crustacea	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Crayfish												
Mussels												
Land animals												
Kangaroos												
Small mammals												
Birds												
Reptiles												
Flood Period												

Table 6.3: Seasonal cycle for *Typha* spp., derived from Klaver (1998:87).

Month	Food Component	Burn	Fibre available	Starch Availability
December	Shoots	No	Yes	Depleted
January	Shoots	No	Yes	Depleted
February	Shoots/flowers	No	Yes	Depleted
March	Shoots/seeds	Yes	Yes	Storing
April	Flower stems	Yes	-	Storing
May	-	Yes	Yes	Good
June	Stems	No	Yes	Stocked
July	Stems	No	yes	Stocked
August	Stems	Yes	Yes	Stocked
September	Shoots/Root	Yes	Yes	Good
October	Shoots/root	Yes	Yes	Good
November	Shoots/root	No	Yes	No

Note: The timing for the burning of *Typha* spp. stands could be varied as a management technique to delay the crop, synchronise the stand or to release nutrients for growth (Klaver 1998:87).

The seasonal use of ovens mounds for the cooking and processing of *Typha* spp. and other root stocks would have been an integral part of the annual subsistence cycle occurring through winter, spring and summer (see Table 6.2, 6.3), prior to and during the annual flood in a normal year. This would have constituted an important and flexible use of this technology (Klaver 1998:88), enabled over an extended period, by the deliberate placement of earth mounds for the processing of *Typha* spp. across a number of discrete ecosystems. This occurred in two separate zones north and south of the anabranch system, which provided strategic redundancy. This is a modern engineering and operations concept, which provides duplication of critical assets or systems to ensure continuity of supply or operation, and which I argue, has relevance to the supply of *Typha* spp. derived carbohydrate and fibre at Calperum.

This contrasts with the opportunistic use of earth ovens and normal hearths for the cooking of larger animals, which would most likely to have been cooked and largely consumed, likely by men, close to kill location and and/or living areas. In the absence of extensive aggregated occupational debris and extensive shell middens at mound locations, shell debris is possibly associated with the casual consumption of shell fish during specific periods of mound use. The presence of mussel shell material on and within mounds, supported by isotopic evidence indicating mussels were a significant food source for women and juveniles, but not men, in the region (Pate 2006:232, Pate and Owen 2014), suggests an association of women with oven mounds (Martin 2006). This pattern possibly indicates the use, by women, of small day-time campsites near foraging and processing areas (plant resource/oven mound) where shell fish was cooked and consumed during the work day. However, in this context, it is important to note oven mounds would quite probably have been used for the cooking of small animals, fish and birds as well, on an opportunistic basis by the women who operated them (Keen 2004:39–44, 307).

In the scenario developed above, oven mounds constitute a sophisticated, communal economic asset with a predominant and repeatable purpose over time, which suggests the potential for a special category within Aboriginal social relationships. The seasonal and repeated use of specific earth oven locations, which gives rise to an oven mound, is a special and important subsistence system, the ownership of which may have been imbued with cultural, social or even spiritual significance (Keen 2004:299–300). The basic questions of course are: Why develop a mound? Why not dig an oven anywhere when needed? Reasons for site location and maintenance potentially include:

- Proximity to specific resources;
- Areas not subject to flooding in some instances;
- Reduced effort of establishing ovens through repeat use of pre-dug soil;

- Reuse of heat retainer material from previous firings;
- Landscape hygiene, derived from confining a smelly and dirty process to a specific location away from general living areas;
- Clan or family ownership of the oven site/mound, resources and surrounding country;
- Factors associated with gender roles and ownership; and
- Cultural or spiritual factors.

As has been argued by others in other regions, the management, harvesting and processing of *Typha* spp. in oven mounds was a critical and relatively sophisticated component of the subsistence economy at Calperum and was managed by women (Eyre 1845 2:291; Keen 2004:307; Lawrence 1969:96). This involved the establishment of oven mounds close to stands of *Typha* spp*.,* which were potentially subject to a system of phased management as outlined by Klaver (1998:87) for the Murrumbidgee region. Physical proximity of processing to raw material is likely for the simple logistic reason that it results in less final product to carry, in contrast to transporting the raw material. During this period, base-camp locations could be situated close, but separate to oven mound sites. Base-camp site choice would involve some flexibility in practice, influenced by factors such as time of year (flood or non-flood), access to water, access to good fishing and hunting locations, quality of campsite locations and group land/asset ownership criteria.

Cultural socio-economic expression

The distribution of oven mounds within the Calperum floodplain suggests that heat retainer oven mounds had a strong seasonal and resource-utilisation basis for their location and intensive use. In addition, as argued previously, there are gender and socio-economic implications in the patterns which can be observed in the landscape. However, to argue that earth oven mounds at Calperum constitute cultural markers is difficult, as there is no discernible deliberate mounding or any feature which makes them stand out within the landscape, as described by Martin (2006) for mounds in the south-western portion of the Hay Plain. However, the regular pattern of oven mound distribution, along and around water features, both within the meander floodplain and the northern bank of Hunchee creek, suggests long-term asset maintenance and exclusivity, with oven mound ownership potentially operating at family and/or clan level. This could have extended to exclusivity with respect to base camp locations and other economic resources (Keen 2004:293-303).

Martin's (2006) hypothesis is that the larger earth mounds in the Hay Plain constitute cultural markers of territory and are part of a social landscape with significant implications for the social positioning of women and their role in society. The presence of two very unusually large mounds in the south-west portion of the Hay Plain adds some credence to this argument. The data from this study indicates that Calperum earth oven mounds are at the very much smaller end of the regional spectrum for this artefact, with a closer similarity to the ashy deposits of the Menindee Lakes rather than the large features of the Hay plain (Martin 2006:211). The active nature of riverine environment, incorporating cycles of erosion and deposition, potentially precludes mounds of a monumental nature since none have been recorded outside the Hay Plain region.

Summary

The Calperum oven mounds are remnant Indigenous artefacts from the late Holocene, associated with a resource rich but variable environment. They were critical to the maximisation of nutritional resources derived from plant resources over the annual flood cycle. The number and distribution of oven mound sites and the postulated distribution, structure and numbers of family groups within the Calperum floodplain, suggests a semi-sedentary lifestyle with seasonal dispersion of family groups determined by the extent of annual flooding. In this settlement scenario, groups would spread out over the floodplain during the period from February to August following seasonal social aggregations at the end of flooding in summer, enabled by an abundance of plant, animal and aquatic foods. During autumn and winter, groups would rely on scarce and dispersed resources including vegetable foods, mussels, fish and whatever animal resources could be accessed. At times of flood the population would withdraw north away from the main river and floodplain, to more elevated areas, to maintain access to *Typha* spp. and other plant resources around the anabranch and lake systems, as well as seeds and the animal resources of the hinterland. Oven mounds constituted a reusable asset which were utilised on a cyclical basis, possibly by family groups, and potentially subject to socio-economic and cultural criteria. Within this interpretation, women likely occupied an important role in the operation and maintenance of oven mounds and the supply of critical nutritional resources to family and clan groups. The inability of this study, to provide radiocarbon ages for oven mounds contained within the Calperum floodplain, precludes assessment of the local human response to long term change during the mid to late Holocene. However, the Calperum oven mounds do provide a useful case study for the response of late Holocene Aboriginal people, in active riverine systems, to local environmental variability, as discussed above, and for which appropriate conclusions will be outlined in Chapter Seven.

7 Conclusion

The central purpose of this study was:

> **To test the hypothesis that the Indigenous earth mounds located on the Calperum floodplain, represent similar adaptations to environmental variability as proposed for other regions of the Murray Darling Basin during the late Holocene.**

The research question posed was:

> **What does ethno-history, the archaeological remains of earth mounds and a comparison with the regional earth mound dataset, reveal about demography, economic settlement patterns, resource utilisation, site selection and function, on the Calperum floodplain?**

The research was initiated through an investigation and recording of a sample of oven mounds located within the boundaries of Reny Island, Hunchee Island, a portion of the northern bank of Hunchee Creek and the north-eastern margin of Lake Merreti (Figure 5.2). Limitations to this research included an inability to excavate, limited location access and time available for survey. Also, the quantification of shell fragments and/or burnt clay nodules on mounds was precluded, in some instances, through vegetation cover, surface disturbance by rabbits or a cover of alluvium. Consequently, the investigation was confined to the compilation of chronological and morphological datasets for the region from previous research, an analysis of demographic information from ethno-historical sources; and morphological and spatial data derived from field survey. The field survey provided a sample of 27 oven mounds which were used for comparison with the regional dataset. An analysis of site location, landscape use and resource utilisation was conducted and socio-economic and cultural factors considered.

The oven mounds of the Calperum floodplain lie within the temporal, dimensional, morphological and functional dataset for earth mounds which occur in similar riverine environments within the Murray Darling Basin. Calperum oven mounds share similarities with the ashy deposits of the Menindee Lakes region but demonstrate a higher and more contained structure.

There is a lack of evidence for the development and use of any Calperum oven mounds as occupational space, as has been suggested by previous researchers for some earth mounds in the upper regions of the Murray River in Victoria and New South Wales. There, larger occupational mounds (type four above) are suggested to have been developed from oven mounds (type three), and often demonstrate a satellite configuration with smaller oven mounds. There is also no evidence for the co-location of living space and intensive oven mound cooking functions as outlined by Westell and Wood (2014) for the lower Murray Gorge.

The diversity in function and morphology, exhibited across the wider region, is most likely a result of diverse geomorphic and other environmental factors acting on basically similar developmental processes and is potentially associated with heat-retainer cooking technology. At Calperum this was influenced by key local environmental factors. The geomorphology and associated hydrological patterns created a uniquely configured floodplain, with a large anabranch system that fed several ephemeral lakes. The lakes then served as a seasonal reservoir providing additional resources into autumn and winter, that underpinned a seasonal pattern of north-south mobility. This contrasted with the stay-put strategy of groups in the central Murray sub-region, which was based on the selective development of some oven mounds into occupation space, as an enabler for continued access to wetland resources during flooding (Coutts et al. 1979:85–86). Oven mound distribution at Calperum indicates an association with water and aquatic plant communities as well as other plant resources of the floodplain, suggesting a deliberate north-south separation to maximise these resources over the annual flood cycle.

An analysis of early European first-hand accounts of Indigenous people in the Riverland region of South Australia, indicates a demographic pattern similar to that reported by others (Allen 1972; Klaver 1998; Pardoe 2003) in similar environments in the region, with populations leading a semi-sedentary lifestyle largely determined by cyclical flooding events. This insight, in association with an analysis of the seasonal availability of food resources, allows the development of a settlement and mobility model tuned to seasonal variability associated with the annual flood cycle. Oven mounds constituted a vital component of production within this system, which is reflected across the region, albeit expressed at various levels of scale and development. The interpretation presented here, attributes a sophisticated management system, as a key factor in the operation of heat retainer technology and the maximisation of staple food production. Whilst no evidence exists to indicate that the Calperum oven mounds served as cultural markers, the location and distribution of mounds within and around the elevated edge of the meander floodplain potentially indicates deliberate placement and cultural influences associated with age, sex/gender and kin relationships (Keen 2004:300). The potential association of women with oven mounds highlights interesting questions about gender roles and the adoption of new ideas and the implementation of technical innovation within Indigenous societies.

The unique geomorphology and extensive archaeological record of the floodplain landscape in the Riverland region of South Australia provides significant opportunities for further archaeological research beyond the scope of this study. Prior to the construction of the current system of weirs and locks, climatic variability and a distinct geomorphology combined to produce an environment characterised by cyclic challenges and stress but which also provided opportunities to mitigate risk. The study outlined, has examined one specific type of archaeological site and considered the adoption of management strategies to mitigate environmental risk at a relatively small scale. An opportunity exists to enlarge this scope to a regional case study which focusses on settlement patterns across the breadth of the floodplain landscape and which considers the full suite of archaeological sites present. Such research may enable a contribution to models which have been advanced to explain change at the continental level, during the mid to late Holocene.

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Appendix 1

Published uncalibrated C^{14} age data and analysis for earth mounds of the Murray Darling Basin, by sub-region.

Table A1.1: Available uncalibrated earth mound C^{14} ages by precinct in 500 year periods. Note Lake Boort ages were not included as they were derived from the same mound.

	Radiocarbon Age BP									
Precinct	0-500	501-1000	1001-1500	1501-2000	2001-2500	2501-3000	3001-3500	3501-4000	4001-4500	Total
Western Victoria	1	2	3	2	1	0	0	0	0	**9**
Nyah	2	6	8	1	0	0	0	0	0	**17**
North Adelaide	0	2	1	0	1	0	0	0	0	**4**
Hay Plain	0	0	0	0	0	0	0	2	2	**4**
Murrumbidgee	7	12	0	0	0	4	0	0	0	**23**
Wakool	0	0	0	0	2	1	0	0	1	**4**
Goulbourn River	2	0	0	0	0	0	0	0	0	**2**
M. Marsh	0	1	0	0	0	0	0	0	0	**1**
Total	**12**	**23**	**12**	**3**	**4**	**5**	**0**	**2**	**3**	**64**

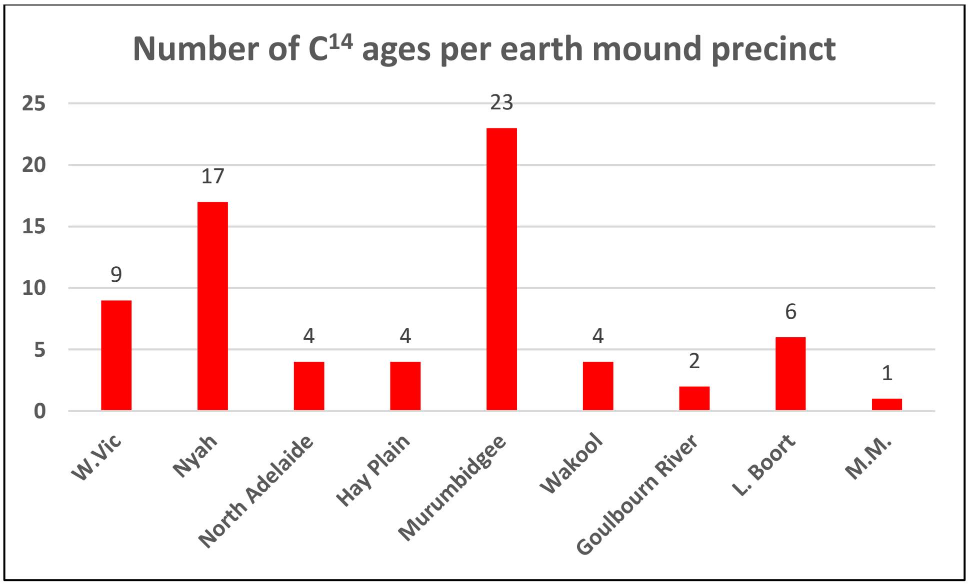


Figure A1.1: Number of available earth mound C^{14} ages per sub-region. Note: Lake Boort ages are from sequential levels of the same mound.

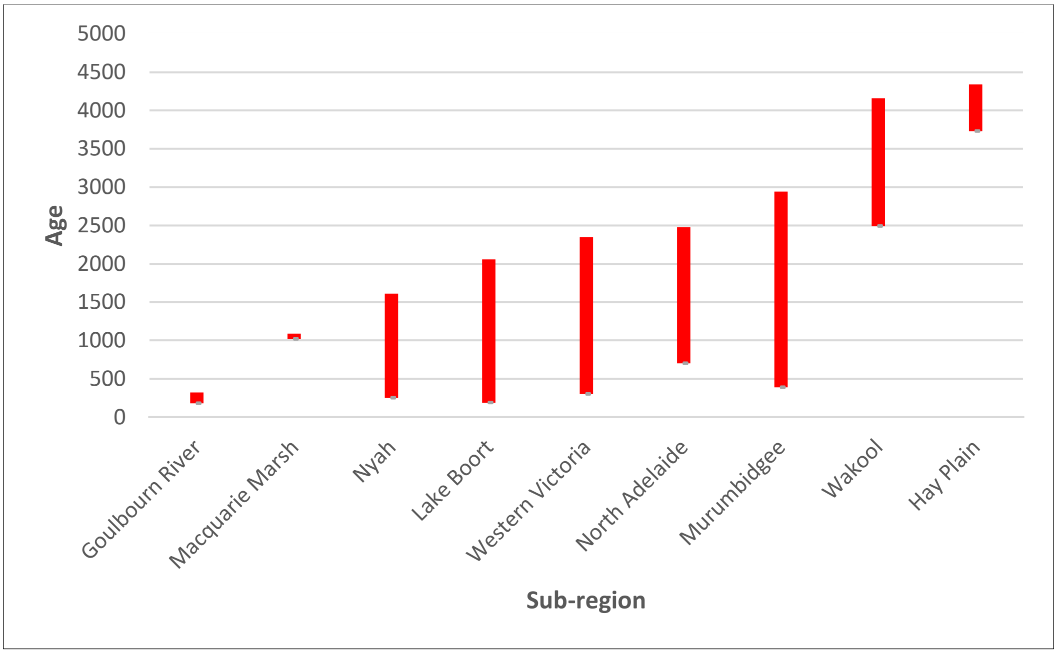


Figure A1.2: Earth mound radiocarbon ages by sub-region in the Murray Darling Basin.

Table A1.2: Oldest available earth mound ages by sub-region (Balme and Beck 1996; Coutts et al. 1977; Godfrey et al. 1996; Johnson 2004; Klaver 1998; Martin 2006; Berryman and Frankel 1984, Westell and Wood 2014).

Region	Code	Age BP	Error (+/-)
Hay Plain	WK-4101	4340	110
Wakool	Beta-7066	4160	90
Murrumbidgee	ANU-7880	2940	170
North Adelaide Plain	N/A	2480	N/A
Western Victoria	SUA-574	2350	300
Lake Boort (Nth. Vic)	WK-11149	2059	46
Nyah Forrest (Nth. Vic.)	SUA-1118	1610	90
Macquarie Marsh	SUA-2829	1050	90
G’bourn River (Nth. Vic)	Beta-63812	320	70

Table A1.3: Selected ages for six separate mounds, in the Nyah Forrest in northern Victoria, indicating a relative span of 470 years (Coutts et al. 1979).

Site	Code	Age BP	Error (+/-)
Nyah Forrest DP/1	SUA-997	1375	80
Nyah Forrest DP/2	SUA-1928	1390	60
Nyah Forrest DP/5	SUA-1119	1470	90
Nyah Forrest DP/6	SUA-1930	1000	80
Nyah Forrest DP/7	SUA-1120	1180	150
Nyah Forrest DP/8	SUA-1241	1000	90

Table A1.4: All available ages for mounds located in the Nyah Forrest area of northern Victoria, in chronological order (Coutts et al. 1979).

Site	Code	Age BP	Error (+/-)
DP/5	SUA-1128	250	80
DP/8	SUA-1917	260	70
DP/1	SUA-1242	730	80
DP/2	SUA-1117	800	100
DP/1	SUA-996	960	80
DP/6	SUA-1916	950	80
DP/6	SUA-1930	1000	80
DP/8	SUA-1241	1000	90
DP/5	SUA-1929	1030	60
DP/7	SUA-1120	1180	150
DP/1	SUA-999	1200	80
DP/1	SUA-998	1245	80
DP/2	SUA-1927	1250	60
DP/1	SUA-997	1375	130
DP/2	SUA-1928	1390	60
DP/5	SUA-1119	1470	90
DP/2	SUA-1118	1610	90

Table A1.5: Age range for a single mound, located in the Lake Boort area of northern Victoria (Johnson 2004).

Site	Code	**Age BP**	Error (+/-)
Boort Swamp Mound 2	WK-11144	187	49
Boort Swamp Mound 2	WK-11146	187	50
Boort Swamp Mound 2	Wk-11147	261	47
Boort Swamp Mound 2	Wk-11145	775	47
Boort Swamp Mound 2	WK-11148	984	48
Boort Swamp Mound 2	WK-11149	2059	46

Table A1.6: Available Age range for mounds in the Goulbourn floodplain, northern Victoria (Godfrey et al. 1996).

Site	**Code**	**Age BP**	**Error (+/-)**
Munroes Plain 1	Beta-63813	180	50
Munroes Plain 1	Beta-63812	320	70

Table A1.7: Age range for mounds in the Wakool region (Berryman and Frankel 1984).

Site	**Code**	**Age BP**	**Error (+/-)**
M1	Beta-7067	2490	60
F3	Beta-7068	2990	100
M1	Beta-7066	4160	300

Table A1.8: Age range for mounds in the Hay Plain region (Martin 2006).

Site	**Code**	**Age BP**	**Error (+/-)**
Tchelery 1	WK-4095	3730	240
Ravensworth 3	WK-17504	3820	36
Ravensworth 3	WK-17489	4109	55
Tchelery 1	WK-4101	4340	160

Table A1.9: Age range for mounds in the Murrumbidgee region (Klaver 1998).

Site	Code	Age BP	Error (+/-)
CP82/4/1-2-3/C	ANU-8620	390	70
CP82/4/1-2-/D	ANU-8623	390	70
CP82/3/BB/7J	ANU-8617	420	70
CP59/4/a & b	ANU-8608	440	70
CP116/D4/	ANU-8616	450	60
CP82/6D/2/G	ANU-8626	490	60
CP16/D3/8	ANU-8611	500	70
CP116/D4/6	ANU-8615	530	70
CP116/D4/5	ANU-8614	550	50
CP82/3BB/7J	ANU-8618	640	60
CP59/4/a&b	ANU-8609	650	70
CP82/4/6/E	ANU-8624	650	60
CP79	ANU-8605	680	60
CP82/6D/7/F	ANU-8625	690	60
CP116/D3/3	ANU-8613	740	60
CP79	ANU-8604	750	60
CP82/4/1-2-3/C	ANU-8622	960	170
CP116/D4/	ANU-8603	970	70
CP116/4/ 9	ANU-8613	970	50
CP82/3BB/6/K	ANU-8619	2660	70
CC36/lev 4	ANU-7879	2720	90
CC36/lev 2/d	ANU-7880	2890	90
CC5/lev1CC32	ANU-7880	2940	170

Table A1.10: Age range for mounds in the western districts of Victoria (Coutts et al. 1977; Coutts et al. 1978; Williams 1988).

Site	Code	Age BP	Error (+/-)
M33	ANU-4322	300	60
MCC5	ANU-3762	790	190
CH/1	SUA-778	995	100
MMS	ANU-3758	1270	100
C/2	SUA-571	1320	100
KP/1	SUA-672	1420	100
C/3	SUA-537	1840	100
MCC6	ANU-3888	1870	130
FM/1	SUA-574	2350	110

Table A1.11: Age range for mounds in the north Adelaide plain (Westell and Wood 2014).

Site	Code	Age BP	Error (+/-)
North Adelaide Plain	N/A	700	N/A
North Adelaide Plain	N/A	760	N/A
North Adelaide Plain	N/A	1126	N/A
North Adelaide Plain	N/A	2480	N/A

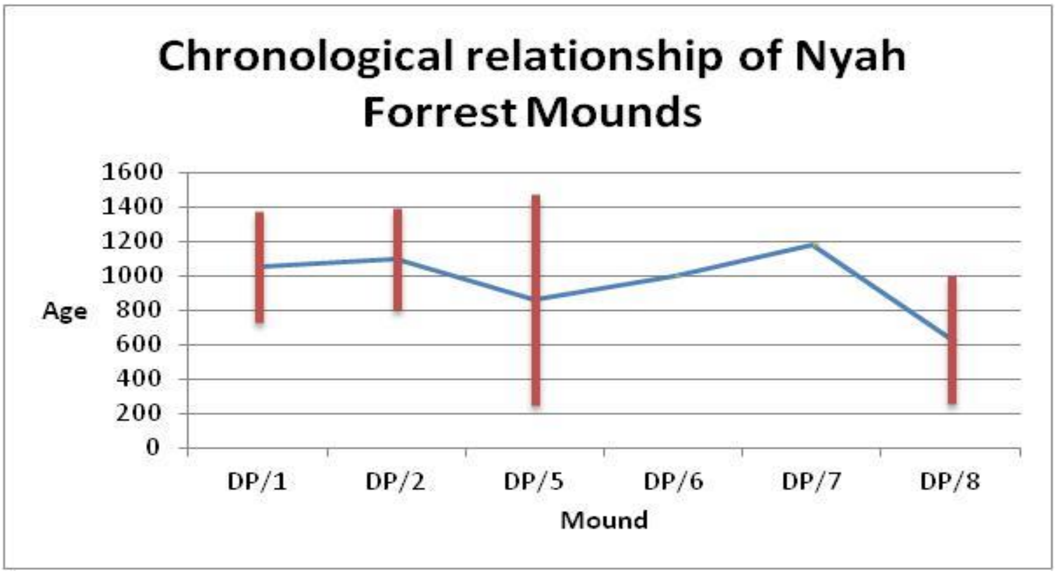


Figure A1.3: Chronological relationship of Nyah Forrest mounds.

Note: Mounds DP/1, DP/2, DP/5, DP/6 and DP/7 lie within 1,200m of each other (Sullivan 1980).

Appendix 2

Published Uncalibrated C^{14} ages for Earth Mounds in the Murray Darling Basin, in age order by location.

(Williams et al 2008, sourced from the Australian Archaeological Association website at: http://www.australianarchaeology.com.au/resources-2/radiocarbon-datasets/, accessed 11:06 23 August 2015; also from Martin 2006:App.4).

RA Region	Long.	Lat.	Site	Site Type	Lab code	14C age	14C error	Material	Context	Open or Closed Site	Directly Related to occupation? Yes/Unknown	Source	Notes
G'bourn River	145.40	-36.38	Munroes Plain 1	Earth mound	Beta-63813	180	50	Charcoal	Spit 3	Open	U	Aboriginal Affairs Victoria cit. Godfrey et al. 1996	A sample referred to as part of a wider review of Victorian radiocarbon dates. This sample comes from an earth mound on the Goulbourn River Plains. No further contextual information provided.
Lake Boort	143.75	-36.14	Boort Swamp Mound 2	Earth mound	Wk-11144	187	49	Charcoal	Sq. 1, layer 1	Open	Y	Johnston, 2004	An earth mound excavated on the edges of Lake Boort, northern Victoria. Excavations indicated occupation occurred between c. 2.2 ka - 0.2ka. The mound included evidence of hearth construction and rejuvenation of stone tools (which were dominated by quartz broken flakes). The study suggests that the nearby Kinypanial creek was exploited during lower lake levels. The site compares well with other earth mounds and fits within Coutts 'Type B' typology.
Lake Boort	143.75	-36.14	Boort Swamp Mound 2	Earth mound	Wk-11146	187	50	Charcoal	Sq. 1, layer 2 (base)	Open	Y	Johnston, 2004	An earth mound excavated on the edges of Lake Boort, northern Victoria. Excavations indicated occupation occurred between c. 2.2 ka - 0.2ka. The mound included evidence of hearth construction and rejuvenation of stone tools (which were dominated by quartz broken flakes). The study suggests that the nearby Kinypanial creek was exploited during lower lake levels. The site compares well with other earth mounds and fits within Coutts 'Type B' typology.

IBRA Region	Long.	Lat.	Site	Site Type	Lab code	14C age	14C error	Material	Context	Open or Closed Site	Directly Related to occupation? Yes/Unknown	Source	Notes
Nyah	143.38	-35.17	DP/5	Earth mound	SUA-1128	250	80	Charcoal	Pit A, sq. 110/111, spit 4	Open		Aboriginal Affairs Victoria cit. Godfrey et al. 1996	A sample referred to as part of a large-scale compilation of radiocarbon dates in Victoria. This sample comes from an earth mound on the Murray River near Swan Hill. It may relate to work by Coutts (1979).
Nyah	143.38	-35.17	DP/8	Earth mound	SUA-1917	260	70	Charcoal	Spit 5	Open		Aboriginal Affairs Victoria cit. Godfrey et al. 1996	A sample referred to as part of a large-scale compilation of radiocarbon dates in Victoria. This sample comes from an earth mound on the Murray River near Swan Hill. It may relate to work by Coutts (1979).
Lake Boort	143.75	-36.14	Boort Swamp Mound 2	Earth mound	Wk-11147	261	47	Charcoal	Sq. 5, layer 1	Open	Y	Johnston, 2004	An earth mound excavated on the edges of Lake Boort, northern Victoria. Excavations indicated occupation occurred between c. 2.2 ka - 0.2ka. The mound included evidence of hearth construction and rejuvenation of stone tools (which were dominated by quartz broken flakes). The study suggests that the nearby Kinypanial creek was exploited during lower lake levels. The site compares well with other earth mounds and fits within Coutts 'Type B' typology.
Caramut			M 33	Earth Mound	ANU-4322	300	60					Williams 1988	

IBRA Region	Long.	Lat.	Site	Site Type	Lab code	14C age	14C error	Material	Context	Open or Closed Site	Directly Related to occupation? Yes/Unknown	Source	Notes
G'bourn River	145.40	-36.38	Munroes Plain 1	Earth mound	Beta-63812	320	70	Charcoal	Spit 2	Open	U	Aboriginal Affairs Victoria cit. Godfrey et al. 1996	A sample referred to as part of a wider review of Victorian radiocarbon dates. This sample comes from an earth mound on the Goulbourn River Plains. No further contextual information provided.
Murrumb.			CP82/4/1-2-3/C	Earth mound	ANU-8620	390	70	Charcoal RC				Klaver 1998	
Murrumb.			CP82/4/1-2-/D	Earth mound	ANU-8623	390	70	Charcoal RC				Klaver 1998	
Murrumb.			CP82/3/BB/7J	Earth mound	ANU-8617	420	70	Charcoal RC				Klaver 1998	
Murrumb.			CP59/4/a & b	Earth mound	ANU-8608	440	70	Charcoal RC				Klaver 1998	
Murrumb.			CP116/D4/	Earth mound	ANU-8616	450	60	Charcoal RC				Klaver 1998	
Murrumb.			CP82/6D/2/G	Earth mound	ANU-8626	490	60	Charcoal RC				Klaver 1998	
Murrumb.			CP16/D3/8	Earth mound	ANU-8611	500	70	Charcoal RC				Klaver 1998	
Murrumb.			CP116/D4/6	Earth mound	ANU-8615	530	70					Klaver 1998	
Murrumb.			CP116/D4/5	Earth mound	ANU-8614	550	50					Klaver 1998	

IBRA Region	Long.	Lat.	Site	Site Type	Lab code	14C age	14C error	Material	Context	Open or Closed Site	Directly Related to occupation? Yes/Unknown	Source	Notes
Murrumb.			CP82/3BB/7J	Earth mound	ANU-8618	640	60	Charcoal RC				Klaver 1998	
Murrumb.			CP59/4/a&b	Earth mound	ANU-8609	650	70	Charcoal RC				Klaver 1998	
Murrumb.			CP82/4/6/E	Earth mound	ANU-8624	650	60	Charcoal RC				Klaver 1998	
Murrumb.			CP79	Earth mound	ANU-8605	680	60	Charcoal RC				Klaver 1998	
Murrumb.			CP82/6D/7/F	Earth mound	ANU-8625	690	60	Charcoal RC				Klaver 1998	
Nth Adel Plain				Earth mound		700						Westell and Wood 2014	

IBRA Region	Long.	Lat.	Site	Site Type	Lab code	14C age	14C error	Material	Context	Open or Closed Site	Directly Related to occupation? Yes/Unknown	Source	Notes
Nyah Forrest	143.38	-35.17	DP/1 (75271/003)	Earth mound	SUA-1242	730	80	Charcoal	Pit G, Sq. 122/147, spit 4	Open		Aboriginal Affairs Victoria cit. Godfrey et al. 1996	An earth mound excavated in Nyah forest on the Murray River near Swan Hill. The site is 600 m from Murray River and 250 m from Parne Milloo. The earth mound was 50 m in diameter and 1 m high at its apex. The upper deposits had been impacted by rabbits and rabbit trappers. Excavation of three test pits revealed six layers. Artefacts were sparse and included one chert and four quartz flakes, one flint core, one quartz tool, one waterworn pebble, one amorphous artefact (possibly ground), three freshwater shell fragments possibly worked and four broken bone bi-points. The nearest known chert is over 100 km from the site. Fish bone, freshwater mussel, gastroliths, burnt clay pellets and emu eggshell were also present. A skeleton was also identified heavily disturbed in layer 1. The bones of this body revealed initial desiccation followed by covering in ochre and cremation.

IBRA Region	Long.	Lat.	Site	Site Type	Lab code	14C age	14C error	Material	Context	Open or Closed Site	Directly Related to occupation? Yes/Unknown	Source	Notes
Murrumb.			CP116/D3/3	Earth mound	ANU-8613	740	60	Charcoal RC				Klaver 1998	
Murrumb.			CP79	Earth mound	ANU-8604	750	60	Charcoal RC				Klaver 1998	
Nth Adel. Plain				Earth mound		760						Westell and Wood 2014	
Lake Boort	143.75	-36.14	Boort Swamp Mound 2	Earth mound	Wk-11145	775	47	Charcoal	Sq. 1, layer 2 (top)	Open	Y	Johnston, 2004	An earth mound excavated on the edges of Lake Boort, northern Victoria. Excavations indicated occupation occurred between c. 2.2 ka - 0.2ka. The mound included evidence of hearth construction and rejuvenation of stone tools (which were dominated by quartz broken flakes). The study suggests that the nearby Kinypanial creek was exploited during lower lake levels. The site compares well with other earth mounds and fits within Coutts 'Type B' typology.
Caramut			`MCC 5	Earth Mound	ANU-3762S	790	190					Williams 1988	
Nyah	143.38	-35.17	DP/2	Earth mound	SUA-1117	800	100	Charcoal	Spit 5	Open		Aboriginal Affairs Victoria cit. Godfrey et al. 1996	A sample referred to as part of a large-scale compilation of radiocarbon dates in Victoria. This sample comes from an earth mound on the Murray River near Swan Hill. It may relate to work by Coutts (1979).

IBRA Region	Long.	Lat.	Site	Site Type	Lab code	14C age	14C error	Material	Context	Open or Closed Site	Directly Related to occupation? Yes/Unknown	Source	Notes
Nyah	143.38	-35.17	DP/6	Earth mound	SUA-1916	950	80	Charcoal	Spit 7	Open		Aboriginal Affairs Victoria cit. Godfrey et al. 1996	A sample referred to as part of a large-scale compilation of radiocarbon dates in Victoria. This sample comes from an earth mound on the Murray River near Swan Hill. It may relate to work by Coutts (1979).
Nyah	143.38	-35.17	DP/1 (75271/003)	Earth mound	SUA-996	960	80	Charcoal	Bottom of layer 4	Open	Y	Coutts et al. 1979; Coutts, 1980	An earth mound excavated in Nyah forest on the Murray River near Swan Hill. The site is 600 m from Murray River and 250 m from Parne Milloo. The earth mound was 50 m in diameter and 1 m high at its apex. The upper deposits had been impacted by rabbits and rabbit trappers. Excavation of three test pits revealed six layers. Artefacts were sparse and included one chert and four quartz flakes, one flint core, one quartz tool, one waterworn pebble, one amorphous artefact (possibly ground), three freshwater shell fragments possibly worked and four broken bone bi-points. The nearest known chert is over 100 km from the site. Fish bone, freshwater mussel, gastroliths, burnt clay pellets and emu eggshell were also present. A skeleton was also identified heavily disturbed in layer 1. The bones of this body revealed initial desiccation followed by covering in ochre and cremation.

IBRA Region	Long.	Lat.	Site	Site Type	Lab code	14C age	14C error	Material	Context	Open or Closed Site	Directly Related to occupation? Yes/Unknown	Source	Notes
Murrumb.			CP82/4/1-2-3/C	Earth mound	ANU-8622	960	170	Charcoal RC				Klaver 1998	
Murrumb.			CP116/D4/	Earth mound	ANU-8603	970	70	Charcoal RC				Klaver 1998	
Murrumb.			CP116/4/ 9	Earth mound	ANU-8613	970	50	Charcoal RC				Klaver 1998	
Western Victoria			CH/1	Earth Mound	SUA-778	995	100					Coutts et al.1978	
Lake Boort	143.75	-36.14	Boort Swamp Mound 2	Earth mound	Wk-11148	984	48	Charcoal	Sq. 5, layer 3	Open	Y	Johnston, 2004	An earth mound excavated on the edges of Lake Boort, northern Victoria. Excavations indicated occupation occurred between c. 2.2 ka - 0.2ka. The mound included evidence of hearth construction and rejuvenation of stone tools (which were dominated by quartz broken flakes). The study suggests that the nearby Kinypanial creek was exploited during lower lake levels. The site compares well with other earth mounds and fits within Coutts 'Type B' typology.

IBRA Region	Long.	Lat.	Site	Site Type	Lab code	14C age	14C error	Material	Context	Open or Closed Site	Directly Related to occupation? Yes/Unknown	Source	Notes
Nyah	143.38	-35.17	DP/6	Earth mound	SUA-1930	1000	80	Charcoal	Tp.1, spit 10	Open		Aboriginal Affairs Victoria cit. Godfrey et al. 1996	A sample referred to as part of a large-scale compilation of radiocarbon dates in Victoria. This sample comes from an earth mound on the Murray River near Swan Hill. It may relate to work by Coutts (1979).
Nyah	143.38	-35.17	DP/8	Earth mound	SUA-1241	1000	90	Charcoal	Pit A, sq. 100/100, spit 19	Open		Aboriginal Affairs Victoria cit. Godfrey et al. 1996	A sample referred to as part of a large-scale compilation of radiocarbon dates in Victoria. This sample comes from an earth mound on the Murray River near Swan Hill. It may relate to work by Coutts (1979).
Nyah	143.38	-35.17	DP/	Earth mound	SUA-1929	1030	60	Charcoal	Sq. 110/103, spit 11	Open		Aboriginal Affairs Victoria cit. Godfrey et al. 1996	A sample referred to as part of a large-scale compilation of radiocarbon dates in Victoria. This sample comes from an earth mound on the Murray River near Swan Hill. It may relate to work by Coutts (1979).
Macquarie Marsh				Earth mound	SUA-2892	1050	90	Charcoal				Balme and Beck 1996	
Nth Adel. Plain				Earth mound		1126		?				Westell and Wood 2014	
Nyah	143.38	-35.17	DP/7	Earth mound	SUA-1120	1180	150	Charcoal	Pit A, sq. 120/105, spit 12	Open		Aboriginal Affairs Victoria cit. Godfrey et al. 1996	A sample referred to as part of a large-scale compilation of radiocarbon dates in Victoria. This sample comes from an earth mound on the Murray River near Swan Hill. It may relate to work by Coutts (1979).

IBRA Region	Long.	Lat.	Site	Site Type	Lab code	14C age	14C error	Material	Context	Open or Closed Site	Directly Related to occupation? Yes/Unknown	Source	Notes
Nyah	143.38	-35.17	DP/1 (75271/003)	Earth mound	SUA-999	1200	80	Charcoal	Layer 5	Open	Y	Coutts et al. 1979; Coutts, 1980	An earth mound excavated in Nyah forest on the Murray River near Swan Hill. The site is 600 m from Murray River and 250 m from Parne Milloo. The earth mound was 50 m in diameter and 1 m high at its apex. The upper deposits had been impacted by rabbits and rabbit trappers. Excavation of three test pits revealed six layers. Artefacts were sparse and included one chert and four quartz flakes, one flint core, one quartz tool, one waterworn pebble, one amorphous artefact (possibly ground), three freshwater shell fragments possibly worked and four broken bone bi-points. The nearest known chert is over 100 km from the site. Fish bone, freshwater mussel, gastroliths, burnt clay pellets and emu eggshell were also present. A skeleton was also identified heavily disturbed in layer 1. The bones of this body revealed initial desiccation followed by covering in ochre and cremation.

IBRA Region	Long.	Lat.	Site	Site Type	Lab code	14C age	14C error	Material	Context	Open or Closed Site	Directly Related to occupation? Yes/Unknown	Source	Notes
Nyah	143.38	-35.17	DP/1 (75271/003)	Earth mound	SUA-998	1245	80	Charcoal	Bottom of layer 3	Open	Y	Coutts et al. 1979; Coutts, 1980	An earth mound excavated in Nyah forest on the Murray River near Swan Hill. The site is 600 m from Murray River and 250 m from Parne Milloo. The earth mound was 50 m in diameter and 1 m high at its apex. The upper deposits had been impacted by rabbits and rabbit trappers. Excavation of three test pits revealed six layers. Artefacts were sparse and included one chert and four quartz flakes, one flint core, one quartz tool, one waterworn pebble, one amorphous artefact (possibly ground), three freshwater shell fragments possibly worked and four broken bone bi-points. The nearest known chert is over 100 km from the site. Fish bone, freshwater mussel, gastroliths, burnt clay pellets and emu eggshell were also present. A skeleton was also identified heavily disturbed in layer 1. The bones of this body revealed initial desiccation followed by covering in ochre and cremation.
Nyah	143.38	-35.17	DP/2	Earth mound	SUA-1927	1250	60	Charcoal	Sq. 118/116, spit 5D	Open		Aboriginal Affairs Victoria cit. Godfrey et al. 1996	A sample referred to as part of a large-scale compilation of radiocarbon dates in Victoria. This sample comes from an earth mound on the Murray River near Swan Hill. It may relate to work by Coutts (1979).

IBRA Region	Long.	Lat.	Site	Site Type	Lab code	14C age	14C error	Material	Context	Open or Closed Site	Directly Related to occupation? Yes/Unknown	Source	Notes
Caramut			MMS	Earth Mound	ANU—3758	1270	100					Williams 1988	
Western Victoria			C/2	Earth Mound	SUA-571	1320	100					Coutts et al.1977	
Nyah	143.38	-35.17	DP/1 (75271/003)	Earth mound	SUA-997	1375	130	Charcoal	Layer 5/6 interface	Open	Y	Coutts et al. 1979; Coutts, 1980	An earth mound excavated in Nyah forest on the Murray River near Swan Hill. The site is 600 m from Murray River and 250 m from Parne Milloo. The earth mound was 50 m in diameter and 1 m high at its apex. The upper deposits had been impacted by rabbits and rabbit trappers. Excavation of three test pits revealed six layers. Artefacts were sparse and included one chert and four quartz flakes, one flint core, one quartz tool, one waterworn pebble, one amorphous artefact (possibly ground), three freshwater shell fragments possibly worked and four broken bone bi-points. The nearest known chert is over 100 km from the site. Fish bone, freshwater mussel, gastroliths, burnt clay pellets and emu eggshell were also present. A skeleton was also identified heavily disturbed in layer 1. The bones of this body revealed initial desiccation followed by covering in ochre and cremation.

IBRA Region	Long.	Lat.	Site	Site Type	Lab code	14C age	14C error	Material	Context	Open or Closed Site	Directly Related to occupation? Yes/Unknown	Source	Notes
Nyah	143.38	-35.17	DP/2	Earth mound	SUA-1928	1390	60	Charcoal	Sq. 102/112, spit 9A	Open		Aboriginal Affairs Victoria cit. Godfrey et al. 1996	A sample referred to as part of a large-scale compilation of radiocarbon dates in Victoria. This sample comes from an earth mound on the Murray River near Swan Hill. It may relate to work by Coutts (1979).
Western Victoria			KP/1	Earth Mound	SUA-672	1420	100					Coutts et al.1977	
Nyah	143.38	-35.17	DP/5	Earth mound	SUA-1119	1470	90	Charcoal	Pit A, sq. 110/111, spit 13	Open		Aboriginal Affairs Victoria cit. Godfrey et al. 1996	A sample referred to as part of a large-scale compilation of radiocarbon dates in Victoria. This sample comes from an earth mound on the Murray River near Swan Hill. It may relate to work by Coutts (1979).

BRA Region	Long.	Lat.	Site	Site Type	Lab code	14C age	14C error	Material	Context	Open or Closed Site	Directly Related to occupation? Yes/Unknown	Source	Notes
Nyah	143.38	-35.17	DP/2	Earth mound	SUA-1118	1610	90	Charcoal	Spit 11	Open		Aboriginal Affairs Victoria cit. Godfrey et al. 1996	A sample referred to as part of a large-scale compilation of radiocarbon dates in Victoria. This sample comes from an earth mound on the Murray River near Swan Hill. It may relate to work by Coutts (1979).
Western Victoria			C/3	Earth Mound	SUA-537	1840	100					Coutts et al.1977	
Caramut			MCC6	Earth Mound	ANU-3888	1870	130					Williams 1988	
Lake Boort	143.75	-36.14	Boort Swamp Mound 2	Earth mound	Wk-11149	2059	46	Charcoal	Sq. 3, layer 3 (base)	Open	Y	Johnston, 2004	An earth mound excavated on the edges of Lake Boort, northern Victoria. Excavations indicated occupation occurred between c. 2.2 ka - 0.2ka. The mound included evidence of hearth construction and rejuvenation of stone tools (which were dominated by quartz broken flakes). The study suggests that the nearby Kinypanial creek was exploited during lower lake levels. The site compares well with other earth mounds and fits within Coutts 'Type B'

IBRA Region	Long.	Lat.	Site	Site Type	Lab code	14C age	14C error	Material	Context	Open or Closed Site	Directly Related to occupation? Yes/Unknown	Source	Notes
Wakool	144.32	-35.57	Q7	Oven Mounds	Beta-7065	2250	105	Charcoal	Basal	Open	Y	Berryman & Frankel, 1984	A study of Aboriginal oven mounds near Wakool River between Wakool and Barham. The survey identified 95 mounds and 11 scarred trees in a 1 sq. km study area. The oven mounds had an average diameter of 10-22 m with some up to 48 m, and were generally 40-50 cm in height. Excavations were undertaken at four mounds, which revealed stone, shell and bone, but were dominated by burnt clay and silts.
Western Victoria			FM/1	Earth Mound	SUA-574	2350	110					Coutts et al.1977	
Adelaide Plain			Gillman	Earth Mound	?	2480						Cited by Westell and Wood 2014	

IBRA Region	Long.	Lat.	Site	Site Type	Lab code	14C age	14C error	Material	Context	Open or Closed Site	Directly Related to occupation? Yes/Unknown	Source	Notes
Wakool	144.32	-35.57	M1	Oven Mounds	Beta-7067	2490	60	Charcoal	Basal	Open	Y	Berryman & Frankel, 1984	A study of Aboriginal oven mounds near Wakool River between Wakool and Barham. The survey identified 95 mounds and 11 scarred trees in a 1 sq. km study area. The oven mounds had an average diameter of 10-22 m with some up to 48 m, and were generally 40-50 cm in height. Excavations were undertaken at four mounds, which revealed stone, shell and bone, but were dominated by burnt clay and silts. This sample comes from the same mound as Beta-7066, but from a different area.
Murrumb.			CP82/3BB/6/K	Earth mound	ANU-8619	2660	70	Charcoal RC				Klaver 1998	
Murrumb.			CC36/lev 4	Earth mound	ANU-7879	2720	90	Charcoal RC				Klaver 1998	
Murrumb.			CC36/lev 2/d	Earth mound	ANU-7880	2890	90	Charcoal RC				Klaver 1998	
Murrumb.			CC5/lev 1 CC32	Earth mound	ANU-7880	2940	170	Charcoal RC				Klaver 1998	

IBRA Region	Long.	Lat.	Site	Site Type	Lab code	14C age	14C error	Material	Context	Open or Closed Site	Directly Related to occupation? Yes/Unknown	Source	Notes
Wakool	144.32	-35.57	F3	Oven Mounds	Beta-7068	2990	100	Charcoal	Basal	Open	Y	Berryman & Frankel, 1984	A study of Aboriginal oven mounds near Wakool River between Wakool and Barham. The survey identified 95 mounds and 11 scarred trees in a 1 sq. km study area. The oven mounds had an average diameter of 10-22 m with some up to 48 m, and were generally 40-50 cm in height. Excavations were undertaken at four mounds, which revealed stone, shell and bone, but were dominated by burnt clay and silts.
Hay Plain			Tchelery1	Earth Mound	WK-4095	3730	240	Bone AMS				Martin 2006	
Hay Plain			Ravensworth 3	Earth Mound	WK-17504	3820	36	Bone AMS				Martin 2006	
Hay Plain			Ravensworth 3	Earth Mound	WK-17489	4109	55	Charcoal RC				Martin 2006	

IBRA Region	Long.	Lat.	Site	Site Type	Lab code	14C age	14C error	Material	Context	Open or Closed Site	Directly Related to occupation? Yes/Unknown	Source	Notes
Wakool	144.32	-35.57	M1	Oven Mounds	Beta-7066	4160	300	Charcoal	Removal 4 of 6	Open	Y	Berryman & Frankel, 1984	A study of Aboriginal oven mounds near Wakool River between Wakool and Barham. The survey identified 95 mounds and 11 scarred trees in a 1 sq. km study area. The oven mounds had an average diameter of 10-22 m with some up to 48 m, and were generally 40-50 cm in height. Excavations were undertaken at four mounds, which revealed stone, shell and bone, but were dominated by burnt clay and silts. This sample comes from the same mound as Beta-7067, but from a different area.
Hay Plain			Tchelery1	Earth Mound	WK-4101	4340	160					Martin 2006	

Appendix 3

Calperum earth mound dimensional and surface data.

Survey data for the Calperum earth features is tabulated below. This includes dimensional, spatial and surface data. All measurements are in metres.

Table A3.1: Dimensions of all Calperum earth features surveyed. Note: all measurements in metres.

No.	Length (m)	Width (m)	Height/Depth (m)	Distance of closest edge to water (m)	Feature Type
Remy Island Features					
MRC1	17	16	0.300	1	Natural – burnt tree
RIBB2	17	5	0.150	6	Above ground hearth/oven
RIBB3	20	20	0.200	2	Oven mound
RIBB4	11	11	0.200	2	Oven mound
RIBB5	9	9	0.150	3	Oven mound
RIBB6	10	7	0.200	3	Oven Mound
RIBB7	23	23	0.200	2	Natural - Levy Edge
Ral Ral Creek features					
RRCW8	19	17	0.250	60	Oven mound
RRCW9	24.5	20	0.500	36	Oven mound
RRCW10	16	16	0.400	60	Oven mound
RRCW11	9	9	0.100	80	Oven mound
RRCE12	15	15	0.200	2	Oven mound
RRCE13	1	1	0.500 (depth)	2	Pit
RRCE14	20	20	0.300	80	Oven mound
Hunchee Island Features					
HIBB15	21	20	0.500	3	Oven mound
HIBB16	10	10	0.100	2	Oven mound
HIBB17	10	10	0.100	10	Oven mound
HIBB18	15	15	0.100	30	Oven mound
Hunchee Creek features					
HCS19	20	20	0.200	30	Oven mound
HCN20	20	14	0.200	62	Oven mound
HCN21	40	23	0.500	42	Oven mound
HCN22	25	25	0.500	40	Oven mound
HCN23	22	22	0.250	40	Oven mound
HCN24	16	16	0.400	40	Oven mound
HCN25	20	20	0.200	63	Oven mound
HCN26	3	3	0.010	59	Above ground hearth/oven
HCN27	30	30	0.200	42	Oven mound
HCN28	20	20	0.200	30	Oven mound
HCN29	20	15	0.600	30	Oven mound
HCN30	20	20	0.100	62	Oven mound
HCN31	25	20	0.500	35	Oven mound
MLE32	16	16	0.500	200	Oven Mound

Table A3.2: Dimensional summary of Calperum Floodplain features classified as oven mounds.

Sub-Region	Spl Size	Mean Lgth (m)	Mean Wdth (m)	Mean Hgt (m)	Median Length (m)	Median Width (m)	Median Height (m)	Max Lgth (m)	Min Lgth (m)	Max Wdth (m)	Min Wdth (m)	Max Hgt (m)	Min Hgt (m)
Calperum Floodplain	**26**	**18.9**	**17.0**	**0.28**	**20**	**17**	**0.2**	**40**	**9**	**30**	**7**	**0.6**	**0.1**

Table A3.3: Average of Calperum oven mound dimensions by location.

Environmental Zone	Sample Size	Average Length (m)	Average Width (m)	Average Height (m)	Average dist. to water (m)
Ral Ral Island oven mounds (Billabong)	4	12.50	11.75	0.19	2.5
Ral Ral Creek oven mounds (Anabranch)	6	17.25	16.17	0.29	53
Hunchee Island oven mounds (Billabong)	4	14.00	13.75	0.20	13.3
Hunchee Creek oven mounds (Anabranch)	12	23.17	20.42	0.33	42.3

Table A3.4: Distance between all site types surrounding the Reny Island Billabong.

Feature	Site Interval (m)	Site Type
RIBB2	0	Isol. Oven Feature
RIBB3	64	Oven Mound
RIBB4	322	Oven Mound
RIBB5	53	Oven Mound
RIBB6	168	Oven Mound
RIBB7	63	Natural Mound
	670	**Total distance**
	134	**Average distance**

Table A3.5: Distance between all site types surveyed along the north-south section of Ral Ral creek west.

Feature	Site Interval (m)	Site Type
RRCW8	-	Oven Mound
RRCW9	82	Oven Mound
RRCW10	286	Oven Mound
RRCW11	134	Oven Mound
Total distance	**502**	
Average distance	**167**	

Table A3.6: Distance between all site types surveyed at Ral Ral creek east and Hunchee Creek south (includes HCS19).

Feature	Site Interval (m)	Site Type
RRC13	-	Pit
RRCE12	50	Oven Mound
RRCE14	578	Oven Mound
HCS19	387	Oven Mound
Total distance	**1015**	
Average distance	**338**	

Table A3.7: Distance between all site types surveyed at the Hunchee Island Billabong.

Feature	Site Interval (m)	Site Type
HIBB15	-	Oven Mound
HIBB16	66	Oven Mound
HIBB17	130	Oven Mound
HIBB18	24	Oven Mound
	220	**Total distance**
	73	**Average distance**

Table A3.8: Distance between all site types, north to south along the northern bank of Hunchee Creek.

Feature	Site Interval (m)	Site Type
HCN20	-	Oven Mound
HCN21	434	Oven Mound
HCN22	80	Oven Mound
HCN23	82	Oven Mound
HCN24	91	Oven Mound
HCN25	220	Oven Mound
HCN26	185	Isolated Oven feature
HCN27	148	Oven Mound
NCN28	267	Oven Mound
NCN29	122	Oven Mound
NCN30	268	Oven Mound
NCN31	335	Oven Mound
Total distance	**2231**	
Average distance	**203**	

Table A3.9: Burnt clay and shell fragment counts for selected features which provided an unobscured surface. Mound area was calculated as either a simple circle or ellipse.

Location	Feature	Mound area	Sample size m²	Burnt clay nodules count			Burnt clay nodules per sq m			Shell fragments count			Shell fragments per sq m		
				1-2cm	2-5cm	>5cm	**1-2cm**	**2-5cm**	**>5cm**	<1cm	1-2cm	2-5	**<1cm**	**1-2cm**	**2-5cm**
	MRC1	854.5	6	1301	97	19	217	16	3	636	22	0	106	4	0
Reny Island Billabong	RIBB2	267.0	10	744	47	4	74	5	0	0	0	0	0	0	0
	RIBB3	314.2	10	1622	49	10	162	5	1	0	0	0	0	0	0
	RIBB4	95.0	6	498	2	2	83	0	0	0	0	0	0	0	0
	RIBB5	63.6	6	78	0	0	13	0	0	0	0	0	0	0	0
	RIBB6	219.9	4	275	25	0	69	6	0	0	0	0	0	0	0
	RIBB7	415.5	14	123	4	6	9	0	0	0	0	0	0	0	0
Ral Ral Creek	RRCW8	1014.7	6	249	9	3	42	2	1	0	0	0	0	0	0
	RRCW9	1539.4	6	367	11	4	61	2	1	2	0	0	0	0	0
	RRCW10	201.1	6	755	62	18	126	10	3	0	0	0	0	0	0
	RRCW11	63.6	6	24	0	3	4	0	1	28	2	0	5	0	0
Hunchee Creek north	HCN20	879.6	6	221	25	9	37	4	2	87	0	0	15	0	0
	HCN21	2890.3	4	231	42	7	58	11	2	114	0	0	29	0	0
	HCN22	1727.9	6	106	9	25	18	2	4	144	0	0	24	0	0
	HCN23	380.1	6	508	54	17	85	9	3	30	0	0	5	0	0
	HCN24	201.1	6	226	30	5	38	5	1	1	0	0	0	0	0
	HCN25	314.2	2	407	11	0	204	6	0	0	0	0	0	0	0
	HCN28	314.2	4	111	17	6	28	4	2	0	0	0	0	0	0
	HCN29	942.5	4	620	38	5	155	10	1	0	0	0	0	0	0
	HCN31	1570.8	2	267	10	2	134	5	1	0	0	0	0	0	0

Site no:	Burnt Clay nodule range (cm)			Shell fragment (cm)				Burnt Clay nodule range (cm)			Shell fragment (cm)		
Sample area	1-2	2-5	>5	<1	1-2	>2	Sample area	1-2	2-5	>5	<1	1-2	>2
1							2						
3							4						
5							6						
7							8						
9							10						
11							12						
13							14						
15							16						
17							18						
19							20						
21							22						
23							24						
25							26						
27							28						
29							30						
31							32						
33							34						
35							36						
37							38						
39							40						
41							42						
43							44						
45							46						
47							48						
49							50						

Figure A3.1: Sample recording sheet for burnt clay nodule and shell fragment counts.

Appendix 4

Main river channel site surface data.

Table A4.1: Surface counts of burnt clay and shell fragments for MRC1.

MRC1	Burnt Clay nodule range (cm)			Shell (cm)				Burnt Clay nodule range ((cm)			Shell (cm)		
Sample Area	1-2	2-5	>5	<1	1-2	2-5	Sampl e area	1-2	2-5	>5	<1	1-2	2-5
1	16	2	0	23	0	0	2	26	2	0	25	0	0
3	69	1	0	31	2	0	4	32	2	1	20	0	0
5	23	0	0	23	0	0	6	22	0	0	23	1	0
7	25	3	0	19	0	0	8	20	3	0	23	0	0
9	57	6	0	27	2	0	10	24	1	0	15	3	0
11	210	10	1	35	3	0	12	54	14	5	53	4	0
13	122	3	1	22	0	0	14	52	4	0	10	1	0
15	95	2	0	41	0	0	16	47	14	1	40	2	0
17	94	8	0	45	2	0	18	28	7	1	58	0	0
19	186	5	9	41	0	0	20	70	5	9	56	0	0
21	3	0	0	7	0	0	22	2	0	0	8	0	0
23	6	0	0	8	0	0	24	3	0	0	9	0	0
25	2	3	0	7	0	0	26	3	2	0	5	1	0
27	0	0	0	10	0	0	28	3	0	0	4	1	0
29	5	0	0	1	0	0	30	2	0	0	3	0	0
31							32						
33							34						
35							36						
37							38						
39							40						
41							42						
43							44						
45							46						
47							48						
49							50						

MRC1

This feature was situated on the junction of the Remy Island main river channel and a small dry flood channel at the termination of a shell midden which extended for 200 metres along the bank to the west. Surface material included faunal remains (bone), mussel shell (A. *jacksonii*), burnt clay nodules, pieces of green class and some charcoal. The feature had a circular ring of larger burnt clay pieces located at its centre. The edge of the feature was undermined by the river to the south and did not exhibit any ashy material in the strata exposed.

From the morphology of the feature it was classified as a natural mound resulting from the remains of a burnt tree. The presence of stone flakes, animal bone, mussel shell and charcoal suggested its use by Indigenous people in the past. The feature was classified as a "utilised natural mound"

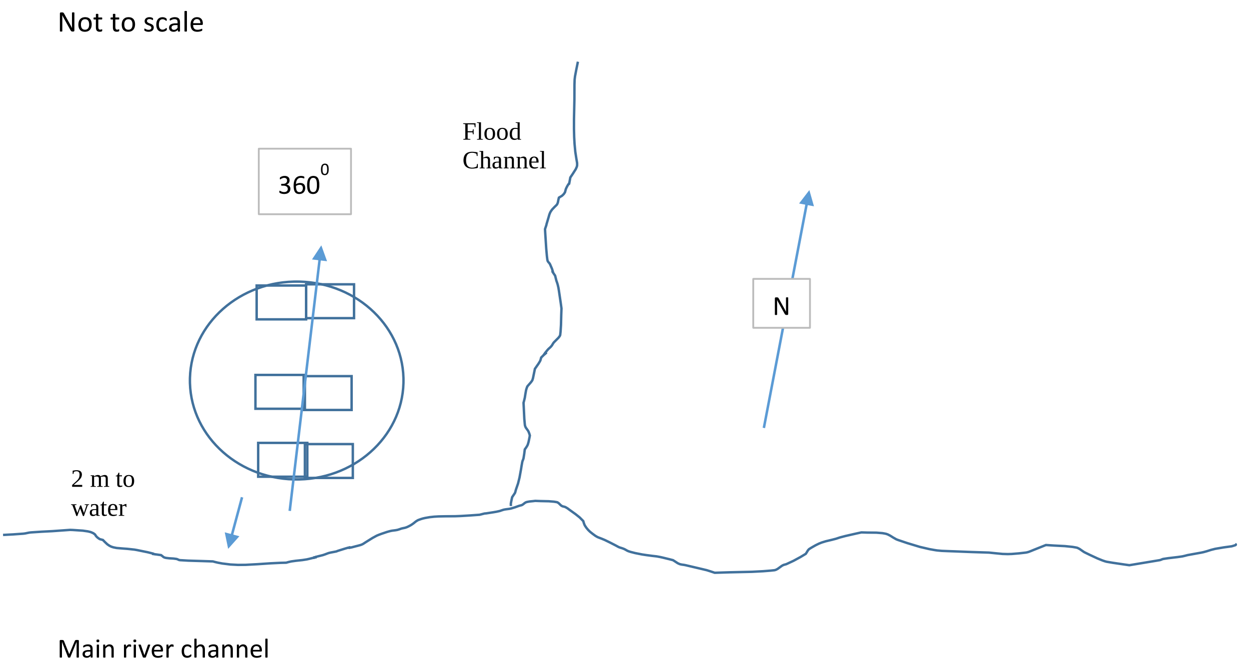


Figure A4.1: MRC1 site detail.

Appendix 5

Reny Island site surface data.

Table A5.1: Surface counts of burnt clay nodules for RIBB2.

RIBB2	Burnt Clay nodule size range (cm)						
Sample Area	1-2	2-5	>5	Sample area	1-2	2-5	>5
1	8	0	0	2	2	1	0
3	1	0	0	4	2	1	0
5	4	1	0	6	3	0	0
7	3	0	0	8	8	0	0
9	5	0	0	10	6	1	0
11	3	0	0	12	10	0	0
13	0	1	0	14	5	0	0
15	9	1	0	16	6	0	0
17	11	3	0	18	3	0	0
19	6	0	0	20	8	1	1
21	138	11	0	22	73	2	0
23	68	8	0	24	44	1	0
25	78	5	0	26	56	0	0
27	34	4	1	28	54	1	0
29	47	4	2	30	45	1	0
31	0	0	0	32	0	0	0
33	0	0	0	34	0	0	0
35	1	0	0	36	0	0	0
37	0	0	0	38	0	0	0
39	0	0	0	40	1	0	0
41	0	0	0	42	0	0	0
43	0	0	0	44	0	0	0
45	1	0	0	46	0	0	0
47	0	0	0	48	0	0	0
49	0	0	0	50	1	0	0

RIBB2

This was an elliptical feature situated to the south of the Reny Island Billabong. Surface material consisted entirely of small burnt clay nodules restricted to an elliptical area in the centre of the main feature, surrounded by a layer of alluvium. There was no indication of ash or charcoal. It was classified as an above ground oven/hearth structure. Roughly elliptical 17 metres by 5 metres, 15 centimetres high in centre, six metres from the edge of the water. Covered in light beige alluvium deflated towards the ends.

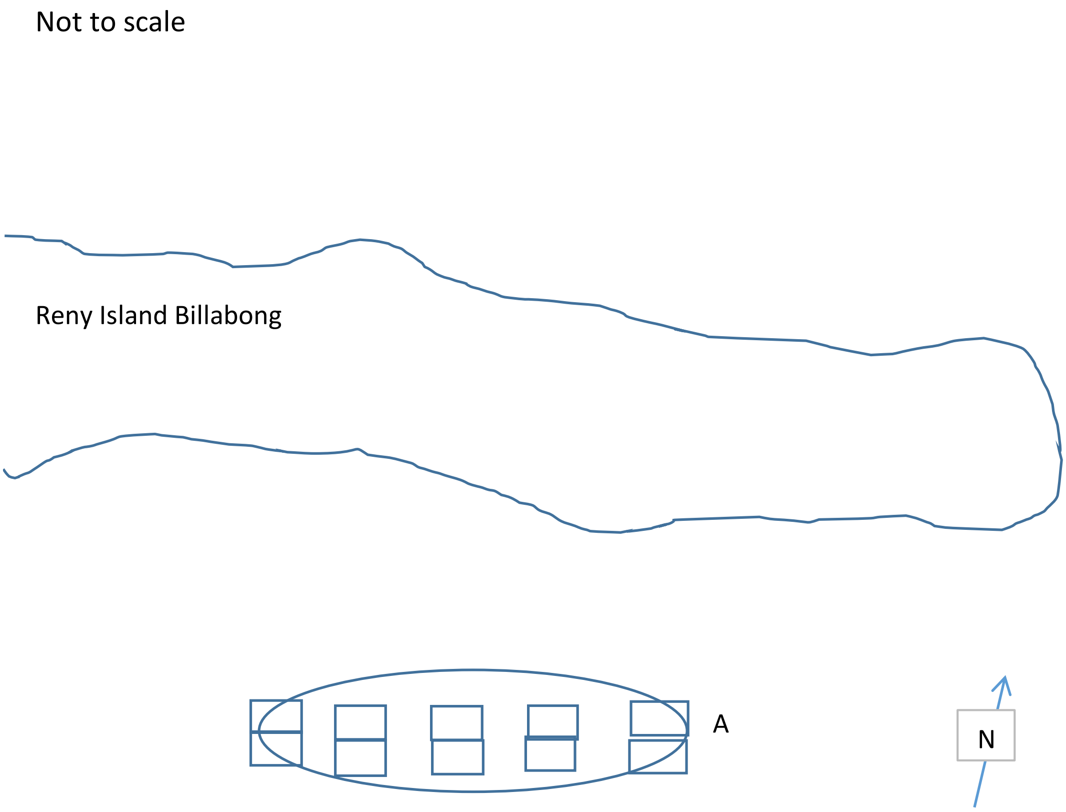


Figure A5.1: RIBB2 site detail.

Table A5.2: Surface counts of burnt clay nodules for RIBB3.

RIBB3	Burnt Clay nodule size range (cm)						
Sample Area	1-2	2-5	>5	Sample area	1-2	2-5	>5
1	54	0	0	2	95	3	1
3	81	1	0	4	194	2	1
5	51	3	1	6	194	0	1
7	96	2	0	8	168	5	0
9	119	10	0	10	73	0	0
11	6	1	0	12	8	0	0
13	10	0	0	14	0	0	0
15	0	1	0	16	7	1	0
17	10	0	0	18	11	2	0
19	14	1	0	20	9	0	0
21	0	1	0	22	0	4	0
23	4	0	0	24	0	0	0
25	0	0	0	26	4	0	0
27	10	0	0	28	0	0	1
29	3	0	0	30	0	0	1
31	18	1	1	32	0	4	0
33	39	0	0	34	5	3	0
35	42	0	0	36	26	0	0
37	37	0	0	38	27	0	0
39	58	0	1	40	77	0	0
41	17	1	0	42	3	0	0
43	26	1	0	44	3	1	0
45	8	0	1	46	3	1	1
47	5	0	0	48	1	0	0
49	3	0	0	50	3	0	0

RIBB3

This circular feature was located to the north of the Reny Island Billabong, two metres from the existing water edge. Small burnt clay nodules predominated in the northern hemisphere of the feature. The hemisphere nearest to the water consisted of a deposit of ashy humic soil with a dominant growth of a *Mesembryanthemum* spp. (ice plant) with a small white flower. The floodplain itself was dominated by a species of *Disphyma crassifolium* (pigface) with a pink flower. Interestingly during the latter part of the survey this became a useful indicator for the discovery of features containing humic earth by the presence a white circle against a background of pink.

No shell fragments, charcoal or artefacts were present in the sampled area. The feature was circular in shape 20 metres diameter, 20 centimetres high in the centre, three metres from the edge of the water. Clay nodules predominantly in the northern hemisphere, humic soil in the south.

Not to scale

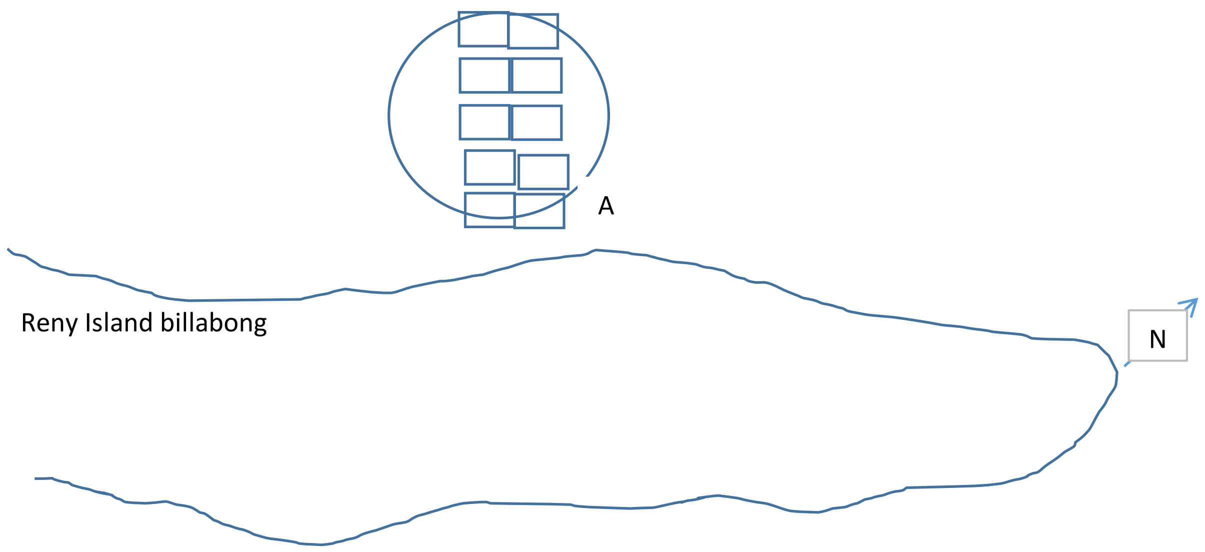


Figure A5.2: RIBB3 site detail.

Table A5.3: Surface counts of burnt clay nodules for RIBB4.

RIBB4	Burnt Clay nodule size range (cm)						
Sample Area	1-2	2-5	>5	Sample area	1-2	2-5	>5
1	30	0	0	2	12	0	0
3	81	0	0	4	13	1	0
5	65	0	0	6	46	0	0
7	64	0	2	8	45	0	0
9	72	0	0	10	3	0	0
11	4	0	0	12	8	0	0
13	5	0	0	14	2	0	0
15	8	0	0	16	8	0	0
17	6	0	0	18	2	0	0
19	3	0	0	20	2	0	0
21	1	0	0	22	9	0	0
23	0	0	0	24	0	0	0
25	3	1	0	26	0	0	0
27	1	0	0	28	1	0	0
29	1	0	0	30	3	0	0
31				32			
33				34			
35				36			
37				38			
39				40			
41				42			
43				44			
45				46			
47				48			
49				50			

RIBB4

This site was positioned to the south of the Reny Island Billabong. Its existence was indicated by the presence of white flowers of *Mesembryanthemum* spp. The feature consisted of ashy humic soil with small burnt clay nodules eroding from the circular edge, this was particularly extensive to the north where a small deflation beach was located on the edge of the billabong. Several stone flakes were observed on or around the feature.

Circular feature, 11 metres in diameter, 20 centimetres high in centre, two metres to the edge of the water. No large vegetation, eroding to north onto deflation beach, good potential excavation site.

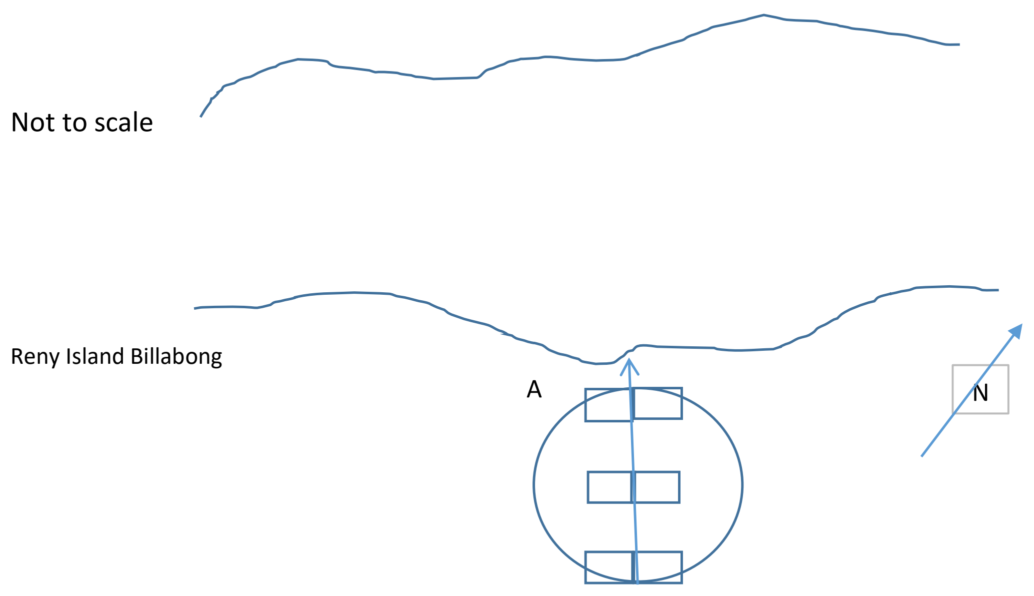


Figure A5.3: RIBB4 site detail.

Table A5.4: Surface counts of burnt clay nodules for RIBB5.

RIBB5	Burnt Clay nodule size range (cm)						
Sample Area	1-2	2-5	>5	Sample area	1-2	2-5	>5
1	2	0	0	2	4	0	0
3	4	0	0	4	0	0	0
5	3	0	0	6	2	0	0
7	4	0	0	8	5	0	0
9	6	0	0	10	0	0	0
11	2	0	0	12	5	0	0
13	8	0	0	14	15	0	0
15	3	0	0	16	3	0	0
17	1	0	0	18	3	0	0
19	2	0	0	20	3	0	0
21	0	0	0	22	0	0	0
23	0	0	0	24	0	0	0
25	0	0	0	26	1	0	0
27	0	0	0	28	2	0	0
29	0	0	0	30	0	0	0
31				32			
33				34			
35				36			
37				38			
39				40			
41				42			
43				44			
45				46			
47				48			
49				50			

RIBB5

The existence of this site was indicated by the presence of white flower, ashy humic soil and small burnt clay nodules. Some larger burnt clay nodules were present in the scatter. Circular feature, 9 metres in diameter, 15 centimetres high in centre, three metres to the edge of the water. A small accumulation of mussel shell was observed 10 metres to the south away from the billabong. A burial was also suspected due to the presence of a single human distal phalanx on the northern edge of the feature. No shell fragments or charcoal was present in the sample area.

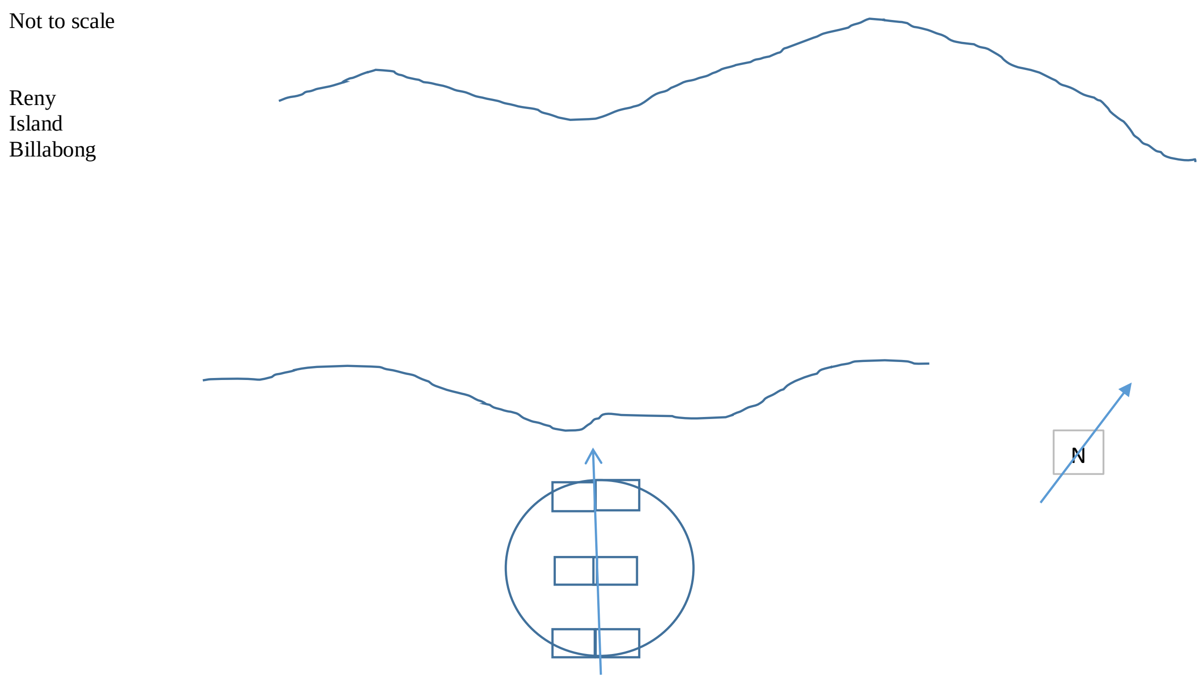


Figure A5.4: RIBB5 site detail.

Table A5.5: Surface counts of burnt clay nodules for RIBB6.

RIBB6	Burnt Clay nodule size range cm						
Sample Area	1-2	2-5	>5	Sample area	1-2	2-5	>5
1	5	0	0	2	1	1	0
3	1	0	0	4	2	0	0
5	0	0	0	6	2	0	0
7	0	0	0	8	5	0	0
9	0	0	0	10	1	0	0
11	50	1	0	12	48	0	0
13	44	3	0	14	12	1	0
15	28	1	0	16	12	0	0
17	22	14	0	18	3	0	0
19	8	0	0	20	6	0	0
21	1	0	0	22	2	0	0
23	0	0	0	24	5	0	
25	0	0	0	26	3	1	0
27	0	0	0	28	6	0	0
29	5	0	0	30	0	3	0
31	0	0	0	32	0	0	0
33	0	0	0	34	0	0	0
35	0	0	0	36	1	0	0
37	1	0	0	38	1	0	0
39	0	0	0	40	0	0	0
41				42			
43				44			
45				46			
47				48			
49				50			

RIBB6

This site was also identified through the presence of white flowers of *Mesembryanthemum* spp., humic soil and small burnt clay nodules. Stone flakes and a small chert core were observed on the feature. Circular, 10 metres by 7 metres, 20 centimetres high in centre, two metres to the edge of the water.

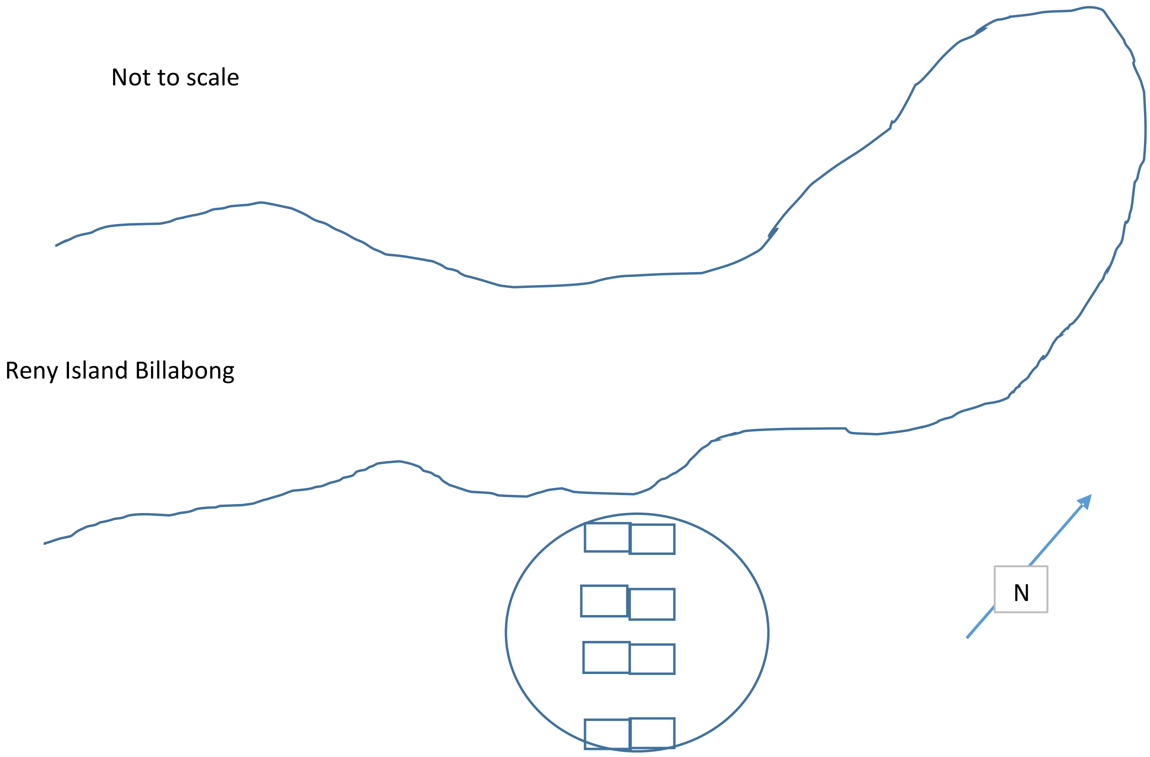


Figure A5.5: RIBB6 site detail.

Table A5.6: Surface counts of burnt clay nodules for RIBB7.

RIBB7	Burnt Clay nodule size range (cm)						
Sample Area	1-2	2-5	>5	Sample area	1-2	2-5	>5
1	4	0	0	2	2	0	0
3	2	0	0	4	6	0	0
5	0	0	0	6	5	0	0
7	0	0	0	8	3	0	0
9	1	0	0	10	6	0	0
11	6	0	0	12	2	0	0
13	1	0	0	14	5	0	0
15	4	0	0	16	2	0	1
17	4	0	0	18	1	0	0
19	4	0	0	20	2	0	0
21	1	0	0	22	2	0	0
23	6	0	0	24	3	0	0
25	1	0	0	26	3	0	0
27	2	0	0	28	1	0	0
29	1	0	0	30	3	0	0
31	6	0	0	32	0	0	0
33	1	0	1	34	0	0	0
35	1	0	0	36	0	0	1
37	1	0	0	38	0	0	0
39	0	0	0	40	0	0	0
41	1	0	0	42	0	0	0
43	1	0	0	44	1	0	0
45	2	0	0	46	0	0	0
47	0	0	0	48	0	0	0
49	1	0	0	50	0	0	0
51	2	0	0	52	0	0	0
53	0	0	0	54	1	0	0
55	2	0	0	56	1	0	0
57	0	0	1	58	0	0	0
59	3	0	2	60	2	0	0

RIBB7

This feature was covered in a layer of alluvium with no *Disphyma* or *Mesembryanthemum* present, in contrast to the surrounding floodplain which was a sea of pink. This potentially indicated a lower salt content in the topsoil since these species are halophiles. This is consistent with the presence of alluvium, presumably from a previous flooding event. Ashy, humic soil was not observed. The feature also contained no faunal material apart from the proximal end of a tibia from a small mammal. Small numbers of burnt clay nodule were widely distributed across the feature but no shell fragments. Several flakes and a small core was noted to the west and north of the feature. The feature was located on the elevated natural levy associated with the north-eastern end of the Ral Ral Island billabong and classified as a “utilised natural mound” and not included in the analysis.

Circular feature 23 metres diameter located on the levy bank of the billabong, 2 metres from the water’s edge.

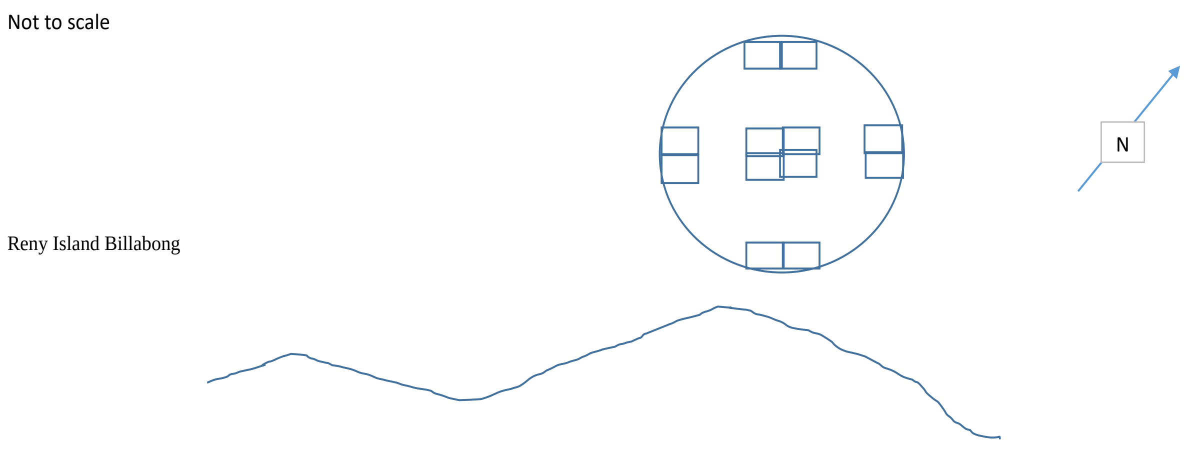


Figure A5.6: RIBB7 site detail.

Appendix 6

Ral Ral Creek west site surface data.

Table A6.1: Surface counts of burnt clay nodules for RRCW8.

RRCW8	Burnt Clay nodule range (cm)				Burnt Clay nodule range (cm)		
Sample Area	1-2	2-5	>5	Sample area	1-2	2-5	>5
1	4	0	0	2	2	0	0
3	2	0	0	4	2	0	0
5	2	0	0	6	3	1	0
7	2	0	0	8	3	0	0
9	10	0	0	10	0	0	1
11	19	3	0	12	24	0	0
13	39	0	0	14	20	0	0
15	24	0	1	16	22	1	0
17	23	1	0	18	4	0	0
19	21	1	1	20	2	0	0
21	1	0	0	22	5	0	0
23	3	1	0	24	2	0	0
25	3	1	0	26	3	0	0
27	1	0	0	28	0	0	0
29	2	0	0	30	1	0	0
31				32			
33				34			
35				36			
37				38			
39				40			
41				42			
43				44			
45				46			
47				48			
49				50			

RRCW8

This site exhibited humic soil, white flowers and small burnt clay nodules and was a located on a levy bank 60metres from the edge of Ral Ral creek. The feature was slightly elliptic, 19 metres by 17 metres and 25 centimetres high. Degraded by rabbits. No shell fragments present in sampled area.

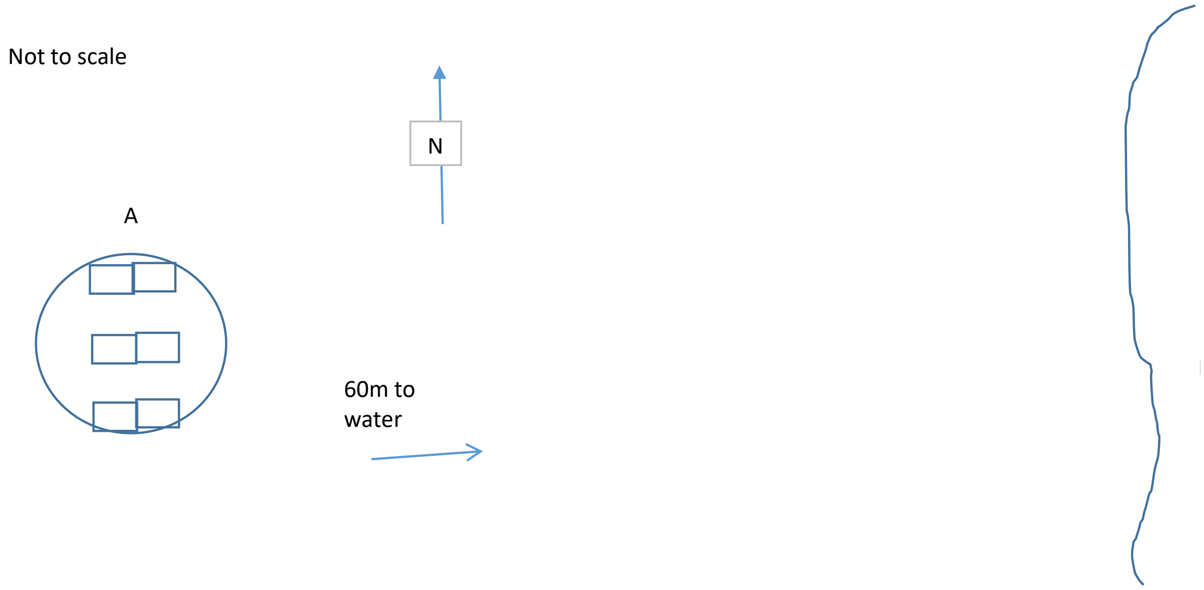


Figure A6.1: RRCW8 site detail.

Table A6.2: Surface counts of burnt clay and shell fragments for RRCW9.

RRCW9	Burnt Clay nodule range (cm)			Shell (cm)				Burnt Clay nodule range (cm)			Shell (cm)		
Sample Area	1-2	2-5	>5	< 1	1-2	2-5	Sample area	1-2	2-5	>5	< 1	1-2	2-5
1	0	2	0	0	0	0	2	2	0	0	0	0	0
3	2	0	0	0	0	0	4	3	0	0	0	0	0
5	2	1	0	0	0	0	6	4	1	0	0	0	0
7	4	1	0	0	0	0	8	7	0	0	0	0	0
9	6	1	0	0	0	0	10	4	1	0	0	0	0
11	10	0	0	0	0	0	12	36	0	0	0	0	0
13	24	0	0	0	0	0	14	43	0	0	0	0	0
15	66	2	0	0	0	0	16	26	0	0	0	0	0
17	70	1	0	0	0	0	18	16	0	1	0	0	0
19	6	0	1	0	0	0	20	18	0	0	0	0	0
21	3	1	1	1	0	0	22	3	0	0	0	0	0
23	1	0	0	0	0	0	24	1	0	0	0	0	0
25	4	0	0	0	0	0	26	1	0	1	1	0	0
27	5	0	0	0	0	0	28	0	0	0	0	0	0
29	0	0	0	0	0	0	30	0	0	0	0	0	0
31							32						
33							34						
35							36						
37							38						
39							40						
41							42						
43							44						
45							46						
47							48						
49							50						

RRCW9

This feature exhibited white flowers, small burnt clay nodules and ashy humic soil but was badly damaged by rabbits. Slightly elliptic, 24 metres by 20 metres and 50 centimetres high. Bird bone fragments were observed on the mound surface. No shell observed.

Not to scale

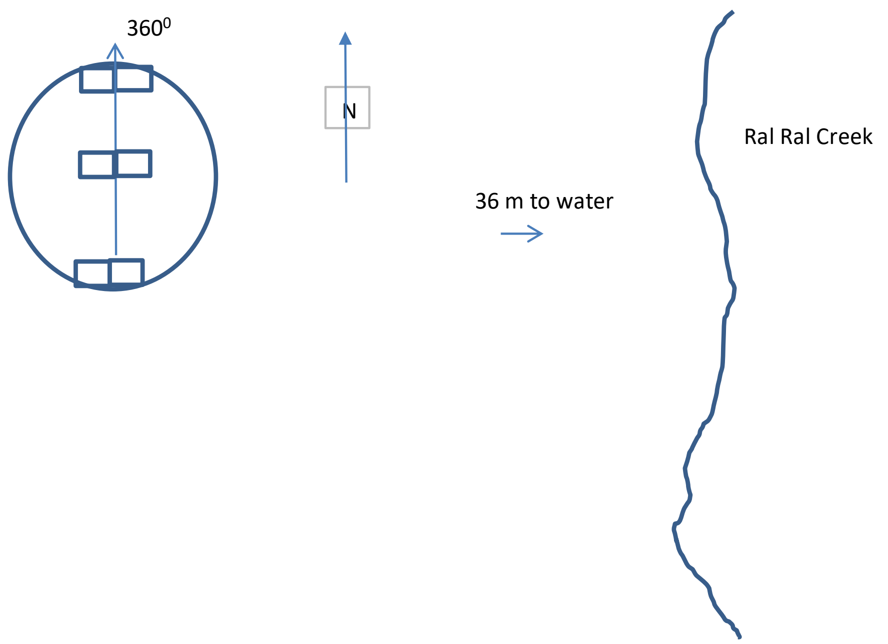


Figure A6.2: RRCW9 site detail.

Table A6.3: Surface counts of burnt clay nodules for RRCW10.

RRCW10	Burnt Clay nodule range (cm)				Burnt Clay nodule range (cm)		
Sample Area	1-2	2-5	>5	Sample area	1-2	2-5	>5
1	14	0	0	2	13	1	0
3	1	0	0	4	2	0	0
5	4	0	0	6	3	1	1
7	2	0	0	8	3	0	0
9	7	0	0	10	9	0	0
11	24	30	0	12	18	1	1
13	57	20	0	14	4	1	0
15	33	2	10	16	10	2	2
17	16	0	0	18	11	1	2
19	22	1	0	20	11	0	1
21	43	0	0	22	60	0	0
23	43	0	0	24	58	0	0
25	48	0	0	26	48	0	0
27	42	0	0	28	57	2	1
29	52	0	0	30	40	0	0
31				32			
33				34			
35				36			
37				38			
39				40			
41				42			
43				44			
45				46			
47				48			
49				50			

RRCW10

This feature was covered by a thick growth of *Mesembryanthemum*, moderate rabbit damage and a colony of large ants. Eroding from the edge, but good preservation. Circular in shape, diameter 16 metres, 40 centimetres high, 60 metres to nearest water. No shell observed.

Not to scale

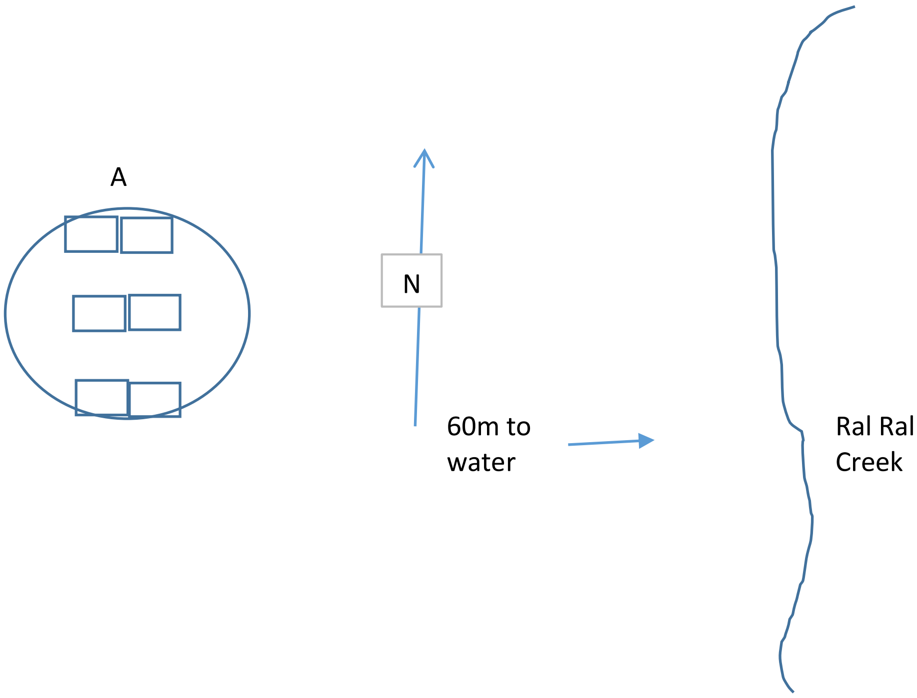


Figure A6.3: RRCW10 site detail.

Table A6.4: Surface counts of burnt clay and shell fragments for RRCW11.

RRCW11	Burnt Clay nodule range (cm)			Shell (cm)				Burnt Clay nodule range (cm)			Shell (cm)		
Sample Area	1-2	2-5	>5	<1	1-2	2-5	Sample area	1-2	2-5	>5	<1	1-2	2-5
1	0	0	0	0	0	0	2	0	0	0	0	0	0
3	0	0	0	0	0	0	4	0	0	0	0	0	0
5	1	0	0	0	0	0	6	0	0	0	0	0	0
7	0	0	0	0	0	0	8	0	0	0	0	0	0
9	0	0	0	0	0	0	10	0	0	0	0	0	0
11	0	0	0	2	2	0	12	1	0	0	0	0	0
13	1	0	0	2	0	0	14	0	0	0	1	0	0
15	1	0	0	0	0	0	16	0	0	0	0	0	0
17	0	0	0	3	0	0	18	0	0	2	5	0	0
19	0	0	0	0	0	0	20	0	0	0	0		0
21	1	0	0	0	0	0	22	4	0	0	5	0	0
23	0	0	0	0	0	0	24	6	0	0	7	0	0
25	0	0	0	0	0	0	26	5	0	0	1	0	0
27	3	0	1	1	0	0	28	1	0	0	1	0	0
29	0	0	0	0	0	0	30	0	0	0	0	0	0
31							32						
33							34						
35							36						
37							38						
39							40						
41							42						
43							44						
45							46						
47							48						
49							50						

RRCW11

This circular, nine m diameter, 10 cm high feature (A) was covered with alluvium and contained little obvious burnt clay but did exhibit some shell fragments. It was immediately adjacent to a shell midden which extended 12 metres to the north east.

Not to scale

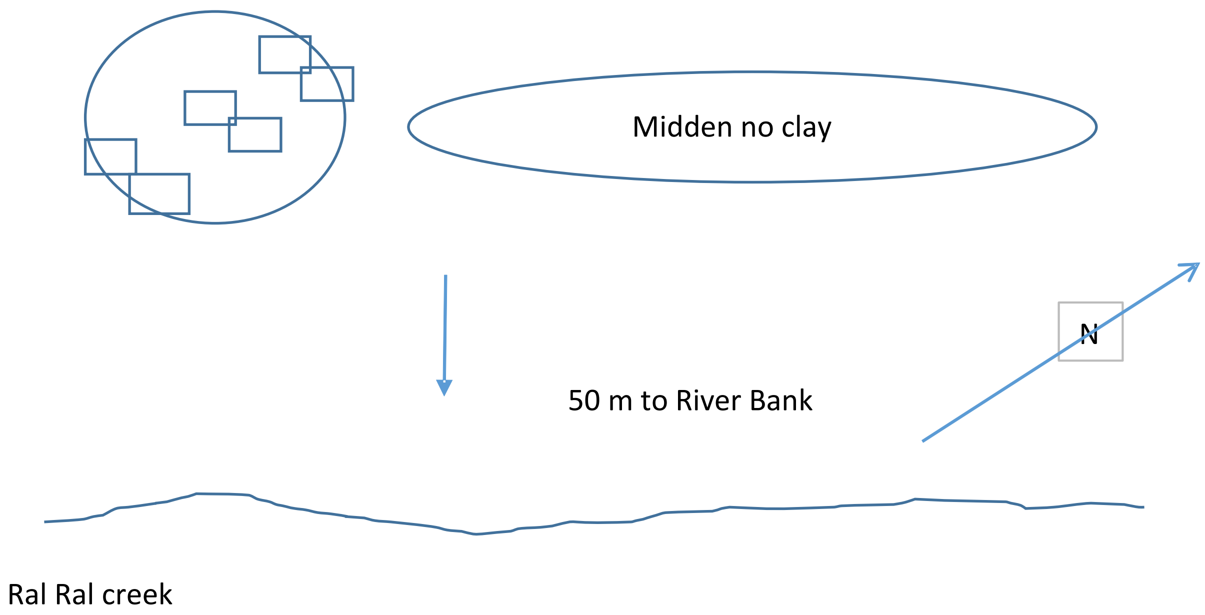


Figure A6.4: RRCW11 site detail.

Appendix 7

Ral Ral creek east site surface data.

RRCE12

This 15 metres diameter, 20 centimetres high feature was located on a steep section of the east bank of the north-south section of Ral Ral Creek, adjacent to a drainage channel which entered the creek from the east. It was covered in alluvium with ashy, humic soil exposed through animal activity. Some burnt clay nodules were eroding from the edge nearest the water. Stone flakes were present in the vicinity. A hearth was observed 15 metres to the north along the bank of the creek. Several isolated stone flakes were noted in the vicinity. No surface counts of clay nodules or shell were possible.

Not to scale

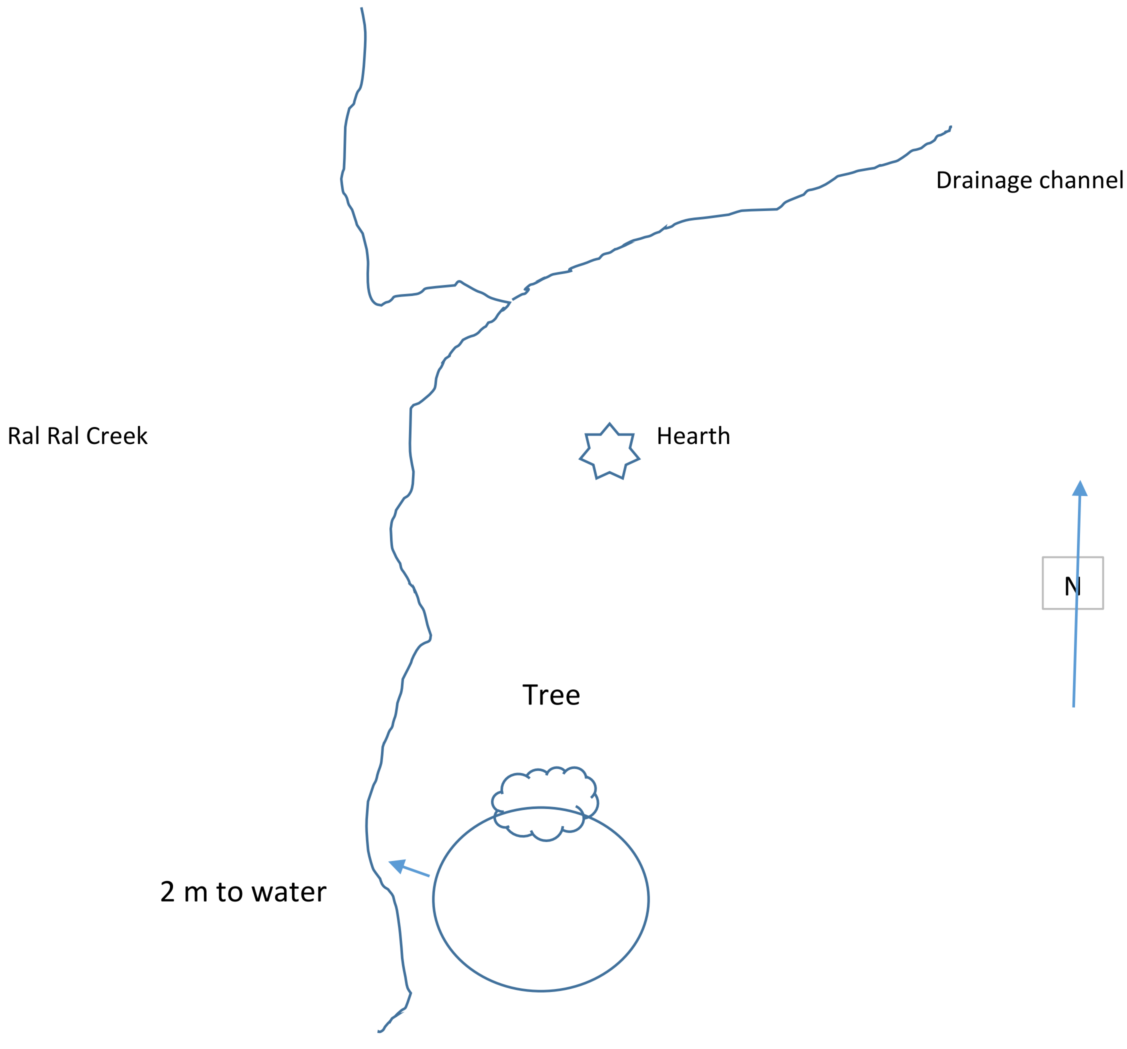


Figure A7.1: RRCE12 site detail.

RRCE13

A circular pit one metre in diameter, 50 centimetres deep, two metres from the edge of the water. It was located 50 metres south of feature RRCE12. The feature was classified as an isolated oven pit and not included in the analysis except for lateral separation..

Not to scale

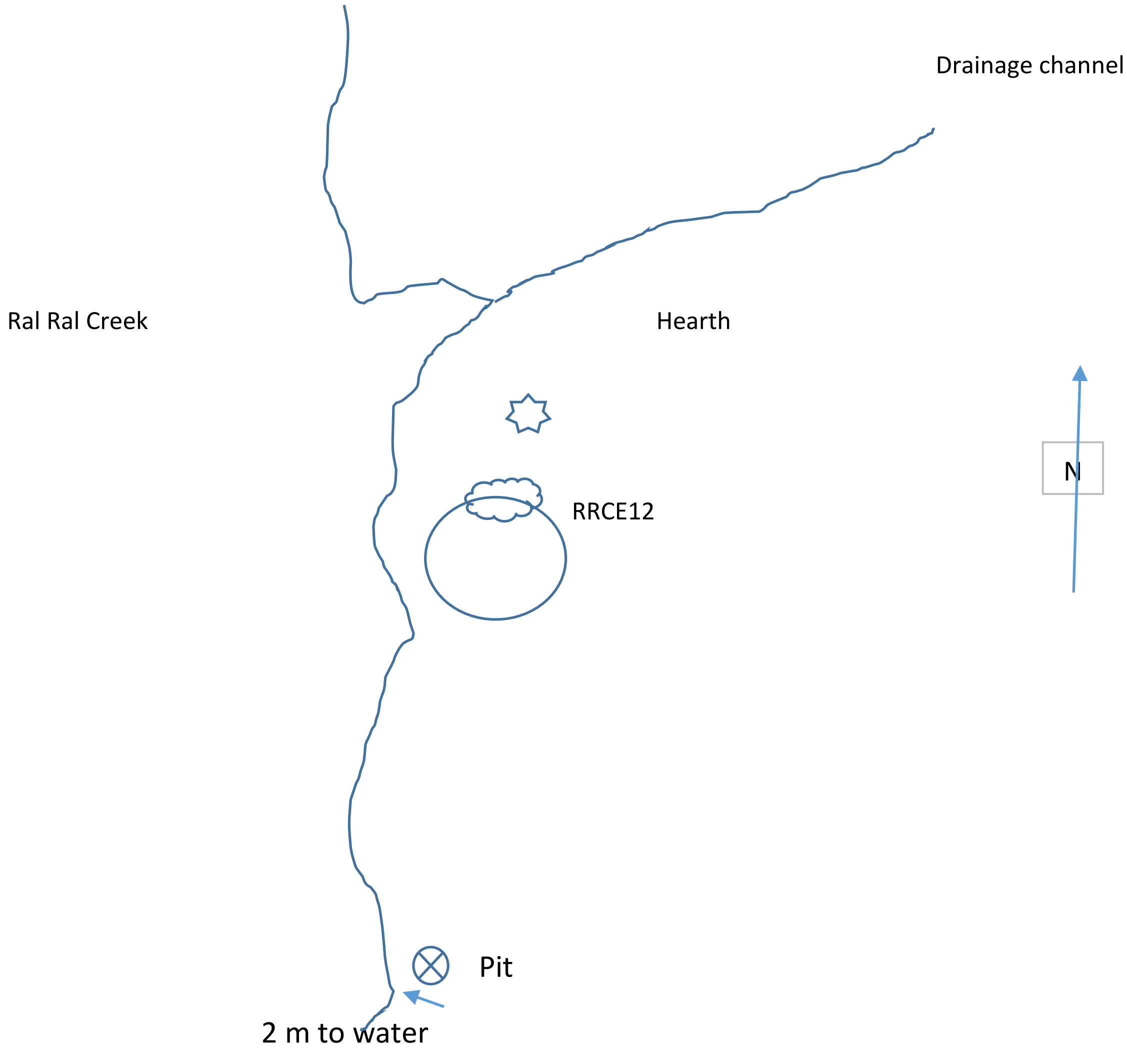


Figure A7.2: RRCE13 site detail.

RRCE14

This 20 metres diameter, 30 centimetres high feature was located on the edge of the levy 80 metres to the east of the north-south section of Ral Ral Creek, north of the Reny Island causeway. It had a large tree located centrally, was badly deflated and significantly damaged by rabbit activity. Stone flakes were present in the vicinity. Mussel shell was eroding from a rabbit hole at the base of the tree. Large nodules of burnt clay were eroding from the edges of the feature. No surface counts of clay nodules or shell were possible.

Not to scale

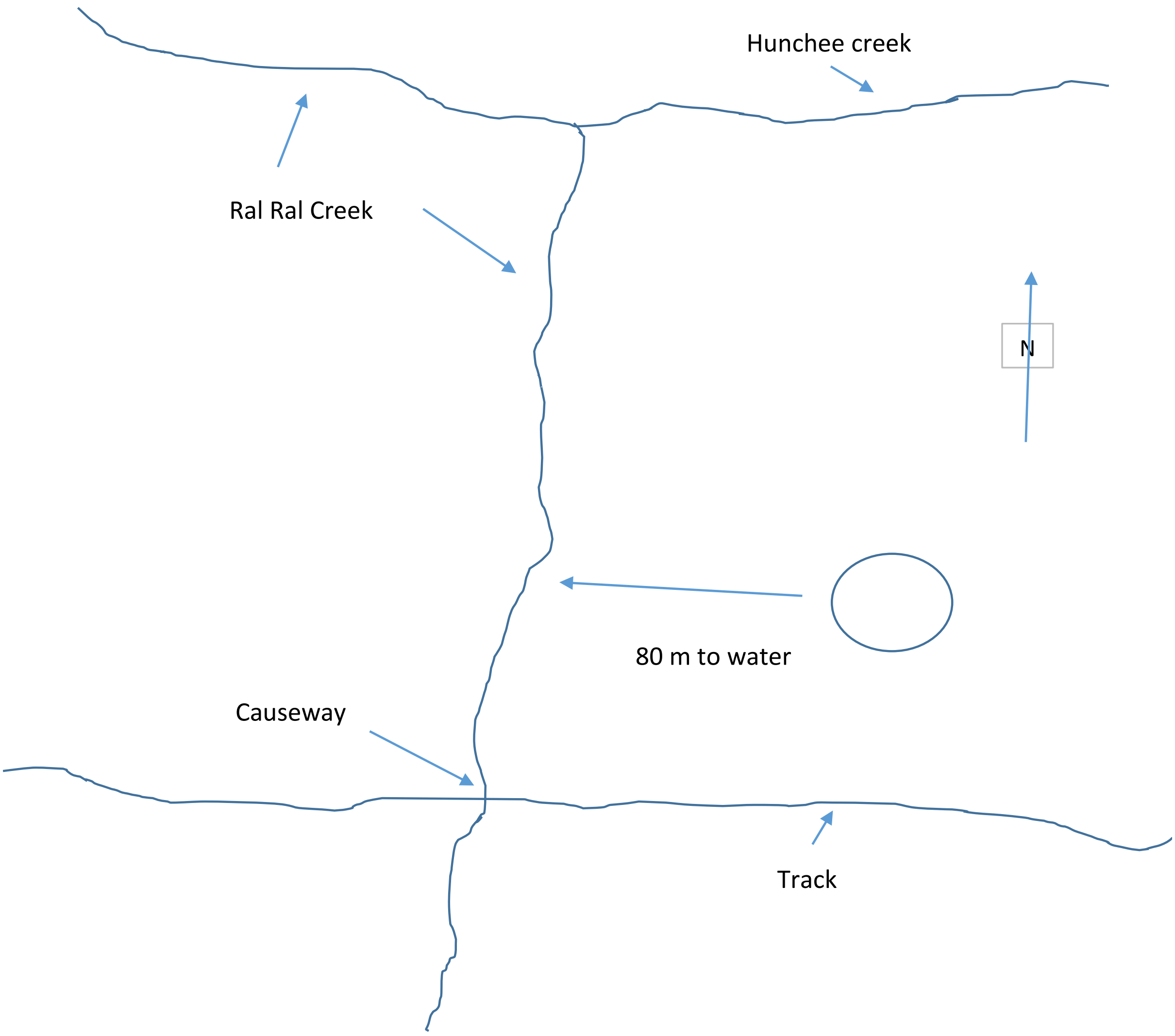


Figure A7.3: RRCE14 site detail.

Appendix 8

Hunchee Island Billabong site surface data.

HIBB15

Large feature 21 metres by 20 metres, 50 centimetres high, located on the north-eastern side of the billabong, badly damaged by rabbit activity with nodules of burnt clay, ashy soil, some shell fragments and a severely disrupted surface. Stone flakes were present in the vicinity. Located on the billabong levy near the track terminus. No surface counts of clay nodules or shell were possible. Three metres to water.

Not to scale

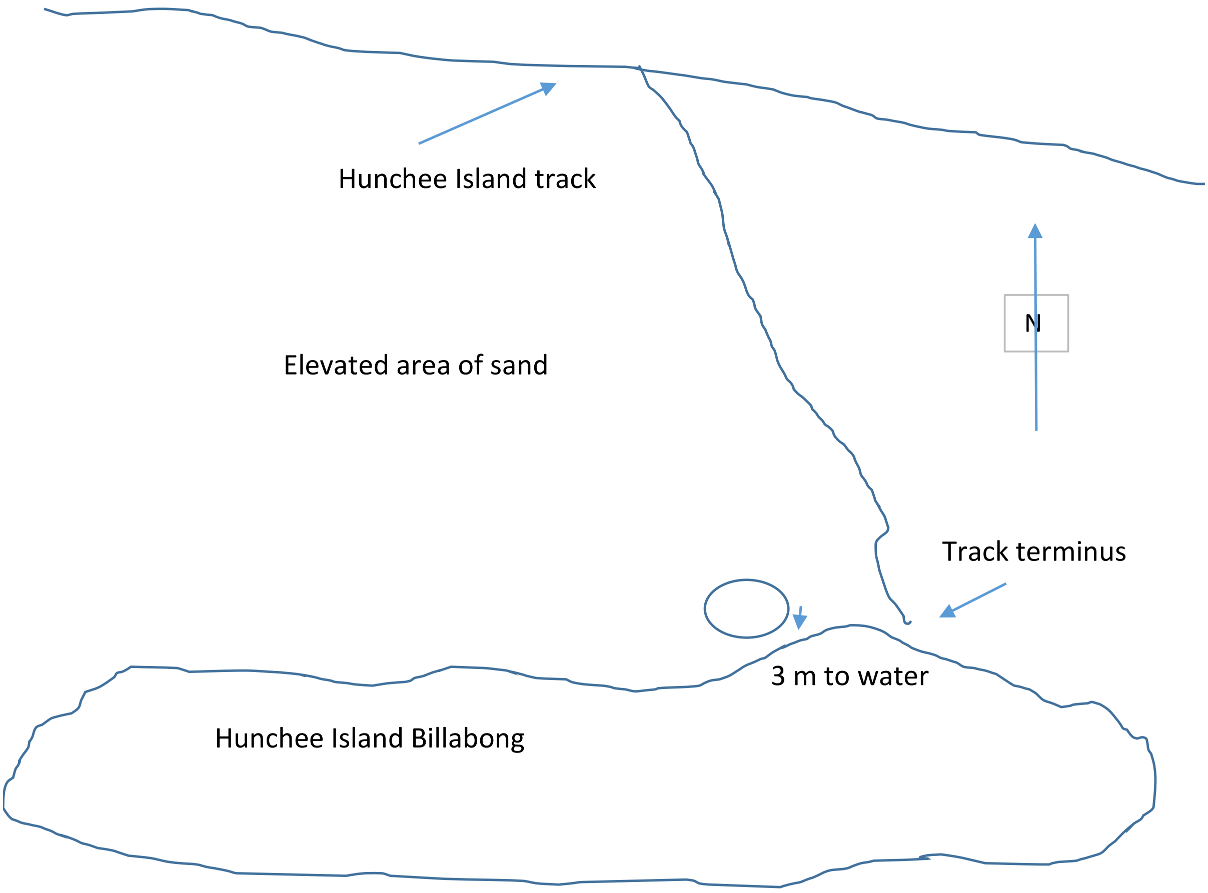


Figure A8.1: HIBB15 site detail.

HIBB16

Small ashy feature 10 metres in diameter, 10 centimetres high, located on the north side of billabong two metres from the edge of the water. The surface was badly damaged by rabbit activity, with shell fragments visible in rabbit holes. Stone flakes were present in the vicinity. No surface counts of clay nodules or shell were possible.

Not to scale

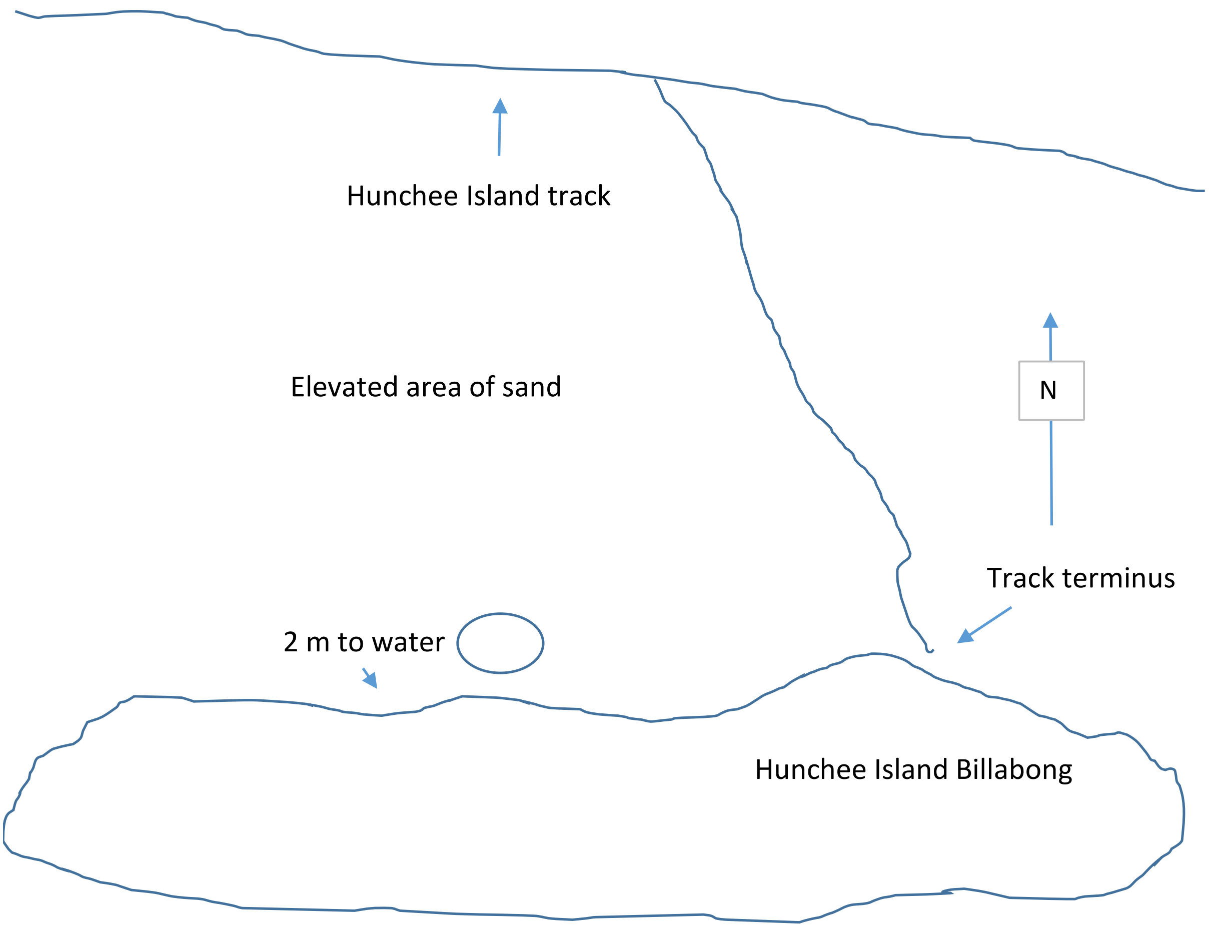


Figure A8.2: HIBB16 site detail.

HIBB17

Small ashy feature 10 metres in diameter, 10 centimetres high and covered in tree debris. It was located on the levy bank at the north-western end of the billabong 10 metres from the water. Stone flakes were present in the vicinity. No surface counts of clay nodules or shell were possible.

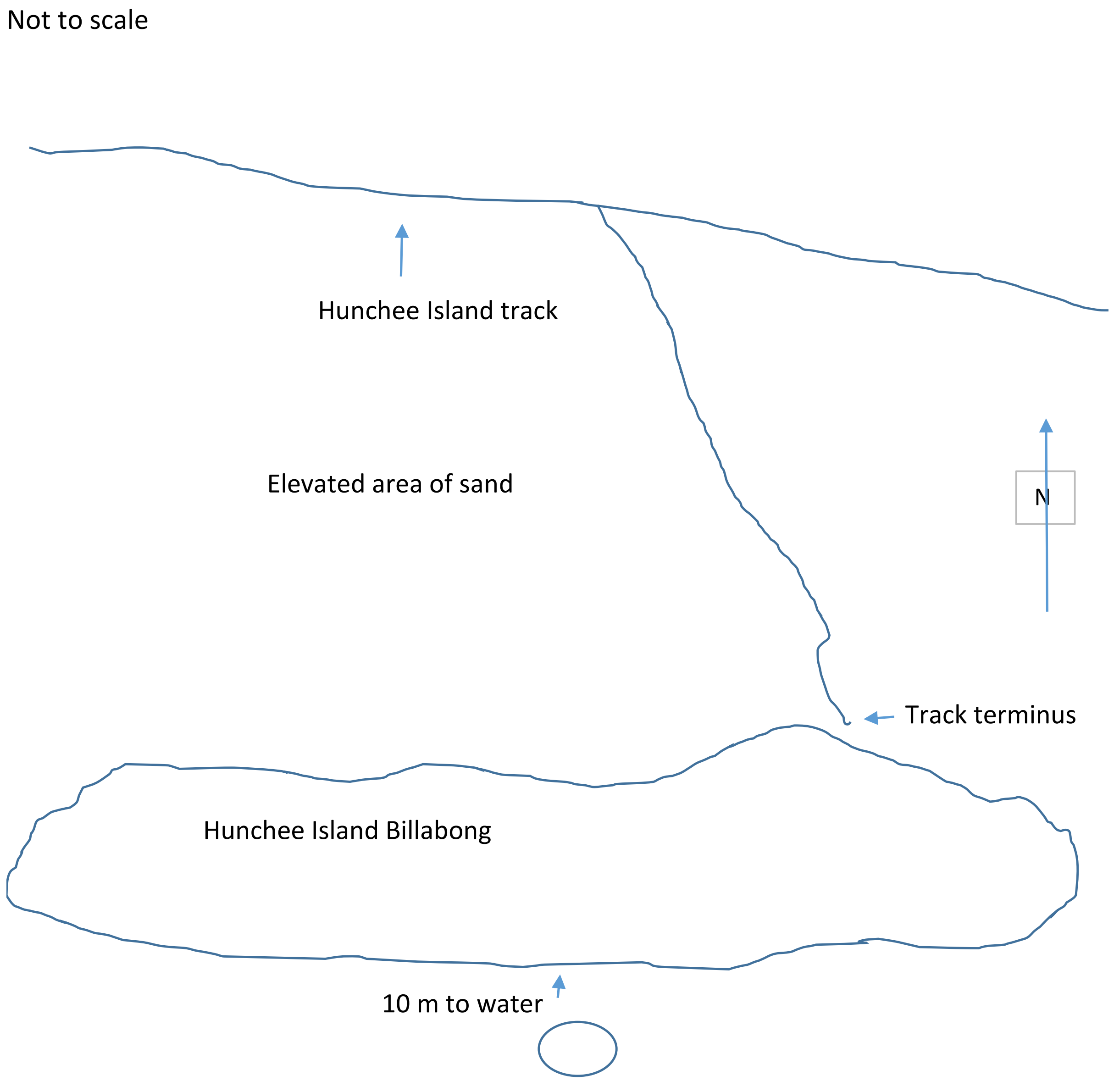


Figure A8.3: HIBB17 site detail.

HIBB18

Small ashy feature 15 metres in diameter, 10 centimetres high and 30 metres from the edge of the water. Located on the southern side of the Hunchee Island Billabong and extensively covered with tree debris. Stone flakes were present in the vicinity. No surface counts of clay nodules or shell fragments were possible.

Not to scale

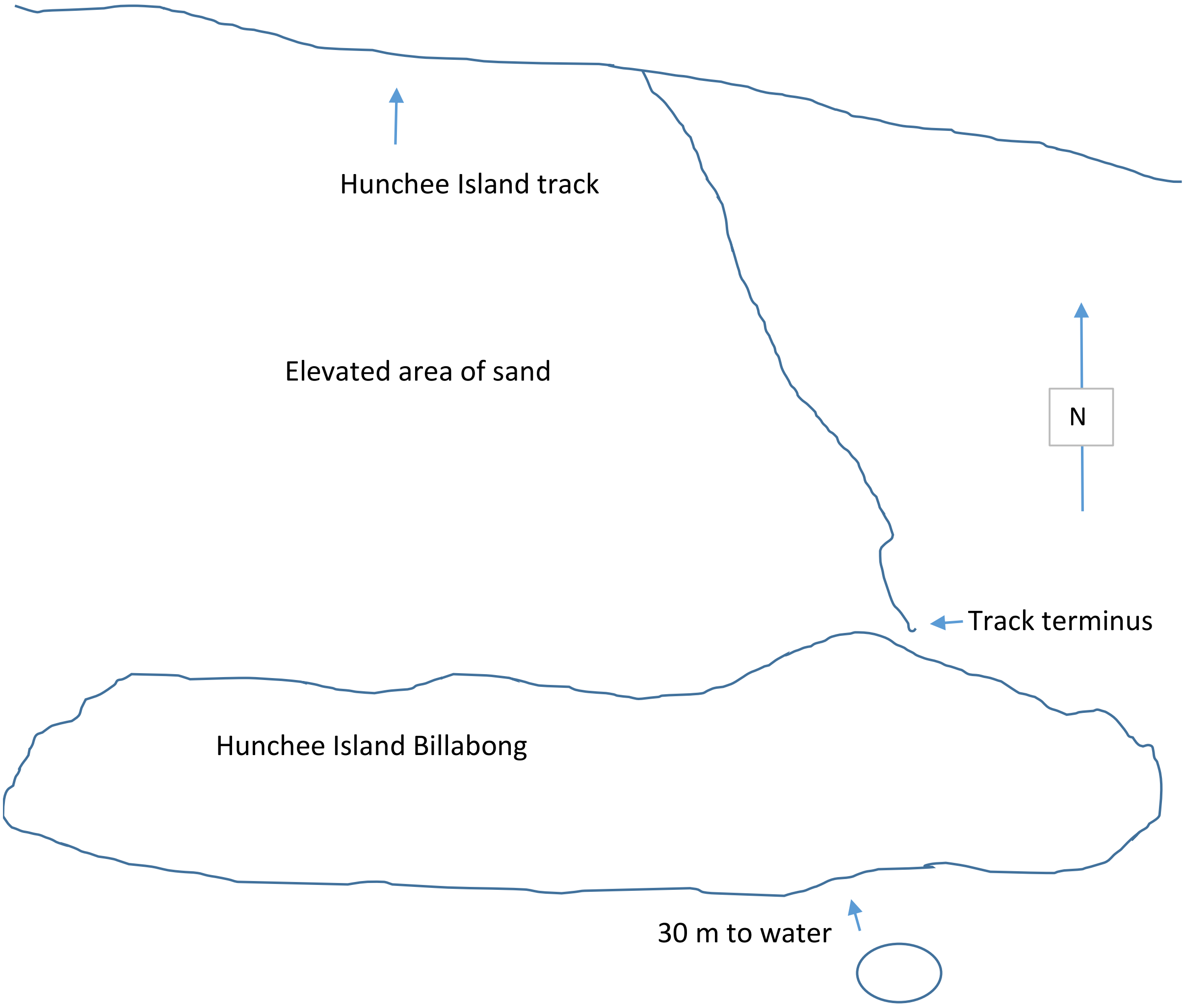


Figure A8.4: HIBB18 site detail.

Appendix 9

Hunchee Creek site surface data.

HCS19

Circular feature with ashy/humic soil, 20 metres in diameter, 20 centimetres high. Located 30 metres from the bank of the Hunchee creek. It was badly damaged by rabbit activity and was covered in metre high foliage. Stone flakes and a large piece of heat effected silcrete were present in the vicinity. No surface counts of clay nodules of shell were possible.

Figure A9.1: HCS19 site detail.

Table A9.1: Surface counts of burnt clay and shell fragments for HCN20.

HCN20	Burnt Clay nodule range (cm)			Shell (cm)				Burnt Clay nodule range (cm)			Shell (cm)		
Sample Area	1-2	2-5	>5	<1	1-2	2-5	Sample area	1-2	2-5	>5	<1	1-2	2-5
1	7	10	0	13	0	0	2	9	3	1	9	0	0
3	9	1	0	9	0	0	4	6	3	0	7	0	0
5	4	2	1	6	0	0	6	6	2	0	4	0	0
7	7	0	0	5	0	0	8	5	2	0	2	0	0
9	9	1	3	3	0	0	10	5	1	0	3	0	0
11	5	3	0	5	0	0	12	9	2	0	5	0	0
13	6	1	0	0	0	0	14	6	1	0	0	0	0
15	9	3	0	0	0	0	16	9	1	0	2	0	0
17	5	1	3	1	0	0	18	11	1	0	0	0	0
19	14	0	1	0	0	0	20	8	1	0	0	0	0
21	10	2	0	2	0	0	22	11	0	0	0	0	0
23	4	2	0	2	0	0	24	10	0	0	2	0	0
25	8	0	0	1	0	0	26	9	0	0	1	0	0
27	11	0	0	0	0	0	28	9	0	0	0	0	0
29	6	0	0	2	0	0	30	6	0	0	1	0	0
31							32						
33							34						
35							36						
37							38						
39							40						
41							42						
43							44						
45							46						
47							48						
49							50						

HCN20

Ashy feature 20 metres by 14 metres, 20 centimetres high and located on the levy bank of Hunchee creek 62 metres from the water. Shell fragments and small to large burnt clay nodules were observed on the surface. Stone flakes, small cores and pieces of heat effected silcrete were observed in the vicinity.

Not to scale

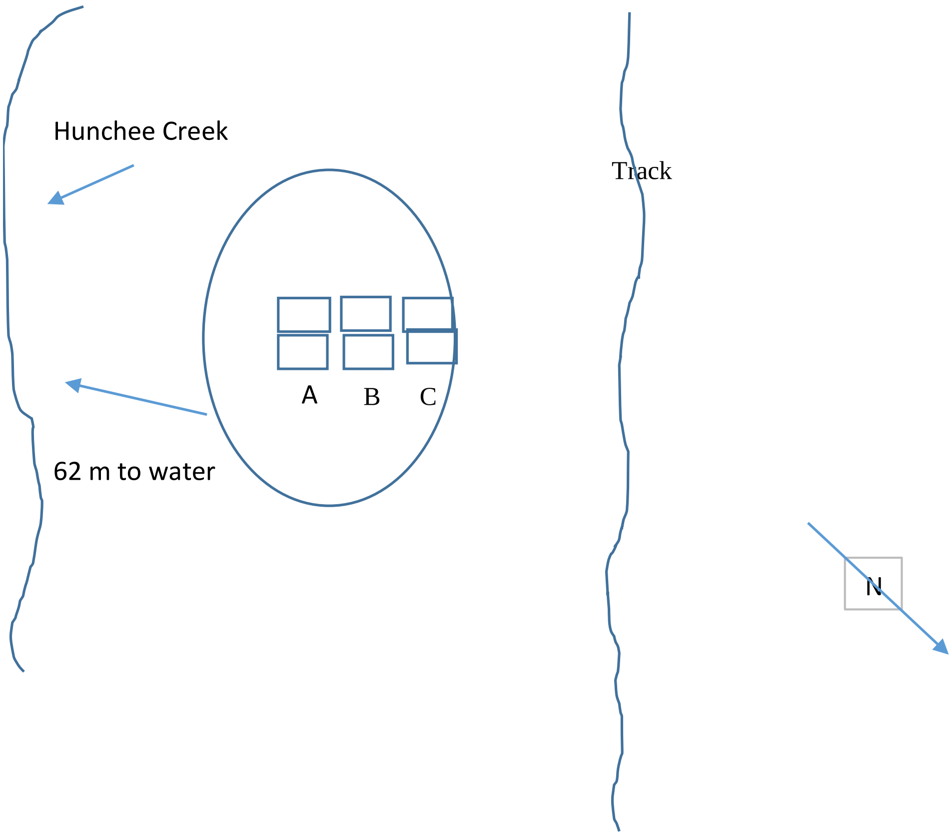


Figure A9.2: HCN20 site detail.

Table A9.2: Surface counts of burnt clay and shell fragments for HCN21.

HCN21	Burnt Clay nodule range (cm)			Shell (cm)				Burnt Clay nodule range (cm)			Shell (cm)		
Sample Area	1-2	2-5	>5	<1	1-2	2-5	Sample area	1-2	2-5	>5	<1	1-2	2-5
1	20	1	0	4	0	0	2	14	5	1	4	0	0
3	22	3	1	0	0	0	4	32	1	0	0	0	0
5	28	1	1	0	0	0	6	11	2	0	0	0	0
7	3	1	0	0	0	0	8	1	3	1	0	0	0
9	16	3	0	0	0	0	10	8	2	0	0	0	0
11	3	0	3	6	0	0	12	9	3	0	14	0	0
13	15	6	1	10	0	0	14	5	0	0	12	0	0
15	9	1	0	9	0	0	16	8	1	0	4	0	0
17	8	1	0	4	0	0	18	8	6	0	4	0	0
19	1	2	0	10	0	0	20	10	0	1	33	0	0
21							22						
23							24						
25							26						
27							28						
29							30						
31							32						
33							34						
35							36						
37							38						
39							40						
41							42						
43							44						
45							46						
47							48						
49							50						

HCN21

Large ellipsoid ashy feature 40 metres by 23 metres, 50 centimetres high Located on the edge of the Hunchee creek levy 42 metres to the edge of the water. Small to large burnt clay nodules, shell fragments and several stone artefacts present on the surface.

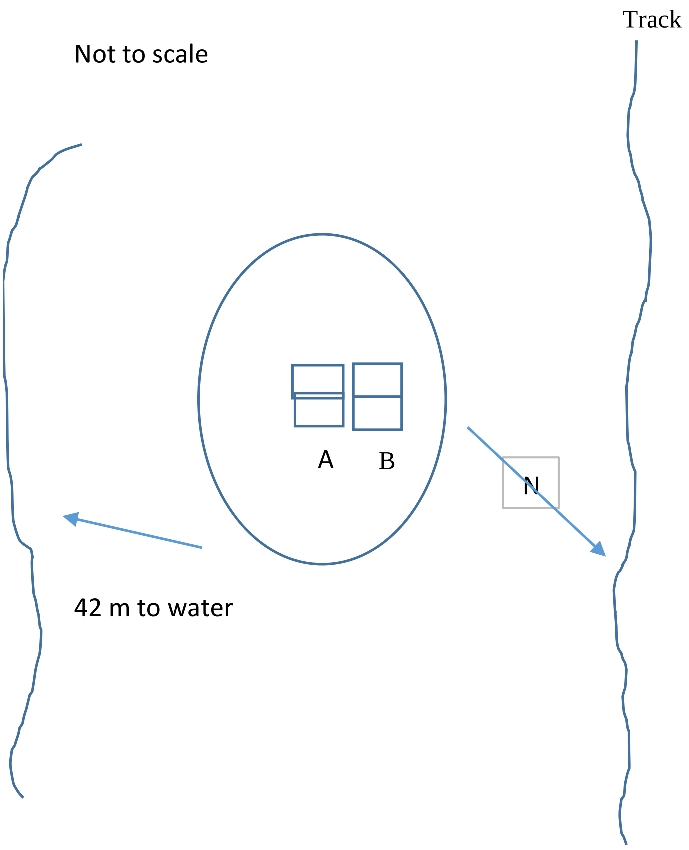


Figure A9.3: HCN21 site detail.

Table A9.3: Surface counts of burnt clay and shell fragments for HCN22.

HCN22	Burnt Clay nodule range (cm)			Shell (cm)				Burnt Clay nodule range (cm)			Shell (cm)		
Sample Area	1-2	2-5	>5	<1	1-2	2-5	Sample area	1-2	2-5	>5	<1	1-2	2-5
1	6	2	0	5	0	0	2	3	1	0	10	0	0
3	15	1	0	12	0	0	4	9	1	0	7	0	0
5	14	1	0	8	0	0	6	10	0	1	0	0	0
7	8	1	1	0	0	0	8	6	1	1	0	0	0
9	9	1	0	0	0	0	10	4	0	0	0	0	0
11	3	0	0	8	0	0	12	2	0	0	12	0	0
13	1	0	0	12	0	0	14	3	0	0	15	0	0
15	3	0	0	10	0	0	16	4	0	0	11	0	0
17	2	0	0	13	0	0	18	0	0	0	10	0	0
19	0	0	10	0	0	0	20	0	0	12	0	0	0
21	2	0	0	1	0	0	22	0	0	0	0	0	0
23	0	0	0	0	0	0	24	0	0	0	0	0	0
25	0	0	0	4	0	0	26	0	0	0	0	0	0
27	1	0	0	4	0	0	28	0	0	0	1	0	0
29	1	0	0	1	0	0	30	0	0	0	0	0	0
31							32						
33							34						
35							36						
37							38						
39							40						
41							42						
43							44						
45							46						
47							48						
49							50						

HCN22

Circular ashy feature, 25 metres in diameter and 50 centimetres high. Located on the Hunchee Creek levy 40 metres from the edge of the water. Small burnt clay nodules and small shell fragments, several stone flakes present on the surface and in the vicinity.

Not to scale

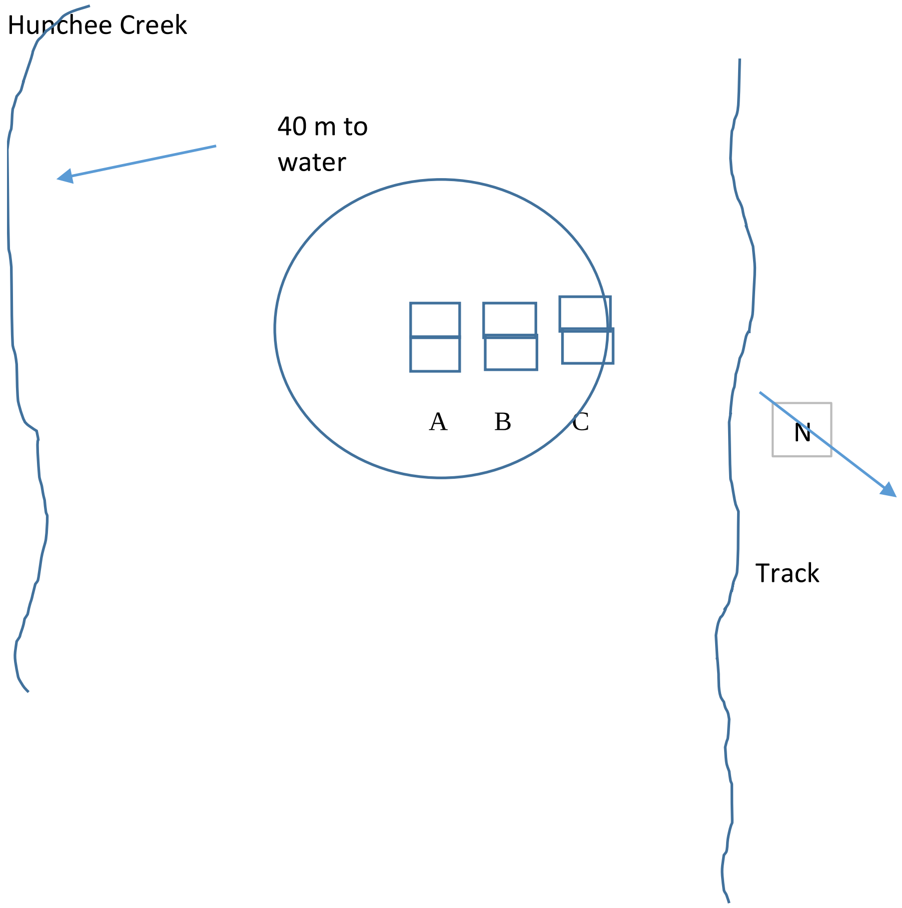


Figure A9.4: HCN22 site detail.

Table A9.4: Surface counts of burnt clay and shell fragments for HCN23.

HCN23	Burnt Clay nodule range (cm)			Shell (cm)				Burnt Clay nodule range (cm)			Shell (cm)		
Sample Area	1-2	2-5	>5	<1	1-2	2-5	Sample area	1-2	2-5	>5	<1	1-2	2-5
1	5	0	0	0	0	0	2	14	0	1	0	0	0
3	8	2	0	0	0	0	4	5	2	0	0	0	0
5	10	1	1	0	0	0	6	9	0	0	0	0	0
7	4	0	0	0	0	0	8	14	1	2	0	0	0
9	11	0	0	0	0	0	10	7	0	0	0	0	0
11	28	6	0	0	0	0	12	14	0	1	7	0	0
13	12	1	1	0	0	0	14	41	1	0	5	0	0
15	3	0	0	0	0	0	16	60	3	0	0	0	0
17	2	0	0	0	0	0	18	43	14	0	0	0	0
19	0	0	10	0	0		20	0	0	0	0	0	0
21	46	4	0	5	0	0	2	36	0	0	5	0	0
23	8	1	0	0	0	0	4	22	7	1	0	0	0
25	23	2	0	3	0	0	6	20	2	0	5	0	0
27	20	3	0	2	0	0	8	18	2	0	1	0	0
29	25	2	0	1	0	0	10	0	0	0	6	0	0
31							12						
33							14						
35							16						
37							18						
39							20						
41							22						
43							24						
45							26						
47							28						
49							30						

HCN23

Circular ashy feature 22 metres in diameter and 25 centimetres high. Located on the Hunchee Creek levy, 40 metres to the edge of the water. The feature was extensively covered in tree debris with burnt clay nodules, shell fragments and a large piece of quartzite present on the surface.

Not to scale

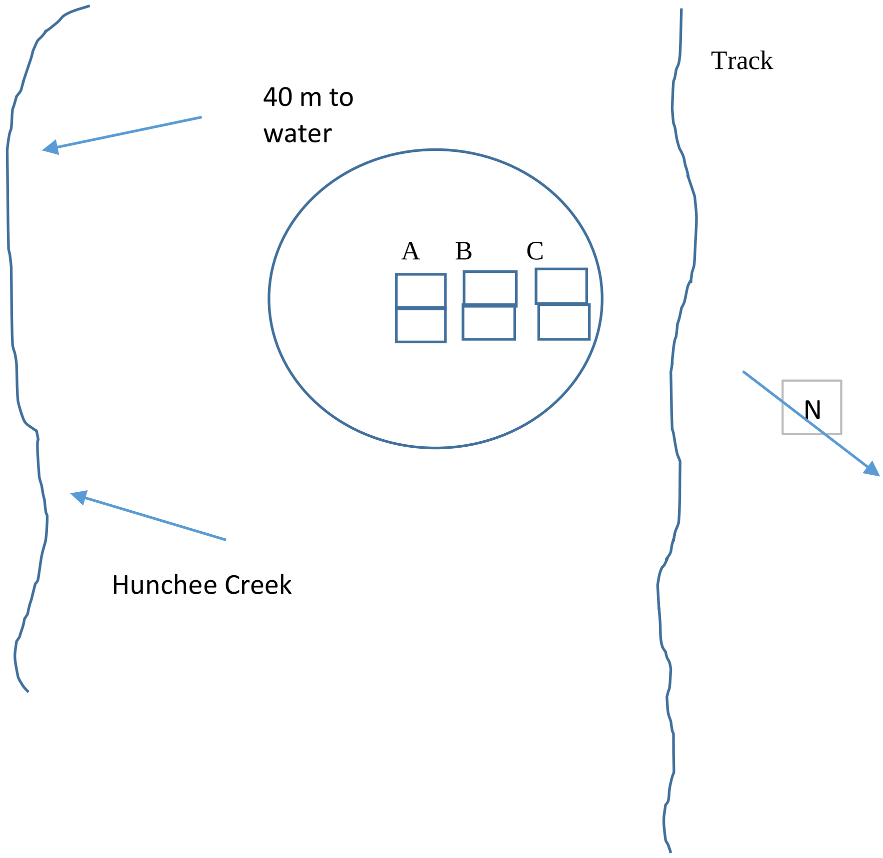


Figure A9.5: HCN23 site detail.

Table A9.5: Surface counts of burnt clay and shell fragments for HCN24.

HCN24	Burnt Clay nodule range (cm)			Shell (cm)				Burnt Clay nodule range (cm)			Shell (cm)		
Sample Area	1-2	2-5	>5	<1	1-2	2-5	Sample area	1-2	2-5	>5	<1	1-2	2-5
1	6	0	0	0	0	0	2	15	2	0	0	0	0
3	15	2	0	0	0	0	4	14	1	0	0	0	0
5	18	1	0	1	0	0	6	6	0	0	0	0	0
7	12	0	0	0	0	0	8	15	2	1	0	0	0
9	15	1	1	1	0	0	10	9	0	0	0	0	0
11	2	0	0	0	0	0	12	3	0	0	0	0	0
13	0	1	0	0	0	0	14	11	1	0	0	0	0
15	13	2	0	0	0	0	16	21	1	0	0	0	0
17	15	3	0	0	0	0	18	9	2	0	0	0	0
19	12	0	0	1	0	0	20	5	0	1	0	0	0
21	0	0	0	0	0	0	2	0	0	3	0	0	0
23	4	0	0	0	0	0	4	1	3	1	0	0	0
25	7	1	1	0	0	0	6	2	0	0	0	0	0
27	2	0	0	0	0	0	8	4	1	0	0	0	0
29	0	3	0	0	0	0	10	0	0	0	0	0	0
31							12						
33							14						
35							16						
37							18						
39							20						
41							22						
43							24						
45							26						
47							28						
49							30						

HCN24

Circular ashy feature 16 metres in diameter and 40 centimetres high. Located on the Hunchee Creek levy, 40 metres to the edge of the water. The feature was extensively covered in tree debris with burnt clay nodules, shell fragments and stone flakes in the vicinity present on the surface.

Not to scale

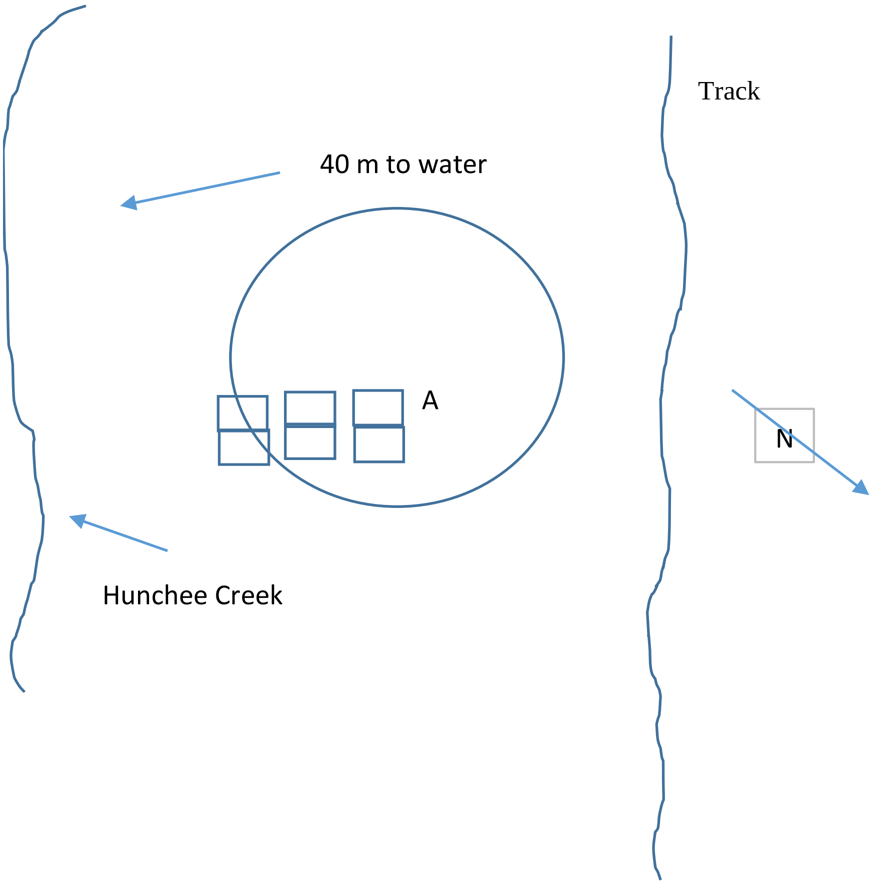


Figure A9.6: HCN24 site detail.

HCN25

A circular ashy Feature,20 metres diameter and 20 centimetres high located on the levy bank of Hunchee Creek 63 metres to the edge of the water. The surface was degraded by ripping. Ashy material was also spread along track. Some clay nodules and small shell fragments. Provides an insight into internal material of local oven mound features. No surface counts of clay nodules of shell were possible.

Not to scale

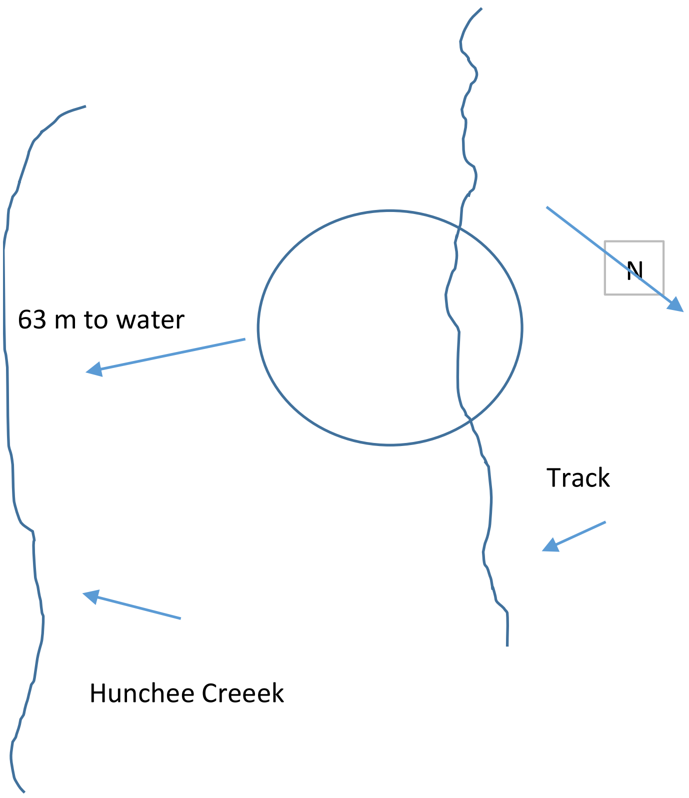


Figure A9.7: HCN25 site detail.

HCN26

Isolated oven/hearth feature six metres in diameter and 10 centimetres high. Contains large bull-ant nest. Small burnt clay nodules present. The feature was classified as an above ground oven/hearth structure. Consequently, it was not included in the analysis.

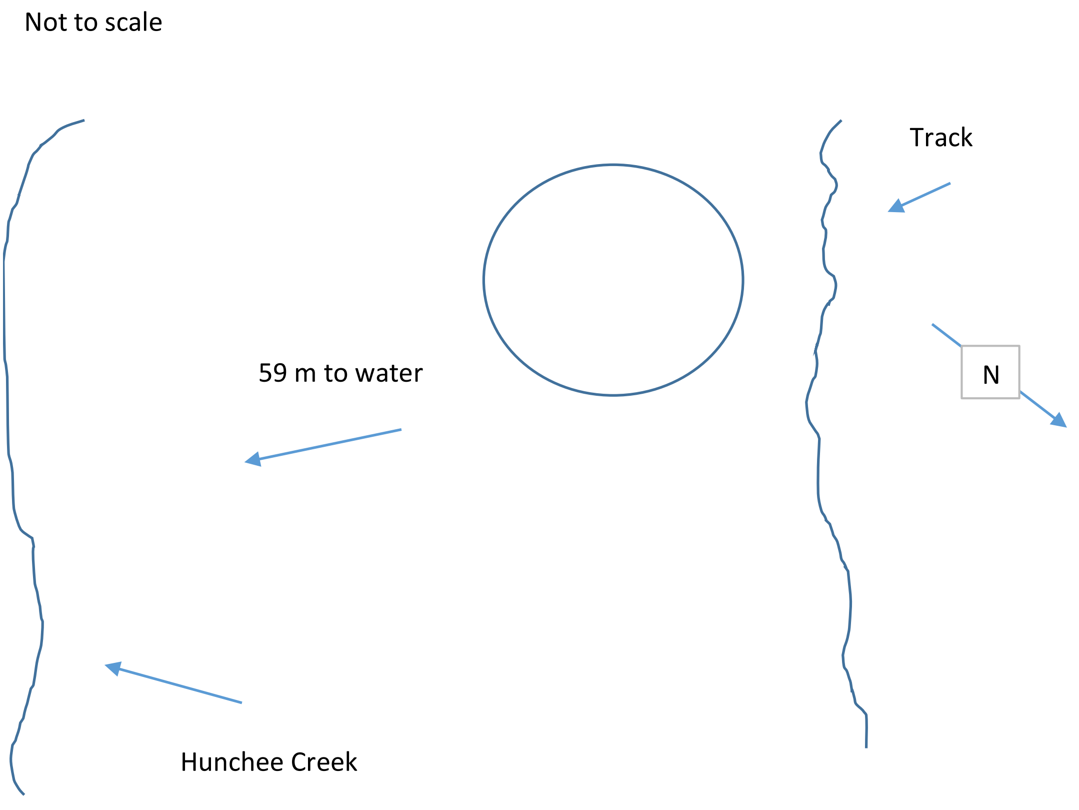


Figure A9.8: HCN26 Site detail.

HCN27

Large circular feature 30 metres diameter and 20 centimetres high, located on the Hunchee Creek levy. A surface scatter of burnt clay nodules and shell fragments was visible under a heavy cover of tree debris. No surface counts of clay nodules of shell were possible.

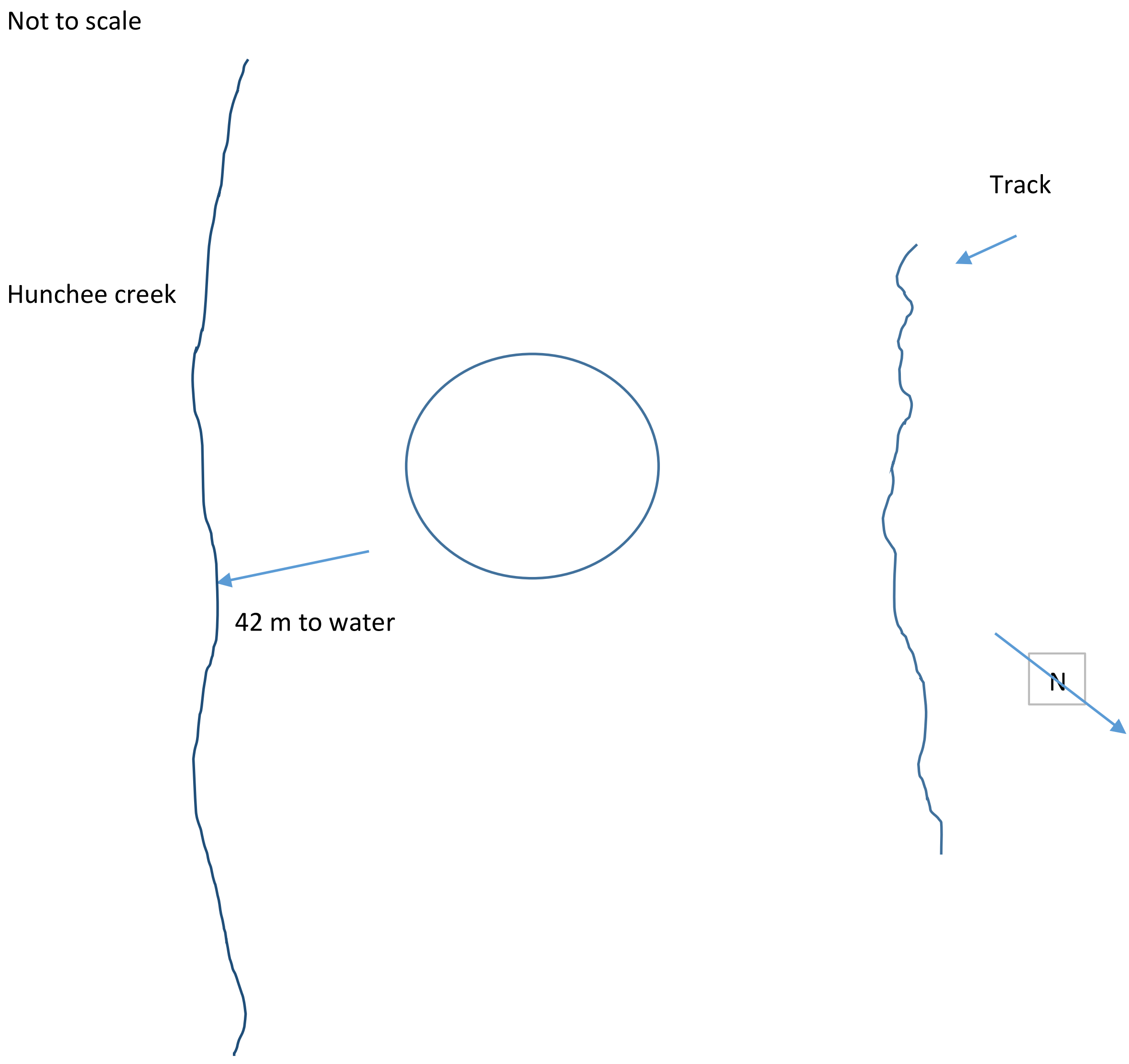


Figure A9.9: HCN27 site detail.

Table A9.6: Surface counts of burnt clay and shell fragments for HCN28.

HCN28	Burnt Clay nodule range (cm)			Shell (cm)				Burnt Clay nodule range (cm)			Shell (cm)		
Sample Area	1-2	2-5	>5	<1	1-2	2-5	Sample area	1-2	2-5	>5	<1	1-2	2-5
1	5	3	0	0	0	0	2	3	3	0	0	0	0
3	5	1	2	0	0	0	4	11	1	0	0	0	0
5	5	0	0	0	0	0	6	7	2	1	0	0	0
7	9	0	2	0	0	0	8	16	0	0	0	0	0
9	20	2	1	0	0	0	10	20	2	0	0	0	0
11	4	0	0	0	0	0	12	0	0	0	0	0	0
13	0	0	0	0	0	0	14	0	2	0	0	0	0
15	1	0	0	0	0	0	16	3	0	0	0	0	0
17	0	0	0	0	0	0	18	0	0	0	0	0	0
19	2	0	0	1	0	0	20	0	0	0	0	0	0
21							2						
23							4						
25							6						
27							8						
29							10						
31							12						
33							14						
35							16						
37							18						
39							20						
41							22						
43							24						
45							26						
47							28						
49							30						

HCN28

A circular ashy feature 20 metres in diameter and 20 centimetres high, 30 metres to the edge of the water. Tree debris and light ground covering vegetation obscured the surface. Several stone flakes were present on and in the vicinity of the site. A large tree was contained within the site. A clay nodule count was not possible.

Not to Scale

Tree within site

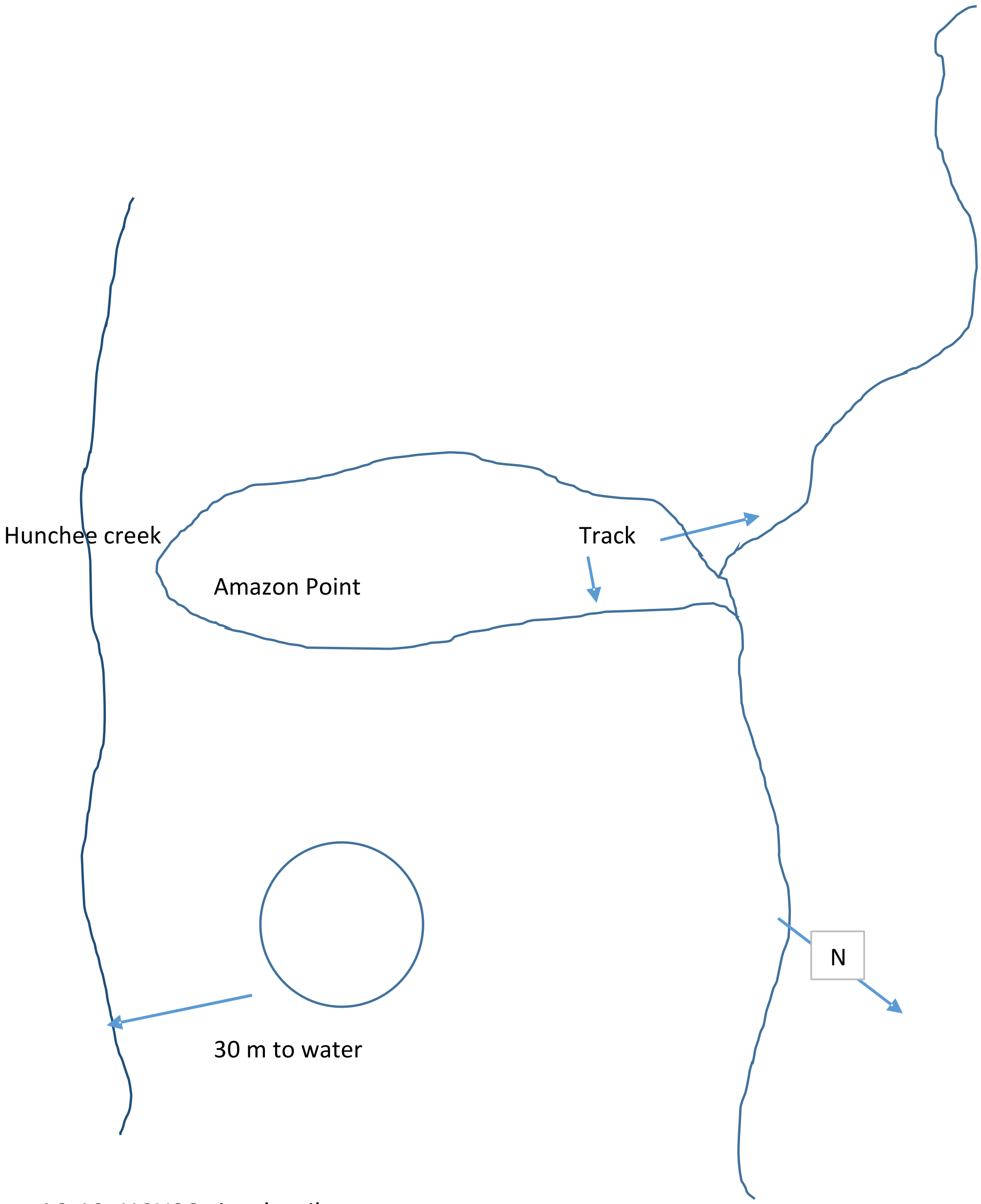


Figure A9.10: HCN28 site detail.

Table A9.7: Surface counts of burnt clay and shell fragments for HCN29.

HCN29	Burnt Clay nodule range (cm)			Shell (cm)				Burnt Clay nodule range (cm)			Shell (cm)		
Sample Area	1-2	2-5	>5	<1	1-2	2-5	Sample area	1-2	2-5	>5	<1	1-2	2-5
1	54	4	0	0	0	0	2	46	0	0	0	0	0
3	46	2	0	0	0	0	4	43	2	0	0	0	0
5	0	3	0	0	0	0	6	25	5	0	0	0	0
7	5	0	0	0	0	0	8	25	11	0	0	0	0
9	1	3	0	0	0	0	10	35	2	0	0	0	0
11	2	4	0	0	0	0	12	14	0	0	0	0	0
13	16	1	0	0	0	0	14	18	1	0	0	0	0
15	4	2	0	0	0	0	16	16	0	0	0	0	0
17	18	0	0	0	0	0	18	10	0	0	0	0	0
19	20	1	0	1	0	0	20	15	0	0	0	0	0
21							2						
23							4						
25							6						
27							8						
29							10						
31							12						
33							14						
35							16						
37							18						
39							20						
41							22						
43							24						
45							26						
47							28						
49							30						

HCN29

An ashy feature 20 metres by 15 metres and 60 centimetres high located at the track junction on the northern edge of Amazon Point Landing, 52 metres to the edge of the water. The site was covered with burnt clay nodules, extensive tree debris and light ground cover vegetation. Stone flakes in vicinity of feature and a potential knapping floor 60 metres to the south-east of the feature within the boundary of the Landing. Large tree within the site.

Figure A9.11: HCN29 site detail.

HCN30

Ashy feature 20 metres in diameter and 10 centimetres high, 62 metres to the edge of the water. Located on the Hunchee creek levy bank west of the junction of the track into Amazon Point and the main track. Extensive small to large burnt clay nodules, shell fragments eroding from the side of a rabbit hole. Alluvium cover. Large tree located within the site. A clay nodule and shell count was not possible.

Not to scale

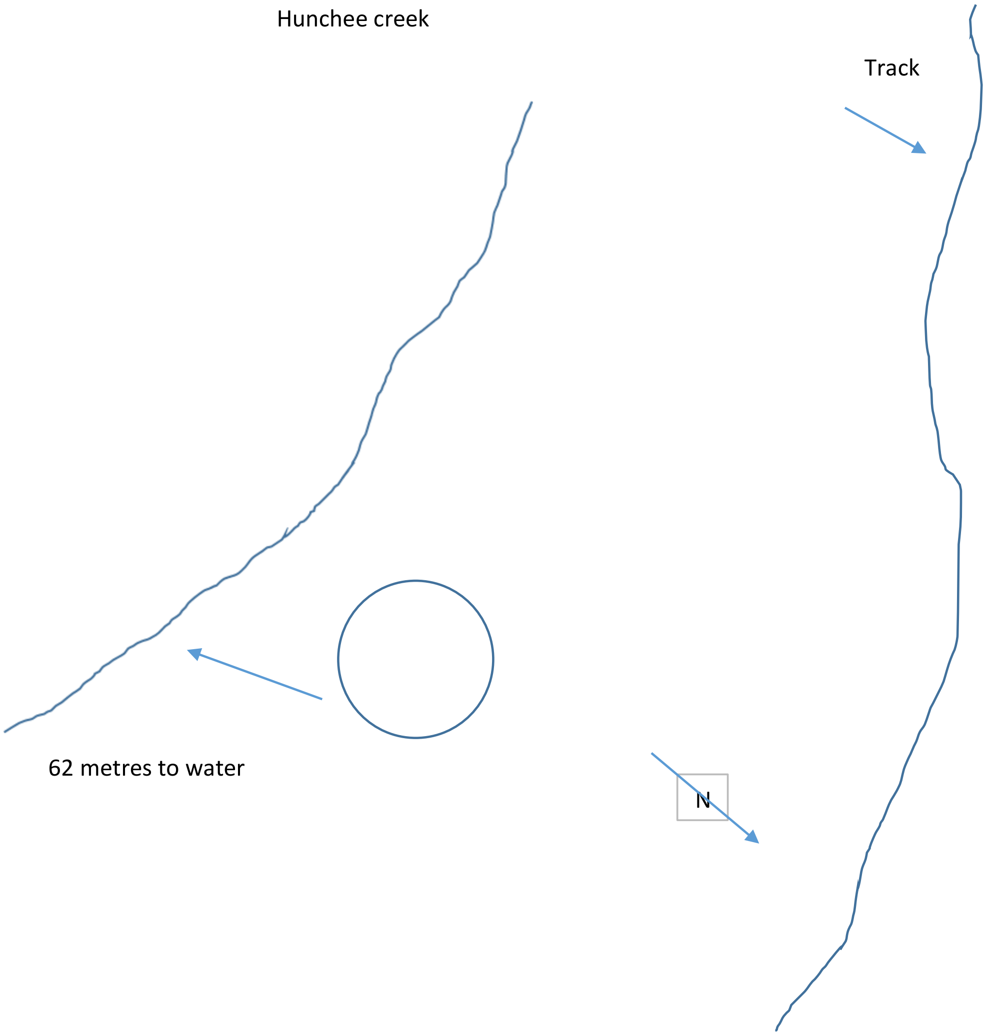


Figure A9.12: HCN30 site detail.

HCN31

Ashy feature 25 metres by 20 metres and 50 centimetres high with extensive cover of tree debris. Located on the Hunchee creek levy 35 metres from the edge of the water. Some large (10 centimetre) burnt clay nodules were present. Immediately adjacent to a large tree located to the south of the feature. A clay nodule count was not possible.

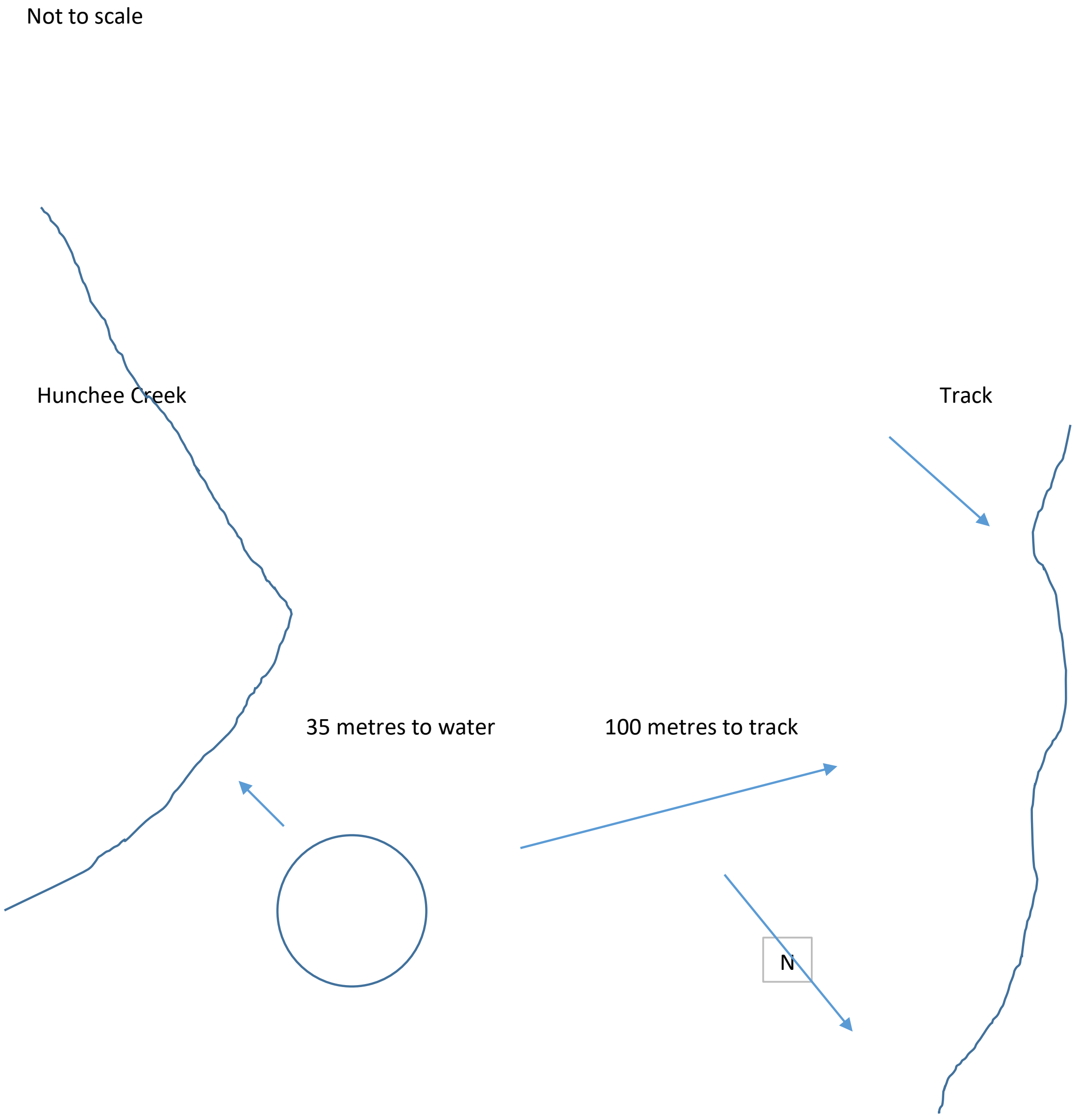


Figure A9.13: HCN31 site detail.

Appendix 10

Lake Merreti east site surface data.

MLE32

Circular ashy feature 16 metres in diameter, 50 centimetres high and 200 metres to the edge of the lake which was encroaching onto the land. The feature had an extensive cover of tree debris and 25% of its area covered in metre high vegetation. No shell was visible but burnt clay nodules were eroding from the edge of the feature. Clay nodule and shell fragment counts were not possible.

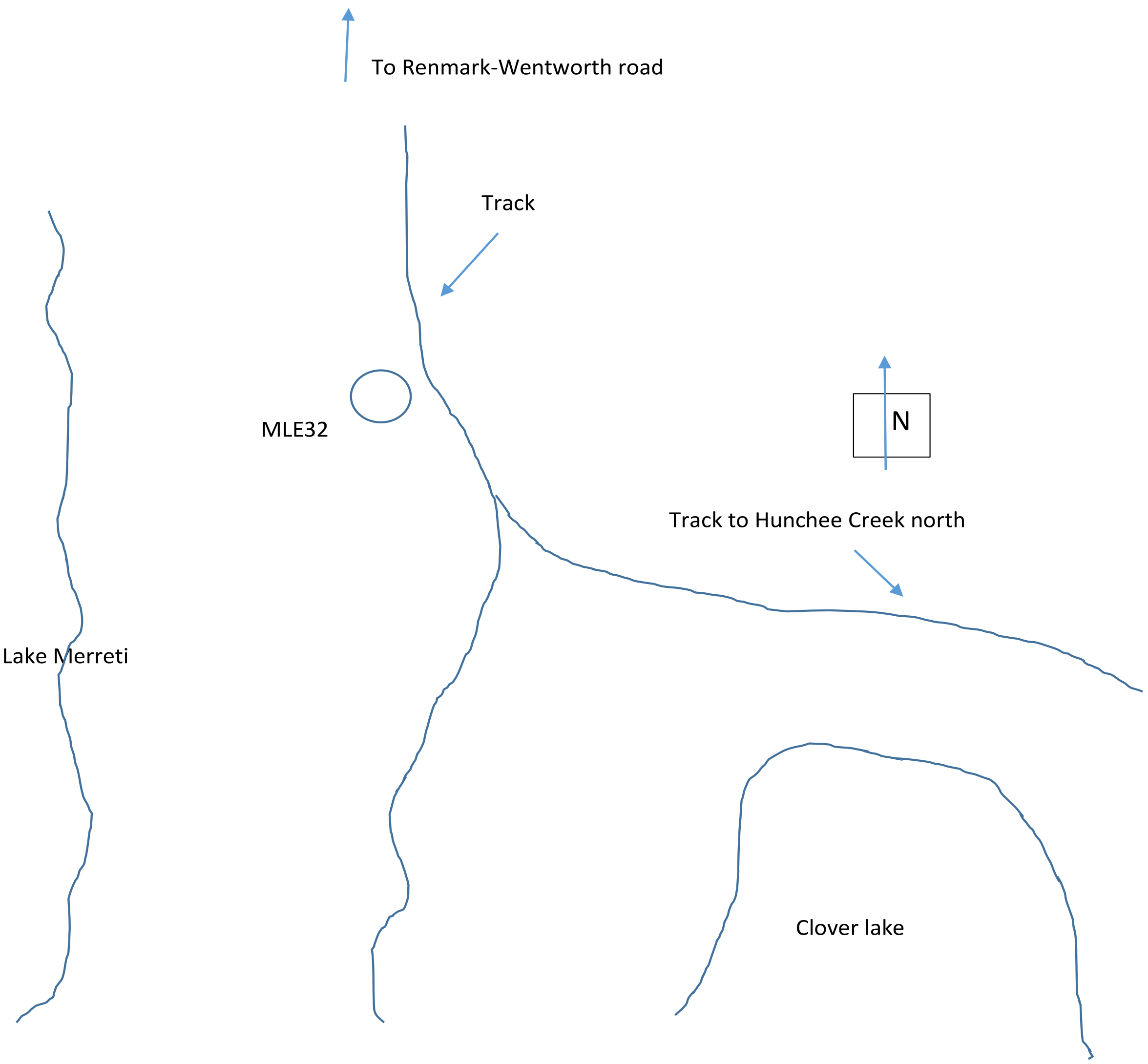


Figure A10.14: MLE32 site detail.

Appendix 11

Mound profile data.

Figure A11.1: Elevation Profile MLE32 showing non-levy bank profile.

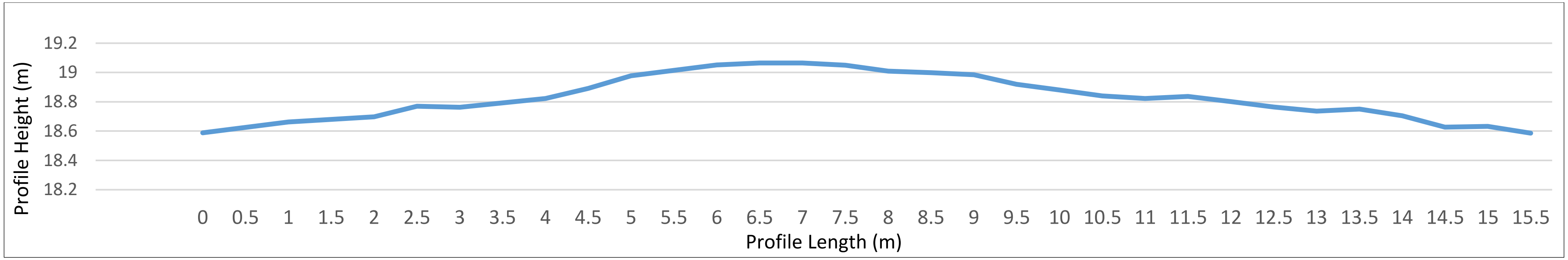


Figure A11.2: Elevation profile HCN20 showing characteristic shape of a levy bank position, ashy soil present over the first 14 metre width displayed.

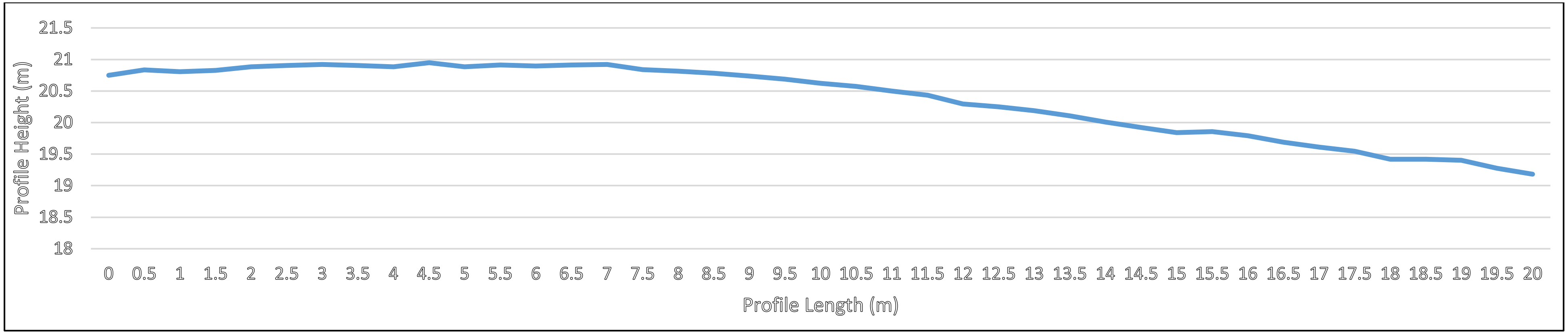


Figure A11.3: Elevation profile for HCN21 showing width dimension to 22 metres.

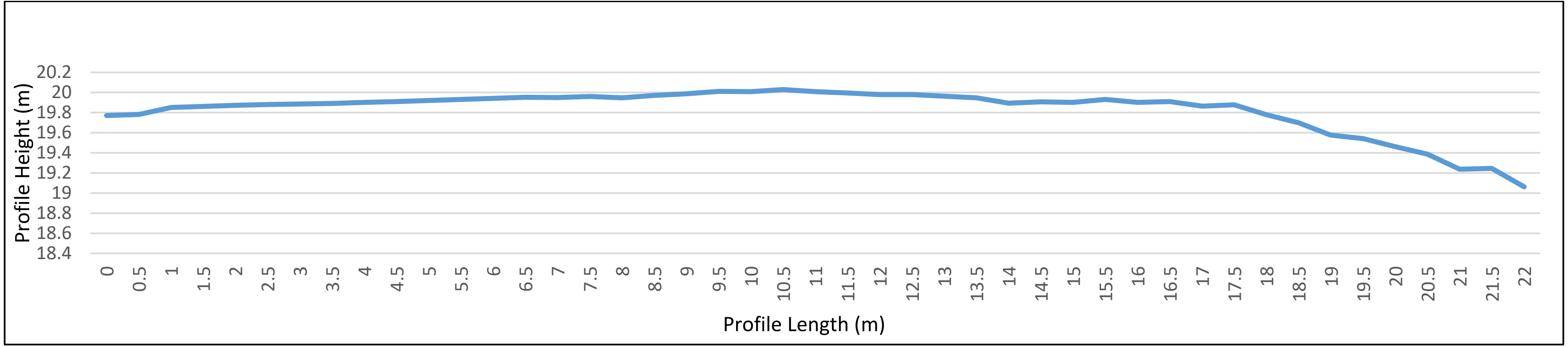


Figure A11.4: Elevation profile for HCN23, ashy material present to 22 metres.

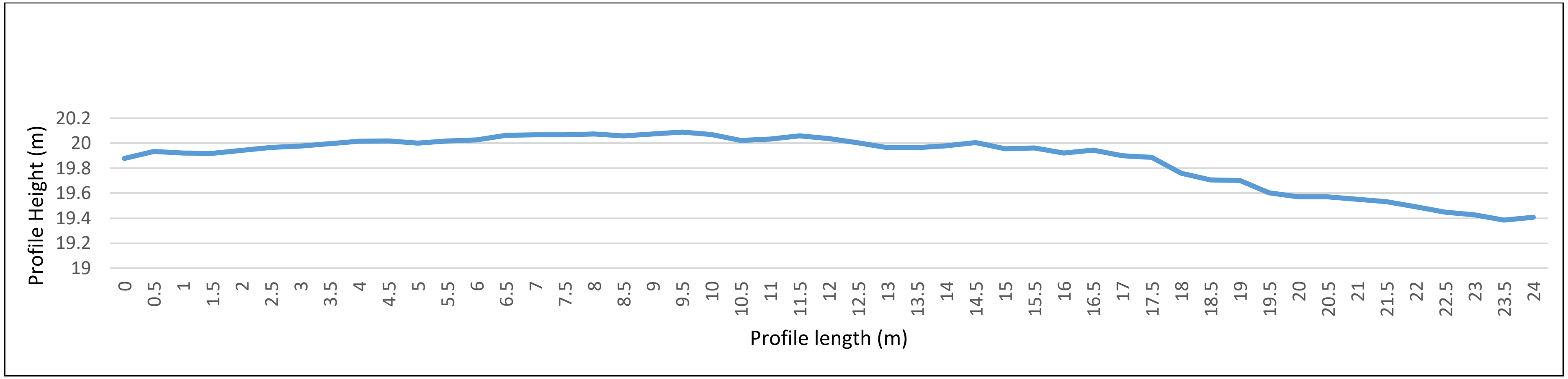


Figure A11.5: levy bank elevation profile for HCN24, ashy material present to 16 m.

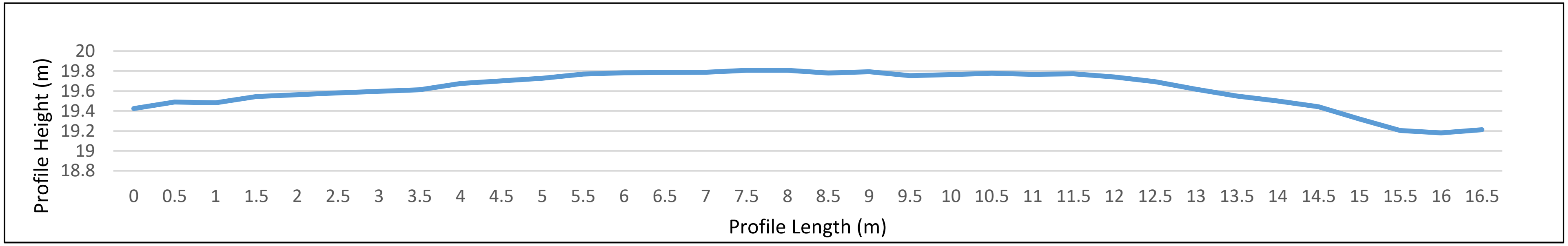


Figure A11.6: Elevation profile for HCN24 parallel to Hunchee Creek (right angle to Figure A10.5), ashy material present to 16 metres.

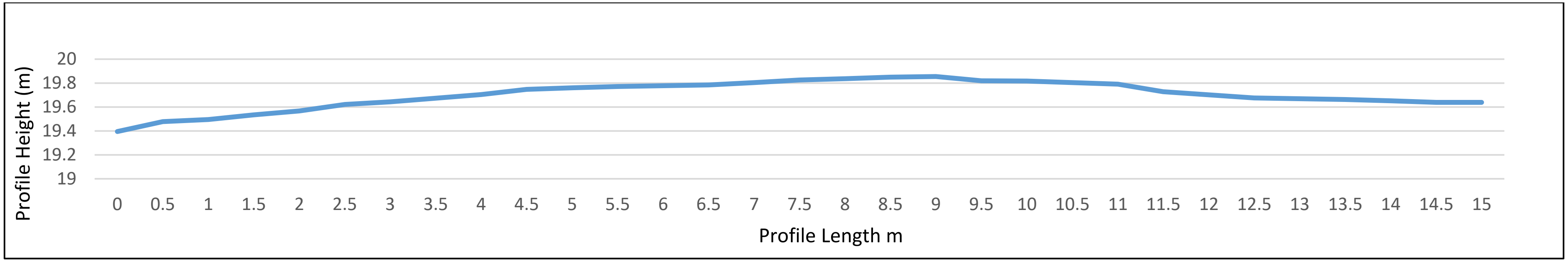


Figure A11.7: levy bank elevation profile for HCN25, ashy material present to 20 metres.

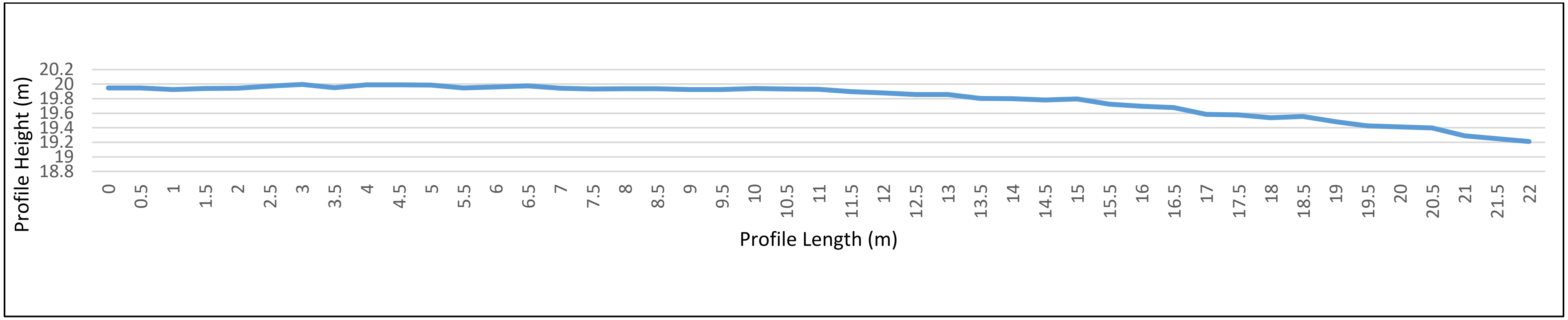
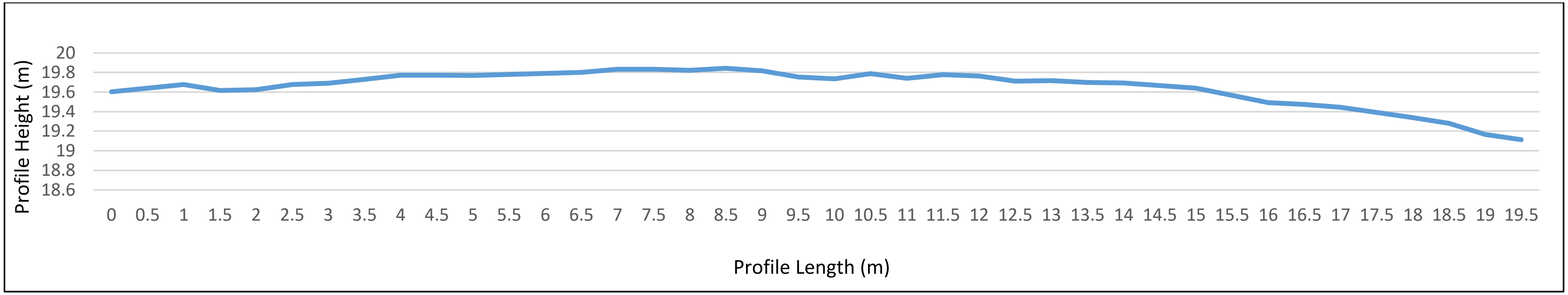


Figure A11.8: levy bank elevation profile for HCN27, ashy material present to 30 metres.



Appendix 12

Photographs of features and related subjects

Reny Island Billabong

Figure A12.1: Feature RIBB6 – toward the west. Photograph R. Jones September 2015.

Ral Ral Creek north-south section

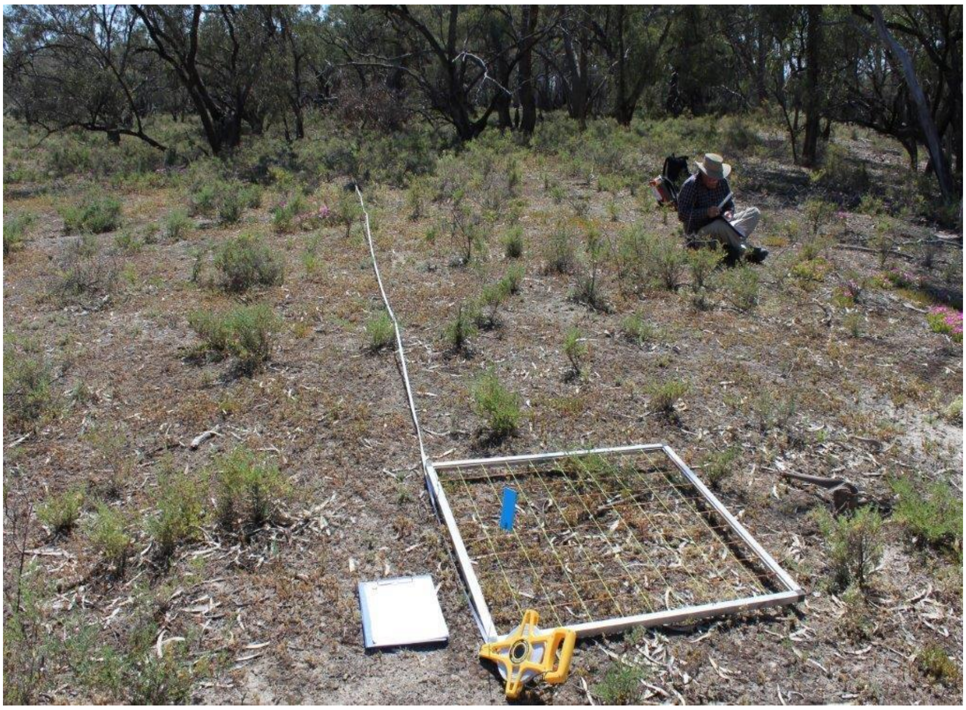


Figure A12.2: Feature RRCW11 – toward the north. Photograph: R. Coles September 2015.

Figure A12.3: Feature RRCE12 – toward the south west, north south section of Ral Ral creek in the background. Photograph R. Jones April 2016.

Figure A12.4: Feature RRCE14 – toward the south. Photograph R. Jones April 2016.

Figure A12.5: Feature HCS19 – toward the south-east. Photograph R. Jones April 2016.

Hunchee Island Billabong

Figure A12.6: Feature HIBB15 - toward the east. Photograph R. Jones April 2016.

Figure A12.7: Feature HIBB18 – toward the south. Photograph R. Jones April 2016.

Hunchee Creek North

Figure A12.8: Feature HCN24 – toward the north east. Photograph R. Jones April 2016.

Figure A12.9: Feature HCN26 – to the north. Photograph R. Jones April 2016.

Figure A12.10: HCN27 from the north. Photograph R. Jones April 2016.

Figure A12.11: Feature HCN28 – toward the south west, Amazon point in the background. Photograph R. Jones April 2016.

Figure A12.12: HCN29 at the Amazon Point track junction. Photograph C. Westell April 2016.

Figure A12.13: HCN30 from the southwest. Photograph R. Jones April 2016.

Figure A12.14: HCN31 from the north. Photograph R. Jones April 2016.

Miscellaneous

Figure A12.15: Stand of *Phragmites* spp. in Ral Ral Creek. Photograph: M. Morrison September 2015.

Figure A12.16: Burnt clay nodule Merreti east hearth feature. Photograph R. Jones September 2016.

Figure A12.17: Mussel shell fragments Lake Merreti east. Photograph R. Jones September 2016.

Figure A12.18: Abraded muller from Lake Woolpoolool west. Photograph R. Jones September 2016.

Figure A12.19: Ral Ral Creek. Photograph M. Morrison September 2015.

Figure A12.20: HCN25 showing ashy/soil matrix. Photograph R. Jones September 2015.

Figure A12.21: Scarred tree Reny island. Photographer unknown September 2015.

Appendix 13

Earth mound regional data

The earth mounds of the region are generally oval to roughly circular with a diameter up to 200 metres and a height range up to two metres (Balme and Beck 1996:42; Coutts et al 1976, 1979; Klaver 1998:18; Littleton et al. 2013; Martin 2006; Westell and Wood 2014:52; Williams 1988).

Aside from the occurrence of larger mounds in the south-western Hay Plain, the data indicates a relative uniformity in length/diameter range throughout the Murray Darling Basin (Table A13.1–A13.5, Figure A13.1). The height profile (Figure A13.2) indicates a cluster of higher mounds in the central Murrayland region associated with smaller lateral dimensions. The latter is in contrast to the Ravensworth 3 and Tchelery 1 mounds, on the south-western Hay Plain, which are in the higher range in all spatial dimensions. This potentially indicates a more complex interaction between cultural/economic practices and environmental factors in the central Murrayland region.

The range data suggests that the typology and functional observations outlined in Chapter two, confirms the action of a developmental process which includes a progression from cooking/processing to occupation sites in some instances. The context of associated processing and occupation sites also potentially indicates the development of a composite economic landscape, representing an economic, social and cultural entity (Coutts et al. 1979).

The mound length/height ratio indicates that mound profiles differ across the region, but with some sub-regional similarities. The sub-regions with similar ratios are:

- South western Hay Plain and the Macquarie Marsh;
- North Adelaide Plain, Caramut and the Hopkins River;

- North western Hay Plain, Lowbidgee, East Murrumbidgee and Barmah; and
- Central Murrayland (Balpool, Lake Jilleroo/Tooley Landing, Wakool and Nyah).

This suggests an interesting opportunity for further research involving a detailed sub-regional comparison of the physical and archaeological characteristics of earth mounds, geomorphic characteristics, climate change, local adaptations and changes in social and cultural systems.

Table A13.1: Comparison of dimensions of earth mounds located in the Macquarie marshes, Hay Plain/ Murrumbidgee region and the Central Murray (Martin 2006).

Sub-Region	Spl Size	Mean Lgth (m)	Mean Wdth (m)	Mean Hgt (m)	Median Diam (m)	Median Diam (m)	Max Lgth (m)	Min Lgth (m)	Max Wdth (m)	Min Wdth (m)	Max Hgt (m)	Min Hgt (m)
Hay Plain SW	79	53	43	0.81	N/A	N/A	200	10	100	7.5	1.86	0.2
Lowbidgee	35	32	27	0.39	N/A	N/A	80	6.0	73	6.0	1.2	0.1
Murrumbid. East	49	13	10	0.23	N/A	N/A	36	1.5	2.7	1.5	0.8	0.08
Hay Plain NW	39	12	11	0.24	N/A	N/A	30	3.0	20	3.0	0.6	0.03
Macquarie Marshes	61	14	11	0.39	N/A	N/A	70	3.3	45	2.7	0.76	0.15
Central Murray - Barmah	56	17	14	0.38	N/A	N/A	37	5.6	29	5.6	0.7	0.1
Central Murray - Balpool	51	17	14	N/A	N/A	N/A	31	3.0	27	3.0	0.8	0

Table A13.2: Dimensions Earth mounds located in South Australia (Westell and Wood 2014).

Sub-Region	Spl Size	Mean Length (m)	Mean Width (m)	Mean Height (m)	Median Diam (m)	Median Height (m)	Max Diam (m)	Min Diam (m)	Max Height (m)	Min Height (m)
Nth Adelaide Plain (Non-burial)	33	N/A	N/A	N/A	14	0.3	45	10	1.0	0.1
Nth Adelaide Plain (Burial)	5	N/A	N/A	N/A	33	1.2	56	30	1.3	1.0
Riverland SA	144	N/A	N/A	N/A	14	0.1	50	3.0	1.3	0.1

Table A13.3: Dimensions of earth mounds in western Victoria (Hopkins River) and Southern New South Wales (Coutts et al. 1976; Simmons 1980).

Sub-Region	Spl. Size	Mean Diam (m)	Mean Wdth (m)	Mean Hgt (m)	Median Diam (m)	Median Hgt (m)	Max Diam (m)	Min Diam (m)	Max Hgt (m)	Min Hgt (m)
Hopkins River Western Victoria	207	12	N/A	0.34	25	0.6	55	2	1.2	0
Lake Jilleroo/Tooley Landing NSW	56	26.5	N/A	0.84	N/A	N/A	58	11	2.0	0.15

Table A13.4: Dimensions of earth mounds at Caramut in western Victoria (Williams 1988).

Sub-Region	Spl Size	Mean Lgth (m)	Mean Wdth (m)	Mean Hgt (m)	Median Diam (m)	Median Diam (m)	Max Lgth (m)	Min Lgth (m)	Max Wdth (m)	Min Wdth (m)	Max Hgt (m)	Min Hgt (m)
Carramut Western Victoria	102	12.7	10.3	0.28	N/A	N/A	22	4	20	4	0.6	0.1

Table A13.5: Dimensions of earth mounds at the Wakool River, southern New South Wales and Nyah Forrest, northern Victoria (Berryman and Frankel 1984, Coutts et al. 1979).

Sub-Region	Spl Size	Mean Length (m)	Mean Width (m)	Mean Height (m)	Median Diam (m)	Median Height (m)	Max Diam (m)	Min Diam (m)	Max Height (m)	Min Height (m)
Wakool River	95	N/A	N/A	N/A	N/A	N/A	48	8	1.5	0.05
Nyah Forrest	100	N/A	N/A	N/A	N/A	N/A	50	5	2.0	0.05

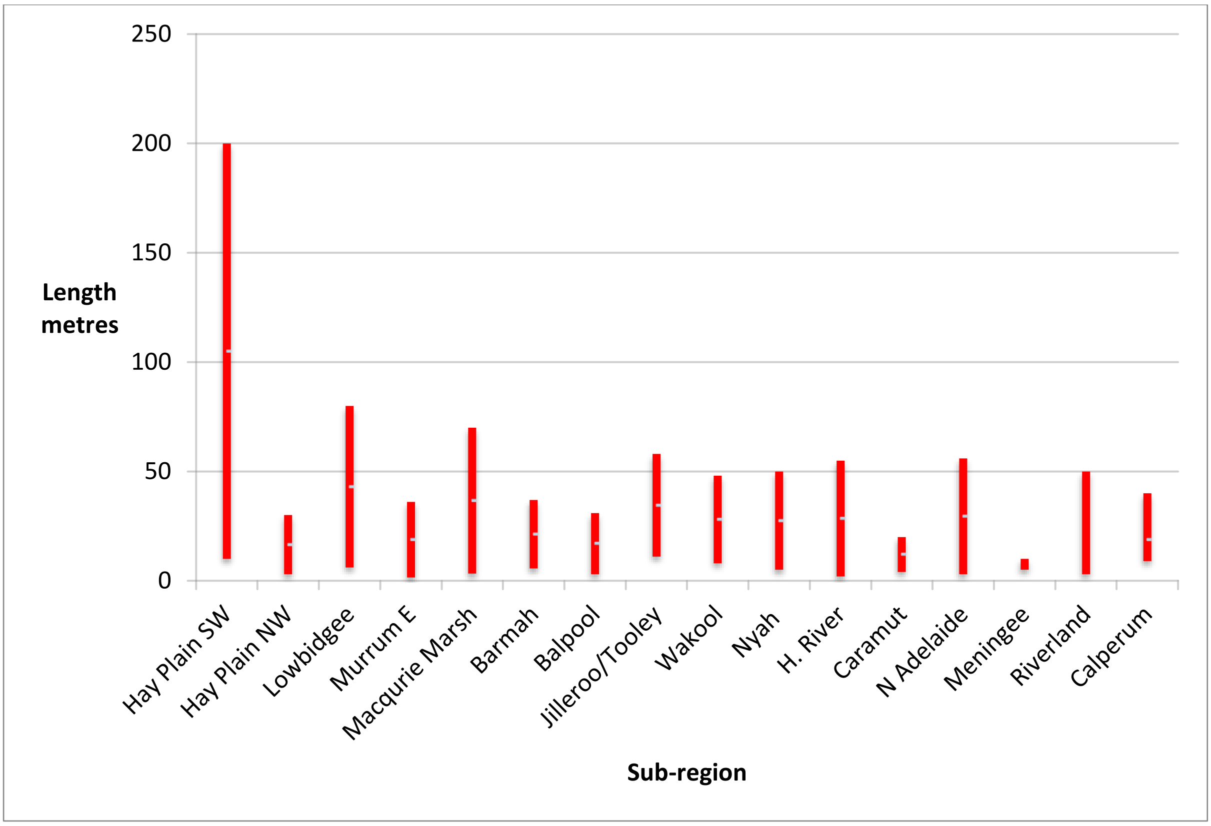


Figure A13.1: Graph of mound length range by sub-region.

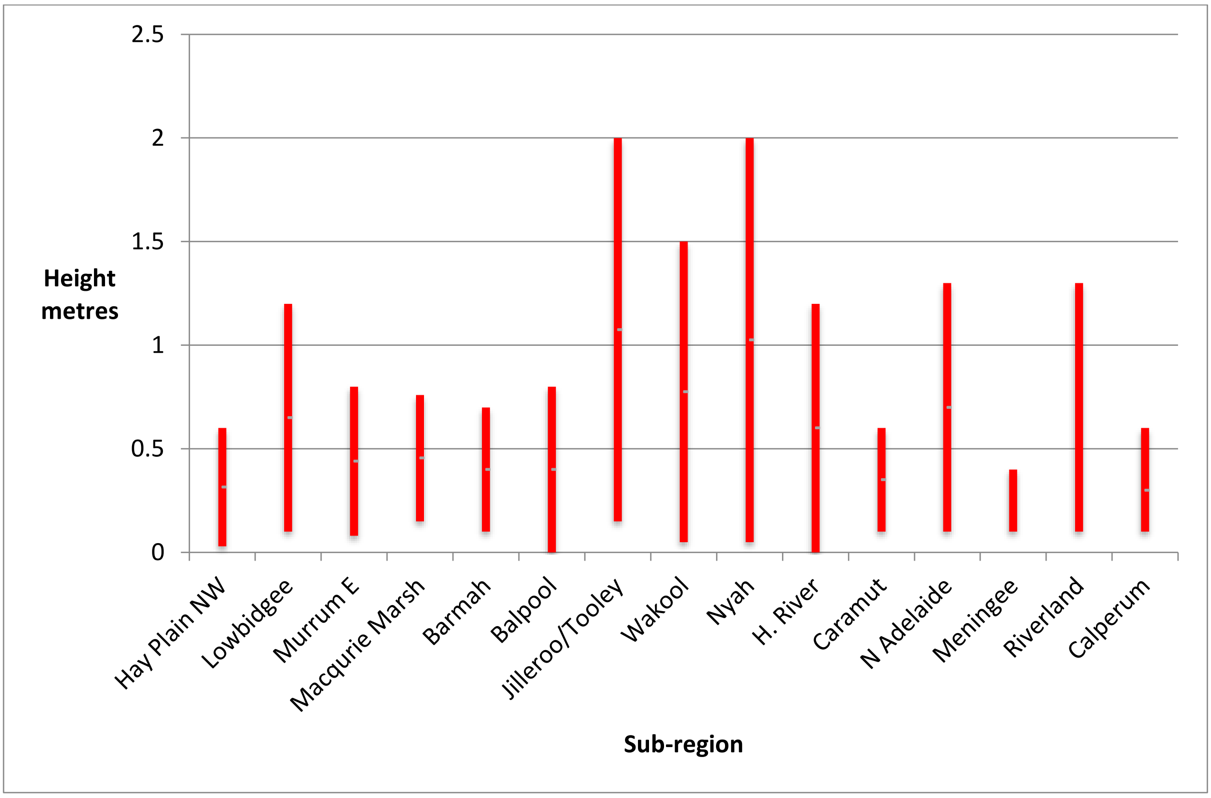


Figure A13.2: Graph of mound height range by sub-region.