ANNEX I

Aboriginal Heritage Assessment

ADDENDUM REPORT – ABORIGINAL HERITAGE ASSESSMENT REPORT

Environmental Resources Management Australia Pty Ltd (ERM) have been engaged by Aspen Group to prepare an Environmental Assessment Report (EAR) pursuant to Part 3A of the Environmental Planning and Assessment Act 1979 (EP & A). The EAR has been prepared to accompany the application for project approval for a residential subdivision consisting of 713 lots called 'Fern Bay Seaside Village'.

While there has been minor changes in the lot structure the overall footprint and layout of the Project Plan has not been altered and the Project Plan application is consistent with the Master Plan approval.

The addendum report has been provided to ensure fulfilment of the requirements of a Part 3A application.

Part of the 'Fern Bay Seaside Village' has an existing approval from the Land and Environment Court in 1997 and is currently under construction. In addition, the NSW Minister of Planning approved a Master Plan for the Fern Bay Estate residential subdivision pursuant to State Environmental Planning Policy No.71 – Coastal Protection on 8 August 2006. The project plan application is consistent with the Master Plan approval. While there have been minor changes to the lot structure the overall footprint and layout has not been altered. This report has been prepared to ensure fulfilment of the requirements of a Part 3A application.

The site is described as Lot 3, DP 270466 Nelson Bay Road, Fern Bay and is within the Port Stephens local government area. The site is approximately 205 hectares in area and comprises 16.4 hectares zoned 1 (a) Rural Agriculture, 136.4 hectares zoned 2 (a) Residential, and 52.2 hectares zoned 7 (a) Environmental Protection under Port Stephens Local Environmental Plan (LEP) 2000.

1.1 *CULTURAL HERITAGE*

The Fern Bay Seaside Village site is situated in a region rich in Aboriginal cultural heritage. Numerous archaeological sites have been recorded on the site and in the surrounding areas. These sites are of particular value to the local Aboriginal community as well as to the broader community.

In accordance with the requirements of the *National Parks and Wildlife Act 1974* (NPW Act), the site and locality has been the subject of extensive archaeological investigations. These assessments (Koettig 1987, Dean-Jones 1992, ERM 2001, 2005b) have identified the high archaeological value and sensitivity of the area and its high social value to the local Aboriginal community (McCardle Cultural Heritage 2004).

The Director Generals Requirements have requested that the cultural heritage assessment addresses and documents information contained in the Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (DEC, 2005).

The objective of these guidelines is to provide information to enable decision makers to ensure that developments have considered the following:

- information regarding the significance to those Aboriginal people with a cultural association with the land of any Aboriginal cultural heritage values on which the proposed activity is likely to have an impact;
- the views of those Aboriginal people regarding the likely impact of the proposal on their Aboriginal cultural heritage;
- any measures which could be implemented to avoid, mitigate or offset the likely impact(s); and
- any justification for any likely impact(s), including any alternatives considered for the proposal (DEC, 2005).

The results of previous assessments and outline of the consultation process below clearly demonstrates that the assessment process to date has satisfied the above objectives and has been an integral part in determining and assessing impacts, developing options and making final recommendations.

1.1.1 *Results of Previous Assessment*

As a result of the above investigations, a number of sites have been recorded in the area. The location of these sites and the high archaeological potential of the study area were considered in the preparation of the Master Plan for the entire estate (ERM, 2005b), and a Section 87 permit was obtained to conduct sub-surface investigations at specified locations within the estate. The sub-surface investigations involved the excavation of five known sites and a secondary phase of auger testing to more accurately define the archaeological sensitivity of different landforms within the site (ERM, 2005b) (see *Annex I*). The results confirmed the high archaeological potential of the area and provided information regarding the timing, nature and extent of Aboriginal use of the area (ERM, 2005b). In recognition of the social and scientific heritage value of the area, it was determined that an Aboriginal Heritage Reserve should be established within the estate to allow for the protection of a sample area of high archaeological sensitivity.

Figure 7.2 shows the sites identified through the Aboriginal Heritage Assessment Report at *Annex I*. These sites are discussed in the report which also considers the sites recorded over a wider area.

A consent under section 90 of the NPW Act was sought for the area of the approved subdivision. The section 90 consent (Permit No. 2026) was issued by the Department of Environment and Conservation (DEC) on the condition that additional archaeological salvage was undertaken within the consent area. Following the completion of the salvage excavations, further mitigation measures involved the monitoring of all ground disturbance and the collection of cultural materials by the Aboriginal community.

Additional Section 87 permits were obtained in relation to the construction of sewerage and water pipelines (Permit No. 2168) and an emergency access road (Permit No. 2355). The Aboriginal community was again involved in monitoring all works that resulted in surface disturbance.

1.1.2 Community Consultation

Aboriginal consultation is required for any assessment of Aboriginal heritage. All of the previous assessments and consultation processes have been consistent with the objectives of the Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (DEC, 2005) which refers to the Interim Aboriginal Community Consultation Guidelines (DEC, 2004).

These guidelines set out a process of inviting Aboriginal groups to register interest as a party to consultation (including local press advertisement), seeking responses on proposed assessment methodology, and seeking comment on proposed assessments and recommendations. Whilst no newspaper advertisements were used in this instance, the objectives of these guidelines were satisfied during the entire consultation process.

Four groups currently represent Aboriginal people in the Fern Bay area: the Worimi Local Aboriginal Land Council (WLALC); Maaiangal Aboriginal Heritage Incorporated (MAHI); Mur-roo-ma Incorporated (MI); and Nur-run-gee Incorporated (NI), which also represents the Worimi Traditional Aboriginal Elders Group Incorporated. MI and NI formed during the latter portion of 2005 and prior to this, members of these organisations were consulted through WLALC.

Consultation with these groups has been extensive and ongoing from the original project inception in 2000. As recorded in the previous reports (ERM 2001, 2005b (*Annex I*)), the viewpoints of the Aboriginal community regarding the cultural importance and sensitivity of the area have been considered and all recommendations and permits relating to the estate have been discussed with representatives of the local community. Consultation with WLALC and MAHI was undertaken during the previous Aboriginal cultural heritage assessments conducted by ERM and the establishment and location of the Aboriginal heritage reserve. Members of the WLALC have been involved in all excavations, monitoring and collection of artefacts.

1.1.3 Aboriginal Community Involvement During 2000

The Worimi Local Aboriginal Land Council (WLALC) was consulted in regards to the proposed development in 2000 and has participated in each stage of the archaeological investigation to date. Ongoing consultation and partnership with WLALC has promoted open dialogue with the local Aboriginal community and facilitated crucial input from WLALC in regards to proposed development and the archaeological investigations.

Mr Len Anderson formally of WLALC, provided a consultative and oversight role throughout the initial project. Representatives of WLALC, Leith Anderson, Gavin Kelly and Jamie Thomas participated in the survey work and the test excavations. During the test excavations, WLALC representatives participated in all aspects of the work including excavation, sieving, identification and interpretation of finds. The role played by WLALC in the archaeological investigations was instrumental in the success of the project.

Recommendations of the Preliminary Excavation Report and the Interim Final Excavation Report were developed in consultation with WLALC. The outcomes of consultation with the Aboriginal community in 2000 are detailed below.

1.1.4 Outcomes of Consultation 2000-2001

WLALC indicated that the site has a high level of cultural significance to the local Aboriginal community. The study area is an important landscape where camping, tool making, food gathering and traditional activities were carried out in the past. The local Aboriginal community was concerned about the impact of proposed development on Aboriginal heritage. WLALC recommended a mitigation and heritage management plan be prepared in advance of development.

Following completion of excavation works in December 2000, ERM and WLALC developed a heritage mitigation approach in consultation with Howship Holdings Pty Ltd and NPWS (now known as DECC). This mitigation approach formed the basis of the recommendations provided in the

Preliminary Excavation Report prepared by ERM in 2000. The mitigation approach included:

a) completion of post-excavation analysis and preparation of a full excavation report describing the results of test excavation at Fern Bay;

b) conservation of an adequate representative sample of landforms. In addition to the areas zoned 7a (Environment Protection), the low ridgeline comprising Site C and Site 8 were conserved as open space and excluded from development. This recommendation was based on the high archaeological and Aboriginal cultural significance of the ridgeline; and

c) WLALC monitoring of development excavation works during the construction phase. Monitoring allows recovery of Aboriginal objects disturbed by development work.

After post-excavation analysis was completed, WLALC requested that all cultural material excavated at Fern Bay be returned to the Aboriginal community and that WLALC be permitted to re-bury the artefacts. Accordingly, an application for a Care and Control permit was made to cultural material returned to WLALC. The artefacts were placed in thick plastic bags, sealed with staples and tape and reburied on the low ridgeline earmarked for conservation. The exact location of the reburial will not be disclosed in this report to ensure the security of the artefacts.

1.1.5 Aboriginal Community Involvement and Consultation During 2004

ERM was commissioned again in 2004 to undertake consultation with the local Aboriginal community with a view to obtaining a Section 90 consent from the Department of Environment and Conservation (DEC) for the approved subdivision. Consultation involved meetings with Lennie Anderson (representing WLALC) and Carol Ridgeway-Bisset (MAHI). These meetings provided the opportunity to inform the community about the approved development plans and to revisit the original Aboriginal significance assessment. They also provide the opportunity for the community to voice concerns and provide recommendations.

A salvage excavation was a condition of the Section 90 consent (# 2026) issued by the DEC. The Aboriginal community endorsed the Section 90 consent application and Peter Morris and Leanne Anderson (representatives of the WLALC), were an integral part of the excavation team. Changes to the salvage design were made in consultation with the WLALC representatives on site. MAHC was kept informed of the developments. Carol Ridgeway-Bisset inspected the excavation site as a representative of MAHC.

1.1.6 *Aboriginal Community Involvement and Consultation during 2005-2007*

As a result of previous consultation with Aboriginal communities it was recommended than an Aboriginal heritage reserve should be created within the Fern Bay Estate in order to retain an area that represents the key aspects of the Aboriginal archaeological record at Fern Bay. The creation of an Aboriginal heritage reserve was adopted by Aspen and a management plan was developed in full consultation with Aboriginal communities.

Mur-roo-ma Incorporated (MI); and Nur-run-gee Incorporated (NI), which also represents the Worimi Traditional Aboriginal Elders Group Incorporated and were formed during the latter portion of 2005, were consulted via WLALC. The Cultural Heritage Management Plan for the Aboriginal heritage reserve at Fern Bay Estate was developed in 2006 by ERM in full consultation with WLALC (represented by Andrew Smith), MAHI (represented by Carol Ridgeway-Bissett), MI (represented by Anthony Anderson) and NI (represented by Lennie Anderson).

Consultation involved two meetings and attendees at these meetings are listed in *Table 1* and *Table 2*. Following the completion of the meeting on the 22nd of May, all meeting attendees were provided with a copy of the minutes of the meeting and a copy of the initial draft management plan. The draft management plan was discussed at the meeting on the 4th of July and the issues discussed during the meeting were incorporated within the draft of the management plan.

Table 1 *Attendees at Meeting 22nd May 2006*

Name	Organisation
Bill Sarkis	Winten Property Group
Greg Burnitt	Monteath Powys Project Manager
Nicola Roche	ERM
Andrew Smith	Worimi Local Aboriginal Land Council
Anthony Anderson	Mur-roo-ma Inc.
Lennie Anderson	Nur-run-gee
Carol Ridgeway-Bissett	Maainagal Aboriginal Heritage Inc.

Table 2 *Attendees at Meeting 4th July 2006*

Name	Organisation
Bill Sarkis	Winten Property Group
Greg Burnitt	Monteath Powys Project Manager
Nicola Roche	ERM
Neville Baker	ERM
Chris Langeluddecke	ERM
Andrew Smith	Worimi Local Aboriginal Land Council
Brendan Lilley	Worimi Local Aboriginal Land Council
Anthony Anderson	Mur-roo-ma Inc.
Lennie Anderson	Nur-run-gee

1. Carol Ridgeway-Bissett was unable to attend and sent apologies.

The draft management plan was provided to all groups for their comments and modifications. The final management plan incorporates the comments received from the Aboriginal community.

WLALC will be kept informed about the timing and details of development at the site and will be given the opportunity to recover Aboriginal objects during excavation work associated with the development. MAHI will also be kept informed about the timing and details of development at the site

1.2 *ADEQUACY REVIEW COMMENTS FROM DECC*

Following review of the draft EAR during the adequacy review period for government agencies, DECC raised issues associated with the aboriginal heritage assessment for the Fern Bay Seaside Village, in particular the protocols for the management of human remains should they be uncovered during construction works on site. DECC requested amendments to the protocol presented in Section 11.3 of the Aboriginal Heritage Assessment (ERM, 2005a). The following provides an addendum to the report to replace Section 11.3 (IV):

1.2.1 *Addendum to Section 11.3 (IV) of the Aboriginal Heritage Assessment Report (ERM, 2005)*

Replace Section 11.3(IV) of the Aboriginal Heritage Assessment Report with the following:

"11.3 IV. If human skeletal remains are identified during construction, all works in the immediate vicinity will cease immediately. No re-burial is to occur which is contrary to the management protocol. Once works have ceased, the following is to occur:

- *inform the NSW Police and DECC immediately; and*
- *fence off surrounding area and declare it a no entry zone until such time as a police forensic analysis identifies the nature of the remains and an appropriate plan of action is formulated."*

1.3 SUMMARY OF CULTURAL HERITAGE MANAGEMENT

The consultation process satisfies the aims and objectives of the Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (DEC, 2005) and has been an integral part in determining and assessing impacts, developing options and making final recommendations.

As a result of the previous assessments and ongoing consultation, it was recommended that an Aboriginal heritage reserve should be created within the Fern Bay Seaside Village in order to retain an area that represents the key aspects of the Aboriginal archaeological record at Fern Bay. The creation of an Aboriginal heritage reserve was voluntarily adopted by Aspen and a management plan was developed, in full consultation with WLALC (represented by Andrew Smith), MAHI (represented by Carol Ridgeway-Bissett), MI (represented by Anthony Anderson) and NI (represented by Lennie Anderson).

Fern Bay Estate

Master Plan Study

WINTEN PROPERTY GROUP

CVC Limited

Fern Bay Estate

Aboriginal Heritage Assessment Report

Winten Property Group & Continental Venture Capital Limited

April 2005

0012720 Final

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ERM

Delivering sustainable solutions in a more competitive world

Project Manager:	*Sally Crews*
Date:	*20 April, 2005*
Partner/ Project Director:	*Steve O'Connor*
Signed:	

Environmental Resources Management Australia Pty Ltd Quality System

Fern Bay Estate

Aboriginal Heritage Assessment Report

Prepared by: Jim Wheeler

Winten Property Group & Continental Venture Capital Limited

April 2005

0012720 Final

CONTENTS

CONTENTS

CONTENTS

LIST OF FIGURES

LIST OF PHOTOGRAPHS

Page No.

1 INTRODUCTION

1.1 PREAMBLE

This report presents the results an assessment of Aboriginal heritage, involving archaeological excavations, carried out by Environmental Resources Management Australia Pty Ltd (ERM) within Lot 16, DP 258848, No. 85 Nelson Bay Road, Fern Bay during November and December 2000 (refer to *Figure 1.1* for the location of this land). The excavation was carried out in accordance with section 87 Preliminary Research Permit N62/PRP/2000 issued by the National Parks and Wildlife Service (NPWS – now the Department of Environment and Conservation) Northern Aboriginal Heritage Unit on the 17th of November 2000.

The excavation and assessment at Fern Bay was originally commissioned by Howship Holdings Pty Ltd. Following completion of the excavation at the site, Howship Holdings Pty Ltd became insolvent.

ERM completed an 'Interim Final Report on Excavations' (ERM 2001) for NPWS in July 2001 in partial fulfilment of the conditions of the section 87 permit.

Since the completion of the Interim Report in 2001, a new developer, Winten (No. 20) Pty Limited, has purchased the site. Winten engaged ERM to complete the report on the archaeological excavations and fulfil the terms of the section 87 Permit N62/PRP/2000. This report presents the results of excavations within the proposed development area. This report includes additional information not included in the Interim Report.

1.2 SITE IDENTIFICATION

The site is approximately 205 hectares in area and comprises 16.4 hectares zoned 1(a) Rural Agriculture, 136.4 hectares zoned 2(a) Residential, and 52.2 hectares zoned 7(a) Environment Protection under Port Stephens Local Environmental Plan, 2000. The land is immediately adjacent to and to the east of Nelson Bay Road, midway between Stockton Beach and Fullerton Cove.

The site generally comprises naturally stabilised dune systems with interdunal depressions. Parts of the site have been disturbed by four-wheel drive vehicle tracks and also as a result of clearing and excavation work associated with an approved subdivision over part of the site.

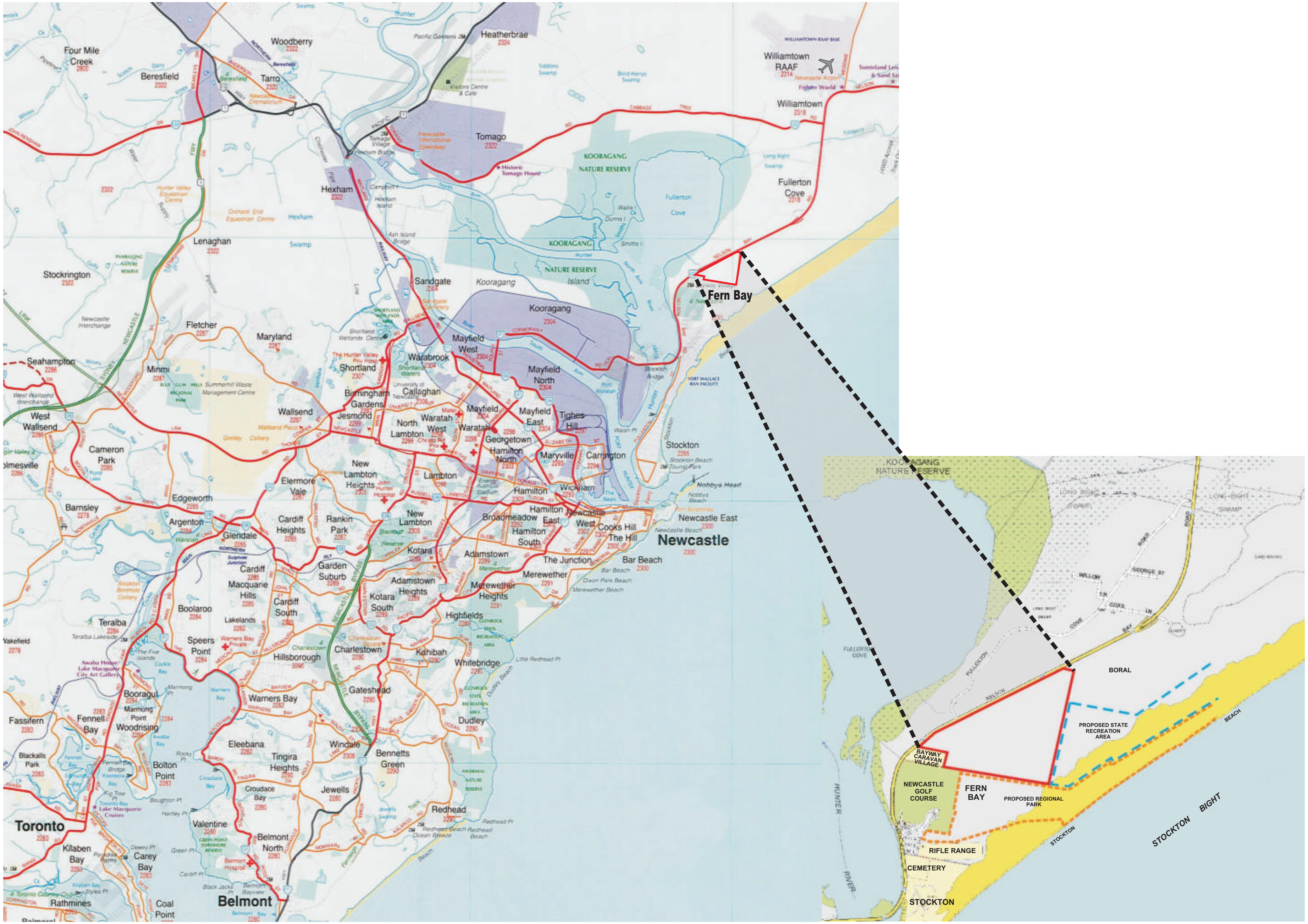

Figure 1.1 **Locality Plan**

Winten Property Group - CVC Limited - Fern Bay Estate

1.3 *SUMMARY OF PROPOSED DEVELOPMENT*

Fern Bay Estate is proposed to comprise:

- approximately 950 residential lots in total (some of which have development approval);
- open space lots, which will include formal parks and an Aboriginal heritage reserve within 2(a) zoned land and conservation reserves within 1(a), 2(a) and 7(a) zoned land. These areas of open space are designed to provide opportunities for passive and active recreation, stormwater management and the protection of sites of Aboriginal heritage significance and ecological corridors;
- a community nursery which will be used for the propagation of plants for use in the landscape areas of the estate;
- community, recreational and commercial facilities;
- new public roads, fire trails and pedestrian trails; and
- bushfire buffers (asset protection zones).

The concept plan for the proposed estate is illustrated in *Figure 1.2*.

There is already an approval to subdivide part of the site into 208 residential lots and a school site (refer to *Figure 1.3* for the approved subdivision). Construction works have commenced for part of this subdivision. Several of the approved lots form part of the proposed Fern Bay Estate however, those approved lots and roads within 200 metres of the northern boundary of the site are not proposed to be constructed. Instead this area is proposed to form part of a minimum 200 metre wide ecological corridor that will connect the site with the vegetated areas to the north and south. The school site is also now proposed to be developed for residential purposes given the Department of Education and Training has confirmed that it is no longer required for educational purposes.

A section 90 consent with salvage has been issued by the Department of Environment and Conservation for archaeological sites within the approved subdivision footprint. A condition of this section 90 consent stipulated that additional excavations be undertaken. This excavation and salvage work was carried out in October 2004 and will be reported to DEC.

The consent authority for the proposed subdivision is the Minister for Infrastructure, Planning and Natural Resources. In accordance with State Environmental Planning Policy No. 71 – Coastal Protection (SEPP 71), the Minister cannot grant consent to the subdivision until a draft master plan has been prepared and adopted by the Minister. A Draft Master Plan has been prepared for the site by ERM. The recommendations contained in this

LEGEND

- Residential Integrated Housing
- Residential Villas 340m² to 399m²
- Residential Premium Villas 400m² to 449m²
- Residential Courtyard 450m² to 589m²
- Residential Conventional lots 590m² +
- Residential Duplex 750m² +
- Part of Existing DA
- Part of Approved Development Footprint
- Recreational Facilities/Community Centre
- Active Recreational Facility
- Open Space - conservation areas
- Open Space - Landscaped areas, playground
- Community Nursery
- Aboriginal Heritage Reserve
- Fern Bay Study Area
- Fire Trail
- Major Walking trail

ALLOTMENT TYPES AND NUMBERS

Residential Integrated Housing 3.78ha x 25/ha	94 units
Residential Villas 340m² to 399m²	123 lots
Residential Premium Villas 400m² to 449m²	120 lots
Residential Courtyard 450m² to 589m²	255 lots
Residential Conventional lots 590m² +	186 lots
Residential Duplex 750m² +	20 units
Existing DA	149 lots
TOTAL	947

- 1(a) Rural Agriculture 1(a) Zone
- 2(a) Residential 2(a) Zone
- 7(a) Environment Protection 7(a) Zone

Source: Robertsday, Town Planning Design

Jobs/2003/0012720/Master Plan Studies - Aarch -Fg1.2 Concept Plan.cdr March 2005 SP Environmental Resources Management Australia Pty Ltd

ERM

0 100m
Approximate only

Figure 1.2 **Concept Plan of Proposed Subdivision**

Winten Property Group - CVC Limited - Fern Bay Estate

ERM

Figure 1.3 **Approved Subdivision**

Winten Property Group - CVC Limited - Fern Bay Estate

Heritage Impact Assessment Report have influenced the design of Fern Bay Estate and will have an impact on construction activities.

1.4 *SCOPE, RATIONALE AND OBJECTIVES*

This report details the results of archaeological excavation and assessment undertaken at the site during November and December 2000. The study assesses the Aboriginal heritage significance of the site and recommends an approach for mitigation of development impacts on Aboriginal heritage. The report also documents consultation and partnership with the local Aboriginal community (Worimi Local Aboriginal Land Council and Maaiangal Aboriginal Heritage Incorporated). The principal objectives of the investigation were to:

1. determine the nature and extent of Aboriginal sites and objects within the study area;
2. assess the archaeological (scientific), and Aboriginal (social) significance of the Aboriginal sites;
3. test Aboriginal sites identified in archaeological assessments of the study area (Dean-Jones 1992 & ERM 2000a);
4. test specific archaeological research questions set out in the section 87 permit application;
5. identify areas and landforms of high archaeological research significance and/or Aboriginal cultural importance;
6. assess the impact of proposed development on Aboriginal sites, objects and heritage values; and
7. in consultation with the local Aboriginal community, recommend appropriate mitigation of development impact to Aboriginal heritage. The recommendations aim to ensure that the proposed development complies with requirements of State and Commonwealth heritage legislation.

The program of excavation, which is the subject of this report, was recommended by a 1992 assessment of the site (Dean-Jones, 1992) and by ERM investigations (2000a) undertaken on behalf of Howship Holdings Pty Ltd for a previous development proposal for the site. The methodology for the excavation was based on an approach agreed by relevant stakeholders including the Worimi Local Aboriginal Land Council (WLALC), Howship Holdings Pty Ltd, the National Parks and Wildlife Service Northern Aboriginal Heritage Unit and ERM.

In accordance with NPWS guidelines and the legislative requirements of section 90 of the *National Parks and Wildlife Act 1974*, the Archaeological

Assessment Report prepared by ERM (2000a) recommended test excavation to determine the nature, extent and significance of Aboriginal sites and objects within the proposed development area. In order to undertake the testing, an application for a Preliminary Research Permit (PRP) was submitted to the NPWS. The Worimi Local Aboriginal Land Council (WLALC) provided a letter of support for the section 87 application and the permit (N62/PRP/2000) was approved on the 17th November 2000.

1.5 STATUTORY CONTROLS

The *National Parks and Wildlife Act 1974* and the *Environmental Planning and Assessment Act 1979* provide the statutory tools for Aboriginal cultural heritage management in New South Wales. The *Aboriginal and Torres Strait Islander Heritage Protection Act 1986* provides protection from a Commonwealth perspective.

The implications of these statutes for the development proposal are outlined below.

1.5.1 The National Parks and Wildlife Act 1974

The provisions of the *National Parks and Wildlife Act 1974* provide blanket protection for Aboriginal objects (material evidence of Aboriginal occupation) and Aboriginal places (areas of cultural significance to the Aboriginal community). The following sections are particularly relevant:

- section 91 states that anyone who discovers an Aboriginal object is obliged to report the discovery to the NPWS;
- section 90 states that it is an offence to destroy, deface, damage or desecrate, or cause or permit the destruction, defacement, damage or desecration of, an Aboriginal object or Aboriginal place;
- section 86 and 87 state that it is an offence to collect or disturb objects or excavate, or in any way disturb land for the purpose of discovering objects without a permit authorised by the Director-General NPWS; and
- section 84 makes provision for protection of 'Aboriginal Places' or locations of special significance to Aboriginal culture.

In practical terms, the provisions of the Act require an archaeological assessment of any land where there is potential that Aboriginal sites or objects may be impacted by development. Aboriginal archaeological assessments are governed by the *NPWS Guidelines for Archaeological Survey and Reporting (1997)*. These guidelines require consultation with Aboriginal communities and relevant representative bodies such as Local Aboriginal Land Council's (LALCs) and Traditional Owner groups. This includes Aboriginal community participation in all archaeological survey and excavation work and consideration of the Aboriginal cultural significance of sites and places.

In accordance with section 90 of the *National Parks and Wildlife Act 1974*, all Aboriginal objects are protected and cannot be destroyed or disturbed without a section 90 consent from DEC. The protection is provided irrespective of both the level of significance of the objects and issues of land tenure. If areas of sub-surface archaeological potential are identified, DEC generally require archaeological test excavation prior to development to determine whether sub-surface objects are present, and the nature, extent and significance of such objects. The results of archaeological testing are used to determine appropriate management strategies, which should be developed by consultation between Aboriginal community representatives, the consultant archaeologist, client and DEC.

1.5.2 Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* requires that environmental and heritage impacts are considered by consent authorities prior to granting development approvals. Under Part IV of the Act, specific approval from state agencies may be required in certain circumstances. This mechanism is known as an 'integrated development application' or IDA.

The DEC is an approval body in the IDA process when a development will impact on an Aboriginal object or place, and thereby require a section 90 consent from DEC to allow the destruction or disturbance of a registered site. In this situation, consent must be granted by DEC prior to a development being approved.

1.5.3 Commonwealth Legislation

The *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* was enacted by the Commonwealth Government to preserve and protect areas (particularly sacred sites) and objects of particular significance to Aboriginal Australians from damage or desecration. Steps necessary for the protection of a threatened place are outlined in a gazetted *Ministerial Declaration (Sections 9 and 10).* This can include the prevention of development.

As well as providing protection to areas, it can also protect objects by *Declaration*, in particular Aboriginal skeletal remains (*Section 12*). Although this is a Commonwealth Act, it can be invoked on a State level if the State is unwilling or unable to provide protection for such sites or objects.

1.6 *REPORT OUTLINE*

The balance of the report is set out as follows:

- background to the archaeological investigations including a summary of the environmental context, geomorphology and Aboriginal 'ethno-history' (*Chapter 2*);
- a summary of the previous assessment reports and investigations in the study area (*Chapter 3*);
- excavation methodology, including a discussion of research aims (*Chapter 4*);
- excavation results (*Chapter 5*);
- discussion of excavation results (*Chapter 6*);
- conclusions (*Chapter 7*);
- results of Aboriginal community consultation and partnership (*Chapter 8*);
- an assessment of Aboriginal heritage significance, including a review of processes used to evaluate Aboriginal, archaeological and public significance (*Chapter 9*);
- assessment of the impact of proposed development on Aboriginal sites, objects and heritage values (*Chapter 10*); and
- recommendations (*Chapter 11*).

Annexures to this report include:

1. excavation data;
2. soil data;
3. stone artefact analysis and data (by Jakub Czastka);
4. faunal remains catalogue;
5. Functional Analysis Report (by Richard Fullagar, Michael Therin & Carol Lentfer); and
6. carbon dating results.

1.7 *AUTHORSHIP*

ERM Archaeologist Jim Wheeler wrote this excavation report. ERM Archaeologist Andrew Collis reviewed the report. It includes contributions made by, and information drawn from research and post excavation analysis by the following people:

- Jakub Czastka: Aboriginal stone artefacts;
- Ursula Frederick: Site and artefact photography;
- Dr Richard Fullagar, Michael Therin and Carol Lentfer: Residues and Use Wear Analysis;
- Liz Shelly: Soils; and
- University of Waikato: C14 dating.

1.8 *ACKNOWLEDGMENTS*

ERM acknowledges the assistance, advice and support provided by the following:

- Len Anderson (Worimi Local Aboriginal Land Council);
- Carol Ridgeway-Bisset (Maaiangal Aboriginal Heritage Incorporation);
- Liam Dagg (Archaeologist – DEC);
- Peter Douglas (Director – Archaeological & Heritage Management Solutions Pty Ltd);
- Ursula Frederick (Archaeologist – Australian National University);
- Richard Fullagar (Archaeologist – University of Sydney);
- Jakub Czastka (Archaeologist);
- Liz Shelly (Environmental Scientist);
- Leith Anderson, Gavin Kelly and Jamie Thomas of Worimi Local Aboriginal Land Council;
- Waikato University Radiocarbon Dating Lab; and
- Winten (No. 20) Pty Limited.

2 BACKGROUND TO THE INVESTIGATION

This section provides background information relevant for understanding the Aboriginal heritage and archaeology of Fern Bay. The following sections present a summary of environmental context, a description of Aboriginal lifestyle and history, and a summary of the archaeological context of Fern Bay.

2.1 ENVIRONMENTAL CONTEXT

Archaeological reports include information about environmental context because of the important role environmental characteristics played in influencing the types of archaeological sites in any given area. Physical environments influenced both the type and availability of natural resources and the types of cultural activities that were carried out in the past. As a result, this also influenced the types of archaeological sites that may be found.

A determination of the former environmental context is essential to develop accurate models of cultural activity, site distribution patterns and the archaeological potential of any given area. The environmental setting of Fern Bay Estate is discussed below.

2.1.1 Soils

The principal soil landscapes in the study area are the "Boyces Track" and "Hawks Nest" (after Matthei; 1995) aeolian landscapes. The Boyces Track landscape includes stable transgressive dune ridges and the Hawks Nest landscape encompasses interdunal depressions (deflation basins) and swales. Small pockets of "Blind Harrys Swamp" (after Matthei; 1995) landscape, associated with the swamp forests, are found within the broader Hawks Nest landscape. The present study was undertaken within Boyces Track landscape. Soil profiles in this landscape typically display the following stratigraphy (Matthei 1995):

- A1 soil horizon – brownish-grey, loose loamy sand with slightly acid pH (5.0 – 6.0). Depth is typically 0 – 400 mm;
- A2 soil horizon – light greyish-yellow bleached loose sand with slightly acid to neutral pH (6.0 – 7.0). Depth ranges from 400 – 1400 mm;
- B soil horizon – dull yellow-orange mottled and fermented loose sand with slightly acid to neutral pH (6.0 – 7.0). Depth ranges from 1.4 m – 1.8 m; and
- C soil horizon – loose dull yellow-orange sand with slightly acid to neutral pH (6.0 –7.0). Depth to greater than 1.8 m.

These are Quaternary sands that typically overlie clay deposits. The surface soil units are normally slightly acid (approaching neutral pH).

2 *BACKGROUND TO THE INVESTIGATION*

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The principal soil landscapes in the study area are the "Boyces Track" and "Hawks Nest" (after Matthei; 1995) aeolian landscapes. The Boyces Track landscape includes stable transgressive dune ridges and the Hawks Nest landscape encompasses interdunal depressions (deflation basins) and swales. Small pockets of "Blind Harrys Swamp" (after Matthei; 1995) landscape, associated with the swamp forests, are found within the broader Hawks Nest landscape. The present study was undertaken within Boyces Track landscape. Soil profiles in this landscape typically display the following stratigraphy (Matthei 1995):

- A1 soil horizon – brownish-grey, loose loamy sand with slightly acid pH (5.0 – 6.0). Depth is typically 0 – 400 mm;
- A2 soil horizon – light greyish-yellow bleached loose sand with slightly acid to neutral pH (6.0 – 7.0). Depth ranges from 400 – 1400 mm;
- B soil horizon – dull yellow-orange mottled and fermented loose sand with slightly acid to neutral pH (6.0 – 7.0). Depth ranges from 1.4 m – 1.8 m; and
- C soil horizon – loose dull yellow-orange sand with slightly acid to neutral pH (6.0 –7.0). Depth to greater than 1.8 m.

These are Quaternary sands that typically overlie clay deposits. The surface soil units are normally slightly acid (approaching neutral pH).

More specific studies of the soils appearing in the study area have been carried out as part of previous site assessment studies. Coffey Partners Int. (1992) for Port Stephens Council described the following soil types, which were encountered during geotechnical investigations:

- a light grey silty sand or sand topsoil that is generally 200 mm thick;
- a light grey to brown fine to medium-grained sand 500 mm to two metres deep overlying dense to very dense sands. Sandy soils are found in active sand dunes, dune crests, and slopes;
- peat, comprising sandy silty clay of low to medium plasticity and soft consistency 800 mm deep. Peat is found in interdunal areas and in low lying swampy areas subject to periodic inundation. Peat is underlain by clean sand; and
- underlying bedrock, up to 60 metres below current ground.

2.1.2 Geomorphology

The site is situated within the Newcastle Bight dune barrier system. This barrier system is divided into an "inner" Pleistocene series of dune deposits and an "outer" Holocene sequence, which is located immediately adjacent to Stockton Beach. The study area is situated within the "outer" or Holocene dune system.

The Holocene dune sequence within is the result of 'accretion' (the increase or addition of land by the deposit of sand washed up naturally by the sea) of a series of beach ridges between 6000 and 4500 years ago (Dean-Jones 1992, 4). There have been three periods of dune transgression (movement) since 4500 BP, each of which has been separated by a period of stabilisation. The first period of transgression occurred approximately between 4500 and 4000 BP, the second between 2300 and 1200 BP and the third, which is still active, began approximately 300 years ago (Dean-Jones 1992, 4). This process has resulted in three distinct Holocene dune sequences within the study area. There is an inner transgressive dune, which has been stable for approximately 4000 years and an outer transgressive dune, which has been stable since 1200 years ago. The present mobile transgressive dune is in the process of overriding the 1200 BP outer dune along the southeast margin of the site. The dune sequences form three distinct parallel ridges oriented north-east to south-west.

The complex geomorphology within the site is the result of processes during the three periods of dune transgression and subsequent stabilisation (refer to *Figure 2.1*). Between the two stabilised sequences (4000 BP and 1200 BP dunes) there is a relict deflation basin, which is also referred to as a "swale". The deflation basin is a large linear depression vegetated with wet heath. In effect the basin represents the original seaward margin of the 4000 BP dune during its period of transgression. Within both stabilised dune fields the topography consists of well-vegetated ridgelines and low-lying hollows

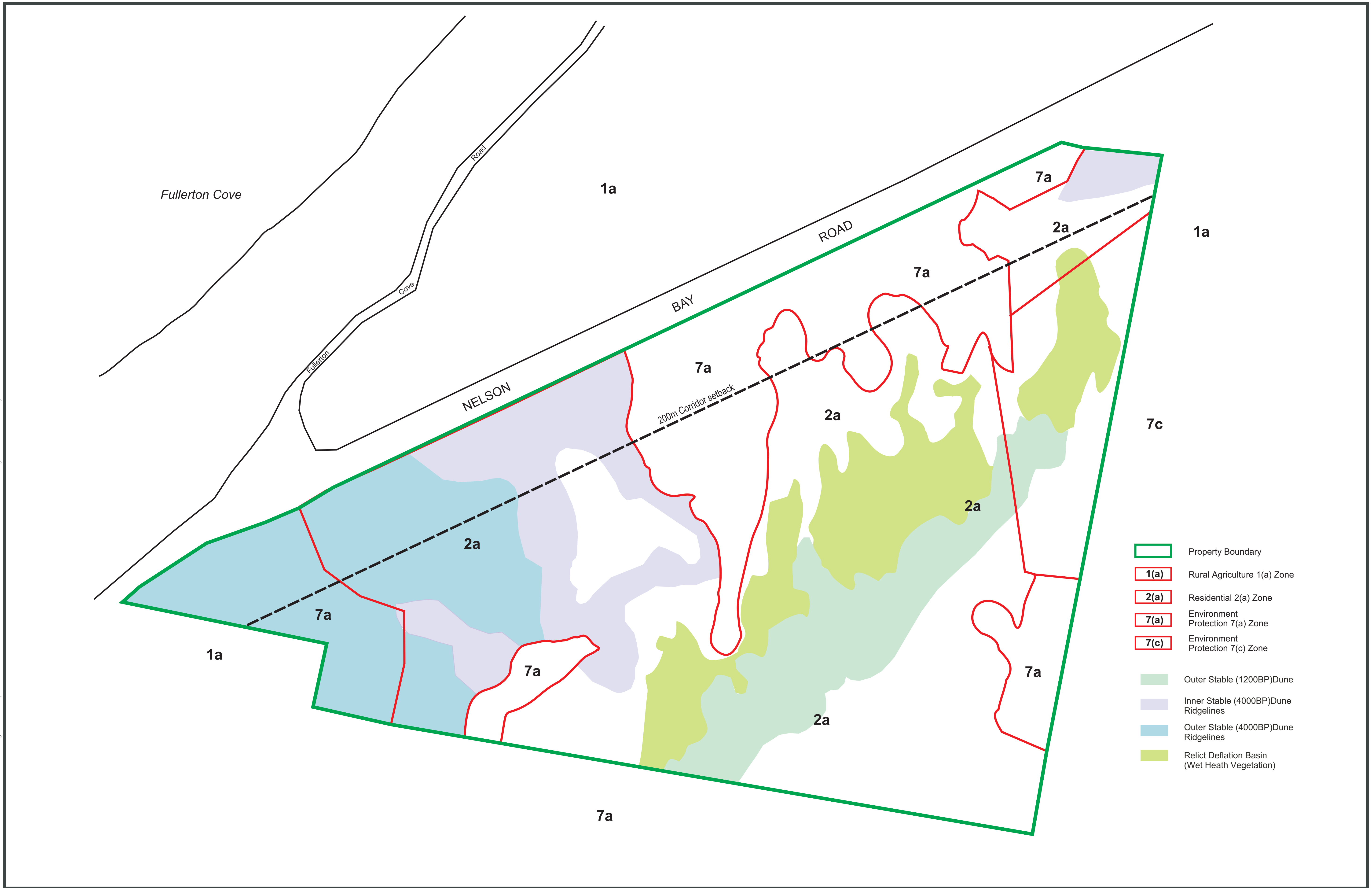


Figure 2.1 **Geomorphic Landform Units**

Winten Property Group - CVC Limited - Fern Bay Estate

known as "Swamp Forests". The Swamp Forests are usually damp, often waterlogged, and support a distinct suite of vegetation as discussed in the following section.

2.1.3 *Vegetation*

The site is characterised by three main vegetation communities. The dunes support coastal sand apple-blackbutt forest. The dune swales support wet heath community with swamp mahogany-paperbark forest in poorly drained swales near Nelson Bay Road. The endangered ecological community 'swamp sclerophyll forest on coastal floodplains of the NSW North Coast, Sydney Basin and south east corner bioregions' is present in the swamp forest on site where it adjoins Nelson Bay Road.

The eastern half of the site has been mapped as coastal sand apple– blackbutt forest, which occurs principally on Holocene sands. The canopy within this community is typically dominated by smooth-barked apple (*Angophora costata*) and blackbutt (*Eucalyptus pilularis*) with occasional red bloodwood (*Corymbia gummifera*) and *Banksia serrata*. Structurally it is an open forest with a moderately open shrubby understorey.

Swamp mahogany – paperbark forest occupies low lying areas along Nelson Bay Road. The swamp forest is dominated by broad-leaved paperbark (*Melaleuca quinquenervia*), swamp mahogany (*Eucalyptus robusta*), swamp oak (*Casuarina glauca)* and cabbage tree palm (*Livistona australis*). The canopy density is 70 percent or greater and there is a sparse mid-storey of occasional broad-leaved paperbark. The ground cover is sparse, often inundated and dominated by swamp water fern (*Blechnum indicum*), jointed twigrush (*Baumea articulata*) and saw sedge (*Gahnia clarkei*). In the western corner of the site swamp oak and broad-leaved paperbark with a sparse to absent understorey dominate the swamp forest. The swamp mahogany – paperbark forest includes a large variety of traditional Aboriginal plant foods. Significant areas of this community on site have been zoned 7(a) Environmental Protection.

The wet heath is characterised by a dense lower shrub strata with occasional emergent swamp mahogany, red bloodwood and old man banksia. This community corresponds to the wet heath community identified by Clements *et al*. (1992). Wet heath species such as *Melaleuca nodosa* and *Restio tetraphyllus* dominate the community. This community corresponds to the LHCCREMS mapping unit of Tomago sand swamp woodland.

2.2 *ABORIGINAL LIFESTYLE, CULTURE AND CONTACT HISTORY*

This section presents a history of Aboriginal use and occupation of the area. The discussion is based on documentary evidence and ethnographic records.

2.2.1 *The Worimi People*

The *Worimi* people are the traditional owners of the Fern Bay area. Early historical records indicate the *Worimi* people extended south as far as Stockton, north to Cape Hawke and inland to Dungog and Maitland (Tindale 1974). The people who lived south of the *Worimi* were the *Awabakal* and to the north were the *Birpai*.

2.2.2 *Lifestyle of the Worimi People*

By studying accounts of early European settlers and drawing on the results of archaeological investigations, we can reconstruct aspects of the *Worimi* lifestyle. The subsistence and economy of Aboriginal groups depended largely on the environment in which they lived. While coastal groups exploited marine and estuarine resources, hinterland groups relied on freshwater and terrestrial animals and plants. A distinction between the two lifestyles is clearly made in early European accounts. For example, during a trip along the Hawkesbury-Nepean during 1791, Watkin Tench wrote that:

> *'[hinterland people] depend but little on fish, as the river yields only mullets, and that their principal support is derived from small animals which they kill, and some roots (a species of wild yam chiefly) which they dig out of the earth'.*

In contrast, Collins wrote that for coastal people:

> *'Fish is their chief support…the woods, exclusive of the animals which they occasionally find in their neighbourhood, afford them but little sustenance; a few berries, the yam and fern root, the flowers of the different Banksia, and at times some honey, make up the whole vegetable catalogue'.*

Tench also noted the importance of marine foods in the economy of coastal groups. According to Tench, the task of fishing was divided between husband and wife, the woman using a hook and line and the man using a *fiz gig* (spear) (Tench 1996:258-260). Bark canoes were often used by both men and women for fishing and fires were commonly placed in the middle of these canoes. When fish were scarce or the weather was foul, coastal groups turned their attention to gathering shellfish, hunting reptiles and small animals, digging fern roots, or gathering berries (Tench 1996:258-260).

Although early observations have provided much useful information about Aboriginal society at contact, archaeological investigations have shown clear deficiencies. Archaeological excavations along the NSW coast have clearly shown that coastal people exploited a wide range of hinterland terrestrial resources, which sits in contradiction to early records that coastal people were almost exclusively 'fishers' and inland people were 'hunters'. The contradiction is probably accounted for by the visibility of fishing and gathering activities on and near the water as opposed to the relative invisibility of hunting and foraging activities in the hinterland.

Ethnohistoric sources indicate that large populations were supported along the coast. One such account comes from Tench and is worth quoting in full:

> *"on the north west arm of Botany Bay stands a village which contains more than a dozen houses and perhaps five times that number of people ....Governor Phillip, when on an excursion between the head of the harbour and that of Botany Bay, once fell in with a party which consisted of more than 300 persons"(Tench 1996: 58).*

This account suggests the existence of large and probably semi-sedentary groups, although Tench does say that the typical social arrangement was that, *"the Indian families confine their society and connections within their own pale"*(Tench 1996:58). Although these accounts come from the Sydney area, it is likely that Aboriginal lifestyles in the Fern Bay area were similar.

The *Worimi* people lived in huts or *'Gunyah's'* which were fashioned from bark. The style of huts the Worimi people made are shown in Joseph Lycett's 1817 painting of *'Aborigines resting by camp fire, near the mouth of the Hunter River'* (*refer to Photograph 2.1*). Tench described how native huts were constructed by laying pieces of bark together in the form of an 'oven'. The end result consisted of a low shelter, which was opened at one end and sufficient to accommodate one person lying down (Tench 1996:53).

Photograph 2.1 Joseph Lycett's 1817 painting of 'Aborigines resting by camp fire, near the mouth of the Hunter River'. Note the Aboriginal huts in the foreground

The exploitation of swamps and wetlands figured prominently in the lifestyle of the *Worimi* people. Swamps are rich in diverse plant and animal resources and were important places in the economy of Aboriginal people living in the Hunter Valley. This is indicated by historic records and by archaeological investigations on the fringes of wetlands. Archaeological excavations at Hexham Swamp (Baker & Effenberger 1996; HLA 1996; Kuskie & Kamminga

1999), Moffatts Swamp Dune (Baker 1994) and during the current investigation at Fern Bay, have found dense complex occupation sites that would have supported a rich economic, social and spiritual life. Staple food plants like the Bungwall Fern, were gathered from swamps and may have been processed with specialised stone tools called *'Worimi Cleavers'*.

Aboriginal groups used 'fire-stick farming' to manage the natural environment. Ethnographic evidence from Northern Australia suggests the systematic burning of the landscape was carried out for a variety of reasons. 'Fire-stick farming' opened up access to land and created pockets of early succession vegetation that increased the amount of important plant foods. Early regrowth vegetation, particularly grasses, attracted animals, which in turn made them easier to hunt. Aboriginal firing of the landscape was an important tool in manipulating the environment to increase food sources.

2.2.3 Aboriginal Contact History

The traditional life of the *Worimi* was broken through the course of the 19th century. The impact of smallpox and influenza decimated the Aboriginal population, with individual epidemics killing large numbers of people. White settlement of traditional hunting lands deprived Aboriginal groups of sources of food and access to camping and ceremonial sites. This forced individuals to either relocate into the potentially hostile lands of neighbouring Aboriginal groups, partially integrate into colonial society as fringe dwellers or to resist. Resistance by Aboriginal groups was often met with retaliatory action by white settlers and the colonial administration. A combination of these factors led to the gradual demise of traditional lifestyles, particularly in and around the early colonial settlement at 'Coal River', later known as Newcastle.

Many of the traditional groups broke up and scattered by the time that early European settlers made detailed records of the Aboriginal inhabitants. Aboriginal people who stayed in settled areas during the early to mid-1800s tended to live on the fringes of white society and became increasingly dependent on welfare.

By 1838, the Aboriginal population between Sydney and Port Macquarie had been reduced to 1220 (Wheeler [AHMS] 2004). A return of Aboriginal natives taken Newcastle in 1837 listed only 26 people in the whole Lake Macquarie – Port Stephens district (Wheeler [AHMS] 2004).

Despite the impact of disease, forced removal from their lands and later, forced re-location to Aboriginal missions and the consequences of the 'stolen generations', the Aboriginal people of the Newcastle area have shown remarkable resilience to survive and maintain aspects of their culture to the present day.

2.3 ARCHAEOLOGICAL CONTEXT

For the purposes of determining settlement and site location patterns, archaeologists examine trends in the distribution of known sites in relation to environment and topography. This provides evidence about economic and social systems in the past and also assists archaeologists in predicting likely site types and locations in any given area.

In terms of regional archaeology, the study area falls within the lower Hunter area. As a result of the extensive development in the Hunter Valley in the form of mining, quarrying, viticulture and housing, the archaeology of the Hunter region has been well documented through development impact assessments. In the last thirty years, over 3000 sites have been recorded, building up a significant database on the archaeology of the Hunter Valley.

2.3.1 *Hunter Valley Site Patterns*

There is general consistency in the types and distribution of archaeological sites throughout the Hunter Valley. In a study of known sites in the Hunter region, Hughes (1984) concluded that:

- sites would be found across the entire Hunter Valley;
- several site types exist, the most common being open artefact scatters;
- artefact scatters are most likely to occur on creek banks, especially at creek junctions, with low frequencies found over 100 metres from creeks and on hillslopes and crests;
- sites will generally reduce in size as associated watercourses decrease in catchment size;
- most archaeological evidence dates to the mid to late Holocene; and
- technological analysis of stone artefacts may assist in relatively dating sites that cannot be directly dated.

Investigations carried out since Hughes' studies have tended to confirm the patterns described above. Environmental and topographic context is an important determinant of the size and nature of sites. In general the following patterns apply:

- open artefact scatter sites are found across the landscape where original soils have been preserved. Open artefact scatter sites increase in frequency, size and complexity near creeks, rivers and swamps;
- isolated finds (stone artefacts) are found anywhere across the landscape and may represent casual discard or the remains of dispersed open scatter sites;

- midden sites are found near estuaries and coastline;

- Aboriginal burials are generally found in soft substrates such as sand and are often found within occupation contexts such as middens;

- scarred and carved trees are found within areas of remnant bushland that contain old growth trees; and

- Aboriginal rock shelters, rock shelter art, rock engravings and axe grinding grooves are found in areas of sandstone outcropping and escarpment.

The most commonly reported pattern in the lower Hunter is the frequency of open artefact scatters found near watercourses. Surveys in the Hunter Valley indicate a high density of open artefact scatters along the Hunter River and associated drainage networks. As a result of cyclical flooding, notably the 1949 and 1955 floods, more recent alluvial and colluvial deposits often bury archaeological material. This means that archaeological material is often found in areas of sub-surface exposure, such as those caused by erosion.

It has been argued that the concentration of sites along watercourses is a result of sample bias (Kuskie & Kamminga 2000) or increased exposure and visibility due to erosion in these areas. Despite evidence of survey bias, Barber (1993) showed that the pattern was real rather than just a function of bias or increased exposure of artefact-bearing deposits along creeklines. Barber excavated a representative sample of all landforms adjacent to Bettys Creek and found 62% of sites were along creeklines even though these areas represented only 22% of the survey area.

2.3.2 *Dating of Hunter Valley Sites*

Hunter Valley duplex soils are classified into two divisions consisting of an upper A-horizon and an underlying B-horizon. The majority of archaeological deposits are found in the A-horizon with artefact assemblages commonly reflecting the Holocene aged Bondaian technology.

In an analysis of Hunter Valley stone artefacts, Hiscock (1986: 40-50) argued that open site assemblages in the region are generally no older than 5000 years BP. However, evidence of earlier Pleistocene occupation has been found at Glennies Creek, north of Singleton. Radiocarbon-dated charcoal and geomorphological evidence suggests that artefacts found in the B-horizon were deposited between 10,000 and 13,000 years BP (Koettig 1986a & 1986b). In the lower Hunter, occupation has been dated to as early as 17,376 years before present at Moffats Swamp (Baker 1994).

2.3.3 *Stone Artefacts*

In an overview of Hunter Valley lithic assemblages Baker (1992: 7-9) has observed that artefacts are generally made from indurated mudstone and silcrete, with Nobby's Tuff common in the coastal zone. Baker also notes that high quality raw materials at Hunter River gravel point bars generally result in abundant flaking debris on the sides of watercourses with a stream order of two or higher. Such locations were important sources of raw material for stone artefact manufacture. Outcrops of Nobby's Tuff in the lower Hunter were also important stone sources.

Aboriginal stone artefacts are an important source of archaeological information because stone is preserved for long periods of time whereas organic materials such as bone, shell, wood and plant fibres decay. Stone artefacts provide valuable information about technology, economy, cultural change through time and settlement patterning. Stone has also been used for 'relative' dating of sites where direct methods such as Carbon dating cannot be applied. Based on direct dating of excavated sequences, an Eastern Regional Sequence has been developed and refined over the last 50 years. The Eastern Regional Sequence phases are as follows:

- Capertian – is distinguished by large uniface pebble tools, core tools, horsehoof cores, and scrapers. Backed artefacts occasionally present. Generally dates to before 5000 years before present (BP).

- Early Bondaian – Aspects of the Capertian assemblage continue, but backed artefacts and ground-edged artefacts increase. Artefacts during this period were predominantly made from fine-grained siliceous stone such as silcrete and tuff. Generally dated from 5000 BP to 2800 BP.

- Middle Bondaian – Characterised by backed artefacts, particularly Bondi Points and ground-edged artefacts. Artefacts made from siliceous materials, however quartz becomes more frequent. Generally dated from 2800 BP to 1600 BP.

- Late Bondaian – characterised by bipolar technology, eloueras, ground-edged artefacts, bone and shell artefacts. Bondi points are virtually absent and artefacts are predominantly made from Quartz. Generally dated from 1600 BP to contact.

It is yet to be demonstrated that the Eastern Regional Sequence is applicable to the coastal region around Fern Bay. Excavation of rock shelters in the upper Hunter River region (Moore 1970) suggest that this sequence may be of limited value in that region.

3 *SUMMARY OF ARCHAEOLOGICAL ASSESSMENTS AT FERN BAY*

Koettig carried out a survey of the current study area in 1987 and Pam Dean-Jones undertook a further archaeological assessment of the site in 1992. Resource Planning carried out an assessment of the western portion of the site in 1994. ERM carried out a follow-up assessment as part of a Statement of Environmental Effects (SoEE) in 2000, detailed in *Section 3.4*.

Prior to the excavation program there were nine sites registered on the NPWS Aboriginal Heritage Information Management System (AHIMS) within the study area. There were at least a further eight sites recorded during Dean-Jones' (1992) investigation of the area (it is unclear why these sites have not been registered) and an additional four recorded during the current study. All sites recorded in the study area are middens and/or open artefact scatters.

A summary of archaeological assessments undertaken within the study area is included below.

3.1 *KOETTIG 1987*

Koettig carried out a survey of the current study area for an assessment for R.W. Cookery and Co. Pty Ltd, who proposed to undertake sand quarrying. Koettig recorded ten sites NBR1 – NBR10. Site locations are shown on *Figures 3.1* and *3.2* (note that AHIMS records are incorrect and indicate that NBR8 is one kilometre north of the location recorded by Koettig). The sites consisted of shell material or stone artefacts or both. Koettig believed that the survey results provided limited information about the archaeological resource in the study area (Koettig 1987:25), but argued that the recorded sites indicate that archaeological material is widely distributed across the area and particularly along the dune crests.

3.2 *DEAN-JONES ASSESSMENT -1992*

Dean-Jones carried out survey and assessment of the current study area for a rezoning study. The survey had excellent effective coverage because a bushfire had removed much of the vegetation and exposed ground surfaces. The investigation included shovel test excavation to assess sub-surface deposits. The report included a thorough discussion of the local geomorphology and its implications for the age and location of archaeological sites. Sites investigated by Dean-Jones within the study area are summarised in *Table 3.1* and shown on *Figures 3.1* and *3.2.* A number of these sites are equivalent to sites previously recorded by Koettig.

Table 3.1 Sites investigated by Dean-Jones (1992)

Site Name	Site Type	Geomorphic Unit	Type of Investigation
Fern Bay Estate 5	Midden/ artefact scatter	4500 BP stable dune (ridge)	Survey
Fern Bay Estate 6 (=NBR1)	Artefact scatter	4500 BP stable dune (ridge)	Survey
Fern Bay Estate 7	midden	4500 BP stable dune (ridge)	Survey
Fern Bay Estate 8	midden	4500 BP stable dune (ridge)	Survey
Fern Bay Estate 9	Midden/ artefact scatter	4500 BP stable dune (ridge)	Survey
Fern Bay Estate 10	Midden	4500 BP stable dune (ridge)	Survey
Fern Bay Estate 11	Artefact scatter	1200 BP stable dune (ridge slope)	Survey
Fern Bay Estate 13 (=NBR9)	Midden/ artefact scatter	4500 BP stable dune (low slope)	Survey
Fern Bay Estate 14 (=NBR6)	Midden/ artefact scatter	4500 BP stable dune (ridge)	Survey and 4 test pits
Fern Bay Estate 15	Isolated Find	4500 BP stable dune (low slope)	Survey
Fern Bay Estate 16	Artefact scatter	1200 BP stable dune (low flat)	Survey and 4 test pits
Fern Bay Estate 17	Midden/ artefact scatter	4500 BP stable dune (ridge)	Survey
Fern Bay Estate 18	Midden/ artefact scatter	4500 BP stable dune (ridge)	Survey and 1 test pit

1. Note that Dean-Jones (1992) originally recorded the Fern Bay Estate' sites as 'Fern Bay' sites. The names have been changed because Dean-Jones (1990) had previously given different sites the same name.

The Dean-Jones report made the following conclusions:

- archaeological sites within the study area have a maximum age of 4500 BP. This is because aeolian re-working of the barrier surface (during the period of accretion) would have effectively destroyed all archaeological sites before 4500 BP (Dean-Jones 1992, 5);

- the maximum age for occupation evidence on the outer stable transgressive dune is 1200 BP. This represents the period of time that this dune has been stable. Prior to 1200 BP this dune was actively mobile which means that archaeological material would have been re-worked and deflated or dispersed (Dean-Jones 1992, 5);

- archaeological evidence is concentrated on elevated ground, but not necessarily on the main or higher ridge crests (Dean-Jones 1992, 25);

- most sites were found within the inner (4000 BP) stable dune field. Archaeological evidence within the 1200 BP dune field is rare except along its seaward margin (Dean-Jones 1992, 25);

- there appears to be a relationship between site distribution and the presence of fresh water within the dune field. Occupation evidence is most common where elevated ground is separated by the swamp forest wetlands (Dean-Jones 1992, 26);

- sites in the study area include shell only, flaked stone only or both shell and flaked stone. It is not clear whether the variations are due to surface visibility or to real differences in site types across the dunes (Dean-Jones 1992, 26);

- the distribution of shell species across the dune field suggests that shellfish were not transported across the barrier system. Sites with pipi (a marine species) are confined to the outer margin of the barrier and sites with Pyrazus and Oyster (estuarine species) are distributed across the inner barrier (Dean-Jones 1992, 26); and

- shovel testing found that flaked stone material occurred most commonly at a depth of 300 – 600 mm below the surface, and as deep as 900 mm at one site (Dean-Jones 1992, 27).

Dean-Jones made a number of specific recommendations in her assessment for the rezoning of the site. The recommendations included in her report refer to specific sites within the study area. Dean-Jones recommended:

- applications for consent to destroy with collection for Sites 5, 6, 13, 15 and 17;

- inclusion of as much as possible of the inner stable transgressive dune into open space areas. The ridge crests around and including Sites 14, 18, 7, 8, 9 and 10 should be included in this reservation. Consent to destroy for Sites 14 and 18 should only be considered on the condition of extensive salvage excavation; and

- open space zoning applied to the area around Sites 11 and 16. If destruction of these sites is essential for drainage works, then a detailed sub-surface excavation and salvage of both sites is recommended.

It is clear from the Dean-Jones (1992) report that sites located during her investigation were identified in areas of erosion or vehicle disturbance. Shovel testing at a number of sites showed that flaked stone was most commonly distributed from 300 mm – 600 mm below the surface and as deep as 90 cm below the surface (Dean-Jones 1992, 27). This suggested that surface survey alone could not provide an accurate reflection of the distribution or nature of archaeological sites in the study area. Test excavation would be necessary to accurately determine the distribution of archaeological sites in the study area.

3.3 NPWS "Newcastle Bight Archaeological Management Plan" - 1992

A NPWS archaeological management plan for the Newcastle Bight was developed by Sullivan in 1992. The plan was largely based on the results of the Newcastle Bight Study undertaken by Dean-Jones in 1990. A number of recommendations were included in the report and of particular relevance to the Fern Bay study area, the report made the following recommendations:

- 18. "It is recommended that NPWS adopt as policy the requirement that all stone artefact layers in the Holocene dunes identified during environmental assessment surveys, should be fully investigated and the information recorded, before they are destroyed by development activities. If large dense sites are located in this environment they would be archaeologically very important and should be salvaged for detailed study";
- 19. "It is additionally recommended that all site surveys for major developments in the Holocene dunes should involve a phase of sub-surface testing through the use of backhoe (or similar mechanically dug) trenches".

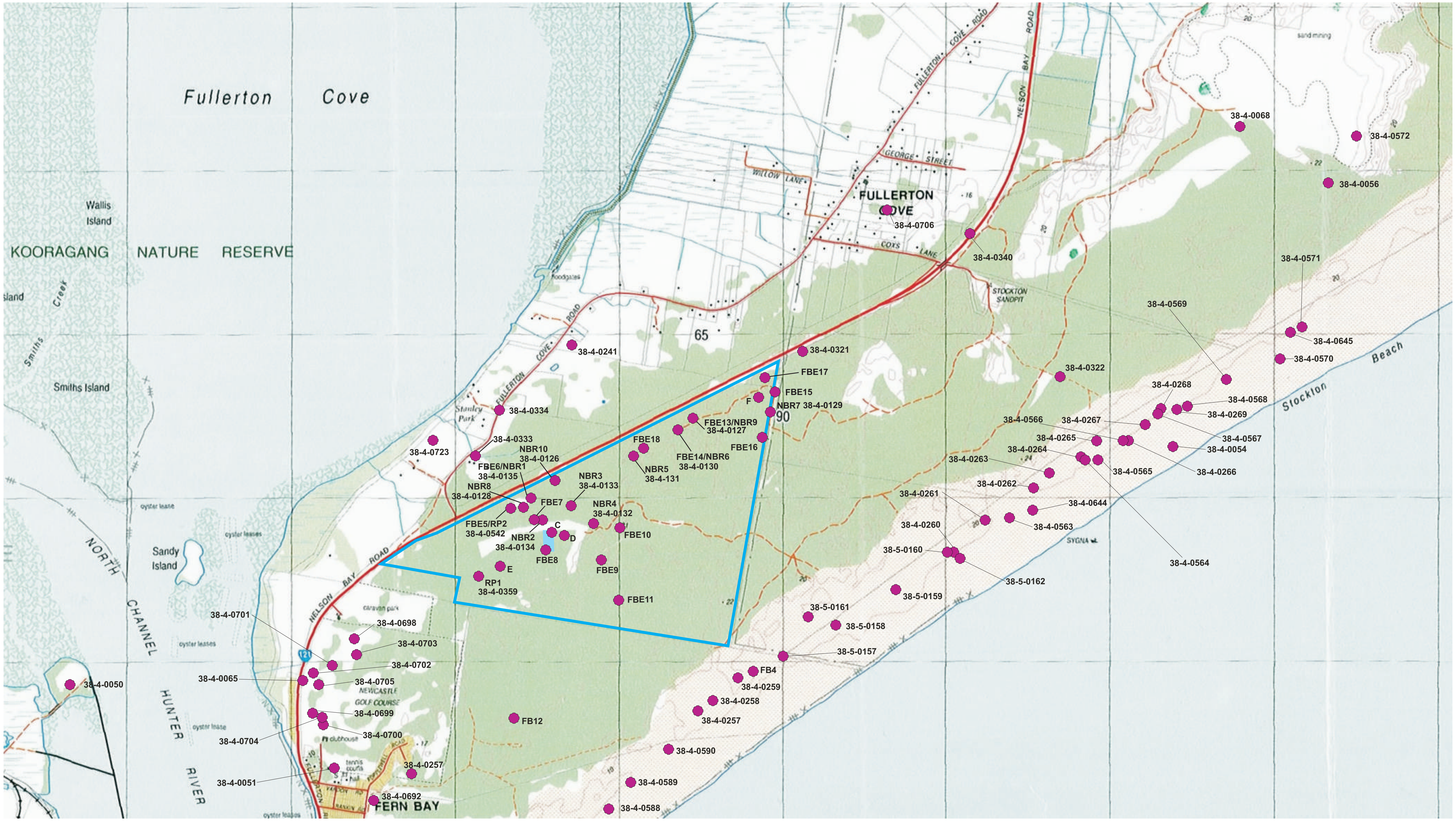
3.4 *RESOURCE PLANNING ASSESSMENT - 1994*

Resource Planning carried out an archaeological survey of the western portion of the study area in 1994. The investigation identified one previously unrecorded site, comprising a sparse shell scatter beside a vehicle track (Site RP1 on *Figure 3.1*) and located Site Fern Bay Estate 5 that had previously been recorded by Dean-Jones. This site was also registered with the NPWS (about seven years after the survey was undertaken). Both sites are shown on *Figures 3.1* and *3.2*. In addition to Dean-Jones' findings regarding the study area, Resource Planning concluded:

- there are no local sources of stone suitable for flaking in the Fern Bay area. The nearest sources are at Nobby's Head and at Tomago. Both of these areas are readily accessible from the study area (Resource Planning, 1994); and
- a large range of traditional plant foods and resources are available within the study area, especially within the swamp forest environment (Resource Planning, 1994).

3.5 *ERM STATEMENT OF ENVIRONMENTAL EFFECTS - 2000*

ERM were commissioned to prepare a Statement of Environmental Effects (SoEE) in support of Howship Holdings development application in 2000. An archaeological assessment of the proposed development area was commissioned as part of the SoEE study (ERM 2000a). T he assessment was undertaken by archaeologist Jim Wheeler in partnership with Len Anderson of the Worimi Local Aboriginal Land Council (WLALC).



RP1	Resource Planning (1994)		Aboriginal Heritage Reserve
FBE16	Fern Bay Estate (Dean-Jones 1992)		
NBR5	Nelson Bay Road (Koettig 1987)	38-5-0158	NPWS Register Number
F	ERM (2000)		

Source: 1:25,000 Topo Series - Williamtown Sheet

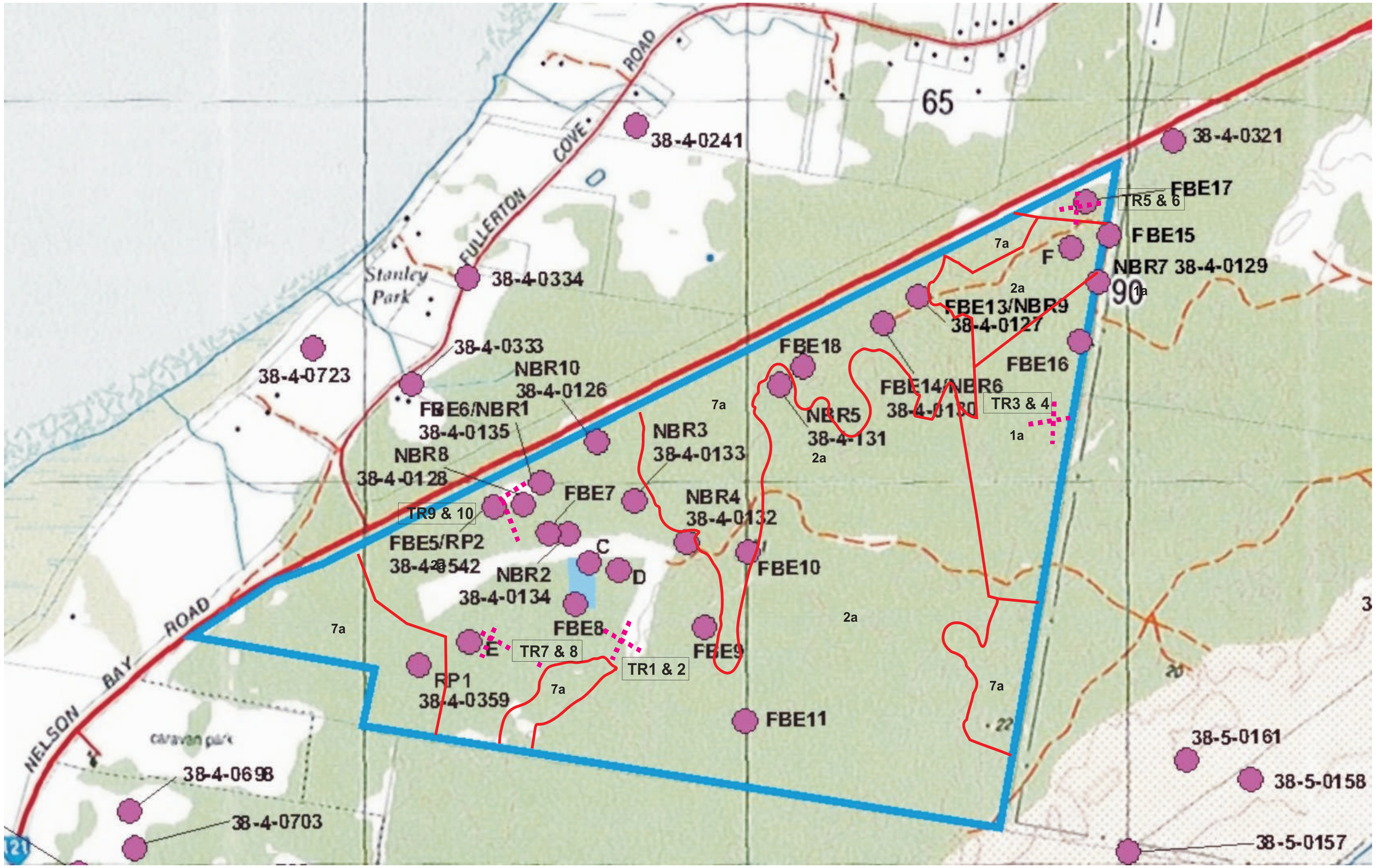
Jobs/2003/0012720/MasterPlanStudies - Arch - Fg3.1Arch Sites Recorded & Surrounding Areas.cdr March 2005 SP Environmental Resources Management Australia Pty Ltd

ERM

0 500m

Figure 3.1 **Location of Archaeological Sites Recorded on Site and in the Surrounding Area**

Winten Property Group - CVC Limited - Fern Bay Estate



7(a)	7(a) Environment Protection Zone	RP1	Resource Planning (1994)
1(a)	1(a) Rural Agriculture Zone	FBE16	Fern Bay Estate (Dean-Jones 1992)
2(a)	2(a) Residential Zone	NBR5	Nelson Bay Road (Koettig 1987)
	Property Boundary	F	ERM (2000)
	Aboriginal Heritage Reserve	38-5-0158	NPWS Register Number
TR	Auger Transect Testing		

Source: 1:25,000 Topo Series - Williamtown Sheet

Jobs/2003/0012720/MasterPlanStudies - Arch - Fg3.2Arch Sites Recorded & LEP.cdr March 2005 SP Environmental Resources Management Australia Pty Ltd

ERM

0 500m

Figure 3.2 **Archaeological Sites Recorded on Site and LEP Zonings**

Winten Property Group - CVC Limited - Fern Bay Estate

The objectives of the assessment were to:

- undertake a field survey to identify Aboriginal sites, objects or potential archaeological deposits;
- attempt to locate sites identified by Dean-Jones' 1992 investigation;
- assess the condition and significance of the sites;
- assess the potential impact of proposed development on Aboriginal heritage; and
- provide management recommendations to ensure that proposed development complies with requirements of the NP & W Act 1974.

Effective survey coverage was limited by poor ground surface visibility. As a result it was not possible to relocate a number of the sites recorded by Dean-Jones. Sites Fern Bay Estate 5, Fern Bay Estate 6 and Fern Bay Estate 7 were successfully relocated and a previously unrecorded site (Site C on *Figure* 3.2) was identified during the survey.

The report made a number of recommendations for inclusion in the SoEE to accompany Howship Holdings development application to Port Stephens Council. Recommendations developed in consultation with Howship Holdings, WLALC and NPWS included:

- conservation of an adequate representative sample of landforms;
- application to NPWS for a section 87 permit to undertake test excavation at the site. The purpose of test excavation was to determine the nature, extent and significance of Aboriginal sites within the proposed development area and to address archaeological research questions about the place; and
- the results of test excavation to form a basis for developing a heritage mitigation plan in advance of development that would form the basis for a section 90 application to NPWS.

4 EXCAVATION METHODOLOGY

4.1 OBJECTIVES

Specific objectives of test excavation were as follows:

- undertake excavation work in partnership with the WLALC;
- identify the extent, nature and significance of archaeological deposits within the proposed development area;
- ascertain the specific topographic locations of high archaeological sensitivity on the basis of density of deposits or undisturbed stratified deposits with high archaeological research significance;
- test known sites within the development area identified by Dean-Jones (1992), Resource Planning (1994) and ERM (2000a);
- test the predictive model developed by Dean-Jones (1992) that archaeological evidence is concentrated on elevated ground in close proximity to freshwater (Swamp Forests) within the inner (4000 BP) stable dune;
- undertake appropriate post-excavation analysis in order to address research questions set out below; and
- prepare a full excavation report detailing the results of excavations, post-excavation analysis and interpretation. The report to form the basis for heritage management decisions such as mitigation or salvage.

4.2 RESEARCH QUESTIONS

The following questions were proposed to structure the excavation methodology, post excavation analysis and reporting. The research questions were based on relevant research issues relating to the archaeology of the Newcastle Bight area and, more specifically, issues raised by Dean-Jones (1992) during her investigation of the study area. The questions were as follows:

<u>How long have Aboriginal people used the land</u>? Recovery of certain artefact types (such as backed artefacts) will provide an indication of how long Aboriginal people have used the site. If hearths are identified during excavation, C-14 dating of charcoal samples will provide for more direct dating of occupation.

What types of artefacts were produced, how were they made, what were they used for and where did the raw materials come from? Adherence to standard procedures in quantifying and classifying the recovered stone artefacts will provide a means of determining what artefact types were produced and/or discarded on-site and how they were made. Functional analysis of potential residue/use-wear evidence on stone artefacts may provide an indication of what different artefacts were used for. Raw material types will be identified, identification of reduction stages and cortex percentages may indicate possible stone sources.

What foods did Aboriginal people eat at the site? Identification of shell and bone remains will provide an indication of what foods were eaten and where they may have been gathered. Stone artefact types and use wear/residue evidence may provide an indication of subsistence activities and plant processing and use.

What is the spatial extent and depth of sites in the study area and are there any patterns in relationships between site size and geomorphic/topographic locations? Correlations between topographic locations and frequency/density of sites may provide evidence of local settlement patterns and foci of occupation in the past.

What are the site formation processes, both cultural and natural? An examination of soil profiles in each test trench will provide evidence of soil formation processes and recent geomorphology. An examination of disturbances in the soil profile such as horizontal mixing, disturbance of horizons or disturbance of soil lamination and lensing may indicate the depth and nature of disturbance caused by past land use. This information will assist in determining the cultural and natural influences on current site formation. An analysis of the distribution of archaeological material through soil profiles may indicate whether sorting or deflation of artefacts through the profile has occurred.

What cultural activities can be identified at each site and is there any evidence that indicates the nature of resource exploitation in the study area? An analysis of the range, distribution, density and types of artefacts recovered may indicate the type of activities carried out at each site. An assessment of this evidence in relation to the local distribution of resources such as water, workable stone material and food sources may indicate a relationship between site activities and the environmental setting.

Why is there an apparent stratigraphic separation of flaked stone and shell and what controls the depth at which shell and stone occur within the dune? Post-excavation will attempt to establish why there is a stratigraphic separation of stone and shell as observed by Dean-Jones (1992). Evidence of size-sorting may indicate deflation of objects through the deposit. Soil acidity and evidence of fluctuating water table may indicate decomposition of shell at depth. This evidence will be used to assess whether the separation of stone and shell is cultural or the result of post-depositional processes.

Is it possible to assess site content on the basis of surface evidence? Comparison of the composition and density of surface evidence with sub-surface deposits will indicate whether it is possible to assess site content from surface deposits.

Does a synthesis of the Fern Bay excavations provide evidence about settlement patterns and the nature of occupation on the Stockton Bight, especially within the dune barrier system? Drawing together the results of excavation and comparing them with previous excavations will provide a means of determining broader settlement patterning and use of the land.

4.3 *SCOPE OF WORK AND METHODOLOGY*

The investigation was divided into three phases. Phase 1 comprised test excavation of five known sites that were identified as having potential for stratified sub-surface deposits. Phase 2 involved auger sampling of landforms that were identified as having high archaeological potential in the Dean-Jones (1992) report. This phase aimed to more accurately determine the location of archaeologically sensitive landforms within the study area. Phase 3 comprised test excavation of areas where archaeological material was identified during phase two.

The investigation did not include areas of land zoned for conservation (refer to *Figure 3.2*). Excavations were undertaken within the proposed development area.

The excavation crew included:

- Jim Wheeler – excavation director;
- Ursula Frederick – assistant archaeologist; and
- Leith Anderson, Gavin Kelly and Jamie Thomas of WLALC – excavation assistants.

The project methodology is set out below:

4.3.1 *Phase 1*

The phase one methodology was designed to sample 5 known sites through controlled test excavation. The sites excavated were (refer to *Figure 3.2* for site locations): Fern Bay Estate 7 (AMG 388400, 6363675), Fern Bay Estate 8 (AMG 388430, 6363540), Fern Bay Estate 11 (AMG 388860, 6363180), Fern Bay Estate 16 (AMG 389820, 6364240) and Fern Bay Site C (AMG 388475, 6363630)[1].

[1] Sites recorded by Dean-Jones in 1992 – Not registered with NPWS AHIMS

Phase 1 aimed to determine the nature, extent and significance of these sites and to address research questions described in *Section 4.2*.

Sites Fern Bay Estate 7, 8, 11, 16 and C were located and subject to auger testing.

Fifteen auger sites were excavated at these locations to determine whether sub-surface deposits were present. In the event that no archaeological material was found in any of the 15 augers, further excavation of these areas was abandoned. If artefacts were found, controlled excavation of two metre by two metre test trenches was undertaken. Test trenches were placed at the centre of visible evidence at each site. Decisions to extend the test trenches were taken by the excavation director and were based on the density and extent of material recovered, the amount of time available and the value of further excavation in terms of answering the research questions. The excavation methodology was as follows:

- excavation was carried out manually with spades and pointing trowels;
- soils containing cultural material were removed in arbitrary 100 mm spits;
- excavated soil was placed in plastic buckets and a tally of buckets from each context was be recorded;
- the excavated soil was dry-sieved through 5 mm screen. One bucket per spit was also sieved through a 3 mm nested screen in order to sample the full range of lithic material present;
- soil samples were retained from excavated soil units for pH testing;
- archaeological material recovered from excavation or sieving was retained in plastic clip-lock bags and labelled with the date, site number and context of the artefacts;
- a standard site recording form was used. Details included site name, area name, date, site recorder, spit number and depth, test trench number, description of finds, description of soil, end of spit levels, soil pH and a bucket tally;
- a water level was used to measure relative levels at the end of each excavated spit. The test trench locations were marked on a site plan;
- a photographic record was kept of the excavations. An overall site plan was produced;
- soil pH was measured; and
- test trenches were backfilled with sand at the completion of the excavation.

4.3.2 *Phase 2*

The results of shovel testing carried out by Dean-Jones (1992) showed that archaeological material typically occurs between 300 mm and 600 mm below current ground surfaces. All surface archaeological evidence within the study area is located in areas of erosion or vehicular disturbance, which have exposed sub-surface deposits. On this basis, the location of surface evidence is largely a function of disturbance rather than an accurate reflection of the distribution of archaeological material in the study area. The primary purpose of phase two, was to obtain accurate data about which landforms contain high densities of intact archaeological deposits and to test whether surface evidence is an accurate indicator of sub-surface deposits.

Dean-Jones identified the ridgelines of the inner stabilised (4000 BP) transgressive dunes as having high potential for archaeological material, especially lower ridgelines. Seventy-five percent of sites recorded by Dean-Jones were identified in this geomorphic/landform context. Sites in this area could be as much as 4000 years old, a prediction that is based on the period of time that the dune has been stable. The occurrence of high density stratified shell and stone deposits along the ridgelines indicate that this geomorphic context has high archaeological value (Dean-Jones 1992, 37).

Sampling Strategy

A targeted sampling strategy was used to test the range of topography on the 4000 BP stable dune ridges. Ten 100 metre transects were located on different ridges and oriented so as to cover toposequences including lower slopes, saddles, mid slopes, ridge lines and crests (refer to *Figure 3.2* for transect locations). Auger tests were carried out at 10 metre intervals along the length of each transect. This equated to an overall total of 100 auger tests. Placement of transects was determined by the excavation director in consultation with the Worimi LALC. The factors affecting the placement of transects were:

- survey priorities, including an adequate spread across the landscape and the requirement for a representative sample of topography and topographical aspects;
- ability to access the area; and
- placement of transects across areas with no previously recorded archaeological material.

Excavation Techniques

A hand-operated 100 mm sand auger was used to conduct the excavations. Testing was undertaken to a depth of one metre, which was the maximum depth of archaeological material encountered by Dean-Jones (1992).

Sieving

Soil removed by the sand auger was dry-sieved through a 5 mm screen. Where possible, soil from the A-horizon and the B-horizon were sieved as separate spits.

Recording

Recording included the GPS location of each test auger site, the depth of the excavation, the respective depths of A and B soil horizons, any relevant observations and a description of any archaeological material recovered. Archaeological material recovered from excavation or sieving was placed in plastic clip-lock bags and labelled with non-perishable tags indicating the date and test-auger number.

Backfilling

All auger holes were backfilled with the sieved spoil.

4.3.3 Phase 3

Phase 3 involved controlled excavation of 1 m by 1 m test trenches at locations of archaeological deposit identified in the phase 2 auger sampling. Phase 1 aimed to determine the nature, extent and significance of these sites and to address research questions described in *Section 4.2.*

Phase 3 employed the same excavation methodology and procedures described for phase 1 above.

4.4 POST-EXCAVATION METHODOLOGY

4.4.1 Stone (lithic) Artefact Analysis

Jakub Czastka was engaged to catalogue and analyse stone artefacts recovered during the excavation. The purpose of the analysis was to determine what forms were produced, how they were made, what they may have been used for and what sources of stone were used. Czastka's report on the stone artefacts from Fern Bay is included in *Annex 3*.

Specific aims of the analysis were:

- identification of the technology represented by the lithic artefacts;
- placement of the assemblage into a local and regional archaeological context; and

- significance assessment of the assemblage.

The attributes used to catalogue the lithic material included:

- raw material;
- the striking platform;
- dorsal scar pattern;
- shape;
- flake terminations; and
- retouch or usewear.

Classification of stone artefact types followed McCarthy (1976).

4.4.2 *Faunal Analysis*

The purpose of the faunal analysis was to identify and catalogue bone and shell remains recovered from the Fern Bay excavations. Jim Wheeler undertook the analysis. The faunal analysis catalogue is included in *Annex 4*.

Specific aims of the analysis included:

- identifying which species were eaten at the site;
- determining the relative proportions of marine and estuarine shell species from each site and examining the implications for Aboriginal resource exploitation in the area;
- determining the diversity of species at each site and examining the implications for Aboriginal resource exploitation in the area; and
- placing the assemblage into a local and regional context.

The following categories were used to catalogue the faunal material:

- catalogue number – identification number for each item;
- site context – site number, square, spit number;
- name – the common and scientific name for each item;
- skeletal element – the anatomical element of each item;
- portion – portion name and % complete of each portion;
- condition – type of condition (weathered etc) and severity;

- attrition – whether any evidence of animal or human attrition is present;
- aging – location (epiphyses etc) and state;
- teeth – wearing state and type of tooth;
- butchery – location, type (saw/cleaver etc) and orientation of butchery; and
- max size – the size of the item on its longest axis.

4.4.3 Functional Analysis of a Worimi Cleaver

Following the discovery of a stone artefact form commonly known as a 'Worimi Cleaver', Dr Richard Fullagar and his team based at the Australian Museum, Sydney, were engaged to carry out an analysis of use-wear and residues present on the cleaver. The aim of the analysis was to identify the function(s) of the artefact. The brief included:

- an analysis of residues (including starch, lipids and phytoliths);
- an analysis of use-wear; and
- a report on functions and uses of the artefact.

The functional analysis report is included in *Annex 5*.

4.4.4 C-14 Radiocarbon Dating of charcoal from Site 8

A charcoal sample was recovered from a hearth found at Site 8. The sample was sent to The University of Waikato Radiocarbon Dating Lab, New Zealand for a conventional radiocarbon age determination. The purpose was to obtain an absolute date for:

- occupation of Site 8;
- early occupation of the inner (4000 BP) stable dune; and
- use of the Worimi Cleaver (found within the hearth matrix).

The carbon dating results are presented in *Annex 6*.

5 *EXCAVATION RESULTS*

5.1 *SUMMARY*

This chapter presents the results of test excavation undertaken at Fern Bay during November and December 2000. The detailed data, post-excavation analysis and catalogue of finds are included in report annexes. This chapter summarises the results of phase 1, 2 and 3 investigations. The interpretation of results and Aboriginal heritage significance assessment are presented in *Chapters 6* and *9* respectively.

5.2 *PHASE 1*

A summary of results for each site (phase 1) is presented below. Site locations are shown on *Figure 3.2*.

5.2.1 *Fern Bay Estate Site 7*

Dean-Jones identified Site 7 in 1992. Site 7 is located on the crest of a low-ridgeline to the north of a grader cutting excavated for the proposed Fern Bay subdivision in 1998. Site 7 is situated within the inner 4000 BP stable dune field.

Auger testing carried out at the location of Site 7 did not find any sub-surface archaeological material. Twelve Augers were excavated within a 15 metre radius of the AMG Grid Coordinates and the area matching the description for Site 7 reported by Dean-Jones (1992). Although there were three small shell fragments on the ground surface, no Aboriginal objects were found below current ground surfaces. On the basis of these results it was concluded that Site 7 comprised a surface shell scatter with no sub-surface deposits. Accordingly, it was decided in consultation with the Worimi LALC and NPWS that test-excavation would be unlikely to find any sub-surface evidence. No further investigation was carried out at the site.

5.2.2 *Fern Bay Site C*

Jim Wheeler and Len Anderson identified Site C during survey work for the Statement of Environmental Effects in 2000. Site C is located on a low ridge crest within the inner 4000 BP stable dune field (refer to *Photograph 5.1*). A swamp forest is located approximately 60 metres to the west of Site C.

The site was exposed and partly disturbed by grader works carried out for the proposed Fern Bay subdivision in 1998. The grader cutting resulted in erosion and exposure of a large, dense scatter of stone and shell on the southern side of the grader cutting. The presence of artefacts eroding out of the lower profile of the grader cutting indicated there were sub-surface archaeological deposits at Site C.

Investigations at Site C included:

- a collection of surface artefacts in a 15 metre by 15 metre area across the top of Site C;
- excavation of a two metre by two metre test trench placed in the area of highest surface density in the middle of the site;
- excavation of a further two, one metre by one metre test trenches as "outliers" to the initial two metre by two metre trench. The outliers were designed to test the spread and consistency of artefact densities across Site C. Outlier 'TT1' was located five metres to the south of the main trench and 'TT2' was located five metres to the east of the main trench; and
- five test augers were excavated at Site C to compare the densities recovered by the technique with the three test trenches excavated. It was hoped that this comparison would test the effectiveness of sand auger as a testing technique.

Photograph 5.1 ***Looking south toward Site C. A Grader cutting excavated in 1998 can be seen in the foreground.***

The test excavations revealed remnant intact A-horizon soils containing high densities of stone artefacts and shell (refer to *Photograph 5.2*). Test trenches were excavated to 800 mm below current ground (9 spits). Artefact density was highest in spits one to five, with the exception of TT1 where the highest densities were found in spits five to eight.

***Photograph 5.2** Section photograph of Site C, TT0. The dark humic A1 topsoil can be seen overlying a bleached sand A2 horizon.*

A total of 1103 stone artefacts and fragments were recovered from five auger probes, three test trenches and a surface collection representing sixty-seven square metres. The surface collection included 333 shell pieces and 293 stone artefacts. A total of 97 shell pieces and 798 stone artefacts were recovered during sub-surface test excavation. Chi-squared significance testing shows these proportions are significantly different with an X^2 value of 14 0136 at 1 degree of freedom (or probability of less than 0.001 of a greater value, P). This demonstrates there is a real difference between the proportions of shell to stone on the surface compared to below ground. Shell is heavily represented on the surface and very poorly represented sub-surface whereas stone is at a much lower proportion on the surface than sub-surface.

Stone artefact densities in excavated contexts were generally very high. Densities were 124.75 per m^2 (138.61 per m^3) for TT0, 94 per m^2 (104.4 per m^3) for TT1 and per m^2 (6.6 per m^3) for TT2. The density of stone recovered from TT2 was much lower than found in TT0 and TT1. As TT2 is located to the east of the ridge crest on the upper side-slope, this may indicate that the distribution of archaeological material is focused on the ridge crest and diminishes further down-slope.

A total of 14 pieces of stone and 10 pieces of shell were recovered from 5 auger samples excavated at Site C. Given the high artefact densities recovered during test excavation, the results of auger sampling suggests the technique is effective for identifying high artefact densities.

Soil acidity throughout the excavated deposit at Site C was consistently pH 7, indicating the soil is neutral.

5.2.3 *Fern Bay Estate Site 8*

Dean-Jones identified Site 8 in 1992. Dean-Jones reported five *Pyrazus* shells exposed along 20 metres of a four-wheel drive track on the same low dune ridge crest that includes Site C. Site 8 is located approximately 80 metres to the south of Site C (refer to *Photograph 5.3*). Site 8 is situated within the inner 4000 BP stable dune field.

Surface investigation and auger testing at the location of Site 8 found four shell fragments and one stone flake. Accordingly, test excavation was carried out.

Investigations at Site 8 included:

- excavation of a two metre by two metre test trench (TT1) placed where auger testing found archaeological material; and

- excavation of a further three, one metre by one metre test trenches as "outliers" to TT1. The outliers were designed to test the spread and consistency of artefact densities across Site 8. Outlier 'TT2' was located 50 metres to the north of TT1, 'TT3' was located 40 metres to the south of TT1 and 'TT4' was located 40 metres south of TT3 at the highest point on the low ridge crest.

Photograph 5.3 Looking south along the low ridgeline that comprises Site 8. TT3 can be seen in the foreground.

The test excavations revealed remnant intact A-horizon soils containing low densities of stone artefacts and very low densities of shell. Test trenches were excavated to 800 mm below current ground (9 spits). Artefact density was fairly evenly spread across spits one to seven.

A total of 15 shell pieces and 51 stone artefacts were recovered during sub-surface test excavation. Stone artefact densities in excavated contexts were generally low, particularly in comparison with Site C. The average density across the test trenches was four per m^2 (4.4 per m^3). No artefacts were found in TT3 on the highest point of the ridge-crest. The excavations demonstrated a low density of stone artefacts along the ridge crest, diminishing toward the south where the ridge crest slopes up to a knoll.

An Aboriginal hearth was found 600 – 700 mm below current ground during excavation of Site 8 TT1. The hearth comprised a dense oval-shaped deposit of greasy ash and charcoal. The feature was approximately 800 mm long by 500 mm wide in plan and 200 mm thick (refer to *Photograph 5.4*). A sample of the charcoal was taken for C 14 radiocarbon dating and submitted to the University of Waikato Radiocarbon Dating Laboratory. A conventional determination of 2,584 +/- 45BP was made (Wk–13446 –refer to *Annex 6*).

Photograph 5.4 Aboriginal hearth found at Site 8 TT1 shown in plan.

The charcoal feature was interpreted as an Aboriginal hearth for the following reasons:

- there was no structure or linear orientation to the charcoal that would suggest that it was a naturally burnt stump or root;
- it was a discrete charcoal feature, therefore unlikely to represent a grassfire (the archaeological signature of a grassfire is usually a diffuse lens of charcoal and ash distributed uniformly across the test trench);

- the charcoal lens was oval in plan, which is a typical feature of Aboriginal hearths (refer to *Photograph 5.4*); and

- the association of the stone artefacts recovered from the charcoal matrix.

In TT1 square B4, spit six, a large artefact manufactured from Nobby's Tuff was recovered from the hearth (refer to *Photograph 5.5*). The artefact was identified in the field as a 'Worimi Cleaver', a distinctive specialised form characteristically a large triangular worked piece of stone, trimmed or 'backed' on the thick margin and a thin working edge on the chord. Worimi Cleaver's essentially appear like large Eloueras. The specimen found at Fern Bay retained a greasy black residue on the working edge. Following consultation with the Worimi LALC, Dr Richard Fullagar was engaged to carry out a functional analysis of the artefact (refer to *Annex 5*). Fullagar and his team analysed residues and polish on the artefact and concluded it was used for processing starchy plants with medium to low silica content. Based on a detailed analysis of starch and phytolith residues, Fullagar et al concluded the most likely plant processed with the artefact was Bungwall fern (*Blechnum indicum*). It is noted that Bungwall fern is a dominant species in the swamp forests of the study area.

Soil acidity varied considerably across the low ridgeline comprising Site 8. Soil pH ranged from 4 (TT4) to 8 (TT2), indicating soils range from highly acid to neutral.

Photograph 5.5 'Worimi Cleaver' found during excavation of Site 8 TT1. The artefact was removed from the Aboriginal hearth.

5.2.4 *Fern Bay Estate Site 11*

Dean-Jones identified Site 11 in 1992. Dean-Jones reported six pieces of flaked Nobby's Tuff exposed in a deeply incised four-wheel drive track that traverses the rise to the landward margin of the 2300-1200 BP 'outer' dune (refer to *Photograph 5.6*). The AMG coordinates provided by Dean-Jones were found to be inaccurate by about 200 metres. The location that best matches Dean-Jones' description for Site 11 is actually beyond the southern boundary of the study area.

Photograph 5.6 ***Looking north across Site 11. Test excavation at the site can be seen in the foreground.***

The Preliminary Research Permit only permitted excavation within the proposed development area. Therefore testing was carried out adjacent to Site 11 but within the study area. A series of ten augers and two, one metre by one metre test trenches were excavated along a toposequence of land running from the ridge crest, down the leeward side slope to the deflation basin (or valley) floor. No archaeological material was found on ground surfaces or from excavated deposits.

Site 8 is located within the outer 1200 BP stable dune field. There is no readily available fresh water source near Site 11. The site is more than 600 metres from the coast and from the estuary at Fullerton Cove. This indicates that freshwater, estuarine resources and marine resources would not have been readily available in the past. The setting of Site 11 is also quite exposed to wind and coastal storm without the sheltering forest canopy present further inland. The distance of Site 11 from resources (particularly water) and the lack of shelter are possible reasons for the absence of occupation evidence in this area.

5.2.5 *Fern Bay Estate Site 16*

Dean-Jones identified Site 16 in 1992. Site 16 is located on cusp between the 2300-1200 BP stable dune sequence and the relict deflation basin that divides the 2300-1200 BP sequence from the 4000 BP sequence. Dean-Jones' investigations at the site included survey and some test excavation. Dean-Jones recorded Site 16 at the southern end of the deflation basin. At the base (landward side) of the 2300-1200 BP dune, Dean-Jones reported a scatter of 11 flakes. The flakes were spread across a 10 metre by 10 metre area. No shell was reported. (Dean-Jones 1992, 23).

Dean-Jones excavated four one metre by one metre test pits at Site 16. Flaked stone was found in two of the pits. All the artefacts were found at depths of between 400 mm and 900 mm below ground surface and all artefacts (Dean-Jones 1992, 23).

During the current investigation, a series of 15 test augers were excavated at the location that matches the AMG coordinates and the description for Site 16 provided by Dean-Jones. No archaeological material was found during the auger testing. No further investigation was carried out at the site.

The densities of stone recovered by Dean-Jones at Site 16 were very low and did not include any shellfish. This suggests that Site 16 should be interpreted as a background scatter or short-stay camp rather than an occupation site. The results of the current investigation support this interpretation.

5.3 *PHASE 2*

A summary of phase 2 results is presented below. Auger transects are shown on *Figure 3.2*.

Transects were placed across toposequences on a representative sample of landforms within the 4000 BP stable dune field. This ensured that higher ridgelines (transects 1,2,3,4,5 and 6) and lower ridgelines (transects 7,8, 9 and 10) were sampled. The results of the transect testing were as follows:

Transect 1: No archaeological material recovered

Transect 2: No archaeological material recovered

Transect 3: No archaeological material recovered

Transect 4: No archaeological material recovered

Transect 5: No archaeological material recovered

Transect 6: 1 small stone flake found in auger 1

Transect 7: 1 shell fragment in auger 10, 1 flake stone piece in auger 5 and 1 flake stone piece in auger 6.

Transect 8: No archaeological material recovered

Transect 9: 2 shell fragments found in augers 2 and 3

Transect 10: 1 shell fragment found in auger 10

The frequency of archaeological material detected by the auger excavations was low (seven augers yielded artefacts from a total of 100 tests). Given the auger technique was demonstrated to be effective at detecting high densities of archaeological material at Site C, the results of phase two indicate that high density Aboriginal deposits are:

a) not distributed generally across the landscape, but focused at specific locations; and

b) appear to be found at greater frequency on lower ridgelines (the landforms sampled by transects 7 to 10).

5.4 PHASE 3

As set out in *Section 4.3* 'excavation methodology', phase 3 was designed to determine the nature, extent and significance of archaeological sites found during phase 2 auger testing. Controlled excavation of 1m by 1m test trenches was undertaken at these sites.

As set out in *Section 5.3*, archaeological material was discovered in four transects. Transect 9 and 10 contained a total of 3 shell fragments, however, because these finds were located within disturbed soils associated with a power easement, further investigation at these sites was considered unlikely to reveal intact deposits. Accordingly, no further investigation was undertaken at transect 9 and 10.

Artefacts found at transects 6 and 7 were within undisturbed soils with potential for intact sub-surface deposits. Controlled excavation of 1m by 1m test trenches was undertaken at these sites. Transect 7 was named 'Site E' and Transect 6 was named 'Site F'.

During phase 2, a previously unrecorded surface scatter of shell and stone was identified to the east of Site 8. This site was named 'Site D'. Controlled excavation of a 1m by 1m test trench was undertaken at Site D.

A summary of phase 3 results is presented below. Site locations are shown on *Figure 3.2*.

5.4.1 *Fern Bay Site D*

Site D is located on a low ridge crest approximately 100 metres to the south east of Site C. It is situated on exposed ground on a 4WD track within the inner 4000 BP stable dune (refer to *Photograph 5.7*). A series of 11 auger excavations across the surface exposure found 28 flake stone artefacts, indicating the presence of sub-surface deposits. A one metre by one metre test trench was excavated at the centre of surface deposit.

Photograph 5.7 Location of Site D. Site D TT1 can be seen in the mid ground. Note the disturbed topsoil in the area.

The excavation revealed high densities of stone, but no shell. A total of 84 stone flakes, pieces and cores were recovered from nine spits.

The absence of shell at the Site is probably the result of localised rill erosion and soil disturbance caused by 4WD traffic across the site. These activities have disturbed the upper portions of the soil profile. Shell within these upper deposits may have been removed through erosion of these exposed soils.

5.4.2 *Fern Bay Site E*

Site E is situated approximately 100 metres east of Black Track within the inner 4000 BP dune. The site is located on a low ridgeline between two swamp forests (refer to *Photograph 5.8*). Excavation of a one metre by one metre test trench revealed an intact stratigraphic profile containing high densities of both shell and stone artefacts. A total of 355 shell fragments and 49 stone flakes, pieces and cores were recovered from nine spits. The highest density of both shell and stone were encountered in spits three and four.

Photograph 5.8 Looking south east from site E towards a swamp forest.

The undisturbed profile found at Site E suggests deposits found during excavation represent a full, undisturbed occupational sequence.

The stratigraphic separation of shell and stone observed at Site C and elsewhere by Dean-Jones (1992) was not apparent at Site E.

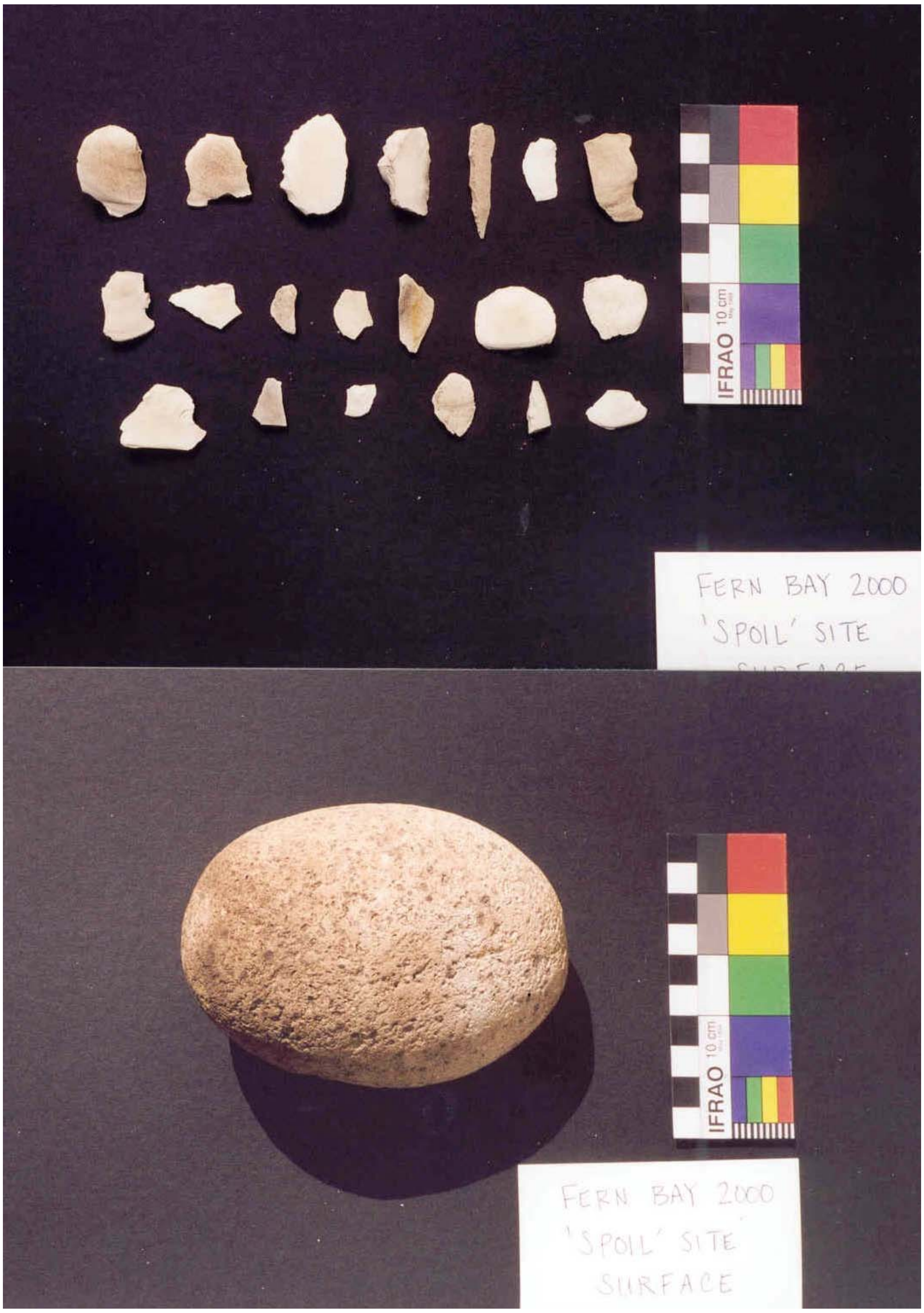
Soil pH at the site ranged from six to seven. This is a neutral pH level and provides good conditions for preservation of shell (note the density of shell found at the site). The pH level may also reflect the alkalinity of shell lime within the soil.

5.4.3 Fern Bay Site F

A one metre by one metre test trench named was excavated at Site F. Excavation was undertaken to a depth of 800 mm and no archaeological material was found. The results of excavation indicate the artefact recovered by auger testing was an isolated find.

5.4.4 Collection of Artefacts from an Overburden Mound

During the survey work undertaken during phase 2 investigations, a dense scatter of stone artefacts was identified on the surface of an overburden mound in the grader cutting near Site D. The mound was created during earth moving associated with 1998 site excavation works. It is likely that the stone artefact material on the overburden mound originally came from the vicinity of Site D and is in effect the archaeological remnants of the eastern part of Site D. The artefacts were collected and returned to Worimi LALC (refer to *Photograph 5.9*).



Photograph 5.9 ***Artefacts recovered from the overburden mound. Flakes and backed artefacts shown above and hammerstone shown below.***

6 *DISCUSSION OF RESULTS*

Section 4.2 of this report presented a series of research questions designed to structure the excavation methodology and post excavation analysis. The research questions were based on relevant research issues relating to the archaeology of the Newcastle Bight area and specific issues raised by Dean-Jones during her investigation of the study area in 1992. The research questions form the basis for a discussion and interpretation of the results of excavation. The research questions are addressed below.

6.1.1 *How long have Aboriginal people used the land?*

Archaeologists use a range of evidence for determining how long people have occupied land. Geomorphology (the study of how landscapes are formed over time) can provide an indication of how old landforms and soils may be, and indicate the maximum age at which those land surfaces may have been lived on. Direct dating methods provide absolute dates for charcoal, bone, organic and soil samples recovered from archaeological deposits. Recovery of certain artefact types (such as Bondi points) provides relative dates for how long Aboriginal people may have used archaeological sites. Relative dating is based on absolute date ranges obtained for the same artefact types found on other archaeological sites. Evidence about how long Aboriginal people used the land at Fern Bay is presented below.

<u>Geomorphology</u>

Archaeological sites within the study area have a maximum age of approximately 4000 years before present (BP). This is the date at which the inner dune sequence stabilised with vegetation and development of soil profiles. Prior to this period, aeolian re-working of the barrier dune surface (during the period of accretion) would have effectively destroyed any archaeological sites (Dean-Jones 1992, 5). The maximum age for evidence of occupation of the study area is therefore approximately 4000 years ago. Before that time, the study area was a mobile sand dune.

The maximum age for occupation evidence on the outer stable dune is 1200 BP. This represents the period of time that this more recent dune sequence has been stable. Prior to 1200 BP it was a mobile sand dune, which means that archaeological material would have been re-worked and deflated or dispersed (Dean-Jones 1992, 5).

<u>Absolute Dating</u>

Carbon-14 dating of charcoal from an Aboriginal hearth found 600 – 700 mm below current ground at Site 8 TT1 found the hearth was approximately 2600 years old (refer to *Annex 6*). Because the charcoal sample was taken near the base of the cultural sequence at Site 8, this indicates earliest Aboriginal occupation of the area occurred around that time. No absolute dates were obtained from any of the other sites, which may be older or younger than

Site 8. The carbon date obtained from Site 8 tells us that Aboriginal people were living in the study area at least as early as 2600 years ago.

Relative Dating

Identification of formal stone artefact types found during excavation provides a relative date range for occupation of the study area. The stone artefact analysis presented in *Annex 3* indicates the assemblage contains early – late 'Bondaian' forms. The assemblage includes backed artefacts such as Bondi points and geometric microliths, which are usually found in sites dated from c.5000 BP to 1600 BP. The assemblage also includes an 'Elouera', a type usually found in sites dated after 1600 BP. Relative dating of the artefact assemblage found at Fern Bay indicates the site could have been occupied from c. 5000 BP to the European contact period. The high occurrence of Bondi Points at Site C may mean that this site was predominantly occupied during the Middle Bondaian (c. 2800 BP – 1600 BP).

Conclusions

- Aboriginal sites found at Fern Bay are no older than 4000 BP. Prior to that time the study area was a mobile sand dune and no archaeological evidence would have been retained because of the movement of the sand dune deflating and dispersing archaeological material;
- Aboriginal people were living in the study area at least as early as 2600 years ago. This is indicated by Carbon dating of an Aboriginal hearth found at Site 8; and
- Aboriginal people were living in the study area after 1600 BP. An Elouera within the stone artefact assemblage provides some evidence of this as this implement type is thought to be associated with the Late Bondaian ie after 1600 BP.

6.1.2 What types of artefacts were produced, how were they made, what were they used for and where did the raw materials come from?

The stone artefact analysis undertaken by Czastka (*Annex 3*) used a technological approach to analyse stones recovered during excavation. Quantification and classification of stone was used to determine what artefact types were produced and/or discarded on-site and how they were made. The process of production (termed the reduction strategy) was analysed by describing and interpreting the physical traits the artefacts retain. The method or methods of reduction are the signposts archaeologists use to interpret and date assemblages. In practice this means that questions like 'what raw materials were chosen for working? How were they worked? And what types of artefacts were produced?' are considered during the process of analysis. The aim of the analysis was to determine the technique or techniques used to work stone, the kind of tools produced and what the tools may have been used for. The functional analysis of residue and use-wear evidence found on the Worimi Cleaver recovered from Site 8, provides direct evidence about what the artefact was used for. Evidence about the stone artefacts made at Fern is presented below.

<u>Artefact types and their possible uses</u>

Artefacts found at Fern Bay fall into the following broad categories:

- Tools – finished implement types recognisable for their attributes. The presence of tools indicates various activities such as hunting and food processing were carried out;

- Cores – stones from which flakes have been struck in order to manufacture tools;

- Debitage – 'waste' flakes produced as a by-product of manufacturing and maintaining tools. Debitage indicates manufacture and maintenance of tools, and provides evidence about how the stones were worked; and

- Pieces – stones with no evidence of working.

All stages of the reduction process are present within the Fern Bay assemblage, indicating pieces of stone were brought to the area and tools manufactured on-site. The majority of stones found at Fern Bay fall into the categories of debitage and pieces. Tools found at Fern Bay and their possible uses are described below:

Bondi Points - Have been interpreted as elongated barbs on hunting and fishing spears (Mulvaney and Kamminga, 1999; 236). The presence of 10 Bondi Points in Site C TT0 may indicate a lost or discarded spear. The wooden spear would have decomposed in the ground, leaving behind the stone barbs. Bondi Points may indicate production of spears for hunting and/or fishing (refer to *Photograph 6.1*).

Photograph 6.1 Bondi Point made from 'Nobby's Tuff' found at Fern Bay.

Geometric microliths – Also known as backed blades, these tools are also interpreted as barbs on fishing and hunting spears. They may have also been hafted in a row to wooden handles with gum resin to form serrated knives (McCarthy 1976: 51).

Elouera – Are segment shaped tools manufactured from elongated flakes. Have been interpreted as implements used to adze or scrape timber and bark (Kamminga 1977: 207 – 211).

Piercer – Used for processing of organic materials, for food or equipment.

Scrapers – Also used for processing of organic materials, for food or equipment.

Worimi Cleaver – Previously thought to have been used for bark and woodwork (McCarthy 1967: 22), Fullagar's functional analysis of the Worimi Cleaver indicates it may have used for processing Bungwall fern. Bungwall ferns are common in the swamp forests at Fern Bay and are known historically as an important staple food source for Aboriginal people. The Worimi Cleaver was probably used for processing (crushing and/or scraping) the fern rhizomes to extract edible starch (refer to *Photograph 5.5*).

Hammerstone – A single granite hammerstone was found on the overburden mound (refer to *Photograph 5.9*). The round stone exhibited pitting on both ends indicating it may have been used as a hammerstone for percussion flaking of stone to manufacture tools. The size of this artefact and location of pitting also indicates it may have been used more generally as a 'percussion stone' to process vegetable material and shell (McCarthy et al 1943:58-59).

<u>How the artefacts were made</u>

Stone artefacts found at Fern Bay generally fall within a category known as 'Bondaian' technology. Bondaian technology was common from 5000 to 1600 years ago. Bondaian technology was oriented towards reducing pieces of stone using free-hand percussion flaking (the application of a hand-held hammerstone onto a striking platform on a core stone) to produce a variety of finished implements, particularly backed artefacts.

Technologically, the majority of material falls within a single sequence: single platform and alternate flaking, without platform preparation. This produced macro-flakes and linear flakes, which were often used as blanks for making backed artefacts. In the stone tool reduction sequence described by Flenniken and White (1985; 132-133), the technology predominantly falls within categories I and II.

Variations to the techniques described above were present – namely the use of bipolar reduction found on a silcrete core. Bipolar reduction is carried out by application of a hammerstone to the centre of a core stone lying on an anvil stone. The force of impact splits the core in half.

Retouch techniques were predominantly unifacial (direct) retouch. Retouch was used to blunt the back (crescentic) edge of backed artefacts such as Bondi points and geometric microliths.

Evidence of 'heat-treating' was found on some of the artefacts found at Fern Bay. Heat treating presents as a discolouration and greasy appearance of natural stone. The technique was used to improve the flaking qualities of natural stone and involved heating stone in fires.

The reduction procedures described above produced an elegant, functional and formal tool kit.

<u>The raw materials</u>

The natural sand dune soils at Fern Bay do not contain the types of stones found during the excavation. Aboriginal people must have brought the stones into the area in the past. Archaeologists call these stones 'manuports', meaning stones carried by people into an area from a natural source.

By far the most common stone found at Fern Bay was fine-grained tuff. Approximately 1190 pieces of tuff were found, representing over 90 per cent of the assemblage. Tuff is a pyroclastic rock formed by the consolidation of volcanic ash. Tuff ranges in colour from shades of grey, brown, orange to yellow or creamy (buff), as well as white. The dominant colours are white and grey. Locally, tuff is found exposed in outcrops along the Hunter River and on the coast, and as pebbles within Hunter River gravels. The closest source to the study area is almost certainly a large prominent outcrop at Nobby's Head, on the south side of the Hunter River, opposite Stockton. The stone from this area is known as 'Nobby's Tuff'.

Nobby's Tuff has minimal cortex (or weathered rind), which is a surface discolouration caused by the influx of minerals and water to the outside of the stone. This was observed on the collection of artefacts from all sites at Fern Bay, where cortex was very rare. Of the 601 artefacts analysed, only 9 (1.5%) had any form of distinguishable cortex. This is probably a reflection of the fact the material is found in beds where only the exposed upper levels have a cortex, rather than an effort on the part of knapper's to prepare stone pieces prior to transportation. However, preparation at source in one form or another cannot be discounted – it just can't be observed from the available evidence. Although there is no direct evidence, it is likely that much of the tuff found at Fern Bay was quarried and transported from Nobby's Head, the closest and most prominent source in the area. Another outcrop source is found to the west at Tomago.

The second most common stone type at Fern Bay was silcrete. Czastka reports 116 silcrete artefacts, representing 8.9 per cent of the assemblage. The silcrete found at Fern Bay ranges in colour from red and pink to yellow and grey. Silcrete is a very variable medium, it's matrix being crypto-crystalline quartz, well-crystallised quartz or opaline silica. Flake edges are sharp and durable and artefacts made from silcrete are commonly found throughout NSW

(Mulvaney & Kamminga; op.cit). Silcrete is a relatively common rock, found in outcrops, riverbed gravels and gravel terraces. Silcrete found at Fern Bay was brought from one of these sources in the past. No local sources of silcrete have been reported.

The remainder of rock types found at Fern Bay include two unidentifiable types, one piece of quartz and one piece of banded mudstone.

Czastka's report on the stone artefact analysis provides a discussion about the flaking and tool making properties of tuff. Tuff is an inferior stone for tool making when compared to more indurated types such as silcrete. The dominance of tuff in the Fern Bay assemblage may reflect the local availability of the this raw material and a trade-off between the time expenditure required in obtaining higher quality stone and convenience and ease associated with obtaining a local but inferior stone.

6.1.3 What foods did Aboriginal people eat?

Identification of shell remains from Fern Bay provides an indication of what shellfish were eaten and where they may have been gathered. No bones were found so no information about consumption of terrestrial animals, birds, fish or marine mammals is available. It is likely that bones have decomposed as a result of soil acidity and fluctuating water table. Bones are far less resilient than shell. Shell often remains in the ground for much longer periods of time.

A total of 879 shells and shell fragments were recovered during excavation. The shells were counted, but due to time constraints no information on shell weights or minimum number of individuals (MNI) was obtained. Much of the shell found during the excavation comprised tiny fragments of shell that were not identifiable to species. A total of 282 unidentifiable fragments were found, representing 32 per cent of the assemblage count. Identifiable species and their proportions are described below:

***Saccostrea* (Rock Oyster)** – A total of 456 rock oyster shells and shell fragments were found, representing 52 per cent of the assemblage. Rock oysters are found on the margins of estuaries and within mangroves.

***Pyrazus* (Mud Whelk)** – A total of 41 mud whelk shells and shell fragments were recovered, representing 4.7 per cent of the assemblage. Mud whelks are found on estuarine mud flats.

Anadara (Cockle) – A total of 33 cockle shells and shell fragments were found, representing 3.8 per cent of the assemblage. Cockles are found on the margins of estuaries.

***Mytilius* (Blue Mussel)** – A total of 65 blue mussel shells and shell fragments were recovered, representing 7.4 per cent of the assemblage. They are found on estuarine margins.

Bembicum auratum – One *Bembicum* shell was found during excavation. *Bembicum* are an edible-sized shell fish found on estuarine rock platforms.

Although the shell count overstates the proportion of particular shell types that tend to break more easily into lots of fragments (such as oyster and cockle), it does reflect at a broad level the relative proportion of shell species. The results described above show that oyster dominates the assemblage, with smaller proportions of mud whelks, cockles and blue mussel. These species are edible varieties often found in Aboriginal shell middens. They are all found on the margins of estuaries. This indicates they were gathered from the Hunter River estuary, probably on Fullerton Cove, approximately 600 metres to the west of the study area. They were gathered and brought back to the site for consumption.

As previously discussed, Fullagar's functional analysis of the Worimi Cleaver found at Site 8 indicates it was most probably used for processing Bungwall fern to extract edible starch from the fern rhizome. This suggests that Aboriginal people living at Fern Bay gathered Bungwall ferns from the swamp forests in the area. The ferns rhizomes would have been brought back to camp sites and crushed with implements like Worimi Cleavers to extract the edible starch (refer to *Photograph 6.2*).

Photograph 6.2 Bungwall fern.

6.1.4 *What is the spatial extent and depth of sites in the study area and are there any patterns in relationships between site size and geomorphic / topographic locations?*

Correlations found between topographic locations and frequency/density of sites at Fern Bay show clear patterns in the settlement and occupation of the stable dunes. The distribution of archaeological sites across the landscape at Fern Bay suggests that low ridgeline landforms in the inner 4000 BP dune sequence were occupied and utilised in preference to higher ridgelines. Low ridgelines are more sheltered from prevailing winds and are in closer proximity to the water and plant resources of the swamp forests.

Excavation of auger transects during phase 2 indicates that archaeological material is concentrated on the lower ridgelines. Only one artefact was found from six auger transects (60 augers) excavated on the high ridgelines in comparison to six artefacts recovered from four auger transects (40 augers) on the lower ridgelines. This represents a large difference in proportions between the high ridgelines and the low ridgelines.

During the current investigation, no archaeological material was found within the outer 1200 BP dune sequence. During her investigations in 1992, Dean-Jones found sparse, low densities of material within these dunes. The paucity of archaeological evidence within the outer dune probably represents a lack of Aboriginal occupation in the past. There is no readily available fresh water source near the outer dune, the area is more than 600 metres from the coast and 600 metres from the estuary at Fullerton Cove. This indicates that freshwater, estuarine resources and marine resources would not have been readily available within the outer dune. The high ridges are quite exposed to wind and coastal storm without the sheltering forest canopy present further inland. The lack of resources (particularly water) and the lack of shelter are probable reasons for the absence of occupation evidence in this area.

Sites excavated at Fern Bay had a range of densities and extent both horizontally and vertically. Archaeological material was found at up to 900 mm below ground surfaces (Site C TT1) but the mean maximum depth across all test trenches was 508 mm for stone and 405 mm for shell. The low ridgeline that comprises Site 8 and Site C contained a continuous low-medium density of sub-surface archaeological material. Higher densities were found on broad lower ridge crests (locations such as Site C).

6.1.5 *What are the site formation processes, both cultural and natural?*

Archaeological sites are formed through a combination of cultural, geomorphic and taphonomic (post-depositional) processes. Archaeologists examine these processes to determine how sites were formed, which has implications for the integrity of archaeological deposits.

The site formation processes evident at Fern Bay appear to be largely cultural although it is possible that differential preservation of shell has also been a factor. Although previous studies (Villa, 1982; Gifford & Behrensmeyer, 1977) have noted post-depositional sorting effects within unconsolidated sandy deposits, and across supposedly separate sedimentary levels (Villa, 1982; 286), the Fern Bay stone artefact analysis (refer to *Annex 3*) found no particular size sorting patterns. A pattern often noticed in unconsolidated sandy deposits is that smaller material is moved downwards into the matrix and larger artefacts are left exposed on the surface (Villa, 1982; 279). The sites at Fern Bay do not seem to have a concentration of larger material or any size sorting on the surface, or indeed, at any specific depth. Where an adequate degree of data is available (eg. Site C TT0, Square H10 and Site E TT1), no size-sorting pattern is noticeable. A general 'concentration' of stone exists between spits one to four, where a range of artefact sizes are fairly evenly spread.

Excavation of Site E TT1 suggests there were no physical sorting processes that differentiated the stone distributions from shell distributions. As *Figure 6.1* illustrates, the distribution and proportions of stone compared to shell conform to a similar pattern. Both shell and stone first appear in spit one, densities for both peak in spit three and four and there is a dramatic drop-off in densities for both in spit five.

The vertical distribution of stone artefacts and shell at Site C TT1 (*Figure 6.2*) also provides strong evidence of site integrity and stratification. This material demonstrates a bimodal distribution suggesting that the material was deposited during at least two periods of occupation and that material through the deposit is not the result of a reservoir effect, whereby artefacts move through the deposit from one level.

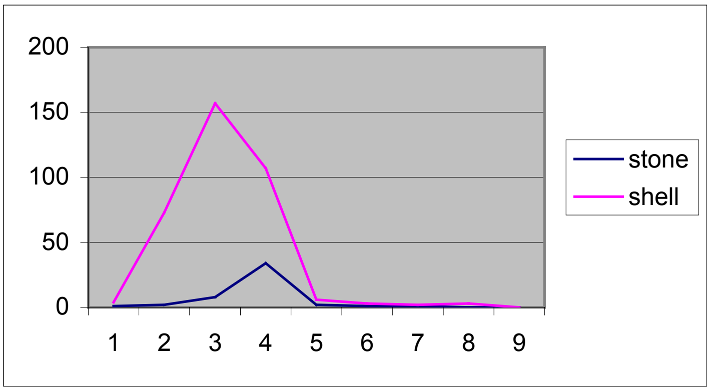


Figure 6.1 ***Stone and shell densities at Site E TT1. Excavation spits are shown on the horizontal axis and quantities are shown on the vertical axis.***

6.1.6 *What cultural activities can be identified at each site and is there any evidence that indicates the nature of resource exploitation in the study area?*

An analysis of the range, distribution, density and types of artefacts found indicates some of the cultural activities that were carried out in the past. An assessment of this evidence in relation to the local distribution of resources such as water, workable stone material and food sources indicates relationships between site activities and environmental settings.

A range of cultural activities can be inferred from the test excavations at Fern Bay, however one of the most striking features of the results is the variation in artefact densities and compositions between each site. This suggests that different sites and landforms were used for a variety of activities at differing intensities. Evidence for cultural activities at the Fern Bay sites with sub-surface evidence are detailed below.

Site C

The stone artefacts found at Site C indicate a range of activities. All stages of the reduction process from core reduction to tool manufacture are present. Hunting is represented by the presence of backed artefacts, and particularly, Bondi points. As previously discussed, they are interpreted as barbs on hunting and fishing spears (Mulvaney and Kamminga, 1999; 236). Broken Bondi points and geometric microliths in the general vicinity of Site C indicate tool maintenance activities. Stone Artefact densities from Site C correlate with McDonald et al (1994) knapping floor densities. This means that tool manufacture was an intense activity at Site C.

The processing of organic products is suggested by the presence of a piercer, end scraper and hatchet fragment. Collectively, the relatively high density of material across the site, the complete range of flaking and retouch present in the stone, the large amount of unworked and discarded material and the high occurrence of artefact breakage (inferring much of the material has been subject to trampling) all suggest Site C was a complex occupation site. Site C is interpreted as a campsite, which encompassed a broad spectrum of activities associated with cultural and economic life.

Shells at Fern Bay C were estuarine species, which indicates that shellfish gathering was probably focused on Fullerton Cove (approximately 600 metres to the west) but not on the coastal zone, which is more than 1.5 kilometres from Site C. This accords with Dean-Jones' (1992) finding that foraging did not occur across the dune barrier. The proximity of Site C and the other Fern Bay sites to swamp forest also suggests that this environment was an important area for gathering fresh water, plant and animal resources.

Site 8

Artefact densities recovered from the Site 8 excavations were at a much lower density to Site C, D or E. The excavation suggests the low ridgeline comprising Site 8 was an area of continuous, but lower intensity use than present at Site C. In all likelihood, artefacts recovered from Site 8 test trenches represent sporadic camping events, loss of artefacts during transit along the ridge and knapping episodes representing tool production or maintenance. Given the consistency of artefacts along the low ridgeline, Site 8 is interpreted as a low to medium density scatter.

The Aboriginal hearth and Worimi Cleaver found at Site 8 TT1 provide evidence about cultural activities in the area. A charcoal sample obtained from the hearth was carbon dated to 2,584 +/- 45 BP. This provides an absolute date for early occupation of Site 8 and a date for use of the Worimi Cleaver (found within the hearth matrix). It has been previously suggested (Baker 1994; Kamminga 1981; Navin & Kamminga 1999) that Worimi Cleaver's were used to process fern roots to remove the edible starch stored in the rhizomes. The functional analysis of the Worimi Cleaver (refer to *Annex 6*) supports this interpretation and suggests that the specimen from Fern Bay Estate Site 8 may have been used for processing Bungwall ferns. These ferns are dominant in the swamp forests at Fern Bay and may have been gathered there.

Site D

No shells were recovered from the Site D excavation. The absence of shell may be a result of disturbance and erosion of the topsoil. Alternatively, Site D may represent earlier occupation where shell has decomposed. Because the upper portions of the soil profile were disturbed, it is more likely that the absence of shell is the result of truncation and removal of more recent deposits that contained shell. Given the disturbance to the soil profile observed at Site 8, it is difficult to assess the nature of cultural activities at the site beyond noting the high densities of stone artefacts.

Site E

Excavation at Site E found high densities of stratified shell and stone artefacts. The high densities of both shell and stone indicates the site was a complex and broad-based activity area involving foraging and consumption of shellfish and also manufacture and use of stone tools, which again suggests manufacture of stone artefacts, processing of organic materials and hunting. The presence of late (or post) Bondaian stone artefacts within the assemblage, indicates the site may represent more recent occupation than found at other sites in the study area. The presence of an elouera at a depth of approximately 500 mm suggests occupation within the last 1600 years. Eloueras do not generally appear in the archaeological record until around 1600 years BP (Mulvaney and Kamminga, 1999; 252). Evidence for recent occupation at the site may explain the larger quantity of shell preserved at the site compared with other Fern Bay sites.

Recent sites generally contain well-preserved shell whereas shell in earlier sites usually decomposes.

The location of Site E between two swamp forests suggests that the swamps were an important source of fresh water, plant and animal resources. The density of archaeological material at Site E supports this conclusion.

6.1.7 *Why is there an apparent stratigraphic separation of flaked stone and shell and what controls the depth at which shell and stone occur within the dune?*

Dean-Jones noted a stratigraphic separation of stone and shell during her investigations in 1992. The current investigation found evidence for this pattern at some sites (particularly Site C) however at other sites (Site E) there was no evidence of stratigraphic separation of shell and stone. A comparison between the density of stone and shell at Site C and Site E illustrates the point (see *Figure 6.2* below)

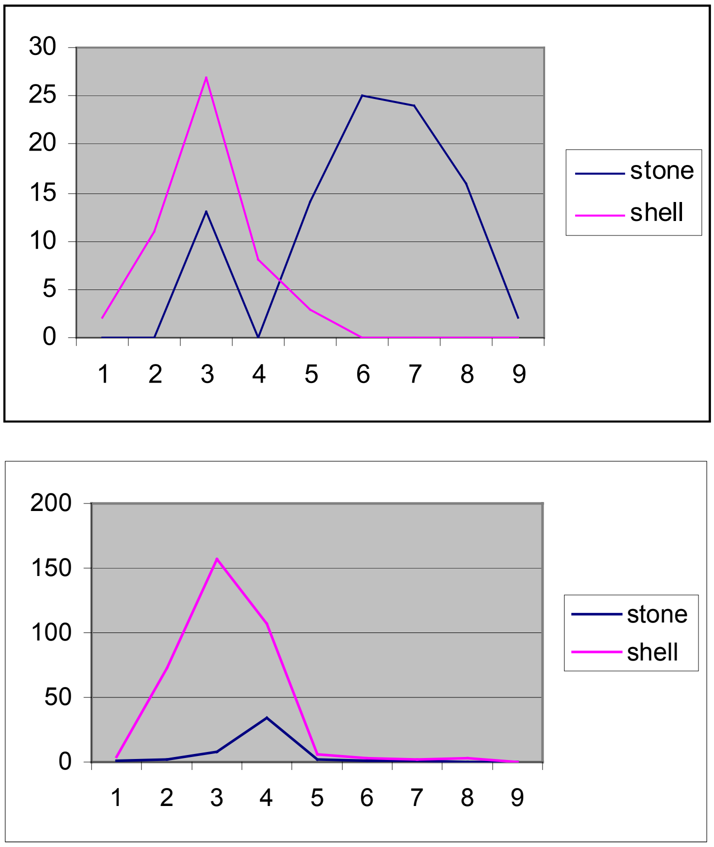


Figure 6.2 ***Comparison of stone and shell densities at Site C TT1 (above) and Site E TT1 (below). Excavation spits are shown on the horizontal axis and quantities are shown on the vertical axis.***

As can be seen from *Figure 6.2*, at Site C the vertical distribution of shell is very different to the vertical distribution of stone. At Site E the vertical distributions of shell and stone are very similar.

It is likely that Site C has been occupied for a longer period of time than Site E and the shell from the earlier levels at Site C has decomposed. Evidence from excavation indicates that Site C is older than Site E because the stone assemblage at Site C suggests middle Bondaian (2800-1600 years BP) whereas the assemblage at Site E includes artefacts that are typically post-Bondaian, such as Eloueras (post 1600 years BP).

Preservation of shell is affected by soil acidity and the effect of fluctuating water tables on deeper deposits. Generally, in most contexts shell is not preserved beyond 3000 years although this is largely affected by localised preservation conditions and soil chemistry. In particular preservation conditions, shell has been reported in contexts older than 6000 years BP (Val Attenbrow – Australian Museum pers. comm.). The pH levels from both sites C and E are between six and seven (refer to *Annex 2*), which are fairly neutral levels and would not indicate any inherent differences in soil chemistry.

The low proportions of stone compared to shell seen in surface deposits and the upper portions of deposits at many of the Fern Bay sites may reflect changes in the use of stone artefacts during recent occupation. During the last 1000 years the archaeological record shows a decrease in the use of stone, (the formal Bondaian technology disappears from the record during this period) in favour of bone, shell and wood artefacts. Stone artefacts present in recent archaeological contexts generally comprise low densities of quartz bi-polar forms. The paucity of stone in surface scatters and upper deposits at Fern Bay probably reflects a decrease in the use of stone artefacts during recent occupation.

In summary, the stratigraphic separation of shell and stone observed at Fern Bay is probably caused by:

1. decomposition of shell at depth in earlier deposits. Stone survives in earlier deposits where shell decomposes over time; and

2. cultural changes in the use of stone artefacts during recent occupation. In the last 1000 years the use of stone artefacts may have diminished in favour of tools made from shell, bone and wood. In recent deposits shell continued to be gathered and discarded at occupation sites, whereas the manufacture and use of stone artefacts may have declined.

Dean-Jones's use of the term 'stratigraphic separation' is inaccurate. Sites excavated during the current study at Fern Bay that contained shell and bone, showed a considerable overlap of stone and shell within vertical profiles. None of the sites showed a complete separation.

6.1.8 *Is it possible to assess site content on the basis of surface evidence?*

Comparison of the composition and density of surface evidence with sub-surface deposits indicates it is not possible to assess site content from surface deposits.

As has been shown, there are differences in the vertical distribution of stone and shell at Site C. The proportion of shell relative to stone is much higher on the surface than it is sub-surface. The density and composition of surface finds are not representative of sub-surface archaeological material.

6.1.9 *Does a synthesis of the Fern Bay excavations provide evidence about settlement patterns and the nature of occupation on the Stockton Bight, especially within the dune barrier system?*

The investigations carried out at Fern Bay support the settlement pattern model presented by Dean-Jones in the original 1992 assessment of the study area. In short, the 4000 BP stable dune ridgelines were the focus for occupation whereas the deflation basin and 1200 BP dune sequence were only very sparsely occupied, probably in the form of transit or temporary foraging camps. Occupation of the 4000 BP stable dune ridgelines was focused on the lower ridgelines particularly adjacent to or between Swamp Forests.

As argued in this report, it is likely that shelter and resource availability were crucial factors in occupation patterning on the Stockton Bight. There is significant local variability in the distribution of shelter, fresh water, plant and animal resources and accessibility to estuarine and marine resources. Investigations at Fern Bay suggest the variability in the abundance and intersection of these resources has influenced settlement patterns in the area. The 4000 BP stable dune ridges are sheltered, in close proximity to fresh water, surrounded by a variety of vegetation communities (especially swamp forest) and in close proximity to estuarine resources at Fullerton Cove. The remaining landforms in the barrier system are deficient in either one or a number of these critical resources. This is the likely reason for the sparse, low density of archaeological material in these areas compared with the 4000 BP dune ridges.

7 CONCLUSIONS

7.1 PREAMBLE

The test excavations have shown that the Fern Bay study area contains a high density of Aboriginal sites, particularly on low ridgelines within the 4000 BP stable dune. Archaeological excavation has revealed stone artefacts, shell midden and an Aboriginal hearth. These finds have provided information about the social, economic and cultural life of Aboriginal people who lived at Fern Bay before European settlement. Evidence found during the investigation tells us about the places Aboriginal people lived, how long they lived there, the foods they ate and where they may have been gathered, the stone implements they made, what they were used for and where they may have gathered the stone.

7.2 SPECIFIC CONCLUSIONS

The following conclusions are made about Aboriginal occupation at Fern Bay:

- Shelter and resource availability were crucial factors in occupation patterning on the Stockton Bight. The 4000 BP stable dune ridgelines were the focus for occupation at Fern Bay whereas the deflation basin, swamp forest and 1200 BP dune sequence were only very sparsely occupied. The availability of shelter, fresh water, plant and animal resources and accessibility to estuarine shellfish was much greater in the 4000 BP dunes than in comparison with the other landforms.

- Occupation was focused on low ridgelines of the 4000 BP stable dune sequence, particularly adjacent to or between Swamp Forests. Archaeological material is found throughout the low ridgeline landforms but is focused on particular locations comprising high-density complex assemblages, such as Site C.

- Carbon dating of a charcoal sample recovered from an Aboriginal hearth found at Site 8 TT1 Spit 8 yielded a date of 2584 +/- 45 BP. Because the charcoal sample was taken near the base of the cultural sequence at Site 8, this indicates Aboriginal occupation of the area by c. 2584 years ago.

- There are marked differences in the vertical distributions of stone and shell at some sites. This was probably caused by decomposition of shell at depth in earlier deposits and a decline in the use of stone artefacts during recent occupation.

- Site content cannot be assessed on the basis of surface evidence because of the markedly different vertical distributions of shell and stone at some Fern Bay sites.

- Stone artefact analysis found no evidence of size sorting effecting the distribution of stone artefacts throughout the excavated profiles at Fern Bay. This indicates that archaeological deposits at Fern Bay have stratigraphic integrity. The bimodal distribution demonstrated at one site also provides strong evidence of site integrity.

- A range of activities can be inferred from the test excavations at Fern Bay, included hunting (large number of Bondi Points recovered), plant processing (piercer, end scraper and hatchet fragment from Site C and the results of functional analysis of Worimi Cleaver from Site 8), knapping (all stages of the reduction process from core reduction to tool manufacture are present), shellfish gathering and camping (hearth excavated at Site 8).

- The raw material used for stone artefact manufacture at Fern Bay is predominantly Nobby's Tuff. This stone is locally available, outcropping at Nobby's Head. Nobby's Tuff is inferior in flaking and edge-holding qualities compared to Silcrete and Indurated Mudstone. This suggests that the proximity to raw material source was the most important consideration when selecting raw materials for artefact manufacture.

- Functional analysis of a Worimi Cleaver found at Site 8 indicates the tool was probably used for processing Bungwall *(Blechnum indicum)* ferns. Bungwall ferns are dominant in the swamp forests at Fern Bay, suggesting use of swamp forests as a resource foraging area.

- The Worimi Cleaver was recovered from charcoal matrix of the hearth found at Site 8 TT1. The date of 2584 +/- 45 BP obtained for the hearth provides a secure date for use of the Worimi Cleaver. Another Worimi Cleaver was excavated by Neville Baker at Moffats Swamp and has been dated by association with charcoal to c. 11 000 BP (Neville Baker, ERM pers. Comm.). This demonstrates continued use of a specialised implement over a period of at least 8000 years. This in turn has implications for cultural continuity and technological conservatism on the Newcastle Bight.

7.3 *DIRECTIONS FOR FUTURE WORK*

Whilst the results of the excavation work have added to our understanding of Aboriginal occupation in the region, a number of issues should be considered as part of any future research or impact assessment along Stockton Bight. Low ridgeline landforms and areas on the margins of swamp forests within Holocene dune sequences should be considered of high archaeological sensitivity. Where possible these areas should be excluded from development or if this is not possible, subject to controlled archaeological excavation. The Stockton Bight should be acknowledged as a unique archaeological resource because of its deep and relatively undisturbed cultural sequences within an environment that is complex and diverse in terms of vegetation, water distribution, shelter and resource distribution. The deep cultural sequences provide the potential to investigate cultural change through time. The diversity of landforms and resources provides an excellent testing ground for examining settlement and site-type patterning in relation to topography and resources.

8 ABORIGINAL COMMUNITY PARTNERSHIP

8.1 ABORIGINAL COMMUNITY INVOLVEMENT DURING 2000

The Worimi Local Aboriginal Land Council (WLALC) represents the local Aboriginal community on matters relating to cultural heritage in the Fern Bay area. The WLALC were consulted in regards to the proposed development in 2000 and participated in each stage of the archaeological investigation. Ongoing consultation and partnership with WLALC has promoted open dialogue with the local Aboriginal community and facilitated crucial input from WLALC in regards to proposed development and the archaeological investigations.

Mr Len Anderson of WLALC, provided a consultative and oversight role throughout the project. Representatives of WLALC, Leith Anderson, Gavin Kelly and Jamie Thomas participated in the survey work and the test excavations. During the test excavations, WLALC representatives participated in all aspects of the work including excavation, sieving, identification and interpretation of finds. The role played by WLALC in the archaeological investigations was instrumental in the success of the project.

Photograph 8.1 WLALC representatives assisting with the test excavations in 2000.

Recommendations of the Preliminary Excavation Report and the Interim Final Excavation Report were been developed in consultation with WLALC.

The outcomes of our consultation with the Aboriginal community in 2000 are detailed below.

8.2 *OUTCOMES OF CONSULTATION 2000-2001*

WLALC have indicated that the site has a high level of cultural significance to the local Aboriginal community. The study area was an important landscape where camping, tool making, food gathering and traditional activities were carried out in the past. The local Aboriginal community were concerned about the impact of proposed development on Aboriginal heritage. In particular, WLALC were concerned about proposed development of the ridgeline comprising Site 8 and Site C, where important evidence of Aboriginal occupation was found during test excavation. WLALC recommended a mitigation and heritage management plan be prepared in advance of development. The mitigation approach developed during 2000 is described below.

Following completion of excavation in December 2000, ERM and WLALC developed a heritage mitigation approach in consultation with Howship Holdings Pty Ltd and NPWS. The mitigation approach formed the basis of recommendations of the Preliminary Excavation Report prepared by ERM in 2000 (ERM 2000b). The mitigation approach included:

1. completion of post-excavation analysis and preparation of a full excavation report describing the results of test excavation at Fern Bay;

2. conservation of an adequate representative sample of landforms. In addition to the areas zoned 7a (Environment Protection), the low ridgeline comprising Site C and Site 8 should be conserved as open space and excluded from future development. This recommendation was based on the high archaeological and Aboriginal cultural significance of the ridgeline; and

3. WLALC monitoring of development excavation works during the construction phase. Monitoring would allow recovery of Aboriginal objects disturbed by development work.

These measures were to have formed the basis of recommendations in a SoEE to accompany Howship Holdings development application (DA) to Port Stephens Council. They were also designed to form the basis for a section 90 consent application to DEC.

After post-excavation analysis was completed, WLALC requested that all cultural material excavated at Fern Bay be returned to the Aboriginal community and that WLALC be permitted to re-bury the artefacts. Accordingly, an application for a Care and Control permit was made to

NPWS. The permit was approved in April 2001 (N82/CC/2001) and all cultural material returned to WLALC. The artefacts were placed in thick plastic bags, sealed with staples and tape and reburied in the vicinity of Site 8 on the low ridgeline earmarked for conservation. The exact location of the re-burial will not be disclosed in this report to ensure the security of the artefacts. The re-burial location was recorded with a hand held GPS and this record is kept by the WLALC and excavation director Jim Wheeler.

8.3 RECENT CONSULTATION

Winten engaged ERM to undertake consultation with the local Aboriginal community with a view to obtaining a section 90 consent from DEC for the approved subdivision. Consultation involved meetings with Len Anderson (WLALC) and Carol Ridgeway-Bisset (MAHI). These meetings provided the opportunity to inform the community about current proposed development plans and to revisit the original Aboriginal significance assessment. They also provided the opportunity for the community to voice concerns and provide recommendations. As Carol had not previously been consulted and had not visited the site during the archaeological excavations, consultation also involved a site inspection.

9 SIGNIFICANCE ASSESSMENT

9.1 BASIS FOR ASSESSMENT

The significance of Aboriginal archaeological sites is assessed using three criteria: Scientific archaeological (scientific), Aboriginal (social) and Public Significance. These criteria recognise that Aboriginal sites are valuable in a number of ways. Namely:

- to the Aboriginal community as an aspect of their cultural heritage and as part of continuing traditions;
- to the broader community, for educational, historical and cultural enrichment values; and
- to the scientific community for potential research value.

The guidelines outlined in the *Draft NSW National Parks and Wildlife publication Aboriginal Cultural Heritage: Standards and Guidelines Kit* provide the basis and background for the following discussion regarding evaluation of site significance.

9.2 ABORIGINAL SIGNIFICANCE

This area of assessment concerns the relationship and importance of sites to the Aboriginal community. Aspects of Aboriginal significance include both people's traditional and contemporary links with a given site or landscape as well as an overall concern by Aboriginal people for sites and their continued protection.

Unmodified natural features in the landscape can signify sacred sites/places of significance. As such they are archaeologically invisible and can only be identified with the aid of Aboriginal interpretation. If such sites are known they hold particular significance to contemporary Aboriginal people. Furthermore, sites of significance are not restricted to the period prior to contact with Europeans. Often events related to the Contact-period, and at times to the period since European settlement, may be so important to the local Aboriginal communities that they become significant. If these events relate to a specific place in the landscape, then that place (ie the site) may become sacred or highly significant to local Aboriginal communities.

Consultation with WLALC during 2000 and 2001 indicates that the Stockton Bight, which includes the Fern Bay study area, is an important cultural landscape. Evidence of Aboriginal occupation is considered to be culturally significant to the Aboriginal community.

WLALC consider the Fern Bay study area is a culturally significant area. Drawing on the results of the test excavation, WLALC have concluded the area was an important place where camping, tool making, food gathering, and other traditional activities were carried out in the past. WLALC consider that the Aboriginal objects recovered during the test excavation are culturally important to their community. This was demonstrated by their ceremonial re-burial of the objects near Site 8.

Consultation with MAHI during 2004 confirmed this assessment and highlighted the significance of the cultural landscape. MAHI believe that ecological issues, such as the protection of endangered species, are inextricably linked with cultural issues because impacts on the native ecology of the region also represent impacts on the cultural landscape.

9.3 PUBLIC SIGNIFICANCE

This category of the assessment process concerns using a site or a site's potential to educate people about the past. It also relates to the heritage value of particular sites as being representative examples of past lifestyles, why they are important, and why they should be preserved.

As the site of a proposed residential development, the study area has an excellent potential for public education of new residents and the broader community about Aboriginal lifestyles and culture. The study area is a rich and in some respects unique Aboriginal landscape. Archaeological excavations have demonstrated many facets of Aboriginal lifestyle in the Holocene dunes of the Stockton Bight. These findings would be of interest to the broader community.

In partnership with the local Aboriginal community, there is an excellent opportunity to utilise the results of the test excavation to educate new residents at the Fern Bay Estate and the broader community about aspects of Aboriginal culture. The results of archaeological investigations at Fern Bay could be used as one method of demonstrating elements of the area's Aboriginal past. The archaeological findings at Fern Bay could be incorporated in the proposed development in a manner acceptable to the local Aboriginal community. Interpretive signage could be considered as one method of communicating the Aboriginal history of Fern Bay.

9.4 SCIENTIFIC SIGNIFICANCE

The objective of undertaking scientific significance assessment for a site is to determine its research potential in terms of potential contributions to our understanding of the past. Criteria used to evaluate scientific potential include condition/integrity, representativeness and rarity.

The findings of the Fern Bay test excavation have shown that the study area has:

Integrity - because of largely intact soil profiles containing in-situ stratified archaeological deposits.

Representativeness - as a fine example of Aboriginal use and occupation of the Stockton Bight Holocene dunes.

Rarity - the study area has rarity in a local and regional context as a largely undisturbed landscape containing archaeological evidence with a high level of research potential. The range of evidence found during excavation at Fern Bay indicates the study area is a rare archaeological resource. Evidence with significant research potential included:

- quite specific settlement patterning;
- clear relationships between settlement patterning and the distribution of local resources;
- specific evidence regarding economic activities and the use of resources within the area, including the importance of swamp forests for foraging;
- the high density of stone artefacts found during the test excavation representing all stages of the reduction process, tool use and maintenance. This has in turn provided evidence about activities that were carried out in the past such as hunting and processing organic materials;
- carbon dating of early occupation of the area; and
- functional analysis of a Worimi Cleaver demonstrating its use and providing evidence for association between its use for processing Bungwall ferns and gathering of these ferns in the nearby swamp forests. Carbon dating of charcoal in association with the Worimi Cleaver has provided a late date for the use of this implement. When compared with previous dating of a Worimi Cleaver at Moffats Swamp (c. 11 000 BP), the Fern Bay date demonstrates a long use of Worimi Cleavers.

Accordingly, the study area is considered to have a high level of scientific significance at a local and regional level. The results of the excavation program have the potential to contribute to a number of broader research issues relating to the coastal archaeology of NSW.

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10 DEVELOPMENT IMPACT ASSESSMENT

This section describes the form of the development proposed at Fern Bay and assesses the impact that it is likely to have upon Aboriginal heritage, as identified by the archaeological test excavation.

10.1 PROPOSED DEVELOPMENT

Winten propose to develop a new residential estate to be known as Fern Bay Estate. The proposed development is located within approximately 205 hectares of land immediately adjacent and to the east of Nelson Bay Road, midway between Stockton Beach and Fullerton Cove. The site is Lot 16, DP258848, 85 Nelson Bay Rd, Fern Bay.

The development footprint for the estate is proposed to comprise approximately 98 hectares of the site (including part of the approved subdivision area). Approximately 107 hectares of natural bushland surrounding the development footprint is proposed to be retained. Vegetation will also be retained within parts of the development footprint. A Draft Master Plan has been prepared for the proposed development for consideration of the Minister for Infrastructure, Planning and Natural Resources in accordance with SEPP 71 – Coastal Protection. Under the provisions of SEPP 71, the Minister will be the consent authority for the proposed development.

The proposed residential estate will include approximately 950 residential lots, open space areas, and recreation, community and commercial facilities. The concept plant for the proposed development is illustrated on *Figure 1.2*.

Following the recommendations of the Preliminary Report (2000) on archaeological excavations at Fern Bay, the proponent has amended the development design to conserve the low ridgeline comprising Site C and Site 8 as an Aboriginal heritage reserve. This area will not be developed for residential purposes.

10.2 IMPACT ASSESSMENT OF DEVELOPMENT DESIGN

The site is currently an unoccupied and undeveloped stabilised sand dune comprising coastal sand apple-blackbutt forest, swamp mahogany-paperbark forest and wet heath. Parts of the site have been disturbed by four-wheel drive vehicle tracks and excavation work carried out for the approved subdivision. The majority of the proposed development area remains undisturbed.

The archaeological test excavation has demonstrated that Aboriginal objects are present across the proposed development area within intact A horizon soils. Aboriginal objects were found in varying densities across most landforms within the study area. Sparse densities of Aboriginal objects are likely to present within intact soils across all landforms. High densities are present within intact soils on low ridgelines in the inner 4000 BP dune sequence. Aspects of the proposed development which involve excavation of intact A horizon soils, may also disturb or destroy Aboriginal objects, particularly on low ridgelines within the inner dune sequence.

As discussed in *Section 10.1*, 107 hectares of the 205 hectare study area is proposed to be retained as natural bushland. In addition, the low ridgeline comprising Site C and Site 8 (marked blue on *Figure 3.2*) will be an Aboriginal heritage reserve and excluded from all forms of development (refer to *Figure 1.2*). These measures will minimise impacts on Aboriginal heritage and retain a representative sample of landforms for both environmental and Aboriginal heritage protection. It is likely that development works including excavations for levelling of residential lots, excavations for roads, drainage and other services will involve disturbance and removal of intact A horizon soils. As a result these excavations are likely to disturb or destroy Aboriginal objects.

Although no Aboriginal burials were found during the test excavation, there is a potential for unrecorded burials within the site. Burials are often found within soft soils, particularly in sand dunes. The density of Aboriginal sites found within the study area indicates intensive Aboriginal occupation of the area in the past. Burials are often found adjacent to or in association with Aboriginal occupation. Therefore, it is concluded that there is some potential for the proposed development works to impact Aboriginal burials.

11 *RECOMMENDATIONS*

11.1 *BASIS FOR RECOMMENDATIONS*

The following recommendations are based upon:

- requirements of the *National Parks and Wildlife Act 1974* (as amended in 2001);
- results of the archaeological investigations of the study area which are documented in this report;
- the potential impact of proposed development on Aboriginal heritage; and
- the heritage mitigation approach recommended by the Aboriginal community and detailed in *Chapter 8* of this report.

11.2 *ABORIGINAL CONSULTATION*

It is recommended that:

1. Liaison established with Aboriginal community should be maintained throughout the development process. The Aboriginal groups (WLALC and MAHI) should be identified as key stakeholders in the development process. Accordingly they should be kept informed about the timing and details of the development schedule.
2. Representatives of the Aboriginal community should be provided the opportunity to recover Aboriginal objects during excavation work associated with the initial stages of the development.
3. The Aboriginal community should be consulted regarding interpretation of archaeological information about the site that could be presented in the form of public display, such as interpretive signage and/or a display in a community centre. This would have the value of enriching the community through education about Aboriginal heritage.
4. A copy of this report should be forwarded to WLALC and MAHI.

11.3 *ABORIGINAL HERITAGE MANAGEMENT*

Recommendations for management of Aboriginal Heritage at Fern Bay Estate during its development are set out below. The recommendations are based on the heritage mitigation approach developed by the Aboriginal community and ERM. The following recommendations should be presented to WLALC and MAHI for their consideration. It is recommend that the proposed Fern Bay Estate development proceed, provided that Winten implement the following:

I. The ridgeline marked blue on *Figure 3.2* should be excluded from any form of development and conserved within an Aboriginal heritage reserve. Vegetation and soils within this area should not be removed or disturbed in any way. Erosion mitigation measures should be implemented on the margins of this area to ensure soils containing Aboriginal objects are not removed through erosion.

II. Prior to commencement of development, Winten will require a section 90 consent from the Department of Environment and Conservation (DEC). Winten should apply to DEC for a section 90 consent before the commencement of development work. The consent should cover salvage of Aboriginal cultural material within the proposed development area. The proposed salvage methodology, to be detailed in the section 90 application, should involve the recovery of Aboriginal objects by the Aboriginal community. The basis for the salvage work, as recommended by the local Aboriginal community, is the Aboriginal cultural significance of the objects. The purpose is to recover Aboriginal objects that may otherwise be destroyed by development work. The salvage work should be limited to the initial stages of development when the ground surface is first disturbed. Aboriginal involvement during development excavation work will also ensure that Aboriginal burials, if present, can be identified and appropriate management regimes put in place.

III. No further controlled archaeological excavation is warranted at the development site. It is considered that the archaeological test excavations undertaken during 2000 adequately addressed the research questions set out in the section 87 application.

IV. If human skeletal remains are identified during construction, work on site should cease, the remains should be covered with clean fill (eg sand) and the site should be secured. The following tasks should be undertaken immediately:

   a) briefing of the development's archaeologist, followed by liaison with DEC, the Aboriginal community and the Office of the NSW Coroner;

   b) amendment of the design (if possible) to avoid the burial remains; and

   c) discussion of appropriate management and mitigation measures with the DEC and the Aboriginal community. Ultimately, the management of Aboriginal burials will be determined by the DEC in consultation with the local Aboriginal community. In situ conservation of any such burial(s) may be required.

V. Measures should be employed to ensure that areas outside the development footprint are not inadvertently impacted during construction. All site workers should be made aware of cultural heritage issues and the consequence of disturbing any Aboriginal sites or objects (under the *National Parks and Wildlife Act)* without first obtaining a section 90 consent.

VI. The recommendations set out above should be incorporated as project tasks in development project planning and included in any contracts or scope of work documents provided to project managers and relevant on-site contractors.

VII. Two copies of this report should be sent to the DEC Northern Aboriginal Heritage Unit together with the section 90 consent application form and letters of support from the Aboriginal community.

REFERENCES

Baker, N. (1992) **Stone Artefact Assessment and Analysis - Recording Techniques and Methodology**. Report to the Hunter Valley Aboriginal Sites Assessment Project

Baker, N. (1994) **Moffats Swamp Dune: Final Report on Archaeological Site Salvage, Testing and Artefact Analysis**. Report to RZM Pty Ltd

Baker, N. & Effenberger, S. (1996) **Archaeological Test Excavation and Significance Assessment F3 Freeway, Black Hill, NSW**. Report to NSW RTA

Barber, M. (1993) **Proposed Mt Owen Extension, Archaeological Survey of Betty's Creek**. Report to Hunter Valley Coal Corp Pty Ltd

Dean-Jones, P (1992) **Archaeological Survey at Fern Bay**. Report to Port Stephens Shire Council

Dean-Jones, P (1990) **Newcastle Bight Aboriginal Sites Study**. Report to NSW National Parks and Wildlife Service and National Estate Grants Committee

ERM Mitchell McCotter (1998). **Fern Bay Rezoning Application.** Prepared for Howship Holdings Pty Ltd

Environmental Resources Management Australia (ERM) Pty Ltd (2000a) **Fern Bay Aboriginal Archaeological Assessment.** Prepared for a Statement of Environmental Effects on behalf of Howship Holdings Pty Ltd

Environmental Resources Management Australia (ERM) Pty Ltd (2000b) **Preliminary Report on Excavations at Fern Bay**. Report to Howship Holdings Pty Ltd

Environmental Resources Management Australia (ERM) Pty Ltd (2001) **Interim Final Report on Excavations, Fern Bay Archaeological Project 2000.** Report to NPWS

Flenniken, J.J. & White, P.J. (1985) **Australian Flaked Stone Tools: A Technological Perspective**. Records of the Australian Museum. Vol 36: 131-151

Gifford, D.P. & Behrensmeyer, A.K. (1977) *Observed Formation and Burial of a Recent Human Occupation Site in Kenya.* In **Quaternary Research 8**

Gunninah Environmental Consultants (1996 and revised in 1997) **Proposed Residential Development Fern Bay Fauna and Flora Assessment** (including Section 5A and SEPP 44 Assessments)

HLA Envirosciences (1996) **Sub-surface Archaeological Testing at Lot 2 DP8844711 Near Minmi, Hunter Valley, NSW**. Report to Highland Country Pty Ltd

Hiscock, P. (1986) Technological change in the Hunter River valley and the interpretation of late Holocene change in Australia. **Archaeology in Oceania**. 21:40-50

Hughes, P.J. (1984) **An Overview of the Archaeology of the Hunter Valley, its Environmental Setting and the Impact of Development.** NSW National Parks and Wildlife Service, Hunter Valley Region Archaeology Project Stage 1, Vol. 1. 1984

Kamminga, J. (1977) **A Functional Study of Use-polished Eloueras.** In Wright, R.V.S. (ed.) Stone Tools as Cultural Markers: Change, Evolution and Complexity. AIAS

Kamminga, J (1981) *The Bevelled Pounder: An Aboriginal Stone Tool Type from Southeast Queensland.* In **Proceedings of the Royal Society of Queensland 92**

Koettig, M. (1986a) **Assessment of Archaeological Sites Along the Proposed Singleton to Glennies Creek Water Pipeline Route and the Reservoir Site at Apex Lookout, Hunter Valley, NSW**. Report to Department of Public Works.

Koettig, M. (1986b) **Test Excavations at Six Locations Along the Proposed Pipeline Route Between Singleton and Glennies Creek Dam, Hunter Valley, NSW**. Report to Department of Public Works.

Kuskie, P. and Kamminga, J. (2000) **Salvage of Aboriginal archaeologcial sites in relation to the F3 Freeway near Lenaghans Drive, Black Hill, New South Wales.** Report to Roads and Traffic Authority

Matthei, L.E. (1995) **Soil Landscapes of the Newcastle 1:100,000 Sheet**. Department of Land and Water Conservation.

McCarthy, F.D. (1976) **Australian Aboriginal Stone Implements**. Second edition. Sydney: Australian Museum Trust

McCarthy, F.D., Brammel, E. and Noone, H.V.V. (1946) **The Stone Implements of Australia.** Mem. 9. Australian Museum

McDonald, J. Rich, E. & Barton, H. (1994) *The Rouse Hill Infrastructure Project (Stage 1) on the Cumberland Plain, Western Sydney*. **Archaeology in the North. Proc. 1993 Aust. Arch. Assoc. Conference**

Moore, D.R. (1970). **Results of an archaeological survey of the Hunter River valley, New South Wales, Australia. Part 1: The Bondaian industry of the upper Hunter and Goulburn River valleys**. Records of the Australian Museum 28: 25-64.

Mulvaney, J. & Kamminga, J. (1999) **Prehistory of Australia**. Allen & Unwin Publishers

NPWS (1997) **Aboriginal Cultural Heritage: Standards and Guidelines Kit**. National Parks and Wildlife Service

Navin, K. & Kamminga, J. (1999) **Proposed Pacific Highway Karuah Bypass and Duplication EIS: Cultural Heritage**. Report to Ove Arup and Partners

Pellant, C. (1992) **Rocks and Minerals**. Harper Collins

Resource Planning (1994) **Archaeological Survey, Part Lot 16, DP 258848, Fern Bay, NSW.** Report to Howship Holdings Pty Ltd

Sullivan, M. & Hibbert, (1994) **Newcastle Bight Archaeological Management Plan**. Report to NPWS, commissioned by Huonbrook Environment and Heritage

Suters Architects (1992) **Fern Bay Environmental Study**. Report to Port Stephens Shire Council

Tench, W. (1996) [1793] **Watkin Tench 1788**. Ed. Tim Flannery

Tindale N (1974) **Aboriginal Tribes of Australia. Their Terrain, Environmental Controls, Distribution, Limits and Proper Names**. ANU Press Canberra

Villa, P (1982) *Conjoinable Pieces and Site Formation Processes.* In **American Antiquity Vol 47 No. 2**

Wheeler, J. [AHMS Pty Ltd] (1994) **Riverwalk Development, 710 Hunter Street Newcastle, Aboriginal Heritage Impact Assessment.** Report to Hunter Land

Annex 1

Excavation Data

Site C

SITE C – TT0 GRID SQUARE I 11

Spit Number	Soil Unit	Stone (total)	Shell (total)	Total All Artefacts
1	A1	0	26	26
2	A1	44	0	44
3	A1 / A2	40	3	43
4	A2	35	1	36
5	A2	0	0	0
6	A2	5	1	6
7	A2	0	0	0
8	A2	0	0	0
9	A2	0	0	0
AVERAGES	N/A	13.7	3.4	17.2

SITE C – TT0 GRID SQUARE I 10

Spit Number	Soil Unit	Stone (total)	Shell (total)	Total All Artefacts
1	A1	15	0	15
2	A1	47	3	50
3	A1 / A2	69	1	70
4	A2	40	1	41
5	A2	12	0	12
6	A2	0	0	0
7	A2	0	0	0
8	A2	0	0	0
9	A2	0	0	0
AVERAGES	N/A	20.3	0.5	20.9

SITE C – TT0 GRID SQUARE H 11

Spit Number	Soil Unit	Stone (total)	Shell (total)	Total All Artefacts
1	A1	24	0	24
2	A1	77	0	77
3	A2	50	1	51
4	A2	23	1	24
5	A2	18	0	18
6	A2	0	1	1
7	A2	0	0	0
8	A2	0	0	0
9	A2	0	0	0
AVERAGES	N/A	21.3	0.3	21.6

SITE C – TT0   GRID SQUARE   H 10

Spit Number	Soil Unit	Stone (total)	Shell (total)	Total All Artefacts
1	A1	36	1	37
2	A1	61	1	62
3	A1 / A2	43	0	43
4	A2	26	0	26
5	A2	7	0	7
6	A2	0	0	0
7	A2	0	0	0
8	A2	0	0	0
9	A2	0	0	0
AVERAGES	N/A	19.2	0.2	19.4

SITE C – TT1   GRID SQUARE   0 12

Spit Number	Soil Unit	Stone (total)	Shell (total)	Total All Artefacts
1	A1	0	2	2
2	A1	0	11	11
3	A1	13	27	40
4	A1	0	8	8
5	A1/A2	14	3	17
6	A2	25	0	25
7	A2	24	0	24
8	A2	16	0	16
9	A2	2	0	2
AVERAGES	N/A	10.4	5.6	16.1

SITE C – TT2   GRID SQUARE   F 4

Spit Number	Soil Unit	Stone (total)	Shell (total)	Total All Artefacts
1	A1	1	4	5
2	A1	5	0	5
3	A1/A2	0	1	1
4	A2	0	0	0
5	A2	0	0	0
6	A2	0	0	0
7	A2	0	0	0
8	A2	0	0	0
9	A2	0	0	0
AVERAGES	N/A	0.6	0.5	1.2

Site 8

SITE 8 – TT1   COMBINED GRID SQUARES   A3/A4/B3/B4

Spit Numbers	Soil Unit	Stone (total)	Stone (avg. for 1m square)	Shell (total)	Shell (avg. for 1m square)	Total All Artefacts
1	A1	2	0.5	4	1	6
2	A1	2	0.5	0	0	2
3	A1	2	0.5	3	0.75	5
4	A1	5	1.25	0	0	5
5	A2	1	0.25	0	0	1
6	A2	1	0.25	0	0	1
7	A2	3	0.75	0	0	3
8	A2	0	0	0	0	0
9	A2	0	0	0	0	0
AVERAGES	N/A	1.7	0.4	0.7	0.2	2.5

SITE 8 – TT2

Spit Number	Soil Unit	Stone (total)	Shell (total)	Total All Artefacts
1	A1	1	0	1
2	A1	0	0	0
3	A1	1	0	1
4	A1	3	1	4
5	A2	0	0	0
6	A2	0	0	0
7	A2	0	0	0
8	A2	0	0	0
9	A2	0	0	0
AVERAGES	N/A	0.5	0.1	0.6

SITE 8 – TT3

Spit Number	Soil Unit	Stone (total)	Shell (total)	Total All Artefacts
1	A1	0	0	0
2	A1	0	0	0
3	A1	0	0	0
4	A1	2	7	9
5	A2	3	0	3
6	A2	1	0	1
7	A2	0	0	0
8	A2	0	0	0
9	A2	0	0	0
AVERAGES	N/A	0.6	0.7	1.4

Site D

SITE D – TT1

Spit Number	Soil Unit	Stone (total)	Shell (total)	Total All Artefacts
1	A1	0	0	0
2	A1	8	0	8
3	A1	61	0	61
4	A1 / A2	8	0	8
5	A2	5	0	5
6	A2	0	0	0
7	A2	1	0	1
8	A2	1	0	1
9	A2	0	0	0
AVERAGES	N/A	9.3	0	9.3

Site E

SITE E – TT1

Spit Number	Soil Unit	Stone (total)	Shell (total)	Total All Artefacts
1	A1	1	4	5
2	A1	2	73	75
3	A1	8	157	165
4	A2	34	107	141
5	A2	2	6	8
6	A2	1	3	4
7	A2	1	2	3
8	A2	0	3	3
9	A2	0	0	0
AVERAGES	N/A	5.4	39.4	44.8

Annex 2

Soil Data

SOILS

Soils on the Fern Bay Estate belong to either the Hawks Nest soil landscape or the Boyces Track soil landscape. These soil landscapes are well known (Matthie 1995) as is the geomorphic context in which they were formed (eg Chapman et al. 1982 see also Umwelt 2000).

The soils consist of loose sands formed as a consequence of the stabilisation of trangessive dunes. Three periods of transgression and two periods of stabilisation have been identified (described in more detail in this report, see also Umwelt 2000). The present land surface in the estate is associated with dunes that stabilised either 1200 years ago or 4000 years ago.

Archaeological excavation enabled detailed description of the soil profile at four locations: Site Fern Bay Estate 8, Site C, Site D and Site E (refer to *Figure 3.2* of this report). Each of these sites is situated on low dune ridges associated with the 4000 year old stabilised dune. Archaeological test pits were excavated to a depth of 900 mm. The excavation recovered cultural material in the A1 unit and A2 unit of this soil profile (soil descriptions are provided in the table below). Excavation did not reach the B unit of the soil profile nor did it reach any relict soil profiles that might be associated with earlier periods of Aboriginal occupation (a schematic diagram of the soil profiles is provided below).

The potential for relict surfaces to occur cannot be ruled out however it is considered to be extremely low (Dean-Jones 1992:5, Umwelt 2000:4.12). Subsurface relict soil profiles have been identified in this area and are likely to occur below the 1200 year old stabilised dune and the currently active transgressive dune immediately south east of the study area. The depth and extent of relict profiles are not well understood despite geotechnical and archaeological investigation (Umwelt 2000).

Fern Bay Soil Data

Sample Description	pH	Texture	Colour
Site 8, Spit 7,TT1 Bulk, Hearth Feature	4	Sand	black
Site E Spit 3, TT1 7/12/00 Soil	6	Sand	7.5YR 4/2 Greyish brown
Site E Spit 3, TT1 7/12/00 Soil from shell bearing deposit	7	Sand	7.5YR3/1 Brownish black
Site C main trench, 22/11/00 Soil from Spit 2	7	Sand	7.5YR 6/1 Brownish grey
11V TT2 Spit 6 4/12/00 soil	4	Coarse sand	7.5YR 3/1 Brownish black
Site C Main trench, 22/11/00 soil from Spit 9	7	Coarse sand	7.5YR 7/2 Light brownish grey
Site 8 TT4 Spit 4 30/11/00	4	Coarse sand	black
Site 8 soil sample base outside hearth Spit 7	6.5	Coarse sand	7.5YR 5/1 Brownish grey
Site 8TT2 soil from base of excavation at centre of pit	8	Coarse sand	7.5YR 7/2 Light brownish grey
Auger transect No 3 Auger 5 5/12/00 soil from 30-40 to 80 cm	6.5	Coarse sand	7.5YR 5/6 Bright brown

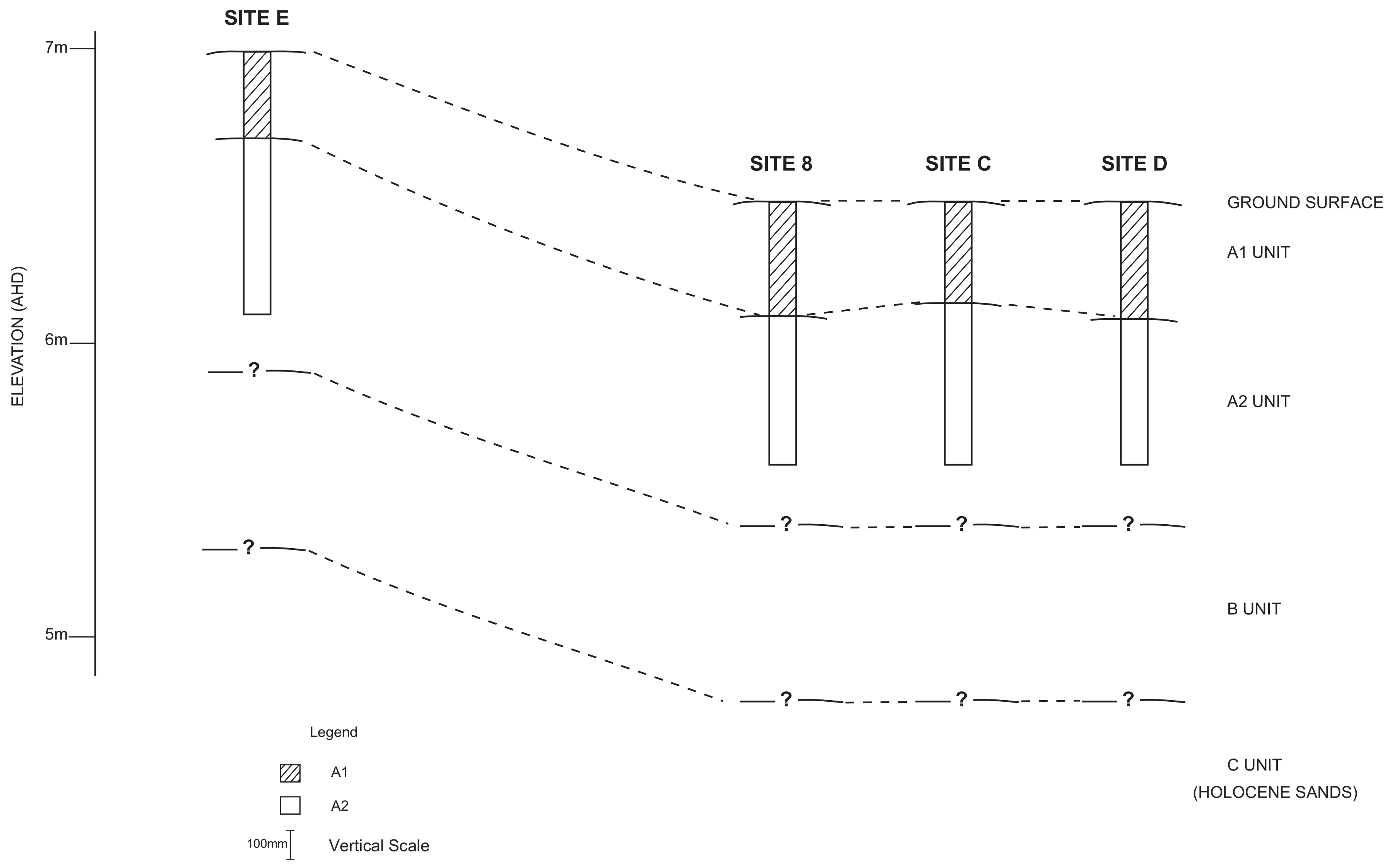

Figure 1 **Schematic Diagram of Soil Profiles**

Winten Property Group - CVC Limited - Fern Bay Estate

ERM

Annex 3

Stone Artefact Analysis

By Jakub Czastka

Stone Artefact Analysis

1 Methodology

1.1 Analytical Analysis

Various methods exist for analysing stone artefacts. The approach adopted here is a technological one with the objective of recovering functional data. The process of production (termed the reduction strategy) is analysed by describing and interpreting the physical traits the stone artefacts retain. The method or methods of reduction are the signposts archaeologists use to infer/designate cultural groups and hence interpret and date assemblages. In practice this means that questions like 'what raw materials were chosen for working? How were they worked? And what types of artefacts were produced?' are considered during the process of analysis. The information being sought is the technique or techniques used to work stone, the kind of tools produced, what they were used for, and what we can infer from these tasks.

Unless conditions during excavation indicate otherwise, it is assumed that the worked stone is broadly within its original drop zone and that the unworked stone, if it is the same as that used for tool making, can be assumed to be manuports. This is considered along with any signs of post-depositional change like soil formation, soil creep, bioturbation, car tracks or earthworks that may have affected artefact scatters. A brief overview of artefact densities will be given, and what they infer about function and duration of occupation. Hence, all the recovered stone showing signs of being worked by human hand is quantified where it is reasonable to discard a natural explanation for its presence.

The attributes usually included within the technological analysis of stone artefacts ideally come from a complete core, flake, or tool. This is rarely the case and so technological data is recovered from broken artefacts, where not all attributes are visible. However, only worked material with at least two visible traits is analysed technologically. The dominant raw material from Fern Bay, tuff, has inherent problems that further complicate analysis, notably being friable and liable to disintegrate during flaking. Hence, a large portion of the flaked material is broken from the flaking process, further exasperated by post-depositional changes. Therefore, only a small portion of the assemblage was useful in terms of technological data recovery, and this effects the detail of the results.

For example, a 'Fragment A' (see section on technology below) refers to an artefact that can be recognised as worked stone, and will be used for overall density quantification only, whereas a 'Broken Flake' refers to an artefact that has at least two attributes that can be used in the technological analysis.

1.2 Methodology

The approach outlined above, where the reduction strategy is examined, means that a particular descriptive method needs to be used in order for this information to be recovered. The whole assemblage is looked at with a specific set of variables being recorded. The variables are chosen to reflect, as accurately as possible, the method or methods employed in flaking and tool production. In addition to metric and raw material data, the variables recorded for these artefacts include the type of platforms retained, dorsal scar patterns, shape, how flakes or blades detached, whether retouch or micro-flaking or use-wear is apparent, as well as their overall condition.

All artefacts were analysed with the aid of a hand-lens (magnification x10). Callipers were used for measurements accurate to the nearest millimetre, and a scale accurate to 0.1 grams was used for weighing. For flakes, length is taken from the point of impact on the platform to the opposite edge, width is perpendicular to this and thickness is taken where these two measures intersect along their axis. Where no obvious point of impact or technological orientation is apparent, the longest axis is defined only.

1.3 Constraints

Due to time constraints a full analysis of the complete assemblage was not possible. Due to the overall size of the assemblages representing sites C, D, E, 8 and test trenches T6 and T7, a compromise had to be made with regards to detail. These were:

1. Site 8 and Site C - all surface contexts B4 to H10 inclusive; all auger transects; and TT0/H10, all spits, were analysed in their entirety; this includes measurements on Fragment A and B artefacts. This provides a controlled sample of trench TT0/H10 and several surface contexts, the results of which will hopefully illuminate any post-depositional effects.

2. Site C – all remaining surface and test trench artefacts were recorded for technological data only where it was present, the remainder (essentially Fragment A and B artefacts) being counted and raw material numbers noted; Site’s D and E, TT 6 & 7 were similarly analysed.

In addition to the limits detailed above, the time constraint meant that only one test trench was analysed in detail suitable for the recovery of post-depositional activity, hence any spit concentrations or ‘levels’ will be missed elsewhere. The results are presented by site and where possible, by area.

In addition to time constraints, the nature of the predominant raw material, tuff, has meant that the majority of artefacts analysed were broken and not all variables were retained. Hence, the technological summary is based upon a sample of artefacts where only some of the data is recoverable.

2 Results

2.1 Sample Size and Composition

Site 8 (Refer to Table 1)

This site consisted of nine trenches/squares, plus a single auger test, from which artefacts were recovered. A total of 51 artefacts were recovered giving an overall density of 4 artefacts per m^2 investigated. Finds included 21 (41.1%) Fragment A and B types, 16 (31.4%) broken flakes, 10 (19.6%) flakes, 2 (3.9%) Bondi Points and single (2% each) examples of a core fragment and microlith fragment.

Site C (Refer to Tables 3 & 4)

The largest, highest density site discovered, a total of 1103 artefacts and stone fragments were recovered from five auger probes, three test trenches and a surface collection representing sixty seven metre squares in an area of c.210m^2. Of these areas, the auger probes revealed 12 artefacts (including Fragment A and B artefacts), eleven surface squares revealed 17 stone fragments, three squares included 5 artefacts (excluding Fragment A and B artefacts) and 14 stone fragments and fifty three metre squares revealed 257 artefacts (including Fragment A and B artefacts). In addition, the three test trenches included 94 artefacts (excluding Fragment A and B artefacts) and 529 stone fragments. Additionally, one of the squares within TT0, H10 (analysed in detail) revealed 175 artefacts (including Fragment A and B artefacts).

The statistics show that the majority of the assemblage is not recordable for technological attributes (see below). Of the assemblage that had Fragment A and B artefacts recorded (see note above), 182 (41%) Fragment A and 162 (36.5%) Fragment B artefacts were noted from a total sample of 444 artefacts and representing 77.5% of this number. If we look at the complete assemblage, 910 (82.5%) were either Fragment A artefacts, or unidentifiable stone fragments – Fragment B. With regard to formal artefacts, 34 (3.1%) were flakes, 123 (11.2%) were broken flakes, 2 (0.2%) were cores, 4 (0.4%) were core fragments, 7 (0.6%) were utilised/retouched flakes, 3 (0.3%) were utilised flake fragments, 1 (0.1%) was a tool fragment and 19 (1.5%) were tools.

The mean density per square for the surface collection with artefacts and unidentifiable stone fragments was 4.7 artefacts/stone per m^2, although if we take the area as a whole this drops to 1.4 artefacts/stone per m^2. The three test trenches revealed a variety of sub-surface densities, with TT0 at 124.75 per m^2, TT1 with 94 per m^2 and TT2 at 6 per m^2. These figures clearly show areas of occupation/in situ knapping for TT0 and TT1, TT2 being the outer limit of the area used. The surface numbers are fairly deceptive with regards to sub-surface densities and are the product of the type of sediments present and post-depositional changes (see below).

Sites D, E, T6 and T7 (Refer to Table 6)

These four areas are grouped together largely for convenience and because of the fact they revealed only small numbers of artefacts. Site D, TT1 had a total of 84 fragments and artefacts, where 79 (94%) were fragments, 3 (3.6%) broken flakes, 1 (1.2%) flake and 1 (1.2%) tool fragment. Although the majority of these finds were unidentifiable fragments, the fact they are within a sandy deposit where they do not naturally belong and were recovered alongside 5 artefacts suggests they are all part of the same event(s), where the density of 84 per m^2 is comparable to sites where in situ knapping took place.

Site E, TT1 had densities of 47 artefacts/stone per m^2 - a range that is comparable with singular knapping events in the vicinity. Of these 47 pieces, only 3 (6.4%) were broken flakes, the remainder being unidentifiable fragments. Finally, two separate trenches, T6 and T7, revealed a single unidentifiable fragment in T6 and a broken flake and unidentifiable fragment in T7.

2.2 *Raw Materials (Refer to Tables 2, 5 & 6)*

This section will cover the description and quantification of the raw materials. More detailed information is available in the catalogue of finds (refer to Lithic Catalogue). Here the data is presented by raw material types only.

The predominant raw material utilised on all the sites was tuff with 1188 (90.7%), with 116 (8.9%) silcrete artefacts, 3 (0.2%) unidentifiable materials, 2 (0.15%) quartz and 1 (0.05%) banded mudstone. Obviously, the reliance on a single raw material has ramifications with regards preferences or the distinct lack of choice (see Discussion below), especially with regards to the nature of tuff as a medium for knapping and producing implements.

Tuff is a fine grained rock, often found with lithic, crystal or vitric inclusions. However, the material from Fern Bay had no form of inclusion within the matrix. There is a high probability that this was what was preferentially selected over other forms of tuff with inclusions as the problem of material flaking around inclusions rather than through them would cause flaking to be unpredictable. A similar problem occurs with silcrete for example. Tuff forms as a deposit from volcanic ash blown into the atmosphere, and can form distinct layers, sometimes graded, especially when the deposit settles underwater (Pellant, 1992; 204). From the authors limited experience of handling the material on excavations in the Newcastle area, when recovered from reworked contexts the material is crumbly and soft, more like a chalk (i.e. powdery, friable). The material has a minimal cortex or rind in the form of a surface discolouration and/or texture change influenced by the influx of minerals and water. This was observed on the collection of artefacts from all sites in Fern Bay, where cortex was very rare. Of the 601 artefacts analysed, only 9 (1.5%) had any form of distinguishable cortex. This is probably a reflection of the fact the material is found in beds where only the exposed upper levels or unconformities (relating to past exposure of tuff surfaces) have a cortex, rather than an effort on the part of knapper's to prepare cores/slabs prior to transportation. However, preparation at source in one form or another cannot be discounted – it just can't be observed from the available evidence.

A great deal of discolouration was observed on the tuff material. Colours ranged through shades of grey, brown, orange to yellow or creamy (buff), as well as white. The dominant colours were white and grey. However, these colours may be an effect of post-depositional leaching within the sediments. Baker (1993; 25) describes a highly degraded grey raw material, probably "Nobby's Tuff", known to occur in outcrops south of the Hunter mouth. Baker (op.cit) describes the artefacts as being extremely light due to the loss of silica through leaching, a process that is almost certainly occurring at Fern Bay. Although the exact source of the tuff at Fern Bay is unknown, it is probably local, especially when we consider it's poor flaking qualities (see Technology section below).

Silcrete is the second most common raw material at Fern Bay. Although it occurs only on Sites 8 and C, where Site 8 has only a single example of red silcrete (representing 2% of this assemblage). Of the 538 artefacts analysed technologically from Site C, only 52 (9.7%) examples occurred. A similar situation occurs amongst the undifferentiated fragments from Site C, where only 63 (8.6%) of 730 fragments were silcrete. The Site C silcrete artefacts (No.=52) showed four colour variations, ranging from pink (No.=3, 0.6%), to red (No.=8, 1.5%), grey (No.=25, 4.6%) and yellow (No.=16, 3%).

Silcrete is a variable medium, it's matrix being crypto-crystalline quartz, well-crystallised quartz or opaline silica (Standards for Archaeological Practice, NPWS, section 6.2). It is often identified by its inclusions - conglomerates of silt to sand sized quartz grains visible to the naked eye (GML; 1998; 36; Mulvaney & Kamminga, 1999; 214). The extent, size and number of quartz grains, as well as other mineral inclusions, varies from <1mm – 3mm in size and varies from occasional to very common. The variation in quartz grain inclusions has an effect on the flaking properties of this raw material. The fewer inclusions of quartz present, the better this stone flakes, where unheated silcrete will tend to fracture along, not through, any quartz inclusion, impeding control of the forces applied to produce flakes and often spoiling and/or breaking a flake (Hiscock 1993:66-67). The colour of silcrete, like it's matrix, is variable. Flake edges are sharp and durable, and could be used for a range of tasks (Mulvaney & Kamminga; op.cit).

Two milky white quartz fragments were identified, both from Site C. Only one was an artefact (flake), the other being a natural fragment. The flake is unusual as it did not show evidence of bipolar flaking, the usual form of reduction for this material because of its hardness. A single example of a banded mudstone was also recovered from Site 8. Finally, three unidentified stone fragments were recovered, two from Site C (one of which was a hatchet head) and most probably a form of igneous rock; the third piece came from Site E, TT1.

The tuff displayed variation in colour and structure. This variation is often the effect of several events, beginning at source (eg bed lithology), as well as heating or staining due to leaching, and represents a combination of physical and chemical changes in the stone, some of which are the result of human action. Variation within the silcrete also affects flaking properties, the suitability of reduction and hence the method(s) used. Evidence of thermal alteration of raw materials is common in assemblages, though distinguishing the affects of bush-fires from those of intentional heating is not always possible, as is the case at Fern Bay.

2.3 *Technology (Refer to Charts 1 – 3)*

In the following assemblages, numbers and percentages are given as a total for a particular sites flakes, broken flakes, cores and utilised flakes being discussed and not as a percentage of the overall assemblage.

Site 8

Twenty six artefacts (flakes, broken flakes) were recovered from five areas representing eleven squares and twenty two spits. Of these, only 10 (38.5%) complete flakes were recovered. Size classes ranged from 2 to 5, with mean length at 28mm (size 3) and width at 24mm. Length/breadth ratios showed that most (no.=8, 30.8%) were less than a 2:1, only two having 2:1 ratios. Eight (30.8%) platforms were discernible, all being plain, with primary (no.=2, 7.7%), secondary (no.=6, 23%) and tertiary (no.=2, 7.7%) reduction stage examples. Two (7.7%) had more than 50 % cortex, the remainder (92.3%) having none, where only unidirectional (no.=5, 19.2%) DSP were identified. Shapes were proximal (no.=3, 11.5%) and medial (no.=3, 11.5%) expanded, with almost half hinging (no.=4, 15.4%), and 5 (19.2%) feathering terminations. In comparison, the broken flake (no.=16, 61.5%) mean is 25mm, well within the range of complete flakes. The only platforms discernable were plain (No.=6, 23%), the stages of the reduction process being 2 (7.7%) primary flakes, 10 (38.5%) secondary and 2 (7.7%) tertiary, with only 3 (11.5%) examples showing cortex. Only 8 (30.8%) dorsal scar patterns were visible, all unidirectional, and flake shapes were mainly distal expanded (No.=7, 27%), with 2 (7.7%) examples each of medial expanded and parallel sided flakes. Five (19.2%) terminations were hinged (see note in Site C) and 4 (15.4%) feathered.

Site C

A total of 164 artefacts (flakes, broken flakes, utilised flakes, retouched flakes and utilised flake fragments) relevant to this section were recovered. Both the surface and sub-surface contexts are dealt with together, on the grounds that separated the sample numbers are small, the technology is uniform and that post-depositional processes have probably contributed to rendering stratification as being the result of non-cultural activity, or at least not related to knapping activities (ie trampling etc – see section below). As was noted in the methodology, not all artefacts retained all the traits of technological activity relevant to the study and therefore, the following discussion is based upon an amalgamation of traits.

A total of 114 platforms were discernable where 96 (58.5%) were plain, 11 (6.7%) shattered, 5 (3%) abraded, and 2 (1.2%) facetted. It is known that a lack of platform preparation causes flake detachment to be more unreliable, a factor reflected in flake terminations, where 4 of the 5 abraded platforms (1 was unclear) were feathered terminations (the desired termination in most cases), whereas plain platforms were mainly hinged terminations. This is due to the hammerstone slipping during percussion on unmodified surfaces, whereas abraded surfaces provide more 'grip' and increase the likelihood of the knapper's hammerstone making contact on the desired spot. Furthermore, all abraded platforms occurred on retouch flakes, illustrating that more care was observed during the secondary flaking process. Dorsal scar patterns were observed on 128 (78%) artefacts and show a dominant pattern of core reduction, namely unidirectional flaking, with 110 (67%) examples. The remaining examples were 8 (4.9%) natural, 6 (3.6%) opposed and 4 (2.4%) at right angles to platforms. These last two examples of opposed and right angled dorsal scar patterns indicate that core rotation occurred, but rarely, the single platform core dominating the assemblage. The stages of the reduction process - as reflected by the number of dorsal ridges – indicate that all stages of the reduction process are present, with 16 (9.8%) primary, 101 (61.6%) secondary and 28 (17%) were tertiary flakes. However, the identification of primary stage debitage is problematical because of the difficulty in identifying cortex on tuff flakes (see note in Raw Materials). This is reflected in the fact that only 5 (3%) examples of artefacts with cortex were observed. Flake shapes were variable, with 47 (28.7%) distal expanded, 28 (17%) medial expanded, 17 (10.4%) proximal expanded and only 6 (3.7%) parallel sided. Flake terminations were dominated by 64 (39%) hinged examples, with 6 (3.7) plunged and 30 (18.3%) feathered flakes.

Although not quantified here, a relationship exists between platform width, flake length, type of termination and flake shape. Hinged terminations *tend* to produce flakes smaller than 30mm, where platforms are 5mm or wider and flakes are distal expanded in shape. Plunged terminations *tend* to produce flakes longer than 30mm, where platforms are at 5mm or wider and again, flake shape is distal expanded. However, exceptions do occur. It is interesting to note that where the majority of the tools are Bondi Points, these types of flakes are the wrong shape with problematical terminations (especially hinged) for use as blanks for Bondi Point production. Finally, a brief note on core maintenance. Seven (4.3%) core edge rejuvenation flakes were recovered which, although a minimal statistic of the overall flake assemblage, it does mean that alongside the abrasion of retouch flake platforms, some forms of preparatory technique were both known and used in flaking.

Six core/core fragments were recovered from Site C. Two were alternate cores, where one was turned at least once, the other 'alternating' twice. Both were made of tuff, where one had plain platforms, the other abraded. Two other tuff cores revealed opposed (shattered platform) and unidirectional (plain platform) flaking patterns. All the cores fit in with the dorsal flaking patterns and platforms observed in the flakes, ie unidirectional flaking (alternate cores will be turned once, alternating more than once, and flake facets do not tend to overlap and will therefore show up as unidirectional flakes). The opposed core was located within TT0, Square H11, Spit 2, alongside 4 of the 6 opposed dorsal scar patterned flakes from site C (found in spits 1 and 2), whereas the other 2 flakes occurred in the adjacent square (H10, Spit 2), confirming the highly localised spatial and activity-specific (single episode of core reduction) nature of this find. Two silcrete cores were found, one being bipolar - a large unwieldy silcrete cobble fragment, tapering at one end, where three intersecting facets are slightly crushed, indicating this was the part in contact with the anvil. The other silcrete core is a single platform (unidirectional). Most of the cores were large fragments with a mean weight of 20.26 grams and a size class of 4 or 5. Only the opposed core is a likely candidate for being worked until exhausted. Finally, it is clear that only the bipolar core is at odds with the evidence of the flakes and cores, since no bipolar flakes were recovered.

Sites D, E, T6 and T7

The sample for all these sites is minimal and so, therefore, are the conclusions reached. Site D only revealed 4 flakes/broken flakes and a single bipolar core. Platforms were plain and dorsal scar patterns unidirectional. Flake terminations are hinged in all but one example, which is feathered. The core (found within an auger probe) is at odds with the observed technology, even considering the small sample size. Site E only provided 3 broken flakes with plain platforms.

2.4 *Implement Types (Refer to Table 7, Charts 3 & 4)*

Site C

A total of 31 tuff tools, tool fragments and utilised flakes/flake fragments were recovered from surface and sub-surface contexts. The implement categories included 3 backed flakes, 12 Bondi Points, 1 ground implement fragment, 1 microlith, 1 piercer, 3 retouched fragments, 2 retouched flakes, 1 end scraper, 4 utilised flakes, 2 utilised flake fragments and 1 tool fragment. Detailed descriptions are available in Table 7 as well as the lithics catalogue, otherwise a summary of the techniques used to work the tools is provided here.

Retouch is fairly predictable for the Bondi Points, where the techniques and position of retouch on other tools tends to be done in the same way. For Bondi Points, retouch is always on the thickest margin, varying from short to covering in extent (depending on how much shaping needs to be done). The form of retouch is abrupt and stepped, frequently bipolar, otherwise always directly induced. Mean measurements for the Bondi Points is 28mm for length, 8mm for width and 4mm for thickness, well within the range given by McCarthy (1976; 44). Only Bondi Points have bipolar (bifacial) retouch, all other tools (except one) showing direct retouch. The single exception for position of retouch is a flake which has been retouched inversely. A comparison of complete flake sizes and tool sizes (Charts 3 & 4) shows that the size range of flakes falls comfortably within that of tools, ie the flakes are of an adequate size to be retouched into implements, which means that tool production was one of the activities carried out on this site.

A single piercer (pointed) on a flake was recovered, where the distal portion has direct, abrupt and stepped retouch - a concave form tapering to point; tip broken. The single End Scraper had a straight (working) edge, showing short, abrupt, direct scaler to stepped micro-retouch. The single example of a ground implement fragment is most probably an example of a hatchet, the unidentified stone likely to be a medium to fine-grained basalt or dolerite, since a very hard stone was required due to the impact stresses experienced during use (Mulvaney and Kamminga, 1999; 92). The utilised flakes and flake fragments have short, direct, abrupt, stepped micro-retouch, usually along the longest lateral margins. The material from which these tools are made – tuff, is fairly soft as found today, where a flake will develop micro-retouch literally after only 30 seconds of use against material like wood. One cannot say how hard the material was in the past but it has obviously softened in the modern context to a point that it would either have not been chosen at all in the past, or, that retouch/use-wear would have been observed to be far heavier/more intrusive than it actually is.

<u>Sites D, E, T6 and T7</u>

Site 8 had only two Bondi Points, with a third broken example that is probably a Bondi Point. Again retouch is abrupt, although scaler in form which is a slight variation to the predominantly stepped form of retouch from Site C.

Site T7, Auger number 6 produced the only example of an Elouera on a large flake. It's shape is the classic orange-quarter, with a thick lateral margin which is crescentic with indirect, abrupt, stepped retouch and some crushing; distal end has direct, abrupt, stepped and scaler retouch with micro-retouch (use-wear); Type 3 (after McCarthy; 1976; pp30). Eloueras only appeared in the archaeological record some 1600 years BP (Mulvaney and Kamminga, 1999; 252).

Site D produced only two tools, a microlith fragment, possibly a Bondi Point and one utilised fragment with short, direct, abrupt, stepped micro-retouch along one edge.

Site T6 produced no tools.

2.5 Site Formation Processes (Refer to Table 4)

The sites of Fern Bay are situated within unconsolidated sandy deposits subject to bioturbation, wind, an oscillating water table and percolating rainwater and the effects of trampling by both humans and animals. In addition, vehicle activity and the sorting effects of amateur collectors in the past can probably be added to the list. This has ramifications with regards to the assemblages composition and density. Previous studies (Villa, 1982; Gifford & Behrensmeyer, 1977) have noted sorting effects that can occur within unconsolidated sandy deposits, and across supposedly separate sedimentary levels (Villa, 1982; 286). Smaller material is moved downwards into the matrix and larger artefacts are left exposed on the surface (Villa, 1982; 279). The sites of Fern Bay do not seem to have a concentration of larger material or any size sorting on the surface, or indeed, at any specific depth. Where an adequate degree of data is available (TT0, Square H10 – see Table 4), no particular pattern is noticeable other than the fact that most material is sub-surface. A general 'concentration' exists between spits 1-4, where a range of artefact sizes are fairly evenly spread across this area. This *may* be due to the effects of a particular post-depositional process whereby material has largely been shifted downwards 10cm's or more. However, a pattern may have emerged had a greater sample of material been investigated for post-depositional changes.

3 Discussion

The sites of Fern Bay occur within an area of known Aboriginal occupation. The type of sites found here, (largely shell middens), their location close to food, water and raw materials, is reflected in whole and in part by other sites identified in the area.

The general nature of sites in the area varies from isolated lithic finds, small discrete lithic scatters and shell midden accumulations to large open camp sites and axe grinding groove localities. The most common site and hence find spot for lithics in the area is that of the shell midden. These include massive accumulations of shell with chert and igneous stone artefacts, found associated with rocky foreshores and dunes and spread across hundreds of square metres, like Birubi Point (Dyall, 1980; pp 52) and Morna Point (Hall, 1928;255). Other middens are more discrete and less dense open-air scatters confined to a few square metres and found both away from the coast, like at Corlette (NPWS #38-5-36), Soldiers Point (NPWS#38-5-3), as well as adjacent to foreshores, as in Cromarty's Bay (NPWS#38-5-9) and Soldiers Point (Dallas et al, 1996; 23-28).

The majority of the artefacts recovered from the sites were Fragment A types. This category denotes flake fragments without areas of fracture initiation but which display sufficient fracture attributes (normally conchoidal markings) for identification as a lithic artefact fragment (after McDonald, 1997). These artefacts are very common on sites and basically represent knapping shatter or material that has been broken due to depositional or post depositional processes. Unfortunately, these artefacts can only be use for general quantative purposes, like site densities, not adding to the overall picture of technology. In addition, it is usual to find fragments of stone which, because of their condition, cannot be assigned a definite type category and are grouped together under the collective term of Fragment B artefacts. They are always made of a raw material which is represented in the formal artefact categories and are usually interpreted as being unrecognisable fragments of stone that had been brought onto a site, some (but not necessarily all) of which were subsequently worked and then broken up by depositional and post depositional processes.

In the context of the Fern Bay sites, only one locality may be considered to represent more than casual occupation – Sites C. The other localities – Sites D, E, 8, T7 and T6 – when considered against the environmental zone they are found within as well as the sites known in the area, can be seen to represent background scatters. In effect, Sites D, E, T6 and T7 are areas in between more frequently occupied campsites. They probably represent areas of tool maintenance or preparation as and when required during the activities of the day, short-term camps and places where food processing activities took place. However, a note of caution is necessary in forwarding such an interpretation. As discussed above, many of the artefacts recovered from all the archaeologically investigated areas were either Fragment A or B type artefacts. This translates to the fact that although these were once flakes etc and manuports to the area, they no longer retain the characteristics which allow for technological interpretation. We are therefore looking at low to medium densities of introduced material into particular places within the landscape which we can only interpret at a very basic level – ie their presence indicates occupation by Aboriginal people. Their meaning and use, however, beyond comparing densities and assuming activities, is not recoverable from an archaeological perspective.

Site C was the only example where meaningful archaeological patterning was recoverable in the form of its lithics. Sixty seven surface squares revealed a density of 4.7 artefacts per m² (upper density limit – see above), whilst two of the test trenches, TT0 with 124.75 artefacts per m² and TT1 at 94 artefacts per m², provided densities of lithic material comparable to localised knapping activities. As the Table below shows, these figures are comparable to sites in the Cumberland Plain where density verses activity studies have been undertaken. The surface densities in those areas of the ridge to the south of the grader cutting only provide an indication of the higher sub-surface densities in test trenches 0 and 1. Post-depositional processes as well the nature of the sediments (unconsolidated sands) have contrived to bury the high numbers of artefacts encountered. Site C represents one of two likely scenarios: either we have a site that was inhabited over a single long period of time, or, more likely, that the area is a site that was repeatedly visited over an unknown period of time.

Technologically, the majority of material falls within a single sequence: single platform and alternate flaking, without platform preparation, producing macro-flakes and occasionally, linear flakes. In the stone tool reduction sequence detailed by Flenniken and White (1985; 132-133), Site C's material predominantly falls within categories I and II. Preparation techniques associated with flaking were absent and direct free-hand percussion seems to have been the only technique of reduction and retouch employed. The occurrence of alternate flaking is possibly a result of the lack of platform and ridge maintenance. If platform-to-working-face angles on percussion cores are not maintained, cores would need to be rotated to an area where a reasonable platform-to-working-face angle could be found and flaking resumed. Occasional examples of variations in the techniques employed were present – namely the silcrete bipolar core and opposed core with associated flakes, but these were highly localised. The technique of bipolar (bifacial) retouch was employed, although it was limited to the retouch of Bondi Points. Otherwise, retouch techniques reflected flake and core technology – namely, unifacial (direct) retouch.

A wide range of activities are represented by the lithic material from Site C. All stages of the reduction process from core reduction to tool manufacture are present. Hunting is represented by the presence of microliths – more specifically, Bondi Points. These have been interpreted as barbs on hunting and fishing spears (Mulvaney and Kamminga, 1999; 236). The presence of 10 Bondi Points in TT0 probably attests to a lost or discarded spear, the broken points and microliths in the general vicinity of Site C tool maintenance activities. The processing of organic products, be they food or equipment, is tentatively alluded to by the presence of the piercer, end scraper and hatchet fragment. Collectively, the relatively high density of material across the site, the complete range of flaking and retouch present in the stone, the large amount of unworked and discarded material and the high occurrence of transverse breakages and general breakage (meaning much of the material has been subject to trampling) all combines to present a picture of an open camp site, most probably revisited over a number of years.

Dating the assemblages of Fern Bay from the perspective of the technology observed is problematical. In terms of the single platform and alternate flaking technology observed on all sites no date can be given as this is not a temporally specific technique, rather it represents the opportunistic nature of Australian lithic technology. The presence of a microlith technology presents us with the best temporal marker on sites C, 8 and D. Microliths appear in the archaeological record some 4,000-5,000 years BP, disappearing with the advent of increased bipolar reduction of quartz around 1,000-2,000 years BP (Mulvaney and Kamminga, 1999; 235, 292). This provides us with a conservative range of at least 2,000 years – 4,000-2,000 years BP, if not longer. In terms of cultural phases, this coincides with both the Early (c.5,000-2,800 years BP) and Middle (c.2,800-1,600 years BP) Bondaian. The high occurrence of Bondi Points on Site C may mean that this site at least was predominantly occupied during the Middle Bondaian. However, the concentration of Bondi Points mentioned in TT0 skewers this result somewhat, since it probably represents the remains of a single spear. The elouera found within an auger probe on T7 represents a tool type that didn't appear until around 1,600 years BP; it also is usually found either in association or immediately above microlith-rich levels (op.cit.; 252).

The most realistic view of the Aboriginal archaeology is of continuous, but largely casual, use of most of this area and the inevitable loss of artefacts; and/or occasional, isolated knapping episodes representing tool production or maintenance undertaken during general foraging in the area. It is a casual re-occupation of a general vicinity. The densities equate with discard and accidental drop zones away from specific sites. Low-density scatters (<100 artefacts/m^2) representing activities such as tool maintenance have been recorded previously in the Cumberland Plain (eg Rich and McDonald; 1995). The number of artefacts in surface contexts falls within the range of 1 –6 artefacts/m^2. McDonald et al (1994; pp281) give a range of artefact densities per square metre relating to inferred use/activities or simply 'background noise' and this is used in the Table below. Note that no association with land units and/or geology is assumed beyond a general proximity to water.

Type of Activity*	Density of Artefacts Per Square Metre*
Knapping Floors	>100
Tool Maintenance	20-100
Singular Knapping Event	20-50
Background Scatter	<20
Isolated Finds	<10

Table. Activities and Inferred Site Type/Function. (*Modified from McDonald et al, 1994).

Only Site C provides us with a location where more intense and/or reoccurring occupation took place. The activities represented here include all stages of the reduction process, tool production and maintenance, as well as a range of subsistence activities. The density of material and the dominance of a single raw material would suggest that the outcrop(s) tuff are fairly localised.

To conclude, several points can be highlighted:

I. Technologically the assemblages are dominated by single and alternate platform technology, macro-blades and occasional linear flakes being the end result. Platform-to-working-face angles are not specifically maintained, indicating the opportunistic nature of flaking technology.

II. All sites except C probably represent continuous, but largely casual, use of most of this area and the inevitable loss of artefacts; and/or occasional, isolated knapping episodes representing tool production or maintenance undertaken during general foraging in the area.

III. Site C represents a location where more intense and/or reoccurring occupation took place, activities including all stages of the reduction process, tool production and maintenance, as well as a full range of subsistence activities.

IV. The dominance of a single raw material means that tuff was either locally available, the effort of acquiring other materials either impossible, impractical or just not considered worthwhile for cultural reasons.

V. Tuff as a raw material for tool manufacture is far from ideal, as the degree of flaking breakages and flake termination failures indicates.

VI. Microliths provide the only realistic temporal marker, giving a conservative range of at least 2,000 years – 4,000-2,000 years BP, if not longer.

4 References

Baker, N. 1993a. Moffats Swamp Dune. Preliminary Report On Archaeological Site Salvage. Unpublished Report to RZM Pty Ltd.

Baker, N. 1993b. Archaeological Testing of the RZM Pty Ltd Plant 9 Planned Sand Mine Run Adjacent to Moffats Swamp Dune, Richardson Rd, Medowie. M.L.1067. Unpublished Report to RZM Pty Ltd.

Brayshaw McDonald Pty Ltd. An Assessment of the Archaeological Context, Landuse History and Management Requirements for Aboriginal Archaeology in the Australian Defence Industries Site, St Mary's. Report to ADI Ltd, NSW Property Group.

Dallas, M. et al. 1996. Soldiers Point, Port Stephens Archaeological, Anthropological and Community-based Study of the Land Effected by the Upgrading of the Soldiers Point Caravan Park. Unpublished Report to Port Stephens Council.

Flenniken, J.J & White, P.J. 1985. Australian Flaked Tools: A Technological Perspective. **Records of the Australian Museum**. Vol. 36: 131-151.

Hiscock, P. 1993. Bondaian technology in the Hunter Valley, New South Wales. **Archaeology In Oceania** 28 (2): 65-76.

Knight, J. 1999. Thoughts on the 'identity crisis' concerning 'fine grained siliceous' knapping stone. Australian Association of Consulting Archaeologists Incorporated Newsletter 81: 16-24.

Gifford, D.P, & Behrensmeyer, A.K. 1977. Observed formation and burial of a recent human occupation site in Kenya. **Quaternary Research** 8: 245-266.

Godden Mackay. 1998. Angel Place Project 1997. Archaeological Excavation, Vol 3 – Prehistory Report. Unpublished Report Prepared For AMP Asset Management Australia Ltd, The NSW Heritage Council & National Parks & Wildlife Service (NSW).

McCarthy, F.D. 1976. **Australian Aboriginal Stone Implements**. The Australian Museum Trust.

McDonald, J. 1993. Archaeological Survey of the Rouse Hill Infrastructure Project (Stage 1). Works along Caddies, Smalls, and Seconds Ponds Creeks. Rouse Hill and Parklea, NSW. Report to Rouse Hill Joint Venture.

McDonald, J., Rich, E. & Barton, H. 1994. The Rouse Hill Infrastructure Project (Stage 1) on the Cumberland Plain, Western Sydney. Archaeology in the North. Proc. 1993 Aust. Arch. Assoc. Conference. Pp259-293.

Rich, E. & McDonald, J. 1995. Archaeological salvage of site WH3 (#45-5-965): Project 12603, Cowpastures Rd, West Hoxton, NSW. Report prepared for Lean Lackenby & Hayward on Behalf of Landcom.

Mulvaney, J & Kamminga, J. 1999. **Prehistory of Australia**. Allen & Unwin.

Pellant, C. 1992. **Rocks and Minerals**. Harper Collins.

Villa, P. 1982. Conjoinable pieces and site formation processes. **American Antiquity** Vol.47, No.2: 276-290.

Table 1Site 8: Artefact Types by Context

Site/ Auger Transect	Trench	Square/ Auger Number	Spit	FA	FB	BF	F	CF	MF	BP	TOTAL
8	Auger	Centre-point	Series 2			1					1
8	N/A	A3	5			1	1		1		3
8	N/A	A3	6				1				1
8	N/A	A3	7			1					1
8	N/A	A3	8		1						1
8	N/A	A4	5				1				1
8	N/A	B3	6			1	1				2
8	TT1	A3	3	1	1						2
8	TT1	A3	5			1					1
8	TT1	A4	2			2					2
8	TT1	A4	4	1	1	2		1			5
8	TT1	A4	6	1							1
8	TT1	B3	7				1				1
8	TT1	B4	1			1				1	2
8	TT1	B4	7	1	1						2
8	TT2	A2	1			1					1
8	TT2	A2	3							1	1
8	TT2	A2	4	1		1	1				3
8	TT3	N/A	4	1		1					2
8	TT3	N/A	5	1	2						3
8	TT3	N/A	6		1						1
8	N/A	?	4	2	5	3	4				14
				9	12	16	10	1	1	2	51
				17.6 %	23.5 %	31.4 %	19.6 %	2.00 %	2.00 %	3.90 %	

Table 2Site 8. Raw Material Type by Context

Site/ Auger Transect	Trench	Square/ Auger Number	Spit	LBT	BT	DBT	GT	WT	RS	BM	TOTAL	Total Tuff	Total Silcrete	Total Other
8	Auger	Centre-point	Series 2				1				1	1		
8	N/A	A3	5				3				3	3		
8	N/A	A3	6				1				1	1		
8	N/A	A3	7				1				1	1		
8	N/A	A3	8				1				1	1		
8	N/A	A4	5	1							1	1		
8	N/A	B3	6				2				2	2		
8	TT1	A3	3				2				2	2		
8	TT1	A3	5				1				1	1		
8	TT1	A4	2				1		1		2	1	1	
8	TT1	A4	4		2	2				1	5	4		1
8	TT1	A4	6				1				1	1		
8	TT1	B3	7	1							1	1		
8	TT1	B4	1				2				2	2		
8	TT1	B4	7				2				2	2		
8	TT2	A2	1				1				1	1		
8	TT2	A2	3				1				1	1		
8	TT2	A2	4				2	1			3	3		
8	TT3	N/A	4				2				2	2		
8	TT3	N/A	5	1		2					3	3		
8	TT3	N/A	6			1					1	1		
8	N/A	?	4			4	10				14	14		
			Totals	3	2	9	34	1	1	1	51	49	1	1
				5.9	3.9	17.60%	66.60%	2%	2%	2%		96%	2%	2%

Table 3Site C: Artefact Types by Context

Site/ Auger Transect	Trench	Square/ Auger Number	Spit	FA	FB	BF	F	C	CF	UF	UFF	RFL	M	T	TF	TOTAL
C	Auger	Centre-point	N/A	1	1											2
C	Auger	north	N/A		2											2
C	Auger	west	N/A	2		2	1									5
C - North	Auger	Centre-point	N/A	2												2
C - North	Auger	east 4	N/A		1											1
C	Surface	B4	N/A	1												1
C	Surface	B9	N/A	1												1
C	Surface	B13	N/A		1											1
C	Surface	B15	N/A			1										1
C	Surface	C2	N/A	1		1	1									3
C	Surface	C5	N/A	4			1									5
C	Surface	C6	N/A	2			1									3
C	Surface	C8	N/A	2	2	1										5
C	Surface	C9	N/A	2												2
C	Surface	C10	N/A				1									1
C	Surface	D2	N/A				1									1
C	Surface	D4	N/A	1			1			1						3
C	Surface	D5	N/A	4	7											11
C	Surface	D6	N/A	2	3	2	2						1			10
C	Surface	D7	N/A	2	5	2	1									10
C	Surface	D8	N/A	6	4	3	2									15
C	Surface	D9	N/A	1												1
C	Surface	D10	N/A	2	2											4
C	Surface	D11	N/A	1	3											4
C	Surface	D12	N/A	2	2											4
C	Surface	E2	N/A		1	1										2
C	Surface	E3	N/A	2												2
C	Surface	E5	N/A	1	2	1										4
C	Surface	E6	N/A					1								1

Site/ Auger Transect	Trench	Square/ Auger Number	Spit	FA	FB	BF	F	C	CF	UF	UFF	RFL	M	T	TF	TOTAL
C	Surface	E7	N/A		1											1
C	Surface	E8	N/A	2												2
C	Surface	E9	N/A	1	1	1								1		4
C	Surface	E10	N/A	2			1									3
C	Surface	E12	N/A	1	4	2										7
C	Surface	E13	N/A	2			1									3
C	Surface	E14	N/A		1											1
C	Surface	F5	N/A	4	6	2	1									13
C	Surface	F6	N/A	2	3	4	2									11
C	Surface	F7	N/A						1							1
C	Surface	F8	N/A	2	1	1										4
C	Surface	F9	N/A	4	2	1					1					8
C	Surface	F10	N/A	2	2											4
C	Surface	F11	N/A	2	3											5
C	Surface	F12	N/A	2	1											3
C	Surface	F13	N/A		3											3
C	Surface	F15	N/A	2												2
C	Surface	G4	N/A						1							1
C	Surface	G6	N/A	2	2											4
C	Surface	G7	N/A	1	1											2
C	Surface	G8	N/A	4	3	4										11
C	Surface	G9	N/A	10	1										1	12
C	Surface	G10	N/A	3	2	2	1		1							9
C	Surface	G11	N/A	3	2	2	2							1		10
C	Surface	G12	N/A	4	1	4	1									10
C	Surface	G13	N/A	2	5	1										8
C	Surface	G14	N/A	1			1									2
C	Surface	H9	N/A	8	3	2				1						14
C	Surface	H11	N/A	2		1	1									4
C	TT0	H11	1	21		3										3
C	TT0	H11	2	65		6	4	1						1		12
C	TT0	H11	3	38		8	1				1			2		12
C	TT0	H11	4	19		3	1									4

Site/ Auger Transect	Trench	Square/ Auger Number	Spit	FA	FB	BF	F	C	CF	UF	UFF	RFL	M	T	TF	TOTAL
C	TT0	H11	5	17		1										1
C	Surface	H12	N/A	7		1										1
C	Surface	H13	N/A	7		3										3
C	TT0	I10	1	14		1										1
C	TT0	I10	2	40		6				1						7
C	TT0	I10	3	60		6						1		2		9
C	TT0	I10	4	36		4										4
C	TT0	I10	5	10		2										2
C	TT0	I11	2	39		5										5
C	TT0	I11	3	32		2	1							5		8
C	TT0	I11	4	32		3										3
C	TT0	I11	6	4		1										1
C	Surface	K14	N/A	0					1							1
C	TT1	N/A	3	11		2										2
C	TT1	N/A	5	12		2										2
C	TT1	N/A	6	23		1								1		2
C	TT1	N/A	7	21		2								1		3
C	TT1	N/A	8	13		2								1		3
C	TT1	N/A	9	0		2										2
C	TT2	N/A	1	0										1		1
C	TT2	N/A	2	3		2										2
		Tot.Frag		**524**		**68**	**7**	**1**	**1**	**1**	**1**	**1**		**14**		**94**
		%Frag.		**84.8**		**72.3**	**7.3**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**		**14.9**		**363**
		Tot.Ass.		%		%	%	%	%	%	%	%		%		

Table 4Site C, TT0, Square H10: Artefact Types by Spit & Size Class

Site/ Auger Transect	Trench	Square/ Auger Number	Spit	Size Class	FA	FB	BF	F	C	CF	UF/RF	UFF	RFL	M	MF	BP	SC	EL	T	TF	TOTAL
C	Surface	H10	N/A	**0**																	
				1	1																1
				2	1																1
				3																	
				4																	
				5																	
				>5																	
				Total	2																**2**
C	TT0	H10	1	**0**		1															1
				1	1	12															13
				2	4	4	1	1													10
				3	6		1														7
				4	1	1	2														4
				5																	
				>5		1															1
				Total	**12**	**19**	**4**	**1**													**36**
C	TT0	H10	2	**0**																	
				1	3	10															13
				2	9	10	2	1			1										23
				3	7	2	3	1											1		14
				4	2	1	2				1	1	1						1		9
				5		2															2
				>5																	
C	TT0	H10	3	**Total**	**21**	**25**	**7**	**2**			**2**	**1**	**1**						**2**		**61**
				0																	
				1	5	6															11

Site/ Auger Transect	Trench	Square/ Auger Number	Spit	Size Class	FA	FB	BF	F	C	CF	UF/RF	UFF	RFL	M	MF	BP	SC	EL	T	TF	TOTAL
				2	10	6		1			1										18
				3	4	4	1														9
				4	2	3															5
				5																	
				>5																	
				Total	**21**	**19**	**1**	**1**			**1**										**43**
C	TT0	H10	4	**0**																	
				1	4	4															8
				2	7	6	1														14
				3	1	2															3
				4			1														1
				5																	
				>5																	
				Total	12	12	2														26
C	TT0	H10	5	**0**																	
				1	2																2
				2	2	2															4
				3		1															1
				4																	
				5																	
				>5																	
				Total	4	3															7

Table 5Site C: Raw Material by Context

Site/ Auger Transect	Trench	Square/ Auger Number	Spit	CT	LBT	BT	DBT	GT	OT	YT	WT	GS	PS	RS	YS	BM	Uniden.	Q	TOTAL	Tuff Total	Silcrete Total
C	Auger	Centre-point	N/A								1				1				2	1	1
C	Auger	north	N/A								2								2	2	
C	Auger	west	N/A					2			3								5	5	
C - North	Auger	Centre-point	N/A				1				1								2	2	
C - North	Auger	east 4	N/A									1							1		1
C	Surface	B4	N/A								1								1	1	
C	Surface	B9	N/A								1								1	1	
C	Surface	B13	N/A					1											1	1	
C	Surface	B15	N/A					1											1	1	
C	Surface	C2	N/A											2	1				3		3
C	Surface	C5	N/A								5								5	5	
C	Surface	C6	N/A								3								3	3	
C	Surface	C8	N/A								5								5	5	
C	Surface	C9	N/A								2								2	2	
C	Surface	C10	N/A								1								1	1	
C	Surface	D2	N/A								1								1	1	
C	Surface	D4	N/A								3								3	3	
C	Surface	D5	N/A								10				1				11	10	1
C	Surface	D6	N/A					2			6				1		1		10	8	1
C	Surface	D7	N/A								8		1		1				10	8	2
C	Surface	D8	N/A					1			14								15	15	
C	Surface	D9	N/A								1								1	1	
C	Surface	D10	N/A							1	3								4	4	
C	Surface	D11	N/A								4								4	4	
C	Surface	D12	N/A								4								4	4	
C	Surface	E2	N/A								2								2	2	
C	Surface	E3	N/A					1			1								2	2	
C	Surface	E5	N/A								4								4	4	
C	Surface	E6	N/A								1								1	1	
C	Surface	E7	N/A								1								1	1	
C	Surface	E8	N/A								1		1						2	1	1

Site/ Auger Transect	Trench	Square/ Auger Number	Spit	CT	LBT	BT	DBT	GT	OT	YT	WT	GS	PS	RS	YS	BM	Uniden.	Q	TOTAL	Tuff Total	Silcrete Total
C	Surface	E9	N/A								4								4	4	
C	Surface	E10	N/A								3								3	3	
C	Surface	E12	N/A					2			5								7	7	
C	Surface	E13	N/A								3								3	3	
C	Surface	E14	N/A					1											1	1	
C	Surface	F5	N/A					2			10	1							13	12	1
C	Surface	F6	N/A					3			7				1				11	10	1
C	Surface	F7	N/A								1								1	1	
C	Surface	F8	N/A					1			3								4	4	
C	Surface	F9	N/A								8								8	8	
C	Surface	F10	N/A					1			3								4	4	
C	Surface	F11	N/A								5								5	5	
C	Surface	F12	N/A								3								3	3	
C	Surface	F13	N/A					1			2								3	3	
C	Surface	F15	N/A					2											2	2	
C	Surface	G4	N/A											1					1		1
C	Surface	G6	N/A								4								4	4	
C	Surface	G7	N/A					1			1								2	2	
C	Surface	G8	N/A								11								11	11	
C	Surface	G9	N/A					2			10								12	12	
C	Surface	G10	N/A					2			6	1							9	8	1
C	Surface	G11	N/A					2			8								10	10	
C	Surface	G12	N/A	2				3			5								10	10	
C	Surface	G13	N/A	1				2			5								8	8	
C	Surface	G14	N/A					1			1								2	2	
C	Surface	H9	N/A								14								14	14	
C	Surface	H10	N/A					1			1								2	2	
C	TT0	H10	1			2		32				2							36	34	2
C	TT0	H10	2		3	1		41	5			10	1						61	50	11
C	TT0	H10	3			4		28	1		3	5		1	1				43	36	7
C	TT0	H10	4					13			2	1		2	8				26	15	11
C	TT0	H10	5					2			2	2			1				7	4	3
C	Surface	H11	N/A					1			3								4	4	

Site/ Auger Transect	Trench	Square/ Auger Number	Spit	CT	LBT	BT	DBT	GT	OT	YT	WT	GS	PS	RS	YS	BM	Uniden.	Q	TOTAL	Tuff Total	Silcrete Total
C	TT0	H11	1					2			1								3	3	
C	TT0	H11	2					11			1								12	12	
C	TT0	H11	3					12											12	12	
C	TT0	H11	4					3						1					4	3	1
C	TT0	H11	5								1								1	1	
C	Surface	H12	N/A								1								1	1	
C	Surface	H13	N/A					1			2								3	3	
C	TT0	I10	1		1														1	1	
C	TT0	I10	2			1		4						1				1	7	6	
C	TT0	I10	3			2		7											9	9	
C	TT0	I10	4					3				1							4	3	1
C	TT0	I10	5					2											2	2	
C	TT0	I11	2					4				1							5	4	1
C	TT0	I11	3					7	1										8	8	
C	TT0	I11	4					3											3	3	
C	TT0	I11	6					1											1	1	
C	Surface	K14	N/A								1								1	1	
C	TT1	N/A	3			2													2	2	
C	TT1	N/A	5					2											2	2	
C	TT1	N/A	6					2											2	2	
C	TT1	N/A	7			1		1									1		3	2	
C	TT1	N/A	8					3											3	3	
C	TT1	N/A	9					2											2	2	
C	TT2	N/A	1					1											1	1	
C	TT2	N/A	2					2											2	2	
		Totals		**3**	**4**	**13**	**1**	**225**	**7**	**1**	**229**	**25**	**3**	**8**	**16**	**0**	**2**	**1**	**538**	**484**	**51**
		Percentage															**0.3%**	**0.2%**	100%	**90** %	**9.5** %

Table 6Sites D, E, T6 & T7: Artefact Type and Raw Material by Context

				Type Of Artefact							*Raw Material*					
Site/ Auger Transect	**Trench**	**Square/ Auger Number**	**Spit**	**BF**	**F**	**C**	**T**	**TF**	**UF**	**Total**	**BT**	**GT**	**Uniden. Frags**	**Tuff Total**	**? Stone.**	**Total**
D	TT1	N/A	2										8	8		8
D	TT1	N/A	3	2	1			1		4	3	1	57	61		61
D	TT1	N/A	4	1						1		1	7	8		8
D	TT1	N/A	5										5	5		5
D	TT1	N/A	7										1	1		1
D	TT1	N/A	8										1	1		1
		Total		3	1			1		5	3	2	79	84		84
D	Auger	centrepoint	N/A										6	6		6
D	Auger	south 2	N/A										25	25		25
D	Auger	south 4	N/A										1	1		1
D	Auger	south 6	N/A										1	1		1
D	Auger	west 2	N/A			1			1	2		2	2	4		4
		Total				1			1	2		2	35	37		37
E	TT1	N/A	1										1	1		1
E	TT1	N/A	2	1						1	1		1	2		2
E	TT1	N/A	3										7	7	1	8
E	TT1	N/A	4	2						2	2		31	33	1	34
E	TT1	N/A	5										2	2		2
E	TT1	N/A	6										1	1		1
E	TT1	N/A	7										1	1		1
E	Auger	north 6	N/A										2	2		2
		Total		3						3	3		46	49	2	51
T6	N/A	1	N/A										1	1		1
T7	Auger	6	N/A				1			1	1		1	2		2
T7	N/A	5	N/A	1						1	1		1	2		2

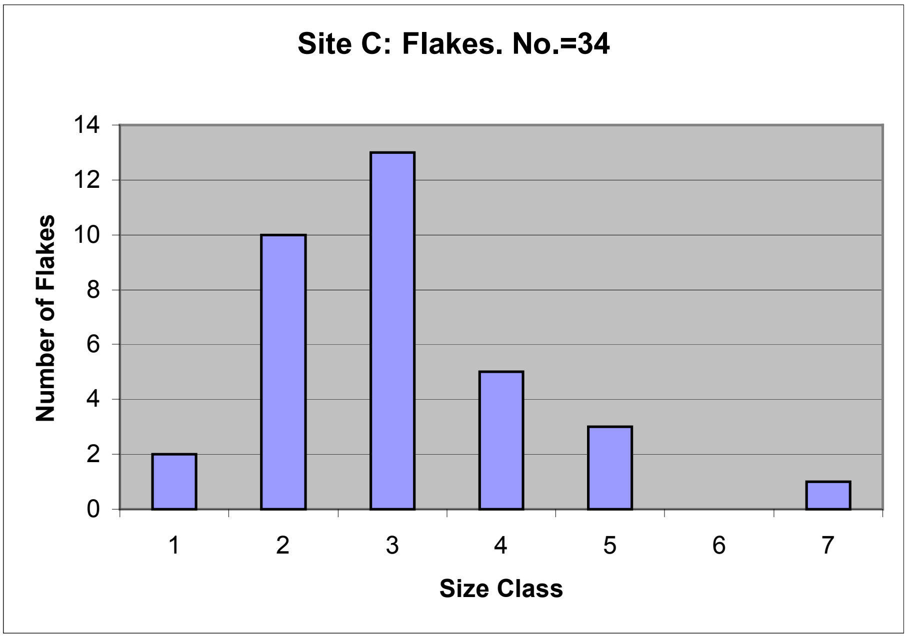

Chart 1: Site C: Flake Size Classes

Note: Size Class Numbers (on X Axis) are Representative Only, Where: 1 = <5mm; 2 = 5-10mm; 3 = 11-20mm; 4 = 21-30mm; 5 = 31-40mm; 6 = 41-50; 7 = 51-60mm .

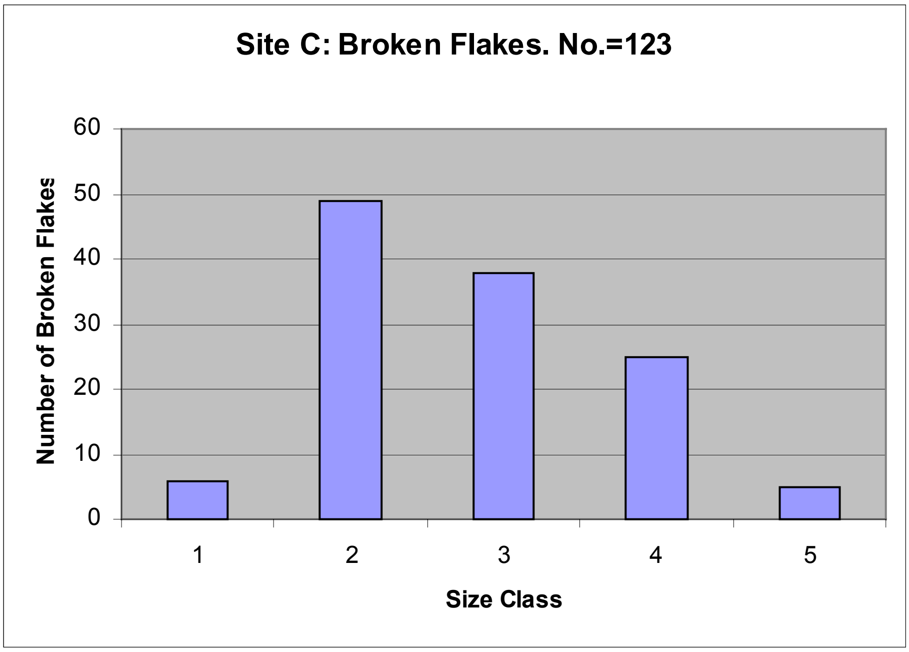

Chart 2. Site C: Broken Flake Size Classes

Size Classes: 1 = 5-10mm; 2 = 11-20mm; 3 = 21-30mm; 4 = 31-40mm;5 = 41-50mm.

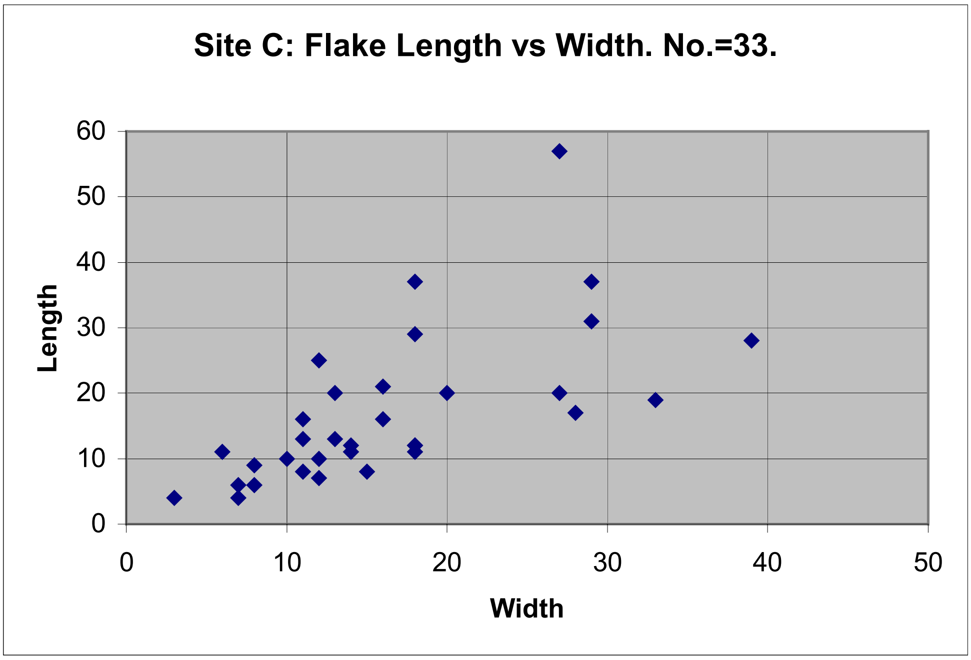

Chart 3. Site C: Complete Flake Length vs. Width

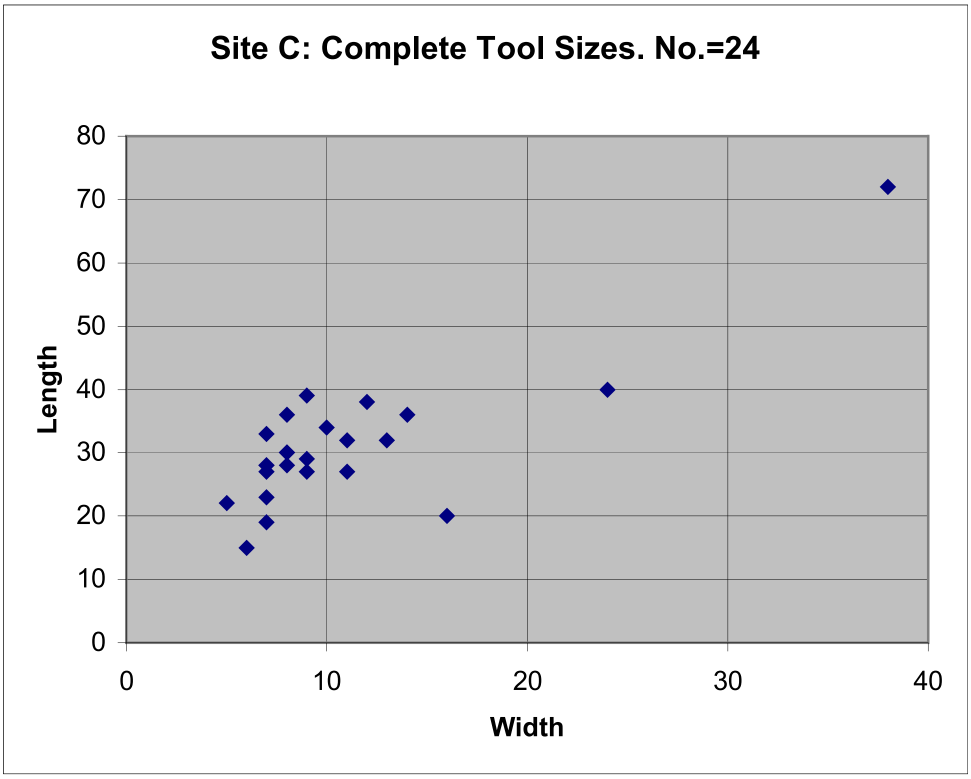

Chart 4. Complete Tool Sizes: Length vs. Width

Table 7 *All Tool Types – All Contexts*

Catalogue No.	Notes
3	Direct, abrupt, continuous retouch along thickest margin - Bondi Point?
24	Bondi Point: tip broken; thickest margin has abrupt, scaler, covering retouch; chord straight, thick edge is concave.
28	Bondi Point: base broken; thickest margin has abrupt, scaler retouch.
111	Microlith: thickest margin has covering, abrupt stepped retouch; chord has scaler micro-retouch
165	End Scraper with straight edge: short, abrupt, direct scaler to stepped micro-retouch.
263	Three semi-parallel abrupt retouch removals, with overlapping usewear.
282	Bondi Point: almost covering retouch on thickest margin; mainly direct, but distal (tip) to medial is bipolar, all of which is abrupt and scaled retouch; triangular x-section, curved form.
412	Bondi Point: proximal and distal extremities broken: continuous, direct, abrupt, semi-parallel to scaler micro-retouch along thickest lateral edge.
413	Bondi Point: proximal and distal extremities broken: continuous, direct, abrupt, semi-parallel micro-retouch along thickest lateral edge.
510	Bondi Point: short, abrupt, direct, semi-parallel micro-retouch on thickest margin; possible use-wear on chord.
520	Bondi Point: short, abrupt, direct, stepped micro-retouch on thickest margin; possible use-wear on chord.
521	Bondi Point: short, abrupt, direct, stepped micro-retouch on thickest margin.
546	Bondi Point: invasive micro-retouch, stepped and abrupt - opposed/bipolar.
548	Bondi Point: bipolar retouch at thickest margin - retouch is covering, abrupt and stepped.
563	Piercer (pointed): on flake, where distal portion has direct, abrupt and stepped retouch, a concave form tappering to point; tip broken.
564	Bondi Point: bipolar retouch at thickest margin - retouch is covering, abrupt and stepped.
565	Bondi Point: bipolar retouch at thickest margin - retouch is covering, abrupt and stepped; butt and tip missing.
566	Bondi Point: bipolar retouch at thickest margin - retouch is invasive to covering, abrupt and stepped; butt missing.
567	Backed flake: bipolar, abrubt and stepped retouch, with crushed edges; proximal missing - pos. Bondi Point.
577	Bondi Point: bipolar retouch at thickest margin - retouch is invasive to covering, abrupt and stepped; butt missing.
579	Ground implement (hatchet head) tip, oval in cross-section, with edge profiles straight and convex: axe head; unidentified stone.
584	Backed flake: bipolar, covering, abrubt and stepped retouch, with crushed edges; rounded backed edge - unclear whether Bondi Point or geometric microlith.
587	Backed flake: bipolar, invasive to covering, abrubt and stepped retouch, with crushed edges; convex backed edge - unclear whether Bondi Point or geometric microlith.
593	Tool fragment: possibly Bondi Point - abrupt, invasive, semi-parallel to scaler micro-retouch along thickest margin.
600	Elouera on large flake: orange-quarter shape; thick lateral margin is crescentic with indirect, abrupt, stepped retouch and some crushing; distal end has direct, abrupt, stepped and scaler retouch with micro-retouch (use-wear); Type 3 (after McCarthy; 1976; pp30).
90	Oblique lateral edge, 25mm long, with usewear: continuous microflakes, stepped and abrupt on irregular edge
216	Lateral edge and distal end have micro-retouch: abrupt, direct, stepped retouch; possibly nosed tool, though unclear due to 'nose' being partly broken.
304	Continuous micro-retouch along one edge: scaler.

Catalogue No.	Notes
410	Posible micro-retouch on distal oblique angled edge
411	Tool: possibly Bondi Point - abrupt, semi-parallel to scaler micro-retouch along 22mm of one lateral edge; asymetrical shape.
414	Tool fragment: either utilised flake or fragment of Bondi Point - micro-retouch, directly induced, abrupt and stepped.
415	Tool, most probably utilised flake: direct, abrupt, stepped, continuous retouch along 19mm of thickest margin of broken flake.
458	Tool fragment: possibly utilised flake - micro-retouch, abrupt and stepped.
522	Utilised Fragment: short, direct, abrupt, stepped micro-retouch
533	Micro-retouch along lateral edges: short to invasive stepped and scaler removals due to (scraping?) use; retouched piece that is unidentifiable as a flake.
547	Retouched inversely, stepped, abrupt and invasive along thick margin; distal end is hinged not retouched, proximal is retouched: Backed flake.
596	Utilised Fragment: short, direct, abrupt, stepped micro-retouch along one edge.

Lexicon For Tables:

Type		Size Class		Platform		DSP	
FA	Fragment A	0	<5mm	Ab	Abraded	Bi	Bipolar
FB	Fragment B	1	5-10mm	Br	Broken	C	Cortex
BF	Broken Flake	2	11-20mm	Cr	Cortex	N	Natural Surface
F	Flake	3	21-30mm	Pl	Plain	O	Opposed
C	Core	4	31-40mm	Sh	Shattered	U	Unidirectional
CF	Core Fragment	5	41-50mm	Ft	Facetted	RA	Right-Angle to butt
UFF	Utilised Flake Fragment	6	51-60mm	?	Unknown	?	Unknown
UF	Utilised Flake	7	61-70mm				
RFL	Retouched Flake	8	71-80mm				
RF	Retouched Fragment						
M	Microlith						
MF	Microlith Fragment						
T	Tool						
TF	Tool Fragment						
BP	Bondi Point						
SC	Scraper						

Cortex		Shape		Termination		Reduction Stage		Raw Material	
1	100%	P	Proximal	Ft	Feathered	P	Primary	GS	Grey Silcrete
2	>50%	M	Medial	Hg	Hinged	S	Secondary	PS	Pink Silcrete
3	<50%	D	Distal	Pg	Plunged	T	Tertiary	RS	Red Silcrete
4	0%	PS	Parallel Sided	Bi	Bipolar			YS	Yellow Silcrete
?	Unknown	Am	Amorphous	?	Unknown			BT	Brown Tuff
		?	Unknown					LBT	Light Brown Tuff
								DBT	Dark Brown Tuff
								CT	Creamy Tuff
								GT	Grey Tuff
								WT	White Tuff
								OT	Orange Tuff
								YT	Yellow Tuff
								BM	Banded Mudstone
								Q	Quartz
								Un	Unidentified

Annex 4

Faunal Catalogue

A GUIDE TO THE FERN BAY ARCHAEOLOGY PROJECT 2000 FAUNAL ANALYSIS CATALOGUE

- **Cat No.** Refers to the unique catalogue number assigned to each catalogue line entry.

- **Site/Auger Transect ID.** This refers to either the site or auger transect identifier (for sites the identifier is either a single number or letter and for auger transects the identifier is "T" followed by a single number).

- **Square/Auger No.** Indicates either the test-trench square number or the auger number (1m by 1m test trenches are identified by "TT" followed by a single number, whereas 2m by 2m test trenches have an additional coordinate identifier such as "B4")

- **Spit Number.** Identifies the Spit number for test trenches (this column will remain blank for auger transect catalogue entries)

- **Species Name.** Identifies the shell species by scientific name

- **No. Complete.** Number of complete shells for the catalogue entry

- **No. Frags.** Number of shell fragments for the catalogue entry

- **% Complete.** For shell fragments, this quantifies the proportion (as a percentage) of a complete shell represented by the fragment

- **Portion Name.** For shell fragments, this indicates the shell portion (proximal, medial or distal)

- **Condition Description.** Describes the physical condition of the shell. The following codes will be used;

  FRE - Fresh Shell

  WEA - Weathered Shell

  BRO - Broken Shell

  DEC - Largely decomposed and eroded shell

  ATT - Evidence of human, rodent or canine attrition

- **Max Size.** Measures in centimetres, the maximum size of the shell along its longest axis.

- **Comments.** Any additional information relating to the entry.

Table 4.1 Fern Bay Archaeology Project 2000 - Faunal Analysis

Context Description					*Faunal Analysis and Identification*							
Cat No.	**Site/Auger Transect ID**	**Trench**	**Square/ Auger No.**	**Spit No.**	**Species Name**	**No. Complete**	**No. Frags**	**% Complete**	**Portion Name**	**Condition Description**	**Max Size (cm)**	**Comments**
1	T10		9		Saccostrea		7	10	N/A	WEA	3	
2	T9		3		Unid		1	10	N/A	BRK	1	
3	T9		2		Unid		1	10	N/A	BRK	1	
4	C	TT0	H11	3	Saccostrea		1	10	N/A	BRK	1	
5	C	TT0	I10	3	Mytilus (Blue Mussel)		1	10	N/A	BRK	1	
6	C	TT0	H11	4	Saccostrea		1	10	HINGE	BRK	1	
7	C	TT0	H11	6	Saccostrea		1	10	HINGE	BRK	2	
8	C	TT0	H10	1	Unid		1	10	N/A	BRK	2	
9	C	TT0	I11	4	Mytilus (Blue Mussel)		1	10	N/A	BRK	2	
10	8	TT1	B4	1	Unid		1	10	N/A	BRK	1	
11	C	TT0	I11	1	Unid		8	10	N/A	BRK/WEA	1	
12	C	SURFACE	I11	N/A	Unid		4	10	N/A	BLE/WEA	1	
13	C	TT1	N/A	1	Saccostrea		2	10	N/A	BRK	1	
14	E	AUGER	SOUTH 4	N/A	Saccostrea		4	10	HINGE	BRK	2	
15	E	AUGER	SOUTH 4	N/A	Saccostrea		2	10	N/A	BRK	2	
16	E	AUGER	SOUTH 4	N/A	Pyrazus		1	30	DIST	BRK	2	
17	C	TT0	I11	6	Unid		1	10	N/A	BRK	1	

Context Description					*Faunal Analysis and Identification*							
Cat No.	**Site/Auger Transect ID**	**Trench**	**Square/ Auger No.**	**Spit No.**	**Species Name**	**No. Complete**	**No. Frags**	**% Complete**	**Portion Name**	**Condition Description**	**Max Size (cm)**	**Comments**
18	C	TT0	I11	1	Saccostrea		2	40	VALVE	WEA	5	
19	C	TT0	I11	1	Saccostrea		2	10	LID	WEA	2	
20	C	TT0	I11	1	Unid		11	10	N/A	BRK/WEA	3	possibly decomposed frags of Oyster
21	8	TT1	B3	3	Saccostrea		3	10	HINGE	BRK/BUR	1	fragments are charred
22	C	TT1	N/A	5	Saccostrea		2	20	VALVE	BRK/WEA	2	
23	C	TT1	N/A	5	Unid		1	10	N/A	BRK	1	
24	C	TT0	H10	2	Pyrazus		1	50	VALVE	WEA	4	
25	8	TT1	B3	SURFACE	Saccostrea		2	20	VALVE	BLE	4	
26	E	TT1	N/A	5	Saccostrea		1	50	VALVE	WEA	5	
27	E	TT1	N/A	5	Saccostrea		3	10	N/A	WEA	2	
28	E	TT1	N/A	5	Unid		2	10	N/A	WEA	1	
29	C	TT0	I10	2	Saccostrea		1	30	LID	WEA	6	
30	C	TT0	I10	2	Unid		2	10	N/A	WEA	2	
31	E	AUGER	SOUTH 6	N/A	Saccostrea		1	10	HINGE	BUR	1	
32	E	TT1	N/A	8	Unid		3	10	N/A	N/A	1	
33	8	TT1	A4	1	Saccostrea		2	20	HINGE	BUR	3	
34	C	TT0	I11	3	Mytilus (Blue Mussel)		3	10	N/A	BLE/WEA	2	
35	E	TT1	N/A	1	Unid		3	10	N/A	WEA	1	
36	C	TT2	N/A	1	Saccostrea		4	10	HINGE	WEA	2	
37	E	TT1	N/A	4	Saccostrea		4	10	N/A	WEA/BRK	1	

Context Description					*Faunal Analysis and Identification*							
Cat No.	**Site/Auger Transect ID**	**Trench**	**Square/ Auger No.**	**Spit No.**	**Species Name**	**No. Complete**	**No. Frags**	**% Complete**	**Portion Name**	**Condition Description**	**Max Size (cm)**	**Comments**
38	E	TT1	N/A	1	Pyrazus		1	30	MID	WEA	3	
39	C	SURFACE	J6	N/A	Saccostrea		1	10	HINGE	BRK	1	
40	8	TT3	N/A	4	Saccostrea		7	10	N/A	BRK	1	
41	C	SURFACE	F14	N/A	Saccostrea		1	20	VALVE	BLE/BRK	2	
42	C	SURFACE	H15	N/A	Saccostrea		1	10	LID	WEA	4	
43	C	SURFACE	G14	N/A	Saccostrea		2	20	VALVE	WEA	3	
44	C	SURFACE	C5	N/A	Pyrazus		1	80	PROX/MID/ DIST	WEA	3	
45	C	SURFACE	E15	N/A	Saccostrea		1	10	HINGE	WEA	1	
46	C	SURFACE	E13	N/A	Saccostrea		1	10	N/A	BRK	2	
47	C	SURFACE	J11	N/A	Saccostrea		1	50	VALVE	WEA	6	
48	C	SURFACE	J11	N/A	Saccostrea		5	20	N/A	WEA	3	
49	C	SURFACE	J11	N/A	Unid		5	10	N/A	WEA	2	
50	C	SURFACE	I7	N/A	Pyrazus		1	40	MID	WEA	3	
51	C	AUGER	SOUTH 4	N/A	Saccostrea		2	30	VALVE	WEA/BRK	4	
52	C	SURFACE	N13	N/A	LAND SNAIL		1	80	N/A	BRK	3	
53	C	SURFACE	N13	N/A	Unid		4	10	N/A	WEA	1	
54	C	SURFACE	E14	N/A	Unid		1	10	N/A	BRK	1	
55	C	SURFACE	G12	N/A	Saccostrea		2	40	VALVE	BRK/WEA	5	
56	C	SURFACE	D2	N/A	Mytilus (Blue Mussel)		1	10	N/A	BLE/BRK	1	
57	7	AUGER-ADDITIONAL 1	N/A	N/A	Unid		4	10	N/A	BLE	1	possibly bone or shell enamel frags

Context Description					*Faunal Analysis and Identification*							
Cat No.	**Site/Auger Transect ID**	**Trench**	**Square/ Auger No.**	**Spit No.**	**Species Name**	**No. Complete**	**No. Frags**	**% Complete**	**Portion Name**	**Condition Description**	**Max Size (cm)**	**Comments**
58	C	SURFACE	K14	N/A	Pyrazus		2	30	PROX	BLE/WEA	3	
59	C	SURFACE	K14	N/A	Saccostrea		5	20	VALVE	BLE	3	
60	C	SURFACE	K14	N/A	Anadara		2	10	UNK	WEA/BRK	2	
61	C	SURFACE	G7	N/A	Saccostrea		1	10	HINGE	WEA	1	
62	C	SURFACE	D11	N/A	Saccostrea		2	10	N/A	WEA	1	
63	C	SURFACE	D11	N/A	Unid		2	10	N/A	WEA	1	
64	C	SURFACE	K11	N/A	Pyrazus		1	20	PROX	WEA	3	
65	C	AUGER	WEST 4	N/A	Saccostrea		1	50	VALVE	WEA	7	
66	C	AUGER	WEST 4	N/A	Saccostrea		2	20	LID	WEA	3	
67	C	AUGER	WEST 4	N/A	Saccostrea		4	10	N/A	WEA/BRK	2	
68	C	AUGER	WEST 4	N/A	Unid		2	10	N/A	WEA/BRK	1	
69	8	TT1	B3	N/A	Unid		1	10	N/A	WEA/BRK	1	
70	C	SURFACE	I9	N/A	Saccostrea		1	10	VALVE	BRK	2	
71	C	SURFACE	I9	N/A	Unid		3	10	N/A	BRK	1	
72	C	SURFACE	I13	N/A	Unid		5	10	N/A	BRK	1	
73	C	SURFACE	K8	N/A	Saccostrea		1	10	N/A	WEA/BRK	1	
74	C	SURFACE	J10	N/A	Unid		3	10	N/A	WEA/BRK	1	
75	C	SURFACE	F4	N/A	Unid		2	10	N/A	WEA/BRK	1	
76	C	TT1	N/A	4	Saccostrea		8	10	N/A	WEA	3	
77	C	SURFACE	G3	N/A	Saccostrea		1	20	LID	WEA/BRK	3	
78	C	SURFACE	L11	N/A	Saccostrea		2	10	N/A	WEA	2	
79	C	SURFACE	N11	N/A	Unid		1	10	N/A	BLE/BRK	1	
80	C	SURFACE	H10	N/A	Unid		1	10	N/A	BRK	1	
81	E	TT1	N/A	6	Pyrazus		1	90	PROX/MID	WEA	6	

Context Description					*Faunal Analysis and Identification*							
Cat No.	**Site/Auger Transect ID**	**Trench**	**Square/ Auger No.**	**Spit No.**	**Species Name**	**No. Complete**	**No. Frags**	**% Complete**	**Portion Name**	**Condition Description**	**Max Size (cm)**	**Comments**
82	E	TT1	N/A	6	Unid		2	20	N/A	WEA	2	
83	C	TT1	N/A	3	Anadara		1	80	VALVE	WEA	5	
84	C	TT1	N/A	3	Saccostrea		2	20	LID	WEA/BRK	3	
85	C	TT1	N/A	3	Saccostrea		3	20	HINGE	WEA	4	
86	C	TT1	N/A	3	Saccostrea		3	30	VALVE	WEA	4	
87	C	TT1	N/A	3	Unid		18	10	N/A	WEA/BRK	2	small frags, prob. Saccostrea
88	C	SURFACE	J15	N/A	Pyrazus	1		N/A	N/A	WEA	6	
89	C	SURFACE	J15	N/A	Pyrazus		2	90	PROX/MID	WEA/BRK	5	
90	C	SURFACE	J15	N/A	Pyrazus		3	60	MID	WEA/BRK	4	
91	C	SURFACE	J15	N/A	Mytilus (Blue Mussel)		5	20	UNK	WEA/BRK	3	possibly Trichoma hirsuta (hairy mussel)
92	C	SURFACE	J15	N/A	Mytilus (Blue Mussel)		8	10	UNK	WEA/BRK	2	possibly Trichoma hirsuta (hairy mussel)
93	C	SURFACE	J15	N/A	Anadara		1	10	UNK	WEA	3	
94	C	SURFACE	J15	N/A	Saccostrea		2	10	LID	WEA/BRK	3	
95	C	SURFACE	J15	N/A	Unid		7	10	UNK	WEA/BRK	1	
96	C	SURFACE	N10	N/A	Anadara		1	20	UNK	WEA	3	
97	E	TT1	N/A	4	Pyrazus		3	80	PROX/MID	WEA	3	immature shells
98	E	TT1	N/A	4	Pyrazus		1	30	MID	WEA	4	
99	E	TT1	N/A	4	Anadara		1	20	UNK	WEA	3	
100	E	TT1	N/A	4	Unid		20	10	UNK	WEA/BRK	1	small frags, prob.

Context Description					*Faunal Analysis and Identification*							
Cat No.	**Site/Auger Transect ID**	**Trench**	**Square/ Auger No.**	**Spit No.**	**Species Name**	**No. Complete**	**No. Frags**	**% Complete**	**Portion Name**	**Condition Description**	**Max Size (cm)**	**Comments**
												Saccostrea
101	E	TT1	N/A	4	Mytilus (Blue Mussel)		2	10	UNK	WEA/BRK	4	possibly Trichoma hirsuta (hairy mussel)
102	E	TT1	N/A	4	Saccostrea		21	40	VALVE	WEA/BRK	5	
103	E	TT1	N/A	4	Saccostrea		14	30	LID	WEA/BRK	4	
104	E	TT1	N/A	4	Saccostrea		12	20	HINGE	WEA/BRK	3	
105	E	TT1	N/A	4	Saccostrea		29	10	UNK	WEA/BRK	2	
106	C	TT1	N/A	2	Saccostrea		2	10	VALVE	WEA/BRK	3	
107	C	TT1	N/A	2	Saccostrea		2	30	LID	WEA/BRK	4	
108	C	TT1	N/A	2	Anadara		1	50	N/A	WEA/BRK	3	
109	C	TT1	N/A	2	Unid		6	10	UNK	WEA/BRK	1	
110	C	SURFACE	J12	N/A	Saccostrea		4	30	VALVE	WEA/BRK	6	
111	C	SURFACE	J12	N/A	Saccostrea		7	20	LID	WEA/BRK	4	
112	C	SURFACE	J12	N/A	Mytilus (Blue Mussel)		14	20	UNK	WEA/BRK	3	possibly Trichoma hirsuta (hairy mussel)
113	C	SURFACE	J12	N/A	Unid		13	10	UNK	WEA/BRK	1	
114	C	SURFACE	O13	N/A	Anadara		2	40	UNK	BRK/BUR	4	shell has been charred
115	C	SURFACE	O13	N/A	Saccostrea		5	20	VALVE	BRK/BUR	3	shell has been charred
116	C	SURFACE	O13	N/A	Mytilus (Blue Mussel)		2	10	UNK	BRK/BUR	2	shell has been charred
117	C	SURFACE	O13	N/A	Unid		6	10	UNK	BRK/BUR	1	shell has been

Context Description					*Faunal Analysis and Identification*							
Cat No.	**Site/Auger Transect ID**	**Trench**	**Square/ Auger No.**	**Spit No.**	**Species Name**	**No. Complete**	**No. Frags**	**% Complete**	**Portion Name**	**Condition Description**	**Max Size (cm)**	**Comments**
118	E	AUGER	NORTH 2	N/A	Saccostrea		6	10	LID	WEA/BRK	2	charred
119	E	AUGER	NORTH 2	N/A	Saccostrea		4	10	VALVE	WEA/BRK	3	
120	E	AUGER	NORTH 2	N/A	Saccostrea		3	10	HINGE	WEA/BRK	2	
121	E	AUGER	NORTH 2	N/A	Unid		7	10	UNK	WEA/BRK	1	
122	E	AUGER	NORTH 2	N/A	Pyrazus		10	70	PROX/MID	WEA	2	all immature shells
123	E	AUGER	NORTH 2	N/A	Anadara		19	30	UNK	WEA/BRK	3	
124	E	TT1	N/A	3	Anadara		2	40	UNK	WEA/BRK	4	
125	E	TT1	N/A	3	Pyrazus		1	30	PROX	WEA	3	
126	E	TT1	N/A	3	Pyrazus		2	40	MID	WEA	4	
127	E	TT1	N/A	3	Pyrazus	3	N/A		N/A	WEA	3	all immature shells
128	E	TT1	N/A	3	Saccostrea		19	40	LID	WEA/BRK	6	
129	E	TT1	N/A	3	Saccostrea		15	40	VALVE	WEA/BRK	7	
130	E	TT1	N/A	3	Saccostrea		14	20	HINGE	WEA/BRK	3	
131	E	TT1	N/A	3	Saccostrea		85	10	UNK	WEA/BRK	2	
132	E	TT1	N/A	3	Unid		16	10	UNK	WEA/BRK	1	
133	E	TT1	N/A	2	Saccostrea		8	40	LID	WEA/BRK	6	
134	E	TT1	N/A	2	Saccostrea		11	40	VALVE	WEA/BRK	6	

Context Description					*Faunal Analysis and Identification*							
Cat No.	**Site/Auger Transect ID**	**Trench**	**Square/ Auger No.**	**Spit No.**	**Species Name**	**No. Complete**	**No. Frags**	**% Complete**	**Portion Name**	**Condition Description**	**Max Size (cm)**	**Comments**
135	E	TT1	N/A	2	Saccostrea		9	20	HINGE	WEA/BRK	3	
136	E	TT1	N/A	2	Pyrazus		1	30	MID	WEA	3	
137	E	TT1	N/A	2	Saccostrea		36	10	UNK	WEA/BRK	2	
138	E	TT1	N/A	2	Unid		8	10	UNK	WEA/BRK	1	
139	C	SURFACE	I15	N/A	Saccostrea		3	30	VALVE	WEA/BRK	4	
140	C	SURFACE	I15	N/A	Saccostrea		3	20	LID	WEA/BRK	3	
141	C	SURFACE	I15	N/A	Unid		2	30	VALVE	WEA/BRK	2	unid. Bivalve species
142	C	SURFACE	I15	N/A	Pyrazus		1	80	PROX/MID	WEA/BRK	5	
143	C	SURFACE	I15	N/A	Pyrazus		1	70	PROX/MID	WEA/BRK	1	immature shell
144	C	SURFACE	I15	N/A	Mytilus (Blue Mussel)		14	10	UNK	WEA/BRK	3	
145	C	SURFACE	I15	N/A	Saccostrea		20	10	UNK	WEA/BRK	1	
146	C	SURFACE	I15	N/A	Unid		31	10	UNK	WEA/BRK	1	
147	C	SURFACE	J5	N/A	Pyrazus			30	MID	WEA	2	
148	C	SURFACE	K15	N/A	Pyrazus		1	20	PROX	WEA	2	
149	C	SURFACE	K10	N/A	Anadara		1	20	UNK	WEA/BRK	2	
150	C	SURFACE	N14	N/A	Saccostrea		1	10	VALVE	WEA	3	
151	C	SURFACE	O12	N/A	Unid		2	10	UNK	WEA/BRK	1	
152	C	SURFACE	J8	N/A	Unid		2	10	UNK	WEA/BRK	1	
153	C	SURFACE	K3	N/A	Saccostrea		1	10	UNK	WEA	3	
154	C	SURFACE	L9	N/A	Unid		7	10	UNK	WEA/BRK	1	
155	C	SURFACE	D5	N/A	Pyrazus		1	80	PROX/MID	WEA	5	
156	C	SURFACE	D5	N/A	Anadara		1	10	UNK	WEA/BRK	2	
157	C	SURFACE	D5	N/A	Unid		4	10	UNK	WEA	1	

Context Description					*Faunal Analysis and Identification*							
Cat No.	**Site/Auger Transect ID**	**Trench**	**Square/ Auger No.**	**Spit No.**	**Species Name**	**No. Complete**	**No. Frags**	**% Complete**	**Portion Name**	**Condition Description**	**Max Size (cm)**	**Comments**
158	C	SURFACE	G13	N/A	Unid		3	10	UNK	WEA/BRK	1	
159	C	SURFACE	L13	N/A	Mytilus (Blue Mussel)		2	10	UNK	WEA/BRK	1	
160	C	SURFACE	L13	N/A	Unid		4	10	UNK	WEA/BRK	1	
161	T7	N/A	10	N/A	Saccostrea		1	10	LID	WEA/BRK	3	
162	C	SURFACE	H11	N/A	Unid		6	10	UNK	WEA/BRK	1	
163	C	SURFACE	L14	N/A	Unid		4	10	UNK	WEA/BRK	1	
164	C	SURFACE	K13	N/A	Saccostrea		2	10	UNK	WEA/BRK	1	
165	C	SURFACE	K13	N/A	Unid		5	20	UNK	WEA/BRK	2	
166	C	SURFACE	D6	N/A	Saccostrea		3	10	UNK	WEA/BRK	1	
167	C	SURFACE	D6	N/A	Unid		1	10	UNK	WEA/BRK	1	
168	C	TT0	I10	4	Anadara		1	30	UNK	WEA/BRK	3	
169	C	SURFACE	M12	N/A	Unid		1	10	UNK	WEA/BRK	1	
170	C	SURFACE	N9	N/A	Mytilus (Blue Mussel)		1	10	UNK	WEA/BRK	1	
171	C	SURFACE	H12	N/A	Mytilus (Blue Mussel)		1	10	UNK	WEA/BRK	1	
172	C	SURFACE	H12	N/A	Saccostrea		3	10	UNK	WEA/BRK	1	
173	C	SURFACE	H12	N/A	Unid		7	10	UNK	WEA/BRK	1	
174	C	SURFACE	D4	N/A	Unid		2	10	UNK	WEA/BRK	1	
175	C	TT2	N	3	Unid		1	10	UNK	WEA	1	
176	C	SURFACE	M9	N/A	Saccostrea		2	10	UNK	WEA/BRK	2	
177	C	SURFACE	I10	N/A	Saccostrea		3	10	UNK	WEA/BRK	1	
178	C	SURFACE	E2	N/A	Saccostrea		1	10	UNK	WEA	2	
179	C	SURFACE	H14	N/A	Saccostrea		1	10	UNK	WEA	1	
180	E	TT1	N/A	7	Bembicium auratum	1		N/A	N/A	WEA	1	possibly an immature shell

Context Description					*Faunal Analysis and Identification*							
Cat No.	**Site/Auger Transect ID**	**Trench**	**Square/ Auger No.**	**Spit No.**	**Species Name**	**No. Complete**	**No. Frags**	**% Complete**	**Portion Name**	**Condition Description**	**Max Size (cm)**	**Comments**
181	E	TT1	N	7	Saccostrea		1	10	UNK	WEA/BRK	2	
182	C	SURFACE	H8	N/A	Saccostrea		1	10	UNK	WEA	1	
183	C	SURFACE	H8	N/A	Unid		3	10	UNK	WEA/BRK	1	
184	C	SURFACE	M11	N/A	Mytilus (Blue Mussel)		2	20	UNK	WEA/BRK	3	
185	C	SURFACE	H6	N/A	Saccostrea		1	10	UNK	WEA/BRK	1	
186	C	SURFACE	J14	N/A	Mytilus (Blue Mussel)		3	10	UNK	WEA/BRK	2	
187	C	SURFACE	I12	N/A	Saccostrea		4	10	UNK	WEA/BRK	1	
188	C	SURFACE	I12	N/A	Unid		13	10	UNK	WEA/BRK	1	
189	C	SURFACE	A13	N/A	Saccostrea		2	10	UNK	WEA/BRK	1	
190	8	TT2	N/A	4	Unid		1	10	UNK	WEA/BRK	1	
191	C	SURFACE	J9	N/A	Saccostrea		1	10	UNK	WEA/BRK	1	
192	C	SURFACE	I6	N/A	Unid		1	10	UNK	WEA/BRK	1	
193	C	SURFACE	O10	N/A	Mytilus (Blue Mussel)		2	10	UNK	BRK/BUR	2	
194	C	SURFACE	G6	N/A	Unid		1	10	UNK	WEA/BRK	1	
195	C	TT0	I11	1	Mytilus (Blue Mussel)		3	10	UNK	WEA/BRK	2	

Annex 5

Functional Analysis of Worimi Cleaver

By Richard Fullagar, Michael Therin & Carol Lentfer

M ***Archaeological and***
C ***Environmental Analysis***
R ***Services***

Functional study of a Worimi, Fern Bay Archaeology Project, Site 8 TT1 B-4, Spit 6

Report to ERM Mitchell McCotter

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Contents

Tables

Appendix

Functional study of a Worimi, Fern Bay Archaeology Project, Site 8 TT1 B-4, Spit 6

1. Introduction

A distinctively retouched stone artefact, called a '*worimi*', sometimes '*worimi* cleaver' (McCarthy 1967: 22) was found during excavations at Site 8, Fern Bay Archaeological Project, in the Hunter Valley Region of NSW. McCarthy (1967: 22) defines a *worimi* as:

> ...a thick, large segment, markedly triangular in transverse section. The straight or crescentic thick margin (the back) has one or both edges trimmed, and the ends are rounded or straight. One surface may be the natural crust, or both surfaces are cleavage faces. The principal working edge is on the thin margin or chord, and is a trimmed chopper or cleaver edge, but in some specimens it is rounded by use-polish. In size the worimi ranges up to 9 inches in length, and up to 71/2pounds in weight. It is abundant on the north coast of New South Wales, where it may have been used for bark and woodwork, and occurs in small numbers elsewhere.

Kamminga (1982) has noted some similarities between chopping implements along the east coast of Australia, and these also include, from southeastern Queensland, bevelled pounders that he and others have demonstrated was used to process fern *(Blechnum)* roots (Kamminga 1981; Higgins et al. 1989). More recent work in unpublished reports has supported functional interpretations of worimi as plant processing implements associated with wetland environments (Navin and Kamminga 1999)

Another *worimi* was excavated by Neville Baker in the region and has been dated by association with charcoal fragments to about 11,000 years (personal communication of Neville Baker, Australian Museum).

- The Fern Bay *worimi* was found approximately 70 cm below the ground surface in a greasy ash and charcoal deposit, roughly circular in plan, which we are interpreting as a hearth. The cleaver is also covered and stained with the same greasy ash material as found in the hearth, especially on the working edge of the cleaver.

2. Aims of study

Jim Wheeler, Environment Resources Management Australia, requested the following tasks (their reference 500140L2RF):

- An analysis of residues (including starch, lipids, phytoliths and usewear)
- A report on the use of the *worimi* and functional interpretations

3. Methods

3.1 Microscopic Study of Artefacts.

A combination of low magnification (low power) and high magnification (high power) microscopy was used for the analysis. Low power microscopy was used to view the general morphology of artefacts and features such as scarring, edge rounding, polish, striations and residues. For these observations, we examined artefacts under a stereomicroscope with external oblique lighting (Orient model, with a total magnification range of x10 to x100).

The metallographic microscope allows observation of the same feature as the stereomicroscope, but permits greater resolution of the tool surface and residues. Very small residues like starch granules and phytoliths can only be seen at higher magnifications. In addition detailed surface features of polish and striations can be more easily seen at higher magnifications. For this analysis we used a metallographic microscope with vertical incident lighting, bright-field, dark-field, cross polarising attachments (Olympus model, with a magnification range of x100, x200, x500, x1000). Direct observation of tool edges was not possible because of the size of the *worimi*. Consequently, polyvinyl siloxane moulds were prepared of three edges. These moulds were then studied under the metallographic microscope.

Following Kamminga (1982), and Fullagar (1986) we recognised the following main forms of usewear: scars, striations, rounding, polish or smoothing and bevelling. The size and termination (step, feather, hinge, bending) of scars were noted, but not recorded in detail. The direction of striations was recorded. Rounding was recorded in terms of qualitative assessment from low to massive. Polish was described in terms of texture (grainy, smooth, and reticular or netlike). If polish is sufficiently developed it can indicate processing of specific materials. The processing of Australian timbers with a low silica content (in the form of phytoliths) often causes distinctive polish on stone tool edges (Fullagar 1991).

Residues were noted during observations of the artefact under reflected light. Extractions were also aqueously removed from utilised edges, and observed through transmitted light specifically to document phytoliths and starch granules.

3.2 Residue Extractions

Most residues can be viewed with greater clarity when removed from the artefact, and mounted on glass microscope slides. Residue extractions were taken from three edges (see artefact sketches for location). Residues were removed aqueously in an ultra sonic cleaner. Used edges identified during the usewear analysis were sonically cleaned in ultra pure water. Sixty microlitres of the ultra pure water/residue solution was then placed on a cleaned microscope slide to dry. Once dry, a drop of Benzol was placed on the slide and a coverslip placed on top. Three residue extractions were also taken using a pipette tip. Twenty microlitres of ultra pure water was placed on the tools surface and agitated using the pipette tip. The resulting ultra pure water/residue solution was then removed using the pipette. These extractions were mounted using the same procedure as used for the samples removed using the ultra sonic cleaner, except only five microlitres of solution was used.

The residues were examined using the Olympus BH-2 microscope under transmitted light. Each slide was scanned under both polarised and non-polarised light. All starch granules and phytoliths were drawn and measured, photographs were taken of representative examples of each type. Starch granules were categorised using the starch identification key developed by Therin (Lentfer et al. in press, Appendix D). Pictures of each phytolith type sent to Carol Lentfer for identification (Appendix D).

4. Results

4.1 Usewear

The acute edge varies from about 20-80 degrees. The edge is extremely rounded and slightly bevelled. It is uncertain whether the bevelling is a consequence of deliberate modification prior to use (cf. Kamminga 1981). Scarring includes step, fether and bending terminations, mostly on the dorsal surface (Slide H2-14 to 17). The largest are about 100mm wide and 5mm long. Striations are at or near 90 degrees to the edge, ranging up to 5mm in length, although most are 2-3mm long. The striations have both rounded and more v-shaped cross-sections (Slide H2-7 and 10). The polish or smoothing is clearly visible at low magnification with oblique lighting, and is similar to polish found on eloueras that are likely to have been hafted implements for processing soft fibrous wood (Kamminga 1977).

At high magnification Mould 1 (Slide H2-22 and 23), has clear alignments of polish at right angles to the edge. Abrasive smoothing seems to be a dominant mechanism, although patches of polish are very smooth and bright suggesting siliceous plants. Starch granules 2-5 microns diameter were visible within dark adhering tissue.

Mould 2 (from the retouched back) also has alignments of polish at right angles to the edge (Slide H2-25 and 26). The poilish is more reticular or net-like, highly suggestive of wood working. Other areas on this mould show rounded high points with low polish development more indicative of wear from holding the implement.

Mould 3 has use traces very similar to Mould 1, although polish formation is more developed and indicates the processing of plant tissue with medium silica content (Slide H2-27 and 28).

4.2 Starch

Starch grains were observed in four of the seven extractions taken from the tool, extractions W1, W2, W3 and W4. All four of these extractions were taken using the ultra sonic cleaner.

Extraction	Starch Types
W1	1 (5x5μm)
W2	1 (8-14x8-14μm) 51 (10x12μm) 12 (8-12x12-16μm)
W3	99 (8x12μm)
W4	1 (8x8μm) 9 (5x5μm)
W5	None
W6	None
W7	None

Table 1: Starch types present.

4.3 Phytoliths

Phytoliths were observed in three of the six extractions taken from the tool, extractions W1, W2 and W4. Each of these samples only contained one phytolith.

5. Discussion

5.1 Usewear

Along the dominant working edge of the implement, the residues, scarring, rounding and polish together indicate that the acute edge was used to chop soft, medium siliceous and starchy plant tissue. Two possible primary functions seem worthy of further investigation:

1. Processing of fern roots, in a similar way to the use of bevelled pounders. Fern roots (eg. *Pteridium* or *Blechnum*) may have been held on a hard wooden base and the the *worimi* was brought down on the bundle of fern roots and the roots drawn away so that the starchy mash would be extruded. An argument against this is that the *worimi* has only a very slight bevel, in contrast with the distinct bevel on the bevelled pounders.

2. Processing of starchy and siliceous soft woody plant tissue. Bark or soft wood has been chopped by the *worimi* in order to manufacture artefacts.

There is also incidental use of the tool for minor woodworking tasks along the steeply retouched edge, which also has blunting and rounding most likely associated with holding the implement when used for its primary function.

5.2 Starch

Starch is the primary food reserve for higher level plants. Starch can grow in all parts of the plant but is generally concentrated in storage organs such as tubers, seeds and fruit. Many studies have shown that starch grains or granules survive for remarkably long periods of time under a wide range of sedimentological conditions (eg. Briuer 1976; Loy 1993; Loy 1994.Loy et al. 1992; Fullagar 1986, 1998; Fullagar et al. 1998).

Examination of starch granules from species through out Australia and Papua New Guinea has revealed that the morphology of starch granules and starch assemblages can be used to identify the species origin (Therin et al. 1996, Loy 1994). At anyone time a plant will contain a range of different sized and shaped starch granules at different stages of development. Mature granules are generally the most morphologically distinct, immature granules tend to be small and round. In some cases the range of starch present can be used to identify the species of origin. The starch granule reference material (Starch Key) used in this study is presented in Appendix C.

Starch is deposited of the surface of stone tools through two main processes; as a result of the handling or use of the artefact or as contamination from the sediment in which the artefact was deposited. Barton et al. (1999) showed conclusively that the number starch granules observed on the surface of obsidian artefacts from Papua New Guinea was many times greater than that found in the surrounding sediment. Although starch is deposited in sediment as a process of plant decay, large numbers of starch granules observed on artefacts can only be related to the use or handling of the artefact.

The starch grains on the Fern Bay worimi were identified in four of the six extractions taken from the tool, extractions W1, W2, W3 and W4. The starch grains were observed in a clump in extraction W2 (Slide W2-4 to 7). It can be assumed that the starch grains observed in this clump come from a single plant species. Starch types 1 (8-14x8-14μm), 51 (10x12μm) and 12 (8-12x12-16μm) are considered to be a single assemblage. The morphology of the remaining starch types observed in extractions, 99 (8x12μm), 1 (8x8μm) and 9 (5x5μm), indicates that these starch grains may be part of the same assemblage. Starch grains extracted from the tool could have come from one, or possibly two, plant species.

The assemblage observed in extraction W2 is not consistent with starch assemblages currently held in the Australian Museum Starch Reference Collection. A sample of one fern rhizome (*Pteridium esculentum,* not vouchered) was collected from the Sydney area for comparison with the starch assemblage observed from the extraction. The starch assemblage from the *Pteridium esculentum* rhizome was not consistent with the one observed in extraction W2. A photograph of *Blechnum indicum* starch granules (Hall *et al* 1989 p153) is consistent with the starch assemblage observed in extraction W2 (Plate W2-4 to 7). Although possibly *Blechnum indicum*, further work is required before a solid identification can be made. Collection of further plant species, particularly *Blechnum* sp., is currently underway to determine if the observed starch assemblages are definitely a result of fern processing.

5.3 Phytoliths

Pictures of the three phytolith types observed from the extractions were sent to Carol Lentfer (Southern Cross University) for identification. Based upon her experience and extensive reference collection from Australia and the Pacific Carol made the following conclusions:

Assuming the stone was used for food processing it would be expected that the phytoliths would have come from a single source, especially since there was very little phytolith residue on the tool.

Grasses and sedges are excluded, since they do not have No.3 (Slide W2-14) the hair base morphotype. Acacias and ferns can have this morphotype. However, while both acacias and ferns have the siliceous shard morphotype No. 2 (Slide W2-11) acacias commonly have irregular ridged scleroids, not the regular blocky morphotype of No. 1 (Slide W2-1). *Acacia* sp. seeds rarely have phytoliths at all. Hair morphotypes are mainly confined to the leaves, stems and pods. Thus, it seems unlikely that the stone was used for processing acacia seeds.

It is possible (given the limitations of this meager assemblage) that the stone was indeed used for processing fern rhizomes. *Blechnum sp.* rhizomes (as do most fern rhizomes) comprise mainly siliceous shards (No. 2) but blocky forms are also present, albeit rarely. While I couldn't find any hair base types (no. 3) in the *Blechnum* sp. samples I examined, I did find a very similar form to the one in the picture, in

Diplazium esculentum rhizome (NB this is an edible fern found in New Guinea, not in Australia). Obviously, a larger sample of *Blechnum* sp. phytolith assemblages needs to be examined for to see if these types are present.

It should also be noted that morphotypes similar to No.3 are commonly found in other major plant taxa including the *Moraceae* sp. (figs), the *Eurphorbiaceae* sp. and the Urticaceae sp.. Although, the morphotype here bears good resemblance to that seen in *Diplazium* sp., it is perhaps not the most suitable morphotype on which to base reliable provenance.

I will conclude by saying that there is very little evidence (three morphotypes only) for food processing. However, given that the three morphotypes are present in one plant group i.e. ferns, the possibility that the tool was used for processing fern rhizomes, should not be dismissed.

6. Conclusion

Previously, the distribution, morphology and usewear on worimi artefacts have been consistent with a primary function of processing wetland plants. Our analysis of residues and polish provides more detailed functional data indicating processing of starchy plants with medium to low silica content. Based upon our current reference collection of starch and phytoliths and the photograph of *Blechnum indicum* (Hall et al 1989 p153) starch, the most likely plant processed with the worimi is *Blechnum indicum.* Further morphometric analyses of starch granules and fern phytoliths are required to support this initial conclusion.

7. References

Barton, H., R. Torrence and R. Fullagar 1998. Clues to stone tool function re-examined: Comparing starch granule frequencies on used and unused obsidian artefacts. *Journal of Archaeological Science* 25: 1231-1238

Briuer, F.L. 1976. New clues to stone tool function: Plant and animal residues. *American Antiquity* 41:478-84

ERM Mitchell McCotter 1999, Flora and Fauna: Carrington Mine. Report to Carrington Mine

Fullagar, R. 1986 *Usewear and residues on stone tools.* Unpublished PhD thesis. Melbourne: La Trobe University.

Fullagar, R. 1991 The role of silica in polish formation. *Journal of Archaeological Science* 18:1-25.

Fullagar (ed.) 1998 *A Closer Look: Recent Australian Studies of Stone Tools.* Sydney: Archaeological Computing Laboratory, Archaeology (Prehistoric and Historical), University of Sydney

Fullagar, R., T. Loy and S. Cox 1998. Starch granules, sediments and stone tool function: archaeological evidence for plant foods from Bitokara, Papua New Guinea. In R. Fullagar (ed.) *A Closer Look: Recent Australian Studies of Stone Tools.* Sydney: Archaeological Computing Laboratory, Archaeology (Prehistoric and Historical), University of Sydney. pp 49-60.

Gott, B. 1997 Compcopy NSWUSE 97. Ethnobotanical database of utilised plants in NSW. Beth Gott, Monash University.

Hall, J., S. Higgins and R. Fullagar.1989 Plant residues on stone tools. In W. Beck, A. Clarke and L. Head (eds) Plants in Australian Archaeology. Tempus Monograph Series, Anthropology Museum, University of Queensland. pp. 136-160.

Kamminga, J. 1977 A functional study of use-polished eloueras. In R.V.S. Wright (ed.) Stone Tools as Cultural Markers. Canberra: AIAS. Pp. 205-212.

Kamminga, J. 1981 The bevelled pounder: an Aboriginal stone tool type from southeast Queensland. Proceedings of the Royal Society of Queensland. 92:31-31.

Kamminga, J. 1982. *Over the Edge: Functional Analysis of Stone Tools.* Brisbane: Anthropology Museum, University of Queensland. *Occasional Papers in Anthropology 12.*

Kamminga, J. 1988.Wood Artefacts: A check list of plant species utilised by Australian Aborigines. *Australian Aboriginal Studies* 2

Kealhofer, L., R. Torrence and R. Fullagar 1999. Integrating phytoliths within usewear/residue studies of stone tools. *Journal of Archaeological Science* 26: 527-546.

Lentfer, C., Therin, M. and Torrence, R. (in press) Starch granules and Environmental Reconstructions: a Modern Test Case from West New Britain, Papua New Guinea. *Journal of Archaeological Science*

Loy, T.H. 1993. Prehistoric Organic Residue Analysis: The future meets the past. In M. Spriggs, D.E. Yen, W. Ambrose, R. Jones, A. Thorne and A. Andrews (eds) *A Community of Culture: The People and Prehistory of the Pacific.* Canberra, Department of Prehistory, Research School of Pacific Studies, The Australian National University.

Loy, T. 1994. Methods in the analysis of starch residues on prehistoric stone tools. In J. Hather (ed.) *Tropical Archaeobotany: Applications and New Developments.* London: Routledge. Pp. 86-114.

Loy, T., S. Wickler and M. Spriggs 1992. Direct evidence for human use of plants 28,000 years ago: starch residues on stone artefacts from the Solomon Islands. *Antiquity* 66: 898-912.

Navin, K. and Kamminga. J., 1999. Proposed Pacific Highway Karuah Bypass and Duplication Environmental Impact Statement: Cultural Heritage. Report to Ove Arup and Partners.

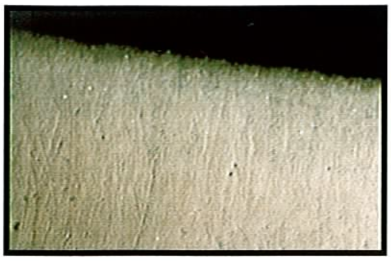
MCR, 2000. Leminton Mine: Archaeological Usewear and Residue Analysis. Report to South Eastern Archaeology.

Navin, K. and J. Kamminga 1999 Karuha Bypass

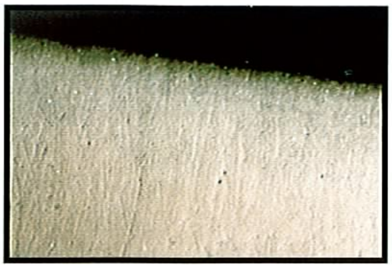
Therin et al 1997. Australian Museum Starch Reference Collection. *Australian Archaeology* Vol 44; pp 52-53.

APPENDIX A

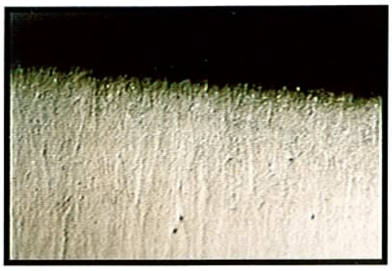
Plates



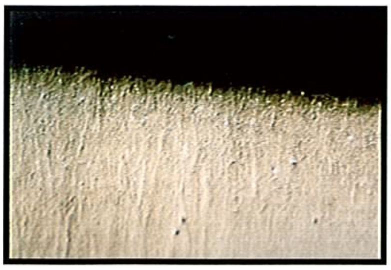
Slide H2-7: Polish and striations, Area 1, x18.



Slide H2-8: Polish and striations, Area 1, x18.



Slide H2-9: Polish and striations, Area 1, x25.



Slide H2-10: Polish and striations, Area 1, x25.

Slide H2-11: Polish, Area 3, x18.

Slide H2-12: Polish, Area 3, x25.

Slide H2-13: Polish, Area 3, x25.

Slide H2-14: Polish, scar and rounding, Area 2, x18.

Slide H2-15: Polish, scar and rounding, Area 2, x18.

Slide H2-16: Polish, scar and rounding, Area 2, x25.

Slide H2-17: Polish, scar and rounding, Area 2, x25.

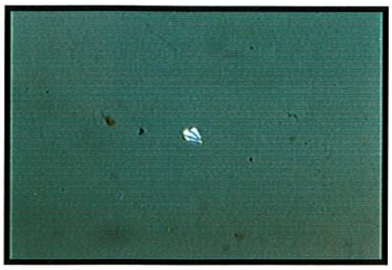
Slide H2-18: Boundary between striations/rounding /polish, Area 1, x18.

Slide H2-19: Boundary between striations/rounding /polish, Area 1, x18.

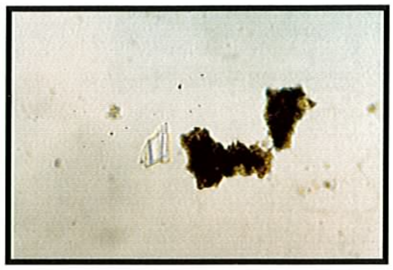
Slide H2-20: Boundary between striations/rounding /polish, Area 1, x25.

Slide H2-21: Boundary between striations/rounding /polish, Area 1, x25.

Slide W2-9: Extraction W2, Starch granule, x500.

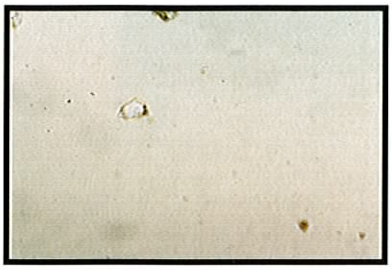


Slide W2-10: Extraction W2, Starch granule, x500.



Slide W2-11: Extraction W2, Phytolith, x500.

Slide W2-12: Extraction W3, Starch granule, x500.

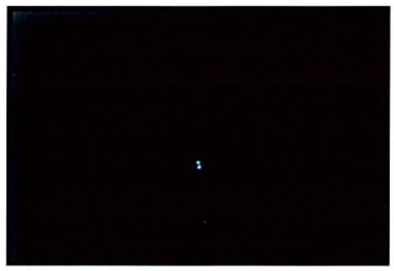


Slide W2-13: Extraction W3, Unknown residue, x500.

Slide W2-14: Extraction W3, Phytolith, x500.

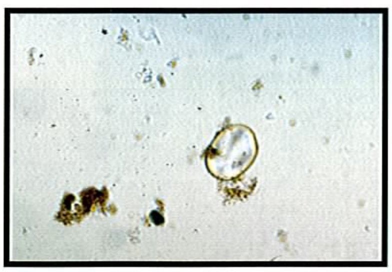
Slide W2-15: Extraction W3, Plant Tissue (not starch), x500.

Slide W2-16: Extraction W3, Plant Tissue (not starch), x500.



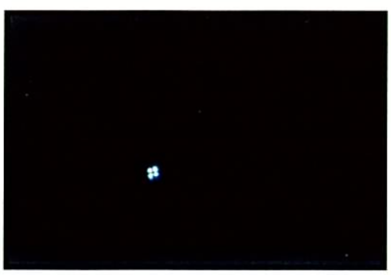
Slide W2-17: Extraction W3, Starch granule, x500.

Slide W2-18: Extraction W4, Starch granule, x500.



Slide W2-19: Extraction W4, Starch granule, x500.

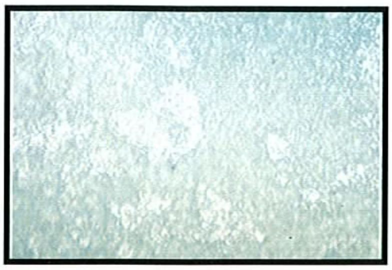
Slide W2-20: Extraction W4, Plant tissue, x500.

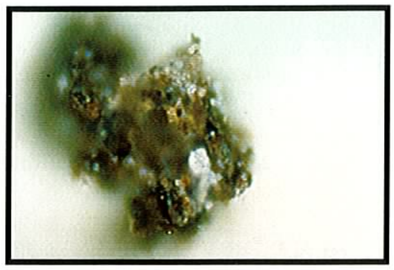


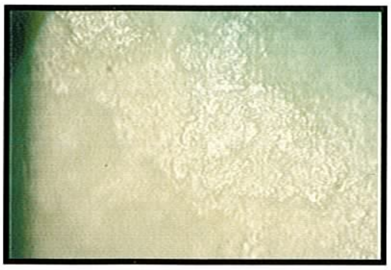
Slide W2-21: Extraction W4, Starch granule, x500.

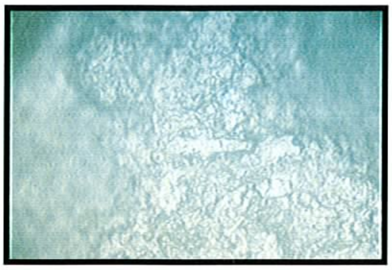
Slide W2-22: Extraction W4, Starch granule, x500.


Slide H2-22: Polish and striations, Mold 1, x200.

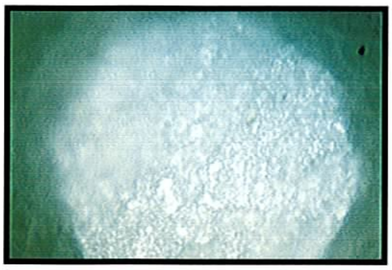

Slide H2-23: Polish and striations, Mold 1, x500.

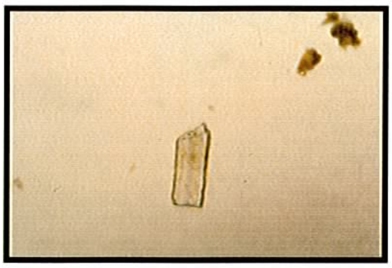

Slide H2-24: Starch grains in a mass of dark tissue, Mold 1, x500.


Slide H2-25: Polish, Mold 2, x200.


Slide H2-26: Polish, Mold 2, x500.

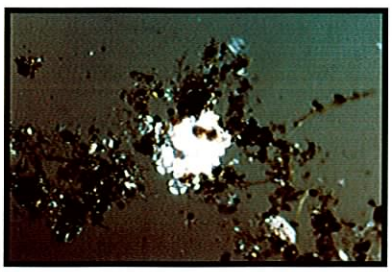

Slide H2-27: Polish, Mold 3, x500.

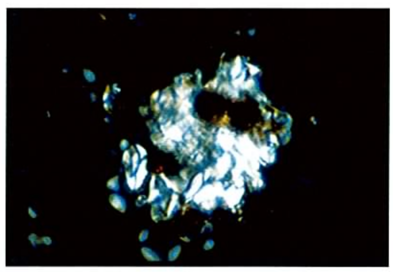

Slide H2-28: Polish, Mold 3, x500.

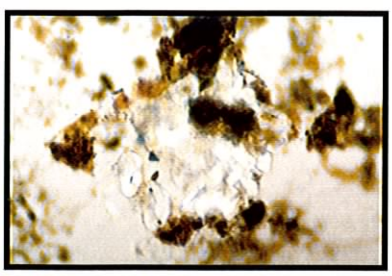

Slide W2-1: Extraction W1, Phytolith, x500.

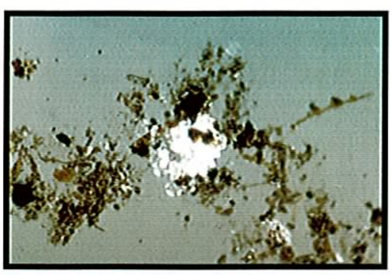

Slide W2-2: Extraction W1, Starch granule, x500.


Slide W2-3: Extraction W2, Starch granule, x500.

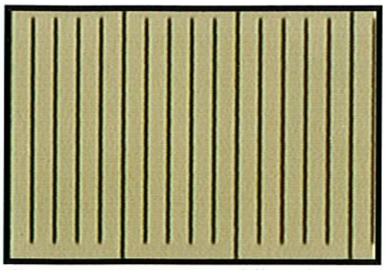

Slide W2-4: Extraction W2, Starch granules, x200.


Slide W2-5: Extraction W2, Starch granules, x500.

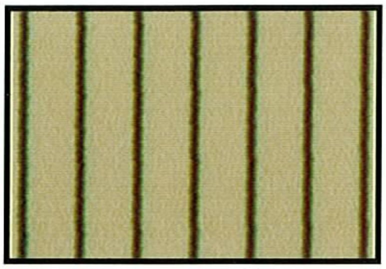

Slide W2-6: Extraction W2, Starch granules, x500.


Slide W2-7: Extraction W2, Starch granules, x200.


Slide W2-8: Extraction W2, Starch granule, x500.



Scale: x200 magnification
each increment is 10 microns



Scale: x500 magnification
each increment is 4 microns

Ventral Side

Dorsal Side

Left Edge

APPENDIX B

Usewear Notes

RF

AREA 4 EXTRACTION IS WHOLE EDGE FROM ① - ③ - in wad abo d 5mm

Fern Bay Archaeology Project Site 2 T.T.1.B-4 Spit 6 Worimi Cleaver

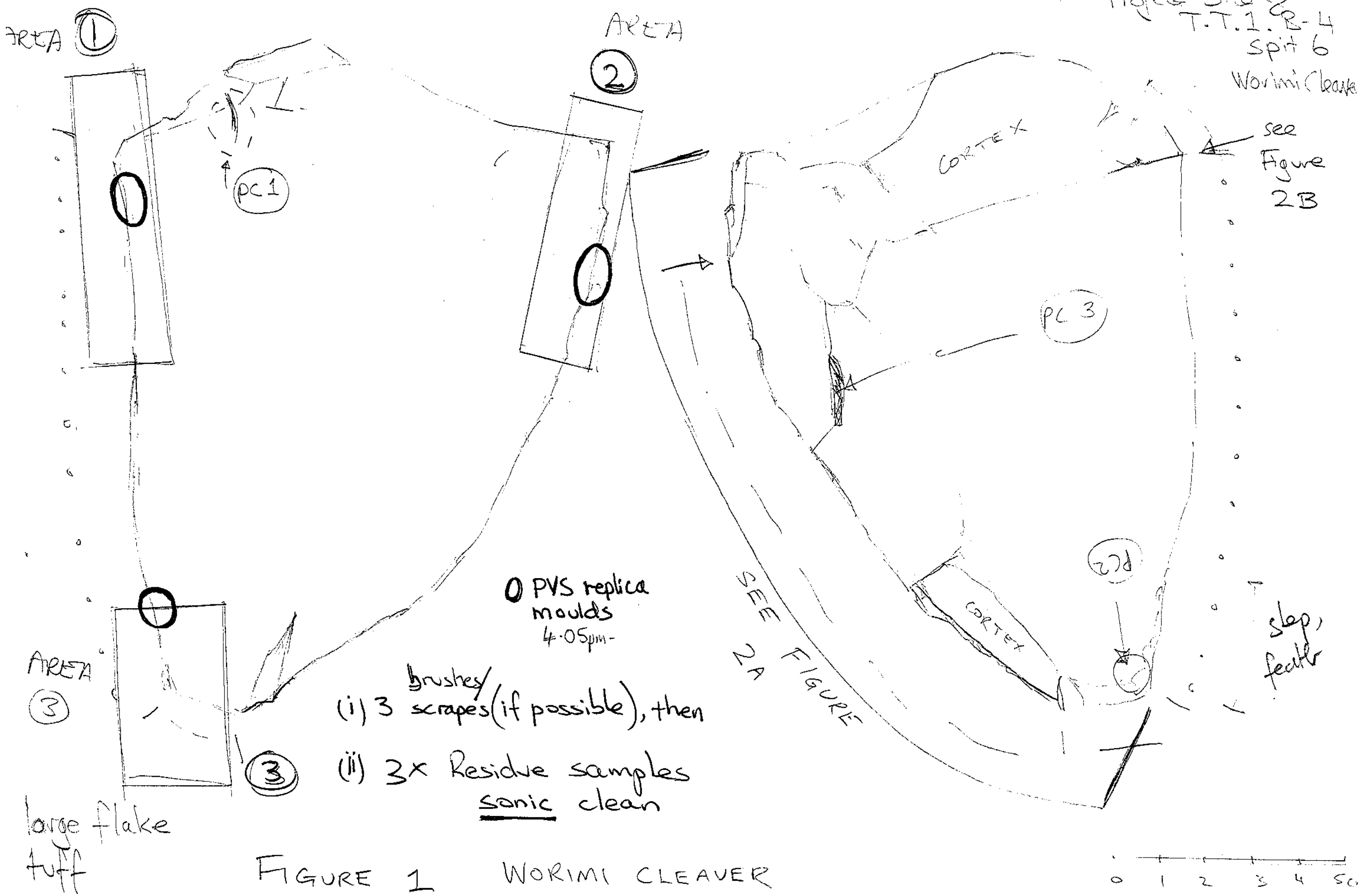


FIGURE 1 WORIMI CLEAVER

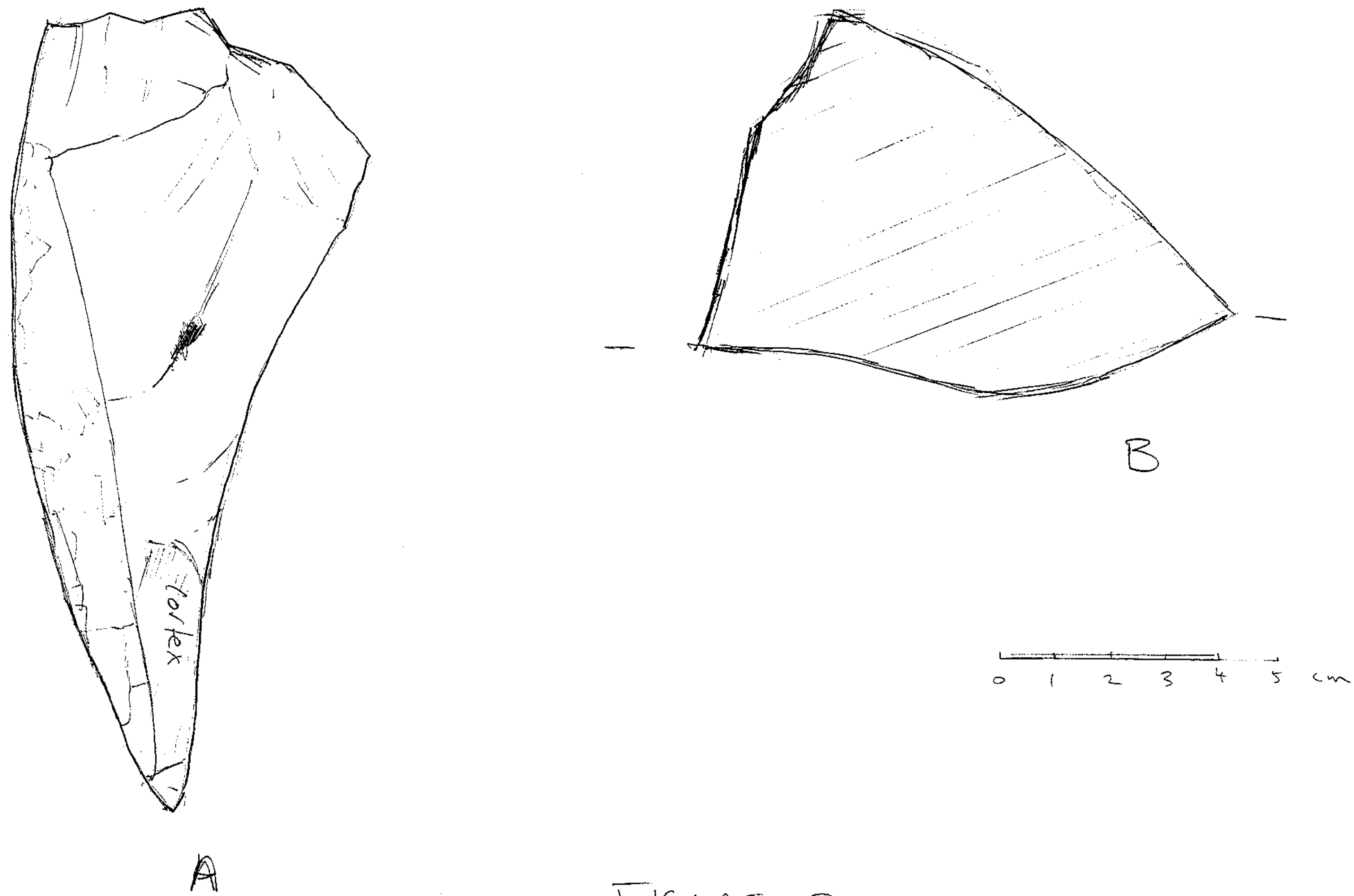
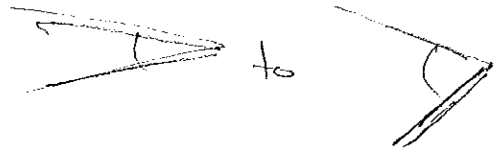


FIGURE 2

• edge angle varies 

wear – rounding is <u>extremely</u> marked and extends on to both surfaces up to ~ 8mm

– the edge <u>seems</u> slightly bevelled towards the centre, but under low power mag, the rounding seems even –

[the curve is wider]

– scarring – step & feather & bending mostly on ~~dorsal~~ surface at the thin distal end (largest s. 10mm wide & 5mm long)

– striations ⊥ near 90° to edge

 , some long ~~5~~ 5 mm
most 2-3 mm

– polish. – smoothing clearly visible macroscopically & at low power oblique light. cf. elovera/bungwall pounder

[s]hould ① • alignment of smooth polish ⊥ edge
• patches of bright, domed polish cf. med. siliceous plant.
• polish forms 2-3 – abrasion is the dominant wear
mostly

mould ① cont. starch grains 2-5 microns
common in dark tissue.

mould ②. (retouched edge)

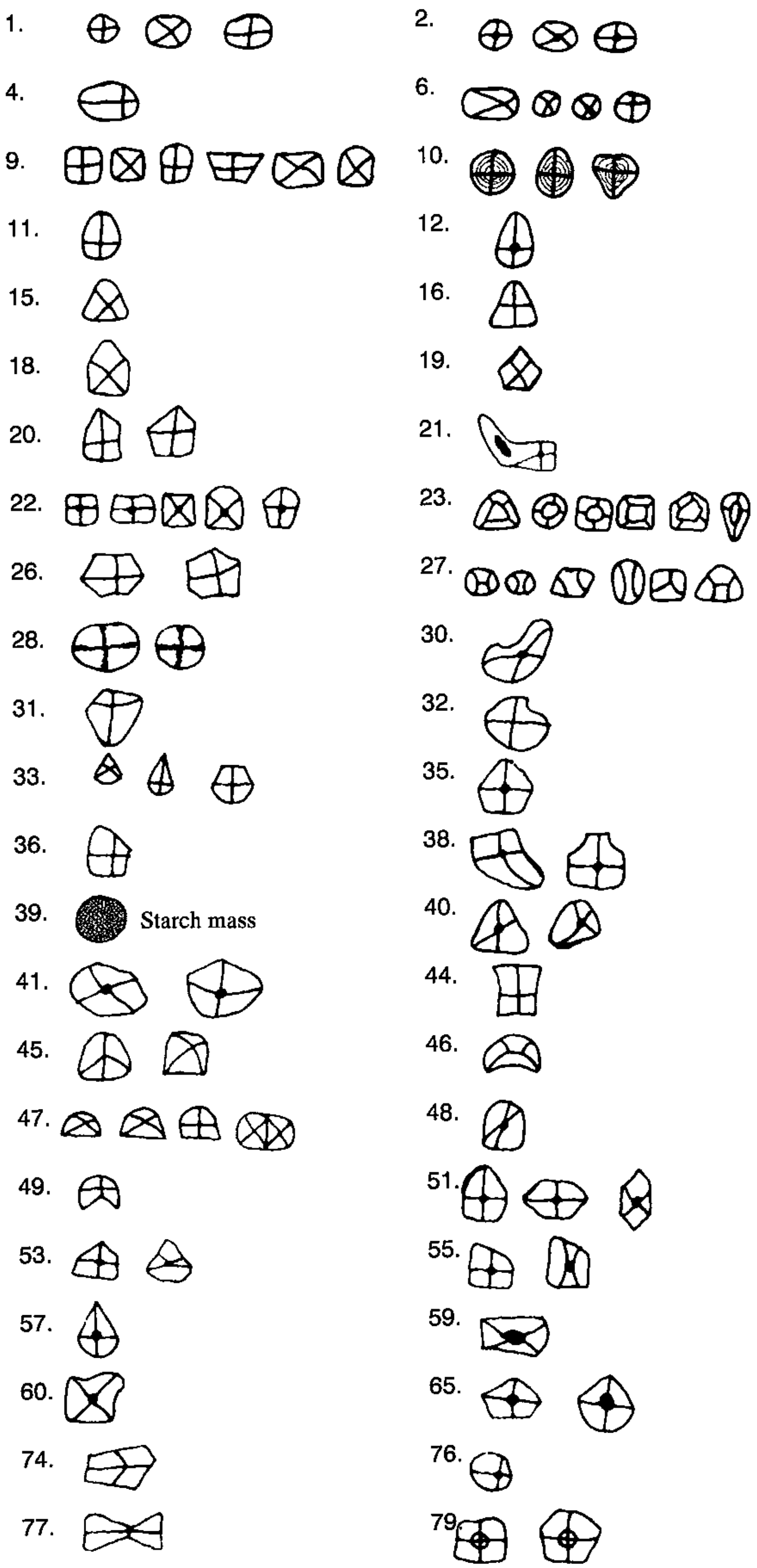
. alignments ⊥ edge
- polish ③ - cf wood in places next
to scarring (incl. steps)
probably wood, but
traces of handling (greasy
surfaces) as well

more not like than
mould ①.

mould ③ similar to ①
polish is patchy and in
alignments longht, smooth
cf. plant, med. silica
high abrasion.

APPENDIX C

Starch Key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Starch mass
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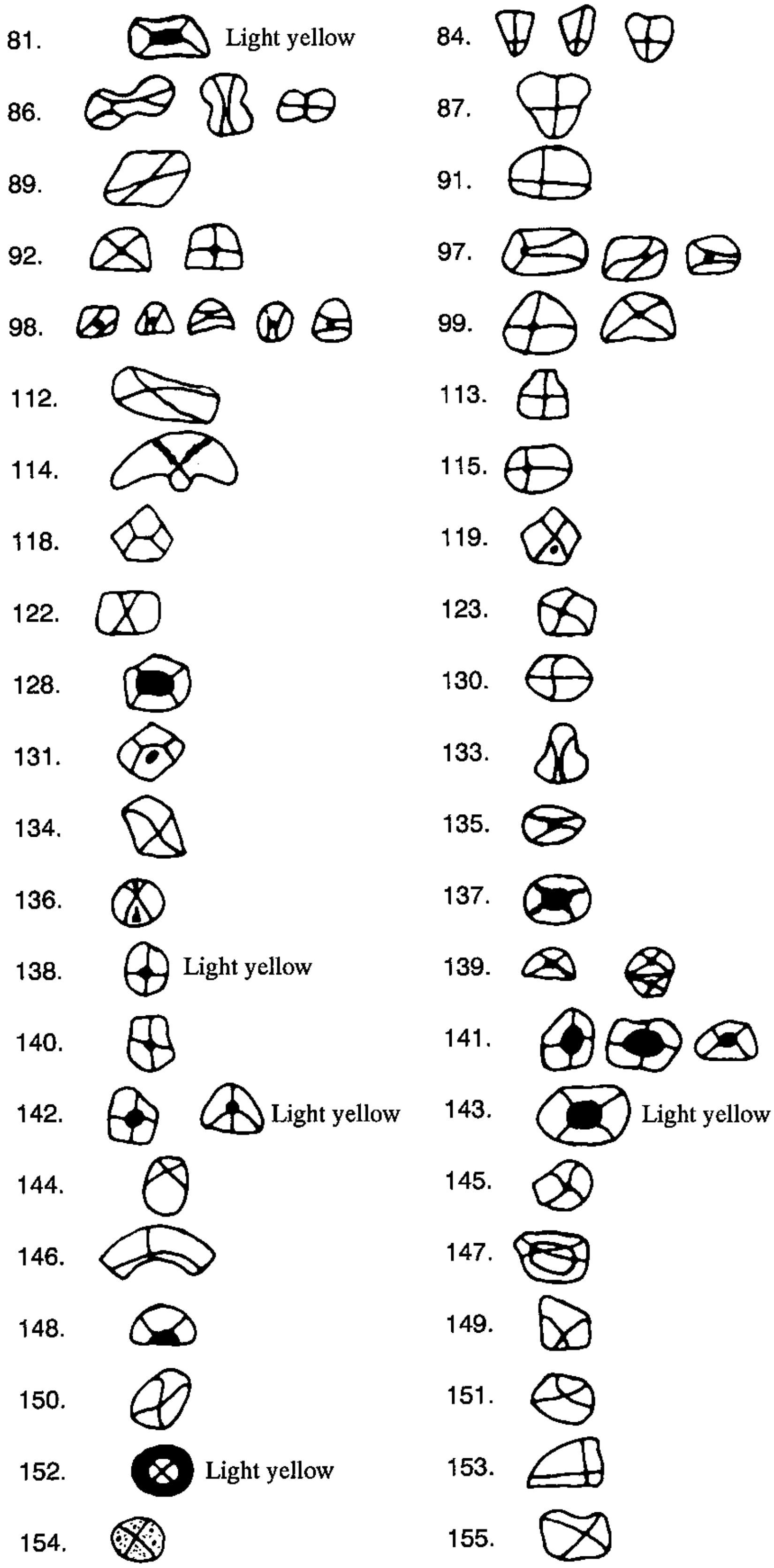


(Key taken from Therin 1995)

Annex 6

Carbon Dating

University of Waikato – Radiocarbon Dating Laboratory

The University of Waikato

Radiocarbon Dating Laboratory

Private Bag 3105
Hamilton,
New Zealand.
Fax +64 7 838 4192
Ph +64 7 838 4278
email c14@waikato.ac.nz
Head: Dr Alan Hogg

Report on Radiocarbon Age Determination for Wk- 13446

Submitter	JS Wheeler
Submitter's Code	Site 8 TT1 Spit 8 - Hearth Deposit
Site & Location	Fern Bay, Stockton Bight, NSW, Australia. Holocene Sand Dune., Australia
Sample Material	Charcoal
Physical Pretreatment	Possible contaminants were removed. Washed in ultrasonic bath.
Chemical Pretreatment	Sample washed in hot 10% HCl, rinsed and treated with hot 0.5% NaOH. The NaOH insoluble fraction was treated with hot 10% HCl, filtered, rinsed and dried.

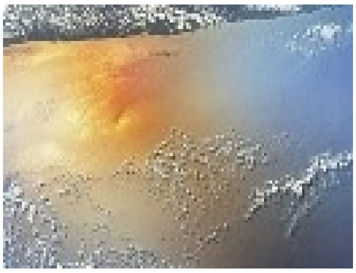
$d^{14}C$	-275.7 ± 4.0	‰
$\delta^{13}C$	-25.5 ± 0.2	‰
$D^{14}C$	-275.1 ± 4.0	‰
% Modern	72.5 ± 0.4	%
Result	**2584 ± 45 BP**	

Comments

7/10/03

- Result is *Conventional Age or % Modern* as per Stuiver and Polach, 1977, Radiocarbon 19, 355-363. This is based on the Libby half-life of 5568 yr with correction for isotopic fractionation applied. This age is normally quoted in publications and must include the appropriate error term and Wk number.
- Quoted errors are 1 standard deviation due to counting statistics multiplied by an experimentally determined Laboratory Error Multiplier of 1 .
- The isotopic fractionation, $\delta^{13}C$, is expressed as ‰ wrt PDB.
- Results are reported as *% Modern* when the conventional age is younger than 200 yr BP.

ERM consulting services worldwide **www.erm.com**



Environmental Resources Management Australia
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Thornton NSW 2322
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Facsimile (02) 4964 2152