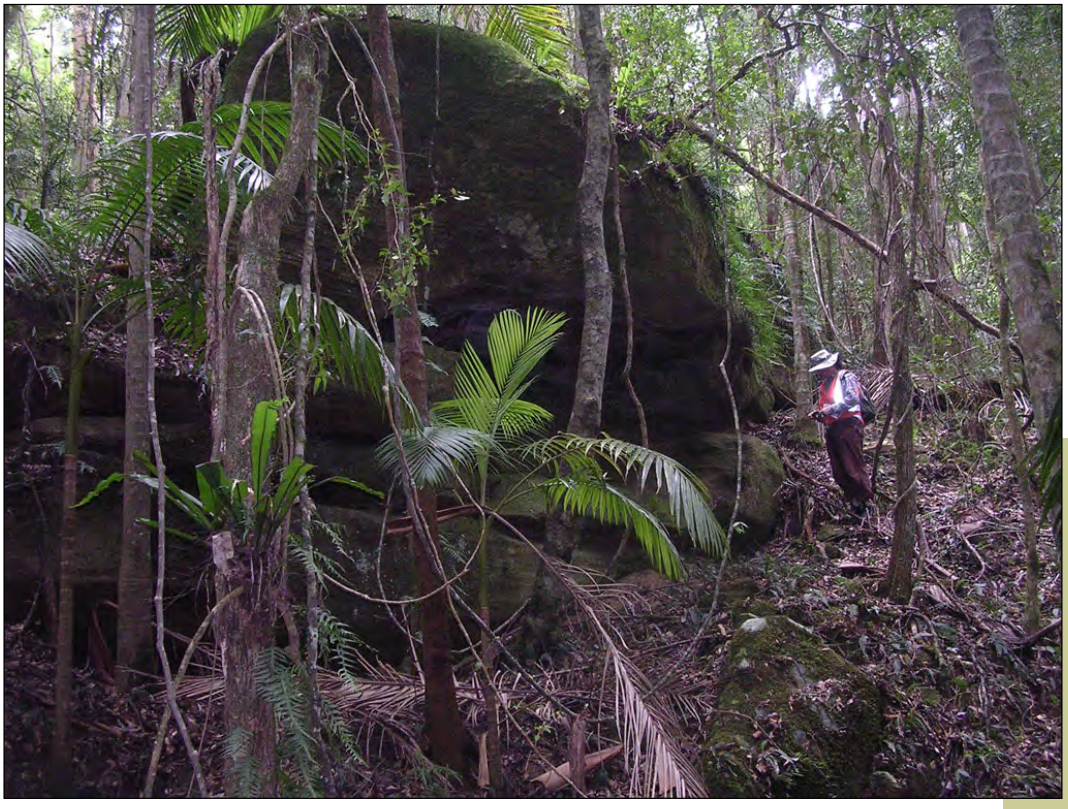

Coastal rainforest vegetation in Calmans Gully.

Indigenous and Historic Heritage Assessment

Subsidence zone for the Wallarah 2 Coal Project

Wyong NSW.

February 2010

Report Prepared by

OzArk Environmental and Heritage Management Pty Ltd

For Wallarah 2 Coal Project

Environmental and Heritage Management P/L

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Executive Summary

OzArk Environmental & Heritage Management Pty Ltd (OzArk) has been commissioned by International Environmental Consultants Pty Ltd (IEC) on behalf of Wyong Areas Coal Joint Venture (WACJV) to undertake heritage assessment within the area of potential subsidence associated with the Wallarah 2 Coal Project (W2CP). This study builds on several existing studies undertaken for the WACJV, the findings of investigations for other projects in the region, for which there is a considerable body of literature, as well as targeted field survey.

In the current Subsidence Study Area assessment, a methodology was developed to establish known and likely heritage values, with a significant focus on the manner in which the potential impacts (subsidence, tilt, altered hydrology etc.) may affect these values. Complete survey was not considered feasible considering the scale of the Study Area and land tenure/land access constraints. Instead targeted survey was undertaken to test the outcomes of predictive modelling based on the review of previous studies placed in their regional context. In this way the predictive model can be tested to extrapolate to areas within the Study Area that have not been assessed.

As a result two areas within the Study Area were surveyed as they represented the major landforms of the Study Area: river flats and hills. The Wyong State Forest Survey Study Area (Wyong Forest Study Area) occupies the western portion of the Study Area and is representative of the steeply rising hills and valleys that characterise this area. The Honeysuckle Park Survey Study Area, by contrast, occupies the river flats on Jilliby Jilliby Creek: a representative landform from the eastern portion of the Study Area.

As a result of the heritage assessment that took place in January 2010, four Aboriginal axe-grinding groove sites were recorded within Wyong State Forest as part of the heritage assessment of Wyong Forest Study Area. Three are clustered together on the one watercourse in the very north of the Study Area (WSF-AG1–3), while WSF-AG4 is located in the southwest of the Wyong Forest Study Area.

In addition the location and condition of a group of previously recorded axe-grinding groove sites in the Wyong Forest Study Area was ground-truthed.

The major potential impact facing these sites is the effects of underground mining on earth movements such as subsidence and tilting. Regarding sites recorded as part of the current assessment, all sites (WSF-AG1–4) are beyond the expected extent of compressive and tensile strain as well as tilt. Two sites (WSF-AG3 and WSF-AG4) are on the very boundary of the subsidence area and may suffer from subsidence in the order of 0.02 m. These effects are considered to have a negligible to very low risk of damage to the sites' integrity.

The previously recorded axe-grinding sites along Myrtle Creek are at a generally low level of risk of damage.

The result of the heritage assessment has enabled testing of the predictive model and has allowed for greater certainty in characterising the Aboriginal heritage resource within the zero subsidence area. The report concludes that the results of survey within Honeysuckle Park Study Area conformed to the predictive model that these intensively farmed river flats are unsuitable for the preservation of archaeological deposits or sites. There is, therefore, a negligible risk that the proposed underground mining would adversely impact cultural heritage in the eastern portion of the Study Area.

In the western portion, sampled as the Wyong Forest Study Area, there remains the opportunity for gathering detailed information about further potential sites within the valleys of the Wyong Forest Study Area. Accordingly, further field assessment may be considered appropriate to inform SMPs in the post-approval phase, or for site specific management resulting from panel by panel pre-mining surveys. All sites located within the subsidence zone within Wyong State Forest would be monitored pre-mining and post-mining to assess potential impacts.

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1. Introduction

1.1. Brief description of the project

OzArk Environmental & Heritage Management Pty Ltd (OzArk) has been commissioned by International Environmental Consultants Pty Ltd (IEC) on behalf of Wyong Areas Coal Joint Venture (WACJV) to undertake heritage assessment within the area of potential subsidence associated with the Wallarah 2 Coal Project (W2CP)[1]. This study builds on several existing studies undertaken for the WACJV, the findings of investigations for other projects in the region, for which there is a considerable body of literature, as well as targeted field survey.

Field assessment of two portions of the Study Area took place between 25–29 January 2010.

To designate the various areas covered by this report there are three components to the current Study Area. They are:

- Subsidence Study Area: this includes all areas within the green line as shown in **Figure 2**: an area that is a little larger than the black dotted line as shown in **Figure 1**. Unless otherwise stated, reference to the Study Area refers to this area.
- Wyong State Forest Survey Study Area (Wyong Forest Study Area): This includes the area within the western blue dotted line in **Figure 3**.
- Honeysuckle Park Survey Study Area (Honeysuckle Study Area): This includes the area within the eastern blue dotted line in **Figure 3**.

The two survey Study Areas, the Wyong Forest and Honeysuckle Study Areas, are within the Subsidence Study Area. They constitute areas that either have public access as they are State Forests (Wyong Forest Study Area), or are owned by the Wallarah 2 Coal Project (Honeysuckle Study Area). These two areas were subjected to a full heritage assessment to verify the predictive model for site location as set out in **Section 4.4**. The remainder of the Subsidence Study Area, being on private property, was not assessed in the field but is the subject of the desktop review presented here.

1.2. Location

The Study Area is located to the west of Wyong on the Central Coast of NSW. In the east the Study Area comprises Jilliby Jilliby Creek and surrounding properties that occupy the floodplains and adjacent rises of Jilliby Jilliby Creek and its tributaries. In the west the Study Area is occupied by the Wyong State Forest and comprises of wooded hills that rise abruptly, albeit to a low relative altitude, from the floodplains of Jilliby Jilliby Creek.

Figure 1 shows the location of the Study Area while **Figure 2** shows the zero subsidence line within which subsidence has a risk of occurring.

[1] The zero subsidence line (otherwise termed the “subsidence impact limit”) delineates the boundary of the area of ground surface that subsidence from underground mining activities may potentially impact.

Figure 1: Location of Study Area. The Study Area (underground extraction area) is shown as a black dotted line

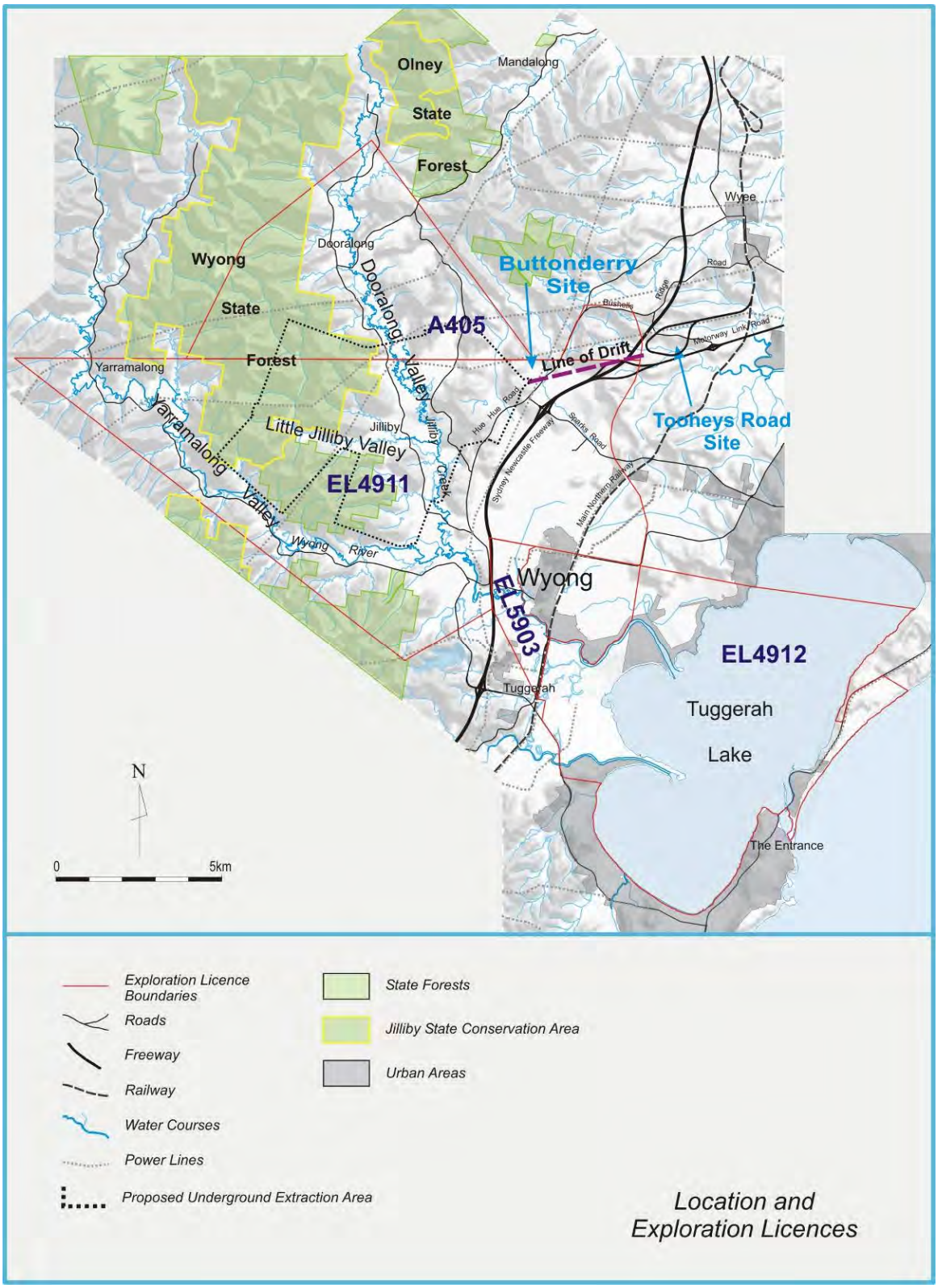
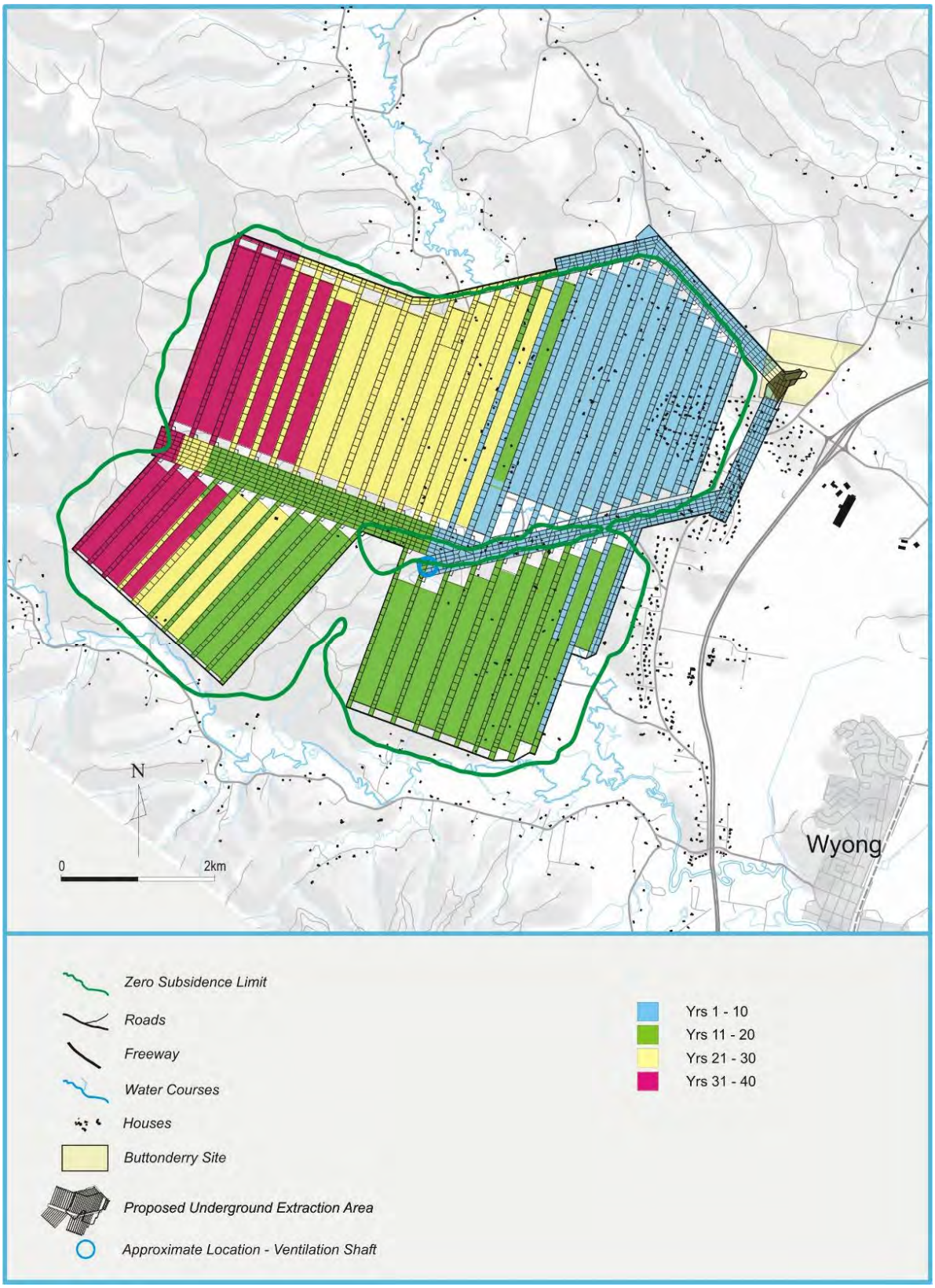


Figure 2: Detail of the underground extraction area showing the zero subsidence line (green).



1.3. Date of heritage assessment

The heritage assessment of the Wyong Forest and Honeysuckle Study Areas took place between Monday 25 January and Friday 29 January 2010 (including Australia Day, 26 January, which was worked). The survey team consisted of two archaeologists from OzArk and representatives from the registered Aboriginal community stakeholders. In total, 34 person days were spent on the in-field component of this report.

1.4. Aboriginal community involvement

The W2CP has been undertaken according to the Department of Environment and Conservation[2] (DEC 2004) Interim Community Consultation Requirements (ICCRs) as recommended in the DEC 2005 *Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation* (for Part 3A assessments). This process has been followed from the current project inception in 2006. The group of Registered Stakeholders comprises the Darkinjung Local Aboriginal Land Council (DLALC), within which the boundaries of the Study Area fall, and Guringai Tribal Link Aboriginal Corporation (GTLAC).

Letters regarding the proposed methodology for bringing the results of the 2006 archaeological assessment into focus for the 2010 project were sent out with copies of the draft report to both registered stakeholder groups. Responses were received from the DLALC and GTLAC. Both organisations were supportive of the methodology proposed, however DLALC requested an extension on their feedback until after the additional survey in the western area potential subsidence district.

The OzArk survey team was accompanied in the field on all survey days by representatives from both the DLALC and GTLAC. The OzArk survey team benefited from the Aboriginal representatives' knowledge of the local landforms, traditional uses of the vegetation present and their past experience gained from working with other heritage survey teams in the district. It is noteworthy that Tracey Howie, David Pross and Sharon Hodgetts participated in the field assessment of the Buttonderry and Tooheys Road areas at W2CP with OzArk in 2006.

The following groups were represented in the current survey:

Darkinjung Local Area Land Council:	Ms Sharon Hodgetts (25–29 January 2010) Mr Darren Carney (28 – 29 January 2010)
Guringai Tribal Link Aboriginal Corporation:	Ms Tracey Howie (25–29 January 2010) Mr Kyle Howie (25-26 January 2010) Mr Warren Howie (25-26 January 2010) Mr David Pross (26-29 January 2010)

The GTLAC have provided a written report relating to the field survey and this can be found in Appendix 2. This report concludes that an Aboriginal Cultural Heritage Management Plan should be prepared in partnership with the GTLAC and the DLALC. It is also noted in the recommendations of the report that a rock shelter, recorded in 2009 during an infrastructure studies (after the AHIMS searches for the current project), may be within the potential subsidence district for the W2CP. It is noteworthy that OzArk have plotted the location of this rock shelter site in relation to the zero

[2] Now Department of Environment, Climate Change and Water (DECCW).

subsidence line and can confirm that this site is outside the potential subsidence area. Its' proximity is however noted and we appreciate that the GTLAC drew our attention to this site.

The DLALC have indicated they will provide comment on both the original and current reports, however, due to time constraints for the EA, this heritage report is being submitted without it. When received, the DLALC report will be made available for the EA exhibition phase. This is in accordance with OzArk's policy to allow a two week time period for response so as to include community feedback with the heritage assessments.

Appendix 1 contains the Aboriginal Community Communication Log associated with the current survey and the 2006 heritage assessment of the Tooheys Road site.

1.5. Native Title

No native title claims appear to exist that encompass the Study Area. An approved claim (Tribunal file number NN00/7) brought by the Darkinjung Local Aboriginal Land Council exists to the east of the Study Area.

1.6. OzArk EHM involvement

OzArk has been involved with a range of studies concerning the heritage assessment of the Wallarah 2 Coal Project. They are:

- In 2006 OzArk conducted field assessment of the Tooheys Road site, as well as conservation off-set areas and the Buttonderry site. The results and recommendations of this survey are in OzArk 2009.
- In 2009 OzArk developed a desktop predictive model report for the subsidence area. The research and findings of this report informed the 2010 survey methodology and is included within this report.
- In 2010 OzArk undertook targeted heritage surveys of two areas within the Subsidence Study Area to test the veracity of the desktop predictive model and to better inform management options for the subsidence area. This survey is the subject of this report.

The 2010 in-field heritage survey was undertaken by Ben Churcher and Pauline Hams.

This report was written by Dr. Jodie Benton and Ben Churcher.

2. The Project

The W2CP is being undertaken by Wyong Areas Coal Joint Venture (WACJV). For the purposes of this report W2CP is the name of the project and WACJV is the name used to refer to the Proponent. A change in majority share ownership saw a new project scope defined to manage resource extraction. A brief history of project ownership is as follows:

- WACJV was founded in 1995, at the invitation of the NSW Government, to submit a competitive tender for the Wyong Coal Development Areas.
- The majority partner in the successful tender was Coal Operations Australia Ltd, with minority partners including Wyong Areas Coal Joint Venture and other Korean and Japanese interests. BHP Billiton subsequently became a majority shareholder through the acquisition of Coal Operations Australia Ltd.
- In 2005, the Korean Resources Corporation (Kores) acquired the BHP Billiton interest in the project, taking its equity in the venture to 82.25%. The WACJV proposes to develop the coal resource with a new project scope, referred to as the Wallarah 2 Coal Project (W2CP). Wyong Areas Coal Joint Venture is undertaking final feasibility studies for the W2CP which is a mining option re-configured from that which had been pursued in the past.

Over the past ten years, a number of environmental and engineering studies have been completed for the WACJV and W2CP. These include:

- Detailed Flood Study covering both the Yarramalong and Dooralong Valleys. This work has been provided to Wyong Shire Council to assist in strategic planning for the area and has been exhibited to the community;
- Detailed environmental investigations covering climate, ecology, heritage and social issues. A full bibliographic summary of relevant heritage reports is presented in **Table** 1;
- Engineering assessments and geotechnical investigations, including subsidence and groundwater which have led to the formulation of the proposed mine plan for the target area;
- Extensive exploration work involving 352 drill holes, which represents 158 km of drill core being logged and analysed; and
- Detailed financial evaluation covering several development options. These options have included various production rates, equipment alternatives, coal processing and handling, transportation options and marketing factors.

A Pre-Feasibility Study was produced in early 2003 by the WACJV. This work has now been refined for the W2CP and will result in a more detailed Feasibility Study which is currently being progressed. The full Feasibility Study will not affect the production of the Environmental Assessment documentation as the economic viability of the project has already been confirmed. The Feasibility Study will concentrate on detailed engineering design but will include all environmental protection initiatives developed as part of the Environmental Assessment process.

The previous heritage work is summarised in **Table 1** and presented in more detail in **Section 4**. It is noteworthy that it seems that more work was commissioned than OzArk has been able to access,

hence **Table 1** and our review may omit a couple of small reports that we have been unable to source. It should be noted that the Buttonderry study area is also referred to as Hue Hue Road in some previous reports and the Tooheys Road study area is often referred to as Bushells Ridge. The Western Area is a term also often used and this encompasses both Buttonderry and Tooheys Road study areas, as well as the larger subsidence area below which long wall mining is proposed (**Figure** 1). Previous studies have at times described the potential mining area in the Western Area exploration licence areas as the Primary Target Area.

Table 1: Previous heritage studies for the W2CP.

Company / Author / Year Finalised	Title	Specialist components	Location
ERM 2001a	Indigenous Cultural Heritage Study – Western Area Study Methodology	Indigenous Heritage Desk top review only.	Entire Western Area
ERM 2001b	Wyong Project – Indigenous Cultural Heritage Assessment – Preliminary Survey of the Bushells Ridge Site	Indigenous heritage preliminary field survey to identify visible archaeological evidence, areas of archaeological sensitivity and areas for further investigation.	Tooheys Road study area
ERM 2001c	Wyong Project – Non-Indigenous Cultural Heritage Assessment – Preliminary Survey of the Bushells Ridge Site	Non-Indigenous heritage preliminary field survey to identify new features of potential heritage significance and areas for further investigation.	Tooheys Road study area
ERM 2001d	Wyong Project – Non-Indigenous Cultural Heritage Assessment – Preliminary Field Survey	Non-Indigenous Heritage Preliminary field survey to identify new features of potential heritage significance and areas for further investigation.	Entire Western Area

These studies were followed in May 2006 by OzArk EHM who prepared a desktop study, entitled *Wallarah No. 2 Coal Project. Gap Analysis & Methodologies for further Environmental Assessment: Terrestrial Ecology and Heritage* (incorporated into OzArk 2009).

The May 2006 report summarises previous heritage data relating to the entire project and makes specific recommendations regarding heritage assessment requirements for the Western Area and consequently the area enclosed by the zero subsidence line that is the focus of the current report. These recommendations, in part, form the basis of the current project scope. The remainder will comprise the basis for the heritage assessment component of the Subsidence Management Plan (SMP), which will be generated once project approval has been achieved and mining lease issued.

2.1. Proposed Works

The W2CP will involve the underground extraction of export quality thermal coal with associated surface facilities and infrastructure. The project is comprised of an underground longwall mine, a coal handling plant (dry processing only) and storage facilities, rail loop and loading infrastructure, an underground drift entry, ventilation shafts and gas management facility.

The combined Wallarah - Great Northern Seam, averaging around 6 m thick, will be mined by a longwall system, conveyed to the surface via a drift conveyor system and processed to produce 4-5 million tpa of product coal from the mine. Between 3 m and 4.5 m of the coal seam is proposed to be extracted. The coal processing consists of crushing only and, because the mine will not require a coal washing plant, no tailings or bulk reject will be produced. Water generated by the mine will be used in the crushing and stockpiling process and any excess water will be treated before discharge or transfer to appropriate reuse. The mine will produce a single 14–18% ash product to be marketed for export and domestic electricity generation.

The mine will also produce natural gas as an integral part of the mining process and this will be collected and marketed for domestic electricity generation or other commercial uses.

The proposed mine area covers a 42 year period of underground mining operations. In order to provide certainty for the proponent and to secure mining title to the proposed mining area, a Project Approval will be sought for the entire Mine Plan as shown in **Figure 1**. The Project Approval will enable mining operations within a Mining Lease granted for a lesser period than 42 years.

The current study provides an overview of the heritage resource within the proposed mining area based on the results of previous studies, predictive modelling and complimented by targeted field survey. The results will be complemented by further detailed investigations as part of the Subsidence Management Plan (SMP) process following project approval. This mining area is defined as all land with potential to be affected by subsidence due to longwall mining. The point at which mining related subsidence will not occur beyond is defined as the zero subsidence line (or 'subsidence impact limit': **Figure 2**).

As this report is specific to the coal extraction area (Subsidence Study Area), only the proposed works in this area will be detailed below. Other proposed works for surface facilities have been described in detail in OzArk 2009.

The proposed longwall mine plan has been designed to minimise impacts to the environment as much as is practicable, particularly potential impacts to the local community and water supply system. The proposed underground mining area has been significantly reduced in response to identified geological and environmental constraints as well as the views of the community. The proposed mine plan, **Figure 2**, extends from deep beneath a portion of the Hue Hue rural residential area and continues at deeper levels below the Dooralong Valley before progressively mining beneath the Wyong State Forest area. Longwall mining will not take place directly beneath the Wyong River nor within the vast majority of the floodplain of the Yarramalong Valley.

The region's water supplies will be safeguarded. No mining will occur in or under the Mangrove Creek Dam catchment, or Mardi Dam, nor under the Wyong River, Wyong Weir, Ourimbah Creek, Porters Creek Wetland or related water facilities and infrastructure.

The project has incorporated a number of protection measures to safeguard against adverse impacts on the local community. The amount of coal to be extracted beneath the Hue Hue area has been

significantly reduced to ensure that surface movement (referred to as subsidence), will readily comply with the levels stipulated by the declared Subsidence District. Houses built in accordance with the Hue Hue Mine Subsidence District criteria should therefore accommodate the effects of mining.

Similarly, when underground mining occurs deep beneath the Dooralong Valley floodplain, which is necessary to access coal reserves within the surrounding Wyong State Forest, less coal will be extracted to reduce the subsidence effects and to ensure that shallow alluvial aquifers and stream systems are appropriately protected.

Evaluation of a series of alternative mine layout plans has been undertaken and the current proposed mine plan is the preferred layout, although some minor adjustment to panel orientation may be made as a result of detailed environmental and engineering studies. The mine layout incorporates a variety of longwall panel widths in order to optimise economic reserve recovery whilst taking into account environmental and subsidence constraints. Detailed longwall width information is as follows:

- 120 m and 150 m wide panels below the north-eastern portion of the Hue Hue Mine Subsidence District;
- 150 m, 170 m or 200 m wide panels (depending on depth of cover) below the 1-in-100 year flood zone; and
- predominantly 250 m elsewhere.

In a few longwall panels, the panel width varies along the length of the panel, as the panel moves from one zone to another zone of higher or lower permissible tilt levels. This process has achieved successful outcomes at other mines. The narrow sections of the variable width panels would have three-heading gate roads on the tailgate side of the panel.

Extraction commences in the north-eastern corner (**Figure 2**: shown in blue) of the mine layout, adjacent to the pit bottom facilities. Due to surface subsidence restrictions, the initial longwall panels are relatively narrow. Extraction in each panel will progress in an up-dip direction (south to north)

While the first ten longwall panels are being developed and extracted, an additional development unit drives the various sets of tunnels or main headings that enable permanent access and ventilation corridors throughout the mining area.

The end of one of the main headings in the centre of the mining area is the selected location for an additional ventilation shaft (downcast). This shaft is required prior to longwall extraction from the southern mains.

Following extraction of the initial ten longwall panels from the northern main headings, extraction of the southeastern panels commences (shown in **Figure 2** in green). This sequence provides the following advantages:

- Better quality coal is extracted first, improving project economics; and
- Better mining conditions are anticipated, as entry into the Awaba Tuff floor areas is delayed.

The initial southeastern most longwall panels are reduced in length, due to the large number of flood affected properties within the Kidmans Lane area. Continuity of the southern longwall panels is interrupted by Smithys Sill. This effectively splits the southern longwall panels into two discrete blocks. Extraction of the southern panels continues in the remaining panels that are coloured green in the southwest quadrant of the mine.

The order of preferential extraction of coal in the mining area is on the basis of pursuing the higher margin coal where possible. A deterioration in coal quality in the south-west corner of the W2CP Target Area results in extraction moving back to the northern panels after the extraction of the three yellow shaded panels in the south-western quadrant (**Figure 2**). Longwall retreat will be down-dip.

The resulting mine layout has an extraction height range of 3.0 m to 4.5 m, recoverable reserves are calculated to be over 150 Mt (ROM). The overall longwall to development tonnage ratio is 12.1:1. The depth of the mine ranges from over 350 m to over 650 m in some areas.

2.2. Heritage Assessment Methodology

2.2.1. Introduction

The Wallarah 2 Coal Project (W2CP) comprises a very large study area. The overall methodological approach for the assessment of heritage over the W2CP study area has divided the area into three major components according to the levels of potential impact:

1. Areas of **direct impact**: Surface facilities and associated infrastructure at the Buttonderry, Tooheys Rd and Western shaft study areas (mine heads, rail loop, buildings, materials stockpiles; utilities and ventilation).
2. Areas of **indirect impact:** Western target area subsidence zones, the subject of the current assessment.
3. Areas of **no impact:** Lands capable of contributing to habitat compensation areas or zones set aside for inter-generational equity.

The assessment requirements for land within each division are deemed to be different due to the nature and extent of the potential impacts. In areas of **direct impact**, detailed assessment established the absolute heritage values of these locations and the resultant report (OzArk 2009) provided mitigation measures and management recommendations.

For areas of **indirect impact,** such as the current Subsidence Study Area, assessment has been undertaken according to a different methodology to establish known and likely heritage values, with a significant focus on the manner in which the potential impacts (subsidence, tilt, altered hydrology etc.) may affect these values. Complete survey was not considered feasible considering the scale of the Study Area and land tenure/land access constraints. Instead targeted survey was undertaken to test the outcomes of predictive modelling based on the review of previous studies placed in their regional context. In this way the predictive model can be tested to extrapolate to areas within the Study Area that have not been assessed. More detailed studies may be generated as part of the SMP process once overall project approval has been obtained.

Locations that are being considered as **habitat compensation** or as **areas of conservation for inter-generational equity** required a more general assessment, primarily focussed on predictive modelling accompanied by targeted survey. These areas, shown in tan outline on **Figure 1,** include the Tooheys Rd and Buttonderry sites, but also include external areas of potential compensation. These were assessed at the same time as those of direct impact and were reported in the same report (OzArk 2009). The achieved aim of this assessment was to establish the heritage values of these potential compensatory areas to determine whether they are equitable to that of lands impacted as a result of the W2CP.

2.2.2. Aim and scope of the current investigation — Subsidence Study Area

The current assessment includes the following components:

- DECCW AHIMS searches for land within the Subsidence Study Area (bounded by the zero subsidence line);
- Plot of the results of this search onto topographic/aerial photographic images;
- Extrapolation of these mapped results through predictive modelling which is informed by the regional contextual data provided;
- Targeted field survey to test the predictive model and assess a sample of landforms including assessment of areas of potential sensitivity;
- Assessed results are viewed from the perspective of the potential impacts of subsidence (including tilt and strain) from longwall mining beneath the zone enclosed by the zero subsidence line and in terms of the potentially altered hydrology; and
- The resultant report provides a predictive assessment of the likely overall potential impacts to the heritage resource within the zero subsidence line and a series of tailored recommendations for further detailed assessments to be completed once project approval has been achieved as well as any mitigative measures that may reduce impacts.

Having completed the desktop review out lined above, a methodology was established to enable targeted surveys of the Study Area to take place. Due to access restraints only two areas within the Study Area were able to be accessed for pedestrian surveys. These were the Wyong Forest Study Area and the Honeysuckle Park Study Area.

2.2.3. Survey methodology for the Wyong Forest Study Area

Due to access issues, particularly as the survey team did not have access to private property within the Study Area, only land within the Wyong State Forest was to be assessed. The State Forest comprises a large portion of the western portion of the Study Area and primarily comprises of hills, ridges and steep-sided valleys.

Therefore access was at the core of the survey methodology, as survey of the Wyong Forest Study Area required a degree of difficulty from the perspective of terrain, vegetation and poorly maintained fire trails. Additionally, for health and safety reasons alone, the survey could hope to cover all areas within the Wyong Forest Study Area and a sampling plan had to be devised.

This methodology first identified areas of archaeological potential within the Wyong Forest Study Area. These were identified as being the 2nd order waterways[3] and the ridgelines. These two landform features were targeted for the following reasons:

[3] Using the Strahler system of stream ordering: starting at the top of a catchment, any watercourse that has no other watercourses flowing into it is classed as a 1st order watercourse. Where two 1st order watercourses join, the watercourse becomes a 2nd order watercourse. If a 2nd order watercourse is joined by a 1st order watercourse - it remains a 2nd order watercourse. When two or more 2nd order watercourses join they form a 3rd order watercourse. A 3rd order watercourse does

- The only previously recorded sites in the Wyong Forest Study Area are axe-grinding grooves along a 2nd order waterway (Myrtle Creek);
- Sites such as axe-grinding grooves and shelter sites are likely to be more significantly impacted should subsidence occur than other sites such as open sites or isolated finds. These 'at-risk' sites would be located in creek lines where suitable sandstone exists and along ridgelines; and
- Other landforms in the Wyong Forest Study Area were steep slopes – often with a slope of up to 60 degrees. These slopes are unlikely to contain, or retain, items of cultural heritage and were therefore not directly targeted (although enough were assessed as the survey team made their way to a particular creek).

A survey methodology was therefore devised to sample the most prominent 2nd order waterways and ridgelines where suitable rock exposure could exist to contain axe-grinding or shelter sites.

In summary the following 2nd order waterways were targeted for survey:

- Calmans Gully;
- Myrtle Creek;
- Little Jilliby Jilliby Creek;
- Armstrongs Creek; and
- Unnamed waterway to the east of Smithys Road West.

Other waterways in the Wyong Forest Study Area were either inaccessible within the timeframe of the survey, or were first order streams with a steep gradient that lacked the sandstone shelving necessary for axe-grinding sites.

The ridgelines within the Wyong Forest Study Area were:

- Whitemans Ridge;
- Little Jilliby Ridge;
- Harris Point; and
- Additional ridgelines able to be accessed by vehicle (such as that followed by Watagan Forest Road).

It was decided to bias the investigation of ridgelines within the Wyong Forest Study Area to favour the ridges to the east of Little Jilliby Jilliby Creek as these displayed features that were likely to contain shelters should they exist.

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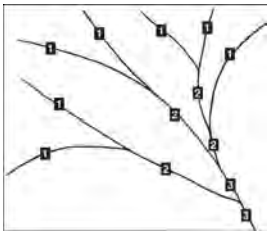
not become a 4th order watercourse until it is joined by another 3rd order watercourse and so on (Source: DWE 2008).



2.2.4. Survey methodology for the Honeysuckle Park Study Area

As the property Honeysuckle Park is owned by the Wallarah 2 Coal Project and consists of cleared paddocks, there were no access issues to constrain full pedestrian survey of the property. The methodology for this study area was therefore to assess as much of the property as conditions (ground surface visibility most importantly) and time allowed. Intensive transects were planned for the portions of the property bordering Jilliby Jilliby Creek and Little Jilliby Jilliby Creek

2.3. Heritage Survey constraints

This report is limited to the area subject to subsidence and enclosed by the zero subsidence line (**Figure 2**). The determinations of potential impacts to the natural and built environment are based upon results from the subsidence assessment (WACJV 2008, MSC 2009), flooding study (ERM 2009) and groundwater assessments (Mackie Environmental Research 2009) included as appendices to the W2CP Environment Assessment report. OzArk has used the results of these studies to extrapolate the potential impacts to heritage.

2.3.1. Wyong Forest Study Area

The vegetated hills of the Wyong State Forest are challenging to access. They are currently densely vegetated (**Plate 1**) and feature steeply sloping terrain (**Plate 2**) which is a significant impediment to close physical inspection. Vegetation is very thick in places necessitating that detours around thick vine tangles be made (**Plate 3**). Otherwise the typical rainforest vegetation on the valley floors made inspection of the ground surface almost impossible (**Plate 9**) due to the dense mat of leaf litter. Nor were conditions for ground surface visibility any better in the more elevated parts of the Study Area as, again, dense leaf litter from the Sclerophyll forests obscured the ground surface (**Plate 9**).

It is acknowledged that a full pedestrian survey of the entire Study Area was not carried out, however, OzArk believes that this methodology ensured that all areas adjacent to higher order waterways were assessed and a range of other landforms were also assessed giving the surveyors confidence that a representative sample of all landforms in the Study Area were included in this survey.

To this end, it is instructive to review the NSW National Parks and Wildlife Service (NPWS) *Aboriginal Cultural Heritage Standards and Guidelines Kit* (1997) which remains the current guiding document for Aboriginal cultural heritage assessment. Within the kit are the 'Standards for Archaeological Practice in Aboriginal Heritage Management' (SAPAHM), which contains a chapter on 'Survey'[4].

Nowhere in this chapter is the requirement for full archaeological survey over a project area documented. Rather it acknowledges that total survey is not feasible even if the scale of the project (i.e. a small project area) may enable it from a physical perspective, because to achieve full survey *per se* would require 100% ground surface visibility. 'It follows that almost all EIA archaeological surveys employ some form of sampling' (NPWS 1997 SAPAHM, Survey: 1). Additional data is then presented about sample size and sampling strategies and the fact that these should be related to the scale of the project. At the time of writing (1997) it was noted that for large projects (considered to be over 1 km^2) it was quite normal for a total of 5% or less of the project area to undergo survey. This is acknowledged as being problematic due to the difficulty in mitigating against potential impact to sites

[4] In referencing this document it is noteworthy that each chapter's pagination starts at 1, so pages are referred to under their chapter headings.

that remain unrecorded. However, the approach then advocated, which encompasses varied survey levels e.g. - low intensity assessment of project area (detects obvious sites, i.e. culturally modified trees) and sample areas for more intensive assessment (to detect artefact sites) – is acknowledged as still leaving undetected sites as likely to be present within a project area.

Sampling strategies are then described (NPWS 1997 SAPAHM, Survey: 1):

> *Sampling strategy may be based on environmental criteria (eg., bioregions, landforms), landuse history and visibility factors (eg., intensively farmed/disturbed areas may be excluded), or on the nature of the projected impact. In most large surveys the sampling strategy will be based on a mixture of these considerations.*

Increased rigour was noted (1997) as the trend in regards to survey sample size particularly if the project involved a total or near total impact footprint. A common and valid practice is also noted as focussing survey on strictly definable areas of impact should these be known.

Therefore, given that all survey is a sample of a particular area (given problems with ground surface visibility and distance between surveyors) OzArk feels that the survey methodology adopted for this assessment ensured that all landforms likely to contain large and/or complex sites were assessed and that a good representative sample of other areas were also included in this assessment.

Specifically constraints encountered in the assessment of the Wyong Forest Study Area were:

Waterways

Calmans Gully (#1 in **Figure 3**): access was reasonable once an entry point from the edge of the State Forest had been located. The gully is in a shallow U-shaped valley supporting thick coastal rainforest. Rock overhangs were present but all were unsuitable for habitation (see cover photo). Calmans Gully is alluvium filled for much of its length before it rises steeply as a typical 1st order waterway. Assessment did not include the 1st order portions of Calmans Gully.

Myrtle Creek: (#2 in **Figure 3**): Access was difficult without asking permission from landholders to cross their land. The portion of Myrtle Creek within Wyong State Forest is thickly vegetated with coastal rainforest and consists of large sandstone boulders interspersed with areas of rock ledges. Survey of the creek was up to the general vicinity of the previously recorded site # 45-3-3041 (**Figure 12**).

Little Jilliby Jilliby Creek (#3 in **Figure 3**): Survey began from the electricity easement at the headwaters of an unnamed tributary of Little Jilliby Jilliby Creek that flows to the east and parallel to the main branch which it joins after approximately 1.5 km. The headwaters of this system consist of thick rainforest with the waterway descending at steep gradients. There are numerous large sandstone boulders interspersed with areas of rock ledges. It was extremely difficult going and many detours had to be made from the creek bed as thick vines blocked passage. When Little Jilliby Jilliby Creek becomes a more-mature watercourse (#4 in **Figure 3**), thick alluvium covers the valley floor and rock outcrops become more and more scarce. Survey down the creek was impossible at this point as the creek was full of water and thick vines blanketed the banks. Instead the remainder of this southern section was surveyed from an old forestry road that parallels the creek on its eastern bank.

Unnamed waterway to the east of Smithys Road West (#5 in **Figure 3**): The creek was accessed from where the electricity easement crosses Smithys Road West. After descending very steep slopes containing small overhangs, the creek was reached and survey continued in a southerly direction. The headwaters of this creek were not assessed. The creek displayed the same attributes as other

already surveyed: thick vegetation, moderate–steep gradients on the waterway and numerous large sandstone boulders interspersed with areas of rock ledges. Survey ceased when evidence of alluvium in the creek bed became more noticeable.

Unnamed waterway to the south of Watagan Forest Road (#6 in **Figure 3**): This waterway was surveyed from its headwaters to where it leaves the State Forest. The waterway is in a steep V-shaped valley and, apart from some water held in pools, did not appear to be a system that carried much water. The gradient of the waterway was moderate but the creek lacked rock ledges although sandstone boulders were plentiful. The vegetation was rainforest but less dense than in other creek systems, as the aspect of the area appears drier. Vine tangles were still an impediment to passage.

Armstrongs Creek (#7 in **Figure 3**): This creek was accessed from Brothers Road where thick lantana stopped any meaningful survey of the creek. From what could be seen, Armstrongs Creek, in the vicinity of Brothers Road, is already mature with thick layers of alluvium present. The headwaters of this system were not surveyed.

Ridgelines

Whitemans Ridge (#8 in **Figure 3**): In the north of the Study Area, on Whitemans Ridge, some of the 'more-likely' shelters of the survey were noticed. While the wind-eroded caves were large enough, sloping floors or inaccessible locations ruled them out as habitation shelters. Nevertheless many of the shelters were inspected, as well as the top of the ridge where the shelters were located. Vegetation is Sclerophyll forest and apart from steep cliffs and slopes, there was no impediment to passage.

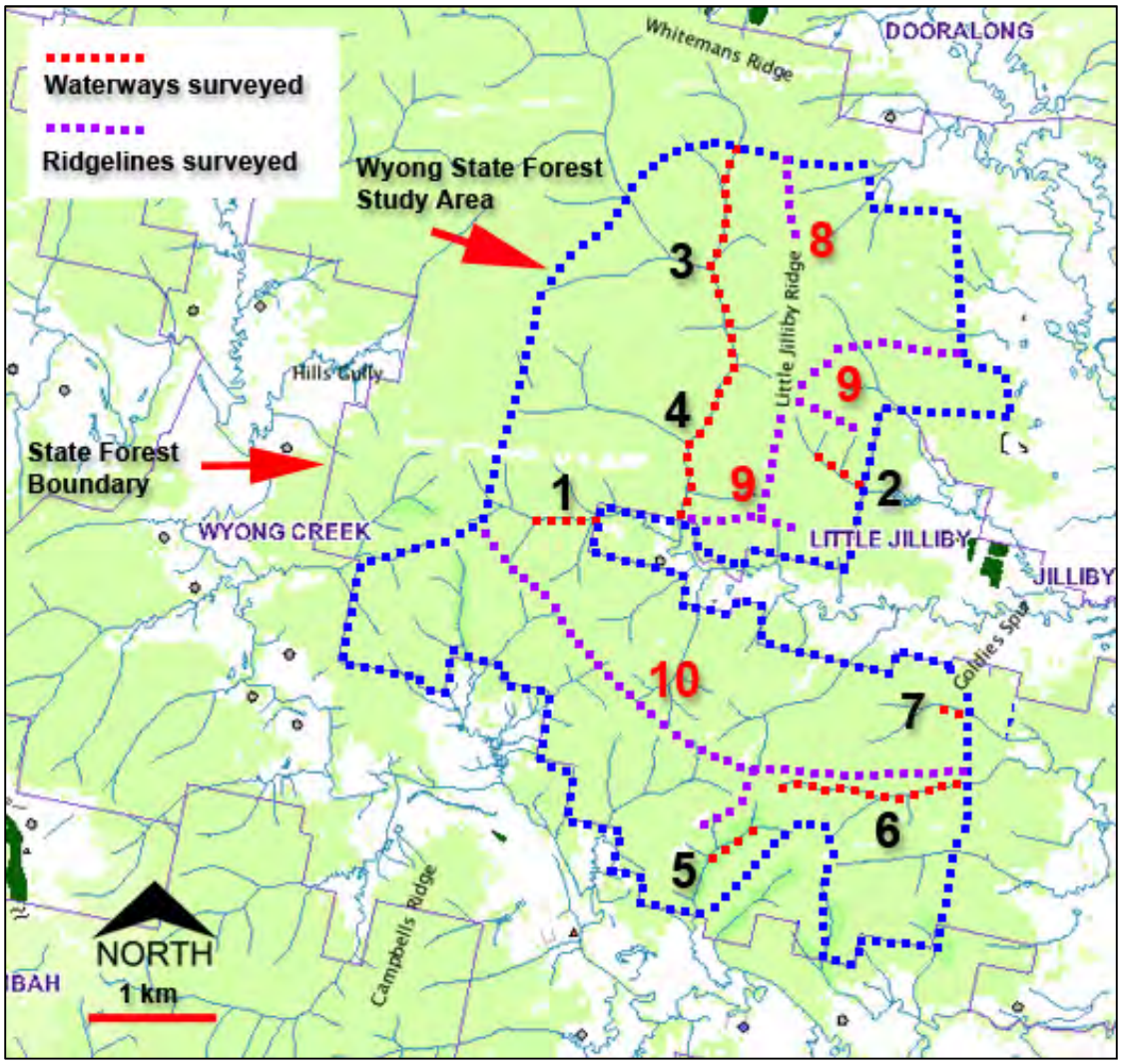
Other ridge systems (#9 in **Figure 3**): The entire length of the ridge to the east of Little Jilliby Jilliby Creek was walked, as was the ridge to the northeast of Myrtle Creek and Little Jilliby Ridge. These areas all displayed similar characteristics in that if a rock cap was present, there were no habitable shelters and the landform primarily consisted of steep slopes coming to a relatively narrow ridgeline. Sclerophyll forest predominated and areas of exposure were afforded by forestry tracks.

Watagan Forest Road ridge system (#10 in **Figure 3**): This road was driven several times and spot checks made. These spot checks also included making detours down some of the forestry tracks that follow the smaller ridgelines off the Watagan Forest Road ridgeline. In character these ridge systems were identical to those surveyed in the east: if a rock cap was present, there were no habitable shelters and the landform primarily consisted of steep slopes coming to a relatively narrow ridgeline.

2.3.2. Honeysuckle Park Study Area

The OzArk survey team accessed public areas but was not permitted to enter private property. As the majority of the valley floor landforms and low hillslopes were on private property, detailed physical assessment of the majority of these areas was not possible. One valley floor property purchased by WACJV (Honeysuckle Park) was, however, able to assessed and is considered to be relatively representative of the valley floor landform unit, comprising additionally a portion of creek bank (**Plate** 10).

Figure 3: Areas surveyed within the Wyong Forest Study Area.



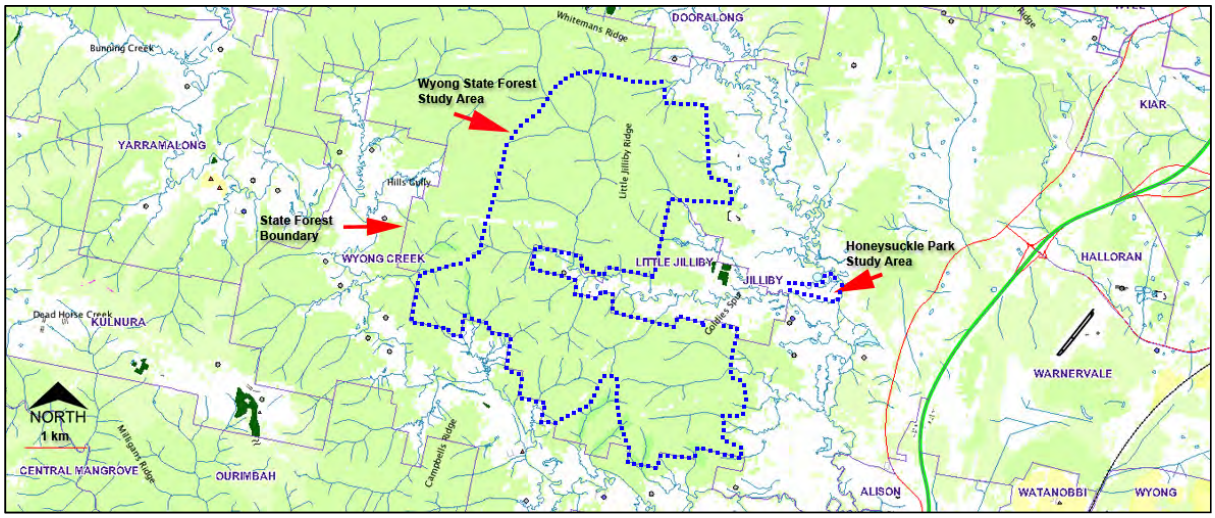
3. The Study Area

There are three components to the current Study Area. They are:

- Subsidence Study Area: this includes all areas within the green line as shown in **Figure 2**: an area that is a little larger than the black dotted line as shown in **Figure 1**. Unless otherwise stated, reference to the Study Area refers to this area.
- Wyong State Forest Survey Study Area: This includes the area within the western blue dotted line in **Figure 4**.
- Honeysuckle Park Survey Study Area: This includes the area within the eastern blue dotted line in **Figure 4**.

The survey Study Areas, the Wyong State Forest Survey Study Area and Honeysuckle Park Survey Study Area, are within the Subsidence Study Area. They constitute areas that either have public access as they are State Forests (Wyong State Forest Survey Study Area), or are owned by the Wallarah 2 Coal Project (Honeysuckle Park Survey Study Area). These two areas were subjected to a full heritage assessment to verify the predictive model for site location as set out in **Section 4.4**. The remainder of the Subsidence Study Area, being on private property, was not assessed in the field but is the subject of the desktop review presented here.

Figure 4: Location of Survey Study Areas.



3.1. Topography, Soils and Climate of the Study Area

3.1.1. General

The Study Area lies within the Sydney Basin Bioregion (SBBR, also known as the Sydney–Bowen Basin) which is on the east coast of NSW and includes a significant proportion of the catchments of the Hawkesbury–Nepean, Hunter and Shoalhaven river systems, all of the smaller catchments of Lake Macquarie, Lake Illawarra, Hacking, Georges and Parramatta Rivers, and smaller portions of the headwaters of the Clyde and Macquarie rivers.

According to the Department of Environment and Climate Change (DECCW 2002), the SBBR is a geological basin formed when the earth's crust expanded and then filled with sediment forming near horizontal sandstones and shales between the late Carboniferous and Triassic ages. These overlie

older basement rocks of the Lachlan Fold Belt. These rocks have been subject to uplift with minor folding and faulting during the formation of the Great Dividing Range. Erosion by coastal streams in some areas (such as Illawarra and the Blue Mountains) has created deep-cliffed gorges and remnant plateaus with an east-west rainfall gradient and differences in soils. Other atypical environs include coastal landscapes of cliffs, beaches and estuaries.

The stages of development saw the continental rift filled with sediments (marine volcanic). Subsequent deposition therefore shifted to rivers and swamps during the cold climates of the early Permian. Coal deposits accumulated in the upper parts of the basin that were then covered in quartz sands by extremely large, braided rivers whose headwaters lay hundreds or even thousands of kilometres away (when Antarctica was joined to the current Australian continent). These waterways flowed in from the south and the northwest to deposit the sands that later formed the Hawkesbury Sandstone. Shallow marine sediments and later more river sediments continued to accumulate in the basin during the Jurassic Period (all currently eroded). There is presently only a thin cap of these latter deposits (shale) over the resistant sandstones.

3.1.2. The Study Area

The proposed subsidence area is enclosed within the zero subsidence line and includes the Yarramalong and Dooralong Valleys, parts of the Wyong State Forest and Jilliby State Conservation Area. This area encompasses numerous waterways including small portions of Wyong River riparian zone and floodplain, Hue Hue Creek, Jilliby Jilliby Creek, Myrtle Creek and smaller and unnamed drainage lines associated with the Wyong River and Jilliby Jilliby Creek.

3.1.2.1. Topography

The topography beyond the Yarramalong and Dooralong Valleys to the west, the Wyong SF and Jilliby SCA, is generally steep and rugged, consisting of steep to very steep slopes with narrow crests and ridges. The local relief for this portion of the study area is generally between RL 50–220 metres ASL with slope gradients between 20–60 percent. Several smaller, steep-sided valleys are associated with tributaries into the Wyong River and Jilliby Jilliby Creek, and these often intersect the steep high slopes, crests and ridges of the Wyong SF and Jilliby SCA. The Yarramalong and Dooralong Valleys are comprised of low slopes and floodplains consisting mainly of flat to gently sloping floodplain terraces and low slopes/toe slopes. The local relief within the valleys is usually less than 30 metres with a slope gradient not exceeding 15 percent.

3.1.2.2. Geology

The general geology of the mining area, including description of the stratigraphic column, is provided in **Figure 5**. The Wyong area is located south of the Newcastle Coalfield on the north eastern margin of the Sydney Basin. The coal resources are contained within the upper part of the Permian Newcastle Coal Measures. Depth of cover to the uppermost coal seam in the region ranges from 200 to over 650 metres (ERM 2001: 2.2) and from 350 m to over 650 m in the proposed W2CP mining area.

This sequence is overlain by the Triassic Narrabeen Group which outcrops across the proposed subsidence area. Although Hawkesbury Sandstone, the uppermost and youngest geological unit present in the general region is commonly found on top of ridge tops within the Central Coast Valleys area further south, none is evident over the Subsidence Study Area. Instead, the Study Area comprises Narrabeen Group sandstone(s) including the Gosford (sandstone, siltstone) and Clifton

(softer sandstone, claystone, shales) Subgroups. Quaternary alluvium occurs along valley floors and floodplains of the Wyong River, Jilliby Jilliby and Little Jilliby Jilliby Creeks (**Figure 6**).

A note on nomenclature is necessary here. Today Narrabeen Group sandstones have been divided into three major units which are the uppermost Terrigal Formation, the Patonga Formation and the underlying Tuggerah Formation. Previous geological division nomenclature, however, saw the Narrabeen Group comprised of the Gosford Formation and the Clifton Sub-groups. As each of these geological units are described below, reference will be made to their previous names as much of the forthcoming regional archaeological context comprises studies that were undertaken using the old nomenclature and for these results to remain meaningful they need to be understood in terms of the new names for these geological zones.

The uppermost strata of the outcropping Narrabeen Group is the Terrigal Formation (Rnt) which consists of sandstones and minor siltstones. This equates in the old nomenclature to the Gosford Formation (Rng). This stratum occurs over the most elevated landforms of the western portion of the subsidence zone, which is partially covered by State Forests. Although this layer can be up to 25 m in thickness, it is more commonly around 10 m thick within the current study area. This geological unit constitutes around 1900 ha or about 46% of the surface geology within the subsidence area.

Figure 5: Geological sequence underlying the proposed mining area (Source WACJV 2008).

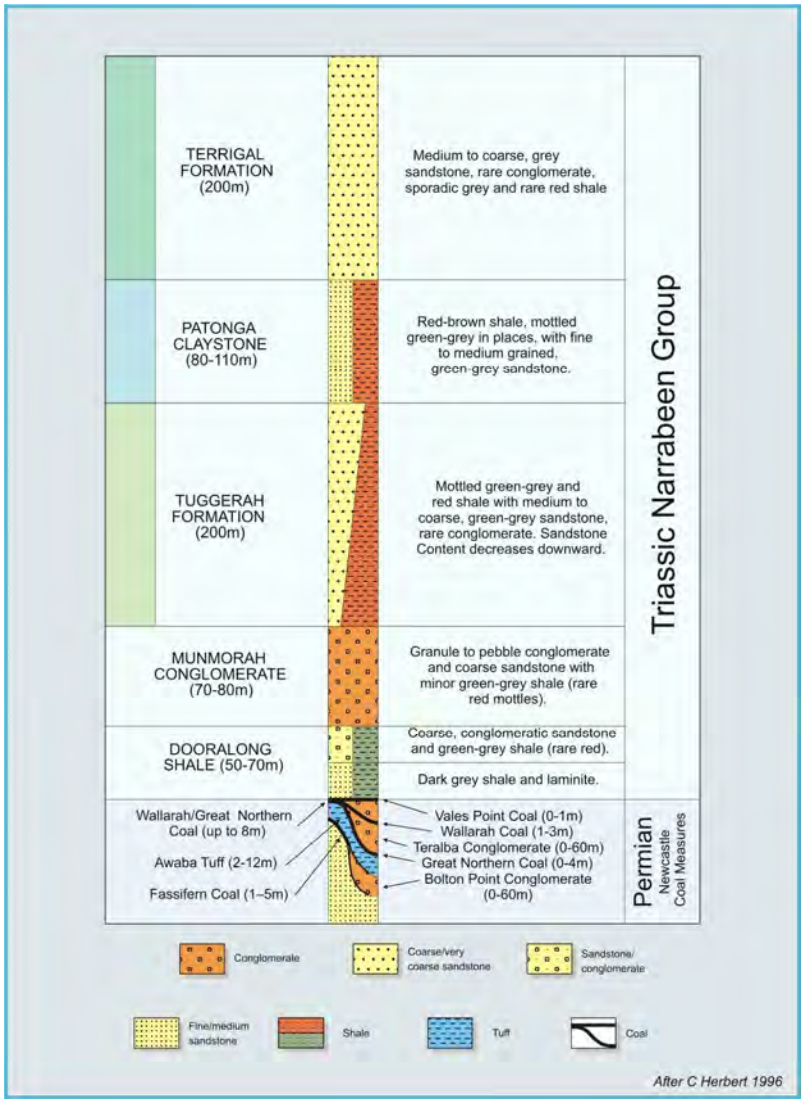
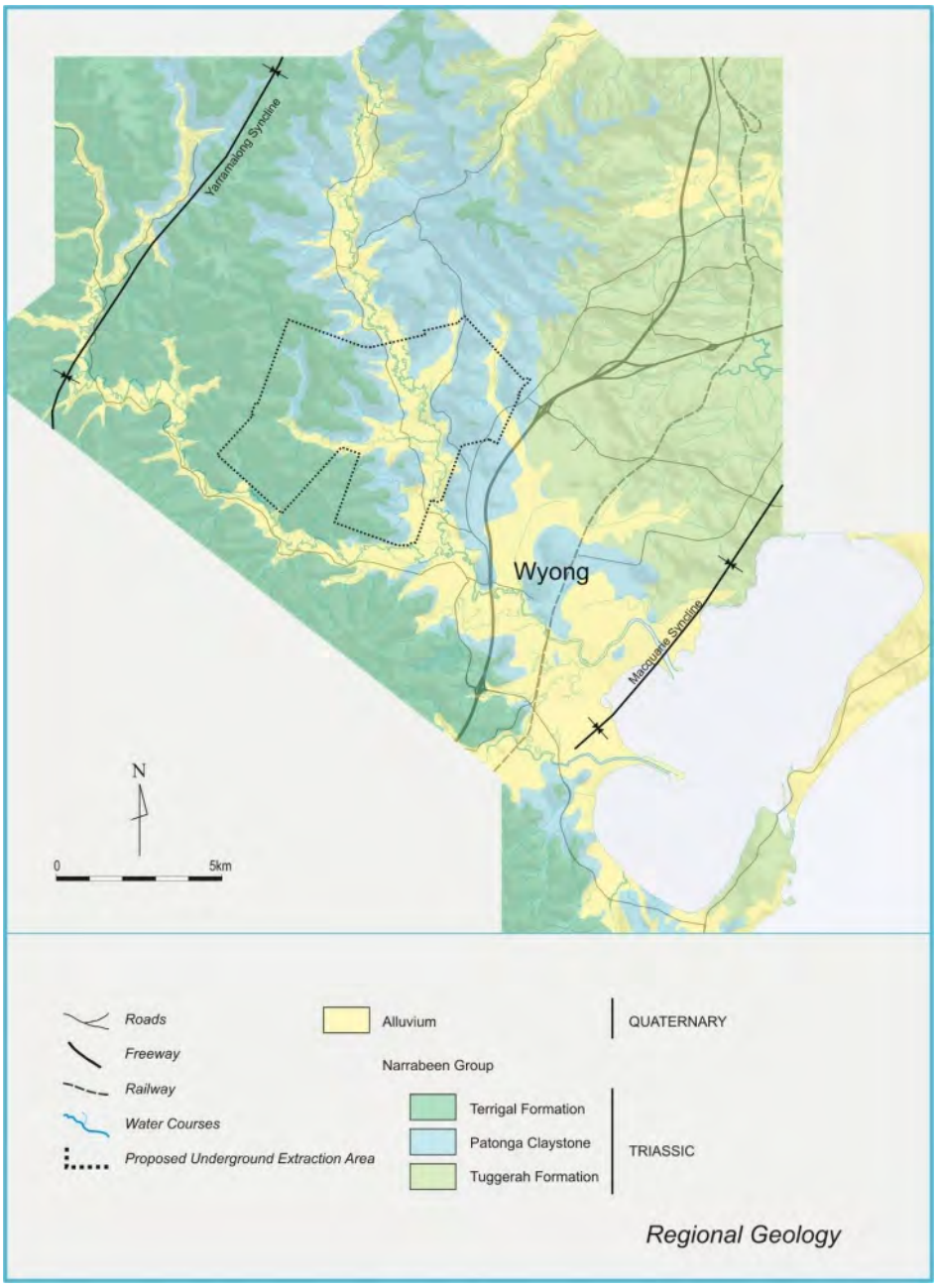


Figure 6: Geological sequence underlying the proposed mining area.



The Terrigal Formation is underlain by the Patonga Claystone (Rnp) which consists of inter-bedded grey-green and red-brown claystones and minor fine grained sandstones with depths of up to 45 m, but more commonly around 20 m. This unit (together with the Tuggerah Formation) was considered to be part of the Clifton Sub-group using the old nomenclature. It commonly outcrops in the mid hillslopes and undulating areas of the Dooralong Valley and constitutes around 880 ha or around 20% of the subsidence area.

Underlying this and outcropping beyond the north-east of the mining area and its zero subsidence line is the Tuggerah Formation (Rnu), a sequence of sandstones with minor siltstones and rare conglomerates. This unit is a transitional unit between the Patonga Claystone and the underlying Munmorah Conglomerate. Using the old nomenclature, this formation was not separated out from the Patonga Formation and both were considered as part of the Clifton Sub-group.

Unconsolidated Quaternary alluvium (Qa) (silts and sands) occurs as fill along the Yarramalong and Dooralong Valleys with recorded depths of up to 50 m (ERM 2001: 2.2). Qa comprises around 910 ha or about 22% of the surface geology within the Subsidence Study Area.

3.1.2.3. General archaeological potential in terms of surface geology

The study area contains no Hawkesbury Sandstone caps, which comprises a geological unit known to yield rock shelters appropriate for human habitation. Evidence of human occupation has been recorded in shelters within this unit to the south and west of the current Subsidence Study Area (see **Sections 4.1** and **4.2**). Surface geology within the current Study Area is instead dominated by the Narrabeen Group sandstones and claystones, which exhibit some areas of outcropping sandstone rock (**Plates 5-7**). As some of these formations (Patonga Claystone, Terrigal and Tuggerah Formations) consist of a number of elements apart from sandstone, including claystone, siltstone and shale — which are susceptible to erosion, there remains potential for sandstone shelter sites (which may contain art or deposits) to occur in these areas. If outcropping sandstone occurred near drainage features they may also have been utilised for grinding grooves, while appropriate sandstone outcrops/surface may have been used for engravings (ERM 2001: 2.6).

While much of the recorded sandstone-based archaeology known in the wider Wyong/Central Coast area is found in Hawkesbury Sandstone, there is also evidence of sandstone sites in Narrabeen Group sandstone(s). As discussed further in **Section 4.2**, much of the previous research in the Wyong area has been based in areas much further south where Hawkesbury Sandstone is prevalent and while this geological formation is considered to be archaeologically richer in terms of sandstone sites, the extent to which Narrabeen Group sandstone(s) are archaeologically significant has not been demonstrated to date.

3.1.2.4. Soil landscapes

The considerable range of rock types, topography and climates in the Sydney Basin has resulted in a large variety of soils and vegetation communities. The coastal area of the bioregion consists of frontal dunes. Dunes behind this accumulate organic matter and begin to develop coloured subsoil. The oldest dunes on the inland side of the barrier and the parabolic dunes high in the landscape, even on headlands, have well-developed podsol profiles. Limited areas of rainforest can be found in the lower Hunter, Illawarra escarpment and on Robertson basalts, as well as in the protected gorges and on richer soil in most subregions. Species composition and structural form are similar on sandy soils of the sandstone plateaus and the sandy soils of the dunes. Better quality shale soils form caps on sandstone and on the coastal ramps.

Within the zero subsidence line, the study area is comprised of four types of soil formations, colluvial, alluvial, erosional and residual. Mapping of these soil landscapes mirrors to some extent, the geological units from which they are derived. The colluvial soils will be discussed first followed by alluvial, erosional and residual deposits.

The largest of the colluvial soil deposits is the Watagan which is derived from the weathering of the massive beds of quartz-lithic sandstone, siltstone and claystone of the Terrigal Formation, which is the uppermost stratum of the Narrabeen Group. These deposits occur north of Wyong River and west of Jilliby Jilliby Creek, comprising the uplands of the Wyong State Forest and Jilliby State Conservation Area. In these areas massive sandstone exposures form minor cliff exposures, local relief is c. RL 50–220 m ASL with slope gradients of up to 25% or more. Soils of this group are very complex and include shallow (<50 cm) lithosols/siliceous sands and yellow earths on coarse sandstone, shallow to deep (<50->150 cm) yellow podzolic soils and some red podzolic soils on fine-grained bedrock, deep (>150 cm) sandstone colluvial deposits, yellow earths, yellow podzolic soils and siliceous sands and alluvial sands along drainage lines. Some of these soils are potentially prone

to mass movement with extreme erosion hazards for shallow soils, rock fall hazards (rock outcropping) and localised seasonal waterlogging (ERM 2001: 2.7).

The second of the colluvial soil deposits is the Mandalong soil landscape, which is derived from the weathering of the massive beds of quartz-lithic sandstone, siltstone and claystone of the Patonga Claystone. This soil landscape generally occurs between the Watagan and Woodbury Bridge landscapes, and is identified as rolling to steep low hills on the Watagan Mountains with narrow crests and ridges, short steep slopes and narrow closely spaced drainage lines. Local relief is to 120 m and slope gradients between 20–60%. Soils are moderately deep to deep (100–>150 cm) red podzolics, brown podzolic soils, yellow podzolic soils on claystone, shallow to moderately deep (<50–150 cm) yellow podzolic soils on sandstones with clays or rock outcrop on drainage lines. This landscape is potentially prone to mass movement and foundation hazards, extreme erosion and has low fertility soils (ERM 2001: 2.8).

The only alluvial soil landscape within the subsidence study area is the Yarramalong alluvial soil landscape which follows Jilliby Jilliby Creek, Little Jilliby Jilliby Creek and the Wyong River. This soil landscape incorporates alluvial terraces in association with various water bodies such as back swamps and oxbows. Local relief is less than 10 m with slope gradients of less than 5%. The deep (>150 cm) alluvial soils and red earths are present along levee banks while deep (<200 cm) yellow and brown podzolic soils are present along the back plains and deep (>200 cm) alluvial soils and yellow earths on the terraces. The Yarramalong landscape is prone to flooding, seasonal water logging and creek bank erosion. The soils are commonly of low fertility (ERM 2001: 2.9).

One erosional soil landscape, the Gorokan soil landscape is present in small areas along the eastern margin of the current study area, situated between Woodburys Bridge and the Yarramalong alluvials. It is identified topographically by undulating low hills, long gently inclined slopes, extensive crests and ridges and broad drainage lines. Soils consist of light coloured lithic sandstone, pebbly in part, red brown and grey green claystone and siltstone with rare conglomerate. Local relief is less than 30 m with slope gradients no more than 15%. The landscape in the Wyong area is usually partially cleared low open-forest. Soils are moderately deep (50–150 cm) soloths; yellow podzolic soils on crests and ridges; soloths, yellow podzolic soils and grey-brown podzolic soils on slopes and along drainage lines. The Gorokan soil landscape has high erodability (especially along stream banks), seasonal waterlogging, low fertility and impermeable soils.

Woodburys Bridge, a residual soil landscape, commonly occurs in association with Mandalong, Watagan and Yarramalong landscapes and is in the eastern half of study area as well as along the Wyong River and Little Jilliby Jilliby Creek. It is characterised by gently undulating rises to rolling low hills on the Patonga Claystone. Local relief is 40–80 m with slope gradients up to 20%. Sandstone capping on the crests of steeper hills is common and much of the Woodburys Bridge soil landscape is cleared tall open-forest. Soils are generally by deep (>150 cm) red podzolic soils with some soloths in poorly drained areas on claystone bedrock; and shallow to moderately deep (50–150 cm) yellow podzolic soils on sandstone bedrock. This landscape is potentially prone to extreme erosion with high foundation hazards, seasonal waterlogging and comprising acid soils of low fertility (ERM 2001: 2.11)

3.1.2.5. Climate

The SBBR is dominated by a temperate climate characterised by warm summers with no dry season. A sub-humid climate occurs across significant areas in the northeast of the bioregion such as that experienced in the assessed Wyong area. Rainfall can occur throughout the year, but varies across the bioregion in relation to altitude and distance from the coast, with wetter areas being closer to the coast or in higher altitudes. Temperature varies across the bioregion, with areas of higher

temperature occurring along the coast and in the Hunter Valley and areas of lower temperature on the higher plateaux and western edge.

More specifically, climate data from the Bureau of Meteorology monitoring station located in Gosford shows that the area has an average annual temperature of 22.9°C (Maximum annual average of 27.5°C and minimum annual average of 4.5°C) with an annual average rainfall of 1,320.8 mm (most of the rainfall occurs in March with the least occurring in October).

3.2. Existing levels of disturbance

As current land use and existing levels of disturbance are relevant to the determination of archaeological potential within the Study Area, brief review of these factors is pertinent.

The Wyong area has been subject to a wide variety of documented land use practices since initial European settlement in the early 1820s. At that time large land grants of over 1000 acres were granted in the Dooralong Valley and by the 1840s land grants were given in the Ourimbah, Wyong and Jilliby areas. Accompanying European settlement was the inevitable need for timber – for housing, heating and cooking as well as for fencing. Hence the timber industry has been a major influence in the Wyong Valley throughout the 1800s with timber getters felling cedar, forest oak and rarer rainforest trees with the timber often being shipped to Sydney. By the 1880s, there were three timber mills operating in the Yarramalong Valley producing rims for wagon wheels, fruit cases and construction timber (ERM 2001: 2.14).

The incidental impact of the timber harvesting was the opening up of the valleys which attracted farmers and settlers who cleared the river flats in the 1850s. These were mainly subsistence farmers growing fruit and vegetables and grazing stock. By the 1860s, settlement incentives offered as part of the Robertson Land Acts attracted an influx of settlers along the Wyong River and its tributaries and Jilliby Jilliby Creek and by the 1880s most of the river flats of the valleys were cleared and under cultivation, with a particular focus on citrus orchards. With the opening of the Sydney/Newcastle railway in 1889, the population of Wyong increased, new timber mills opened and produce of the area become available to overseas markets as a result. The height of the timber industry was reached in the early 1900s when exports boomed, however by the late 1920s much of the local timber had been felled and the area exhausted (ERM 2001: 2.14).

Dairy farming became a major industry of the Wyong valleys in the 1930s, and by 1970 there were over 100 operational dairies in the area. Decline in this industry followed and by 1995/6 no dairy farms were operational in the Wyong Valley. Poultry farming remained a smaller industry, which peaked in the 1960s.

Residential development significantly increased once the Sydney Freeway was opened in 1987. This brought an influx of hobby farmers and rural residential development centred on the Yarramalong Valley. Traditional large acreage agriculture has given way in the last twenty years to smaller hobby farms running stud and beef cattle, rural weekend retreats, market gardens, orchards, nurseries, horse studs and turf farms (ERM 2001:2.14).

Review of the past and present land use patterns within the zero subsidence line demonstrates that substantial parts of the landscape, especially along river flats and low slopes around the Yarramalong and Dooralong Valleys, have undergone significant physical modification as a result of Historic settlement. These activities have potentially disturbed and/or destroyed any Aboriginal sites including occupation sites, burials, scarred trees or ceremonial sites that may have been located in the resource rich valleys in prehistory. Other processes of transformation have also no doubt been

responsible for the modification/destruction of Aboriginal occupation sites in these valleys, including increased erosion and soil movement as a result of tree clearance and agriculture as well as the altered hydrological impacts of flooding, both of which may have contributed to the disturbance and/or redistribution of archaeological material.

In the Wyong Forest Study Area the impact from farming is less while a long history of logging has drastically altered much of the Study Area. Much of the open woodland, particularly on ridgelines and slopes is regrowth with the few residual ancient trees being clearly seen when present. Parts of the Wyong Forest Study Area appear to have been recently logged (within the past 10 years? **Plate 8**). As well as evidence of logging there is also evidence of logging tracks, culverts and assembly areas which have all impacted the ground surface.

At the Honeysuckle Park Study Area, the property has been almost completely cleared, probably ploughed and is intensively grazed (**Plate 11**). While some landform features, such as terraces, are evident (**Plate 10**), the majority of the Study Area has been drastically altered by farming/timber clearing activities and flooding episodes. The effect of these disturbances would be to lower the integrity of any site had it existed, or potentially remove certain site types such as modified trees.

In terms of Historic heritage, however, it is this recent European history (1800s on) that has no doubt left its mark on the Dooralong and Yarramalong Valleys in the form of remnant buildings and agricultural/industrial remains as well as cemeteries. Much of these remains have not survived the increasing intensification of habitation within the valleys, but there are some items of assessed heritage significance and others of local heritage interest, which will be discussed in later chapters.

4. Aboriginal Heritage

4.1. Ethno-historic sources of past Aboriginal culture

Although the exact position of traditional (pre-European) tribal boundaries is not clear, most of the Central Coast in the Gosford and Wyong area was the country of the Darkinjung tribe; an area today covered by the two local government areas. Their neighbours were the Daruk people, whose country included the shores of Broken Bay and extended south to Sydney Harbour, the Awabakal tribe, who lived around Lake Macquarie in the north, the Wiradjuri tribe to the west, and the Wonnarua tribe to the inland north (www.samuseum.sa.gov.au).

The Darkinjung lived by fishing, gathering bush foods and hunting. The region was part of an extensive trade network and large ceremonies were held at times of the year when fish were plentiful. Ourimbah, in the middle of the Central Coast region, was a ceremonial ground in which boys were initiated (Vinnicombe 1980).

The Historic occupation of Australia started at Sydney in 1788 and its effects were soon felt in Darkinjung country. Smallpox, measles and other exotic diseases quickly reduced the population (Stinson 1979: 11). It is also recorded that the Darkinjung men did not take too kindly to the invasion of white settlers to the area. According to the Town and Country Journal, 6th March 1875, Aboriginal men were “ruthlessly slaughtered” when reacting to the provocation of the stealing of land or women.

Before the invasion there may have been 1,500 Aborigines in 12 family groups living between the Hawkesbury River and Lake Macquarie. In six years, between 1821 and 1827, the Darkinjung population was reduced from 200 to 65. A second smallpox epidemic in about 1828 almost completely destroyed the local population. In 1874 Billy Fawkner, said to be the last remaining Darkinjung, drowned in Tuggerah Lake, which had been the source of life for his people (Stinson 1979).

After the dispossession of Aboriginal people from their land, Aborigines and White Australians tended to live separately in space (Coombs 1994: 70). Though there were a few people who may have been descendants of the original inhabitants living near Mangrove Mountain (Vinnicombe 1980). The Central Coast region grew rapidly as a centre of European population. By 1968 a local historian could comment that “these friendly and worthy people... are no longer with us” (Bennett 1968: 3).

4.2. Regional Archaeological Context

Although several broad archaeological studies have been conducted in the Wyong region over the last thirty years, there have been only a few, limited investigations that incorporate land within the area of proposed subsidence by W2CP. Studies from the broader region are therefore important to establish an overall picture of Indigenous site distribution including the site types, frequencies and locational patterns. Review of these studies has been presented in considerable detail as much of this prior work will be extrapolated to predict the site types and frequencies that may be expected within the boundaries of the proposed zero subsidence line.

The most relevant studies undertaken in the vicinity of the W2CP Subsidence Study Area are summarised below, while those commissioned for the current W2CP project for direct impact or conservation areas will be summarised in **Section 4.2.10**. Studies with direct physical relevance to, the current Study Area will be presented in the Local Context: **Section 4.3**.

Approximately 270 Aboriginal sites have been recorded within the Wyong area and are now listed on the NSW DECCW AHIMS database. More sites are added to the list as further specific studies are completed (Wyong Shire Council 2004). The oldest date for the region (11,050 years BP) is based on evidence from Logger's Shelter at Mangrove Creek, recorded by Attenbrow (as cited in Vinnicombe 1980). Much of the following contextual review builds upon work already commissioned for this project, primarily ERM 2001, with additional studies included where appropriate.

4.2.1. Vinnicombe (1980) Predilection and Prediction: A Study of Aboriginal Sites in the Gosford–Wyong Region.

Patricia Vinnicombe (1980) undertook a major survey that sought to categorise and define Aboriginal heritage resources in the Gosford/Wyong area as a means to integrate cultural heritage into the early stages of development planning. The project comprised a thorough background research, detailed survey and analysis of results to produce a predictive model for the region that was relevant to her 1560 km^2 study area. Vinnicombes' study area lies to the south of the current Subsidence Study Area, but comprises landscapes similar to those incorporated within the current project scope. It is noteworthy, however, that the majority of similar landforms assessed by Vinnicombe were of the Hawkesbury Sandstone formations, not the Narrabeen Group formations that characterise the current WCP2 area.

As a result of this study, Vinnicombe identified various ecological zones within the study area and sought to determine the differences within and between these areas that might make Aboriginal site prediction more accurate. Three different environments were investigated, including open coastline and coastal estuary, riverine estuary and inland sclerophyll forest (most relevant to the current project scope).

Vinnicombe conducted intensive 10km^2 surveys within each of these three zones, identifying an average of 11 sites/km^2 in coastal estuary areas, 8 sites/km^2 in riverine estuary areas and 6 sites/km^2 in inland sclerophyll zones. Given the (then) current levels of development and the ecological make up of the Gosford/Wyong area, Vinnicombe predicted that there could be an overall total of 13,000 sites within the locality. Vinnicombe was also able to postulate that decreasing site densities are directly related to the distance from marine resources.

A total of 243 sites were recorded during intensive survey, as well as additional sites recorded in spot surveys and *ad hoc* inspections.

A total of 127 rock shelters with occupation evidence were located, along with another 469 shelters considered to be potentially habitable, thereby being the most common site type recorded during the survey. The following points synthesise the most relevant data regarding these sites[5] (ERM 2001: 2.17):

- Most were located on steep valley slopes associated with the Hawkesbury Sandstone although others were found in Narrabeen Group sandstone(s). These occurred to a lesser extent in the Gosford Formation subgroup (Terrigal Formation) and rarely in areas with combination claystone, sandstone and shale (Patonga Claystone);

[5] It is noteworthy that direct access to this report has not been possible and there is heavy reliance upon summaries presented in ERM 2001; and to a lesser extent Heritage Concepts 2005. There are several elements of this summary that the author would like to extrapolate upon but, unfortunately, lack of access to the original document has not been possible.

- Occupation shelters were more common close to valley floors while those with art were said to be located below ridge tops;
- Shelters varied in size and there seemed to be a preference for a north-westerly aspects in terms of occupied shelters;
- Proximity to permanent water sources did not appear to be a significant factor in occupation shelter selection, as they were most commonly found on high ridge tops, far from drainage lines. Water was still available, either from rock pools, seepage or aquifers;
- Archaeological deposits recorded in shelters varied in terms of content and density. More substantial deposits included stone artefacts, bone, shell and charcoal; and
- Art sites within shelters (67) occurred in both high ridge tops and on lower valley slopes. The size and aspect of the shelter did not seem to be a key factor in the location of art sites. Art included figurative and non-figurative work in wet pigment paintings (mostly red with some white and black), stencils (predominantly white, red, yellow and pink) and dry pigment drawings (most commonly black). Images were found on both ceilings and walls. Engravings within shelters were rare.

A total of 49 middens were recorded in sandy, alluvium and Narrabeen Formation landscapes, and these were most often observed near freshwater creeks/aquifers at the bottom of slopes towards the valley floor.

Artefact scatters were not commonly observed during survey. Five were located (only one is recorded as a separate site, the others as middens or shelter with deposit), all of which were either associated with middens or found on creek banks or a high plateau. It was noted, however, that there was a reasonable likelihood that vegetation and/or accumulated deposits may have covered archaeological sites causing them to be invisible in terms of survey.

A total of 54 grinding grooves were found, mostly in and along creek beds at the heads of valleys on Hawkesbury Sandstone. These were also found on Narrabeen Group sandstone(s) although not as often as in Hawkesbury Sandstone. They were usually located near the tops of waterfalls, near rock pools or close to aquifers on rock platforms. The numbers of grooves varied from 1–81 and the average groove size was 29 x 7.5 x 1 cm, making them likely to have been for spear/tool point sharpening rather than any sort of food preparation.

Engravings usually consisted of pecking, abrasion or both. Most motifs were human, fish or macropods, with birds and other animals, weapons and animal/human tracks also being observed. Of the 12 engravings recorded, they were usually found in Hawkesbury Sandstone on ridge tops and plateaus. Others were found on Narrabeen Group sandstone(s) at sea level;

As the Gosford-Wyong area has been heavily logged in the past, scarred trees were considered rare in the region and none were recorded during the assessment.

The majority of the 1000 registered sites listed on DECCW records for the Gosford-Wyong area at the time of the Vinnicombe study were engravings, axe-grinding grooves, rock shelters containing art and shelters with deposit. Shell middens, stone arrangements, open camp sites, burials and quarries were also recorded but in far fewer numbers. Vinnicombe argued that the bias in favour of engravings in the then NPWS register, largely reflected past survey strategies. In addition, the greater Gosford-

Wyong area was dominated by Hawkesbury Sandstone ridges and as a result, the predominance of sandstone-derived sites recorded may have contributed to this trend.

The average site density within the Vinnicombe's study area was estimated at 8 sites per square kilometre.

4.2.2. Attenbrow (2004a) Upper Mangrove Creek Investigations

Although over 20 kms west of the current Subsidence Study Area, the archaeological investigations in the Upper Mangrove Creek sandstone hinterland area provides the largest systematic and best-published survey and excavation programme in the region, having taken place in the 1970s and the 1980s.

The project included the following components (ERM 2001: 2.23):

- Intensive survey of the Mangrove Creek dam storage area (1,215 hectares) which covered valley floors and low ridges underlain by the Narrabeen Group sandstone(s).
- Stratified random sampling of 10.1 square kilometres (or 10 percent) of the entire dam catchment, ensuring representation of the Hawkesbury Sandstone and underlying Narrabeen Group. This area was divided into three broad topographic zones: ridge tops to 10 m below break of slope (separated into those dividing catchments from those within); valley bottoms (colluvial / alluvial) up to 40 m up the low toe slopes (separated into minor and major) and ridge sides of the Hawkesbury and Narrabeen sandstones (separated into those above major versus minor creek lines).

Her findings generated the flowing predictive statements:

- That ridge tops between major catchments are likely to have a large number of sites including rock shelters with archaeological deposits and grinding areas. Density was predicted to be less than that for main creek valley bottoms and subsidiary creek sides, however. Ridge tops within catchments are likely to have few sites and the lowest density. If present, rock shelters will tend to be in cliff lines just below the flat ground of the ridge top.
- Main creek valley bottoms have a high density of sites, especially artefact sites with sub-surface deposits.
- Although ridge sides above main creeks have a high density of potentially habitable rockshelters or those with potential archaeological deposits (PAD), there will be an overall low density of sites while ridge sides above minor creeks have a relatively high density of sites and rock shelters with art will have the highest number of figures. Shelter archaeological deposits will be mainly small scale.

Attenbrow also investigated the Mangrove Creek alluvial flats from Wattle Creek to the site of the dam roughly 8.5 kilometres away. This investigation was conducted specifically to search for open artefact scatters and was undertaken in two stages, the first being an opportunistic approach followed by a more systematic survey after logging had occurred in the area, thus exposing sub surface archaeological deposits. Excavations also later formed part of this study to further investigate numerous sites.

As a result of both the survey and excavation programme, 179 sites were identified in the Upper Mangrove Creek, presented in **Table 2**.

Table 2: Upper Mangrove Creek types and frequencies

Site type	Number	Percentage frequency
Grinding grooves in the open	41	23%
Rock shelters with deposit and art	33	18%
Rock shelter with deposit alone	30	17%
Isolated finds	28	16%
Open scatters of artefacts	25	14%
Rock shelter with art alone	15	8%
Rock engravings in the open	2	1.1%
Rock shelters with deposit, art and grinding groove	2	1.1%
Rock shelters with deposit, art and burial	1	0.6%
Rock shelter with deposit and grinding groove	1	0.6%
Scarred trees	1	0.6%
Total	179	100%

In terms of the site location of the isolated finds, 82% were identified in the main creek valley bottoms, 11% on ridge lines above main creeks and 7% on ridge tops. It was noted that the discrepancy in distribution may be a result of more intensive survey in valley floors. Of the open artefact scatters, 84% were identified in main creek valley bottoms with the remainder identified on ridge tops. The overall density of archaeological features was determined as 5.8 per km^2.

A further noteworthy result of this project was the introduction of the concept of potential habitation (PH) shelters as it was realised that many rockshelters without any visible sign of Aboriginal use had deposits that looked as if they would contain archaeological materials. Important to future archaeological investigations, this work introduced the concept of PADs to Australia (Attenbrow 2004a).

Twenty-eight rockshelters with deposit were excavated during the salvage component of this project, along with many open artefact scatter sites. Of these, only 16 had been recorded as having archaeological deposit from the presence of surface artefacts sighted during the initial site survey. Of the twelve potential archaeological deposits in rockshelters that were test excavated, eight (67%) proved to contain sub-surface cultural materials. Additionally, this salvage program was among the first pieces of research aimed at the scientifically rigorous understanding of an environmentally defined area that was able to shed light on the processes of 'intensification' of Aboriginal occupation during the late Holocene around 4000 BP (Attenbrow 2004b).

4.2.3. Dyall (1981) Tuggerah–Sterland 330kV Transmission Line Assessment

Dyall (1981) conducted a survey for the then Electricity Commission of NSW on the route of the Tuggerah-Sterland 330kV transmission line located 10 km south of the current Study Area. A total area of 120 square kilometres was covered by this survey, encompassing a variety of landforms, including steep Narrabeen Group sandstone ridges and Gosford Sub-Group sandstone outcrops. Particularly the eastern portion of the survey covered similar landforms to those found in the current Study Area.

Thirteen Aboriginal occupation sites were recorded during the survey. An 'art gallery' was identified at the head of Moran's Creek. Six rock shelters were located, one with a single drawing. Six sets of axe-grinding grooves were also identified, ranging from a single groove to a set of seventeen, all located

in minor creeks, at locations where the creeks flow over sandstone shelves, high on the ridges. Two isolated finds of stone flakes were also recorded.

Based on the results of the preliminary survey, Dyall hypothesised that while it was unlikely that more art would be found within the study area, a more detailed survey should reveal more Aboriginal material, especially around the swamp areas.

4.2.4. Koettig & Hughes (1983) The Hungry Creek Survey in Upper Wollombi Brook

This survey covered an area of 300 hectares and identified 17 sites, (average site density was 5.7 per square kilometre) of which 12 were rock shelters with associated traits such as art and/or deposits. It was noted that these 12 sites represented 24% of 51 potential habitation shelters. This added to the previous survey results of Vinnicombe and Attenbrow that of all the potential habitation shelters identified, 16% and 24% respectively had actually been utilised as activity or habitation sites. This indicates that on average one in four or five potential shelter sites will show evidence of occupation.

The difficulty in distinguishing between Hawkesbury Sandstone and Narrabeen Group sandstone(s) was also noted by Koettig and Hughes (1983).

4.2.5. Dallas (1986) Hue Hue Rd assessment

In 1986 the Wyong Shire Council commissioned an archaeological survey along Hue Hue Road as part of their Draft LEP (Dallas 1986). The study area consisted of land abutting Hue Hue Road, to the west of the Sydney–Newcastle Freeway. The landforms that comprised this study are more akin to those in the valley bottoms and toe slopes within the proposed subsidence area than that the sandstone country.

Based on the limited previous archaeological work in the area and the environmental setting of the site, Dallas limited site prediction to open camp sites and modified trees.

A surface scatter of three artefacts was identified, on compact exposed clays and gravels, located on a slope overlooking a creek. The artefacts consisted of a yellow mudstone flake, a grey silcrete flake and a yellow chert flake. It was assessed as unlikely that any undisturbed subsurface deposits remained in the area.

The scatter was interpreted to represent sporadic use of the area. Its location may indicate use of the area by small foraging groups who would have exploited the resources of the nearby swamp. However, European land use practices are likely to have obliterated any traces of substantial significant occupation sites within Dallas' study area.

4.2.6. Kinhill (1995a) Morisset Forestry District EIS: An Assessment of Aboriginal Archaeological Sites

The Morisset Forestry District (MFD), located north of the Subsidence Study Area, was assessed to describe the Aboriginal heritage and cultural values of the area the likely environmental impact of forestry operations on Aboriginal heritage sites. The study also endeavoured to establish the nature and distribution of stone artefact scatters across the landscape as it appeared that the database for sandstone sites was sufficiently large enough for predictive purposes.

The study area was approximately 1,160 km^2, and was divided into 10 environmental zones based on geology and topography. The geographical nature of these zones was used to predict the frequency and distribution of different site types (ERM 2001: 2.21). Written descriptions of these zones make them somewhat difficult to distinguish from one another but it is noteworthy that they are all fairly

rugged and comprise no alluvial/valley components. Although descriptions of zones do note whether Narrabeen or Hawkesbury sandstones are present, zones sometime include both formations. Survey was limited to identify zones 4, 5, 6, 8 and 10, of which 4–6 and 8 comprise deeply dissected Hawkesbury Sandstone plateaus with steep valley sides, mainly on sandstones of the Narrabeen Group and overlying Gosford Formation sandstone and shales; while zone 10 comprises low hills on Permian sedimentary rocks.

At the time of this study, approximately 200 sites had already been recorded within the study area and registered on the AHIMS. Most were sandstone rock shelters with art and axe-grinding grooves on sandstone outcrops. In the wider region, (i.e. all forests in MFD) approximately 4,800 sites were listed with NPWS. Of these, 75 percent were rock shelters with art and/or deposit, axe-grinding grooves and rock engravings. The area also yielded open campsites (artefact scatters) in the Hunter Valley region and shell middens on the coast. Very few open artefact scatter sites were recorded in the study area.

Based on previous archaeological research, it was assumed that sandstone sites were more likely to be found in areas with geology characterised by Hawkesbury Sandstone. It was also predicted that open artefact scatters were likely to be more prolific on ridge tops and valley floors.

Results of this study saw a total of 41 Aboriginal sites recorded, including open artefact scatters, axe-grinding grooves and rock shelters. Of the 22 open artefact scatters, the majority were low density sites with an average of six artefacts per site, with largest bearing 34 artefacts. Most scatters were located on ridge tops or valley floors as predicted. Four axe grinding groove sites were recorded, three in creek beds and the final on top of a sandstone ridge next to water ‘potholes’. Five rock shelters with PAD of c. 25 cm depth were also recorded, four of which overlooked a tributary of Deep Creek.

In summary, rock shelters were most commonly located on sandstone cliffs, ridges and dissected plateaus of Hawkesbury Sandstone, where outcropping was common. Rock shelters were likely to occur in similar topography in Narrabeen Group sandstone(s) and associated formations although they were less probable in Gosford Formation sandstone and shales and the Clifton Subgroup (Zones 4, 5 & 8) (ERM 2001: 2.22). It is important to note here that these extrapolations regarding sites and their relationship to the underlying geology are somewhat difficult to interpret. As the Narrabeen Group is comprised only of the Gosford Formation and the Clifton Subgroup (as well as a lower undifferentiated component), it is hard to see where the shelters were more likely to occur within the Narrabeen Group.

Open artefact scatters were most likely to occur on ridge tops and on the lower reaches of some of the creek lines in both Hawkesbury and Narrabeen Group sandstone(s). Of all the landscapes surveyed, those underlain by Gosford Formation with cappings of Hawkesbury Sandstone and Clifton Subgroup had the highest potential to yield artefact scatters as a result of the broader ridges associated with this geology. The scarcity of open artefact scatters was attributed to the long logging tradition in the area which had disturbed those areas where artefact scatters usually occur (ridge tops and valley floors), while the higher number of sandstone sites (rock shelters and engravings) was probably due to the fact that logging activities were concentrated away from sandstone outcrops.

4.2.7. Kinhill (1995a) Compartments 182, 183 and 184 of the McPherson State Forest, NSW

Assessment of 812 ha proposed for timber harvesting in the McPherson State Forest (SF) was undertaken, which resulted in the survey of Hawkesbury Sandstone on the plateaus, ridge tops and high slopes and underlying Narrabeen Group sandstone(s) on lower slopes and valley sides. No

valley bottoms were assessed. Predictions for site type and location were made based on Attenbrow and Vinnicomb's work in the Upper Mangrove catchments and it was anticipated that most, if not all, of the sites identified during the survey would be sites associated with rock outcrops. The study area was divided into eleven sample survey areas and three transects, which together comprised 147.7 ha (18%) of the total study area. Descriptions of all these areas indicate that Hawkesbury Sandstone was the predominant formation assessed.

A total of 12 sites were located and site density calculated at 8.2 per km^2. This is higher than reported for previous studies in the McPherson SF and the Upper Mangrove Creek area at 6.5 per km^2. Open artefact densities were calculated at 1 artefact/ 10,000 m^2 on ridge tops and at 1 artefact/16,500 m^2 on shelves on ridge sides.

4.2.8. Silcox (1996) Archaeological Survey and Assessment of Compartment 128, Ourimbah State Forest, Mangrove Mountain, NSW.

An archaeological investigation in the Ourimbah State Forest, Mangrove Mountain near Gosford, NSW, (approximately 5 kilometres south west of the current Subsidence Study Area) was conducted over 536 ha in preparation for further forestry activities. Geologically the area is comprised of Hawkesbury Sandstone cappings overlying Gosford Formation sandstone and shales of the Narrabeen Group. Topographically, the area comprised a deeply dissected plateau surface with ridge tops within and between major creek catchments.

On the basis of previous research and the area's geography, Silcox predicted that rock shelters (containing art and/or deposit) and axe grinding grooves were the most likely site types to occur in the region. As a result of survey, 59 new sites were recorded, including 40 axe grinding groove sites, 18 shelter sites and one boulder with art. Of the axe grinding sites, 50% were found on creek beds of major tributaries on valley floors, 32.5% on top of or on the side of ridge tops, 12.5% on the plateau surface, and 5% were found on the sloping sides of plateaux. The number of grooves in each site ranged from two to 131.

Of the shelters recorded, 72% were found along the ridge sides and ridge tops/cliff lines, 17% were found on the plateau surface, 5.5% were found on the side of the plateau, and 5.5% were found on the lower side of a valley. A total of 16 shelters (89%) contained Aboriginal art, including animal and human motifs, as well as hand stencils. Six shelters (33%) contained archaeological deposit consisting of stone artefacts, including mudstone, chert, quartz, silcrete and volcanic artefacts. Two isolated shells of the *Anadara trapezia* (Sydney cockle) species were also found. In addition, three shelters (17%) contained axe grinding grooves, recorded separately from the 40 axe-grinding groove sites already mentioned. The boulder with art (a human motif) was found on the side of a ridge.

As predicted, shelters and axe grinding grooves were the most common sites found. Site density was calculated at 11 sites per km^2, higher than originally predicted at six sites per km^2.

4.2.9. Nexus (1998) Green Waste Processing Facility, Hue Hue Rd, Warnervale

Nexus Environmental Planning (1998) undertook an archaeological survey at the proposed Green Waste Processing Facility on Hue Hue Road, Warnervale, adjacent to the Buttonderry study area, as part of an EIS in preparation for a development application.

The site had previously been used as a waste disposal area and therefore it had already been highly disturbed and striped of vegetation due to previous land use. Further, the new facility was to be built on land fill. No items of archaeological or heritage significance were found on the site. It was also

concluded that any items which may have previously existed, were probably removed during the previous stage of site development.

4.2.10. Direct impact and conservation offset areas for the W2CP

In 2000 a preliminary Indigenous cultural heritage assessment of the proposed coal mine surface infrastructure area at the Bushells Ridge (Tooheys Road) site was carried out by Environmental Resources Management Australia Pty Ltd (ERM 2001a) on behalf of Coal Operations Australia Limited for the WACJV. The assessment was undertaken to establish the likely possibilities and constraints to the development of the site in terms of Indigenous archaeological potential. This survey covered the same land area as that later covered by a survey by OzArk in 2006 (OzArk 2009).

This assessment comprised an initial desktop study which was undertaken to review the existing environmental and archaeological landscapes in and around the study area. From this review a predictive archaeological model for likely site types and their distribution across the landscape was developed. The predictive model was then used to design a two-staged survey that targeted sampling within the main geological and topographic zones considered as having archaeological sensitivity and value.

The result of this survey (ERM 2001a) was that no visible evidence of Aboriginal cultural material was found. Consequently, an adaptive management approach was adopted whereby other environmental indicators were used to identify areas of archaeological potential. The landforms with greatest archaeological potential were identified at two places along Wallarah Creek and concluded that the entire length of Wallarah Creek within the surveyed area was a zone of archaeological sensitivity.

In 2005 three isolated artefacts and two artefact scatters were recorded as a result of a survey for a proposed Gas Turbine Facility associated with Munmorah Power Station (Heritage Concepts 2005). Part of this survey traversed very close to the Tooheys Road area (the mine infrastructure area to the east of the Subsidence Study Area: OzArk 2009), particularly in the north where the Munmorah Power Station survey ran down the TransGrid easement. Of the three isolated finds recorded, two are located along the TransGrid easement within the Tooheys Rd area generally, but outside the direct impact corridor surveyed for the rail loop as part of the W2CP surface infrastructure study (OzArk 2009). Underneath TransGrid pylon 21TL16, the pylon closest to Spring Creek on its western bank, isolated artefact (IA2) was recorded. It consisted of a large flake of mudstone. The ground surface in this area also has been heavily disturbed from vehicle (mostly motocross) traffic.

The other isolated artefact (IA3), a single flake of indurated mudstone found sitting on the hard, eroded track surface, was located in a section of the TransGrid easement adjacent to the Tooheys Rd area.

In 2006, OzArk commenced a comprehensive and final assessment for the W2CP areas of direct impact and potential offset conservation zones that was finalised in 2009 (OzArk 2009). The assessed area was divided into the four categories, based on potential impact and distinct physical locations, as follows:

- Direct impact areas:
    - Tooheys Road study area: No Indigenous sites were recorded; however, two zones of archaeological sensitivity were delineated. The first comprising a 150 m wide corridor centred on Wallarah Creek and extending for c. 1.4 kms (the length of Wallarah Creek within this study area) and the second being a 100 m zone centred on Spring Creek and extending for 200 m;

- Buttonderry study area: No sites were recorded; and
- Western Shaft Rd study area: No sites were recorded.

- Potential conservation offset areas:
  - Hue Hue Rd study area: Three sites were recorded – one possible modified (scarred) tree; one open camp site and one isolated find. All were located close to Wallarah Creek; and
  - Buttonderry potential conservation study area: No sites were recorded.

4.3. Local Archaeological Context

4.3.1. Previous studies

In 2001, ERM was commissioned to prepare a methodology for the full assessment of the western area and the then current mine plan (which has been significantly modified since that time). As noted earlier, much of the background from this document has been useful in the preparation of the current report; however, it is noteworthy that no field work was undertaken for this study, which was purely a desktop review.

4.3.2. AHIMS database

4.3.2.1. General 'Western Area'

In 2001, ERM undertook an AHIMS search over a 540 km^2 area including the then called Western Area which includes the current Subsidence Study Area. This search revealed 80 sites, of which 43 were located within the Western Area and 6 within the proposed mine plan. Site frequencies over the Western Area can be seen below in **Table 3**.

Most of the sites recorded in the broader Western Area are axe-grinding grooves (30%) and shelters (27%). Open sites account for 25% while isolated finds are also quite well represented at 18%. The majority of sites have been recorded in the context of archaeological assessments for development applications, several of which were discussed previously under the Regional Context **Section 4.2**. This is undoubtedly the key reason why many of the recorded sites occur in concentrations. It is also worth noting that all known sites within the Western Area are above the 100 year flood line, i.e. outside the floodplains of the Yarramalong and Dooralong Valleys where substantial agricultural land practices have transformed the landscape (such as occupied by the Honeysuckle Study Area). 60% of recorded sites are located on the Terrigal Formation geological unit/Watagan soil landscape which comprises the steep hills and outcropping sandstone that characterises much of Wyong Forest Study Area. Sites recorded in this unit/landscape include shelters, axe-grinding grooves, open sites and isolated finds, quite evenly represented. About 23% of recorded sites are on Patonga Claystone geology and the associated Mandalong soil landscape that occurs between the Terrigal Formation and the alluvials of the valley floor. Sites in this group are predominantly axe-grinding grooves followed by shelters, with no artefacts sites represented at all. No sites have been recorded on the valley floors, which is likely to be result of the significant landscape alteration in these areas.

Table 3: Site type frequencies in the Western Area (ERM 2001: Table 2.7)[6].

Site Type	Frequency	Percentage of Total Site Types %
Axe-grinding Grooves	13	30
Shelters	12	27
Shelter with Art	8	(18)
Shelter with Deposit	1	(2)
Shelter with Art and Deposit	2	(5)
Shelter with Midden	1#	(2)
Open Camp Site (Stone Artefact Scatter)	11	25
Isolated Find	8	18
Total Sites	44*	100

Sources: NPWS Aboriginal Site Register (July, 1999)

Notes: 1 # Site 1 comprises axe-grinding grooves and a shelter with midden and is therefore counted twice, bringing the total to 44.
*2. *Total site types when Site 1 is considered*

4.3.2.2. Specifically within the Subsidence Study Area

A search of the DECCW AHIMS[7] within the current zero subsidence line revealed six (6) previously recorded Aboriginal sites in this area. **Table 4** displays the site information for these sites.

It is very important to note that three of the six sites that plot to within the zero subsidence line have, in fact, been afforded wrong site co-ordinates on the DECCW AHIMS. Review of the site cards for these three sites show, as their names reflect, that they are located in the Gosford and Strickland State Forests and they are therefore situated around 13 kilometres south of the current Study Area. Hence, for the purpose of mapping sites relevant to this study, we have removed these three sites from the DECCW AHIMS plotted data. In the interests of improving the accuracy of the AHIMS data, we have also advised them of this discrepancy and have been informed that the error has been rectified.

Figure 7 plots the confirmed three recorded Aboriginal sites noted in the Wyong Forest Study Area portion of Subsidence Study Area. The three erroneously defined sites mentioned above are not included.

These axe-grinding groove sites are located along the base of the deeply incised Myrtle Creek, which is a tributary into Little Jilliby Jilliby Creek. These sites were recorded by State Forests during a site recording exercise. Site # 45-3-3040 is comprised of 14 grooves in three groups within a 15–20 m area. The first group with two grooves, the second with nine grooves and the third with three grooves, all measuring between 16 and 43 cm in length, 5–17 cm wide and 1–4 cm deep. This groove area is located 10 m west of the confluence of a minor tributary with Myrtle Creek.

Site # 45-3-3041 is comprised of 30 grooves in two groups on a flat rock surface. The first group with 22 grooves, the second with eight grooves, all measuring between 11 and 47 cm in length, 3–34 cm

[6] It is noteworthy that the ERM table as presented here contains the same site anomaly data which is discussed in the following paragraphs.

[7] Search date: 29.5.2007. While the AHIMS database search is over two years old, the results of a more-recent search would be relatively similar in terms of site types and relative numbers of sites. The authors, from information given by the Aboriginal community representatives, are sure no new archaeological work has taken place within the Survey Study Areas in the intervening time.

wide and 0.5–6 cm deep. The variation in dimensions and shape indicates that the sharpening of different tools was taking place here and also possibly the preparation/grinding of particular foodstuffs, for example in a ground area measuring 42 x 34 x 3 cm.

Site # 45-3-3042 is comprised of five grooves in one group on a small rock surface c. 250 m southeast of Myrtle Creek/Maculata Rd #1.

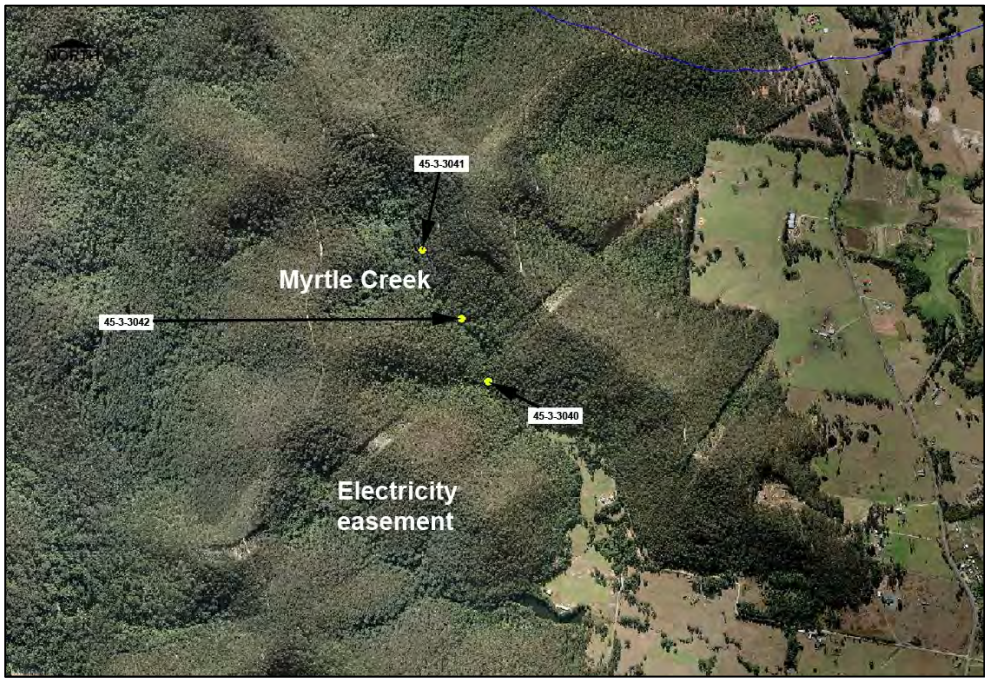
Plotting of these sites in terms of surface geology indicates that all three sites are located on Patonga Claystones. It is noteworthy that axe-grinding grooves are once again the predominant site type (as was the case within the broader search of the Western Area). The lack of modified (scarred) trees in the vicinity is undoubtedly reflective of the early and complete logging of the region.

Table 4: Previously recorded sites within the zero subsidence line (co-ordinates in AGD). Sites with a grey background plot to within the Study Area but are in fact located in Gosford and surrounds.

Site ID	Site Name	Easting	Northing	Site Types	Recording
45-3-0559	Gosford	344800	6319400	Axe-grinding Groove, Shelter with Midden	Dyall
45-3-2966	Strickland Airstrip	345100	6319500	Axe-grinding Groove	Welsh
45-3-3040	Myrtle Creek/Maculata Road #3; Wyong State Forest	346850	6322700	Axe-grinding Groove	Donovan, Welsh
45-3-3041	Myrtle Creek/Maculata Road #1;Wyong State Forest	346600	6323180	Axe-grinding Groove	Donovan, Welsh
45-3-3042	Myrtle Creek/Maculata Road #2; Wyong State Forest	346750	6322930	Axe-grinding Groove	Donovan, Welsh
45-3-3089	Dog Trap/Strickland SF	344890	6320130	Open Camp Site	Welsh

It is important here to re-emphasise that the distribution of recorded sites within the current zero subsidence line study area reflects more the pattern of development, the *ad hoc* nature of incidental recordings and factors of visibility, rather than providing a true picture of Aboriginal site distribution.

Figure 7: Aerial photograph showing the location of the Myrtle Creek axe-grinding sites.



4.4. Predictive model for site location

Proximity to a permanent water supply is the primary factor appearing to determine the location of Aboriginal campsites. In the Sydney region, stream ordering has been used to predict the potential for site occurrence, and further to indicate the possible nature of these sites in terms of their complexity. Results of an integrated series of studies including a serious excavation component suggests a high correlation between the permanence of a water source and the permanence and/or complexity of the areas' Aboriginal occupation. This was further reflected in the lithic assemblages from sites close to permanent water, which suggested that a greater range of activities was represented (e.g. tool use, manufacture and maintenance, food processing and quarrying). Sites near ephemeral water sources had evidence for one-off occupation (e.g. isolated knapping floors or tool discard), and creek junctions were also proven to be foci for site activity.

The size of the current Study Area is such that a variety of landform features are present, although these can be broadly classed into two main groups: predominantly cleared valley floors/toe slopes on alluvial/colluvial deposits and steep sided forested ridges of the Wyong State Forest.

The majority of the valley floors have been cleared and intensively used for agriculture while the hills have been logged. These land use impacts, as discussed in greater detail in previous chapters, have undoubtedly had a significant impact on Indigenous site preservation and hence on the type of sites and their distribution that can be predicted within the Subsidence Study Area.

The following points summarise the landforms of the Study Area and their potential:

Hilly landforms (ridge caps) of Terrigal Formation sandstones and mid-hillslopes of the Patonga Claystones (Wyong Forest Study Area):

- A significant portion of the outcropping geology of the Wyong Forest Study Area is comprised of these formations.
- Headwaters for many tributaries into Wyong River, Jilliby Jilliby Creek and Little Jilliby Jilliby Creek start in these hills.
- The results of previous research indicate that Hawkesbury Sandstone formations are favoured over Narrabeen Group sandstones (including Terrigal formation) in terms of rock shelter site location. However, as no Hawkesbury Sandstone is present within the Wyong Forest Study Area, a greater emphasis is likely to have been placed on the available shelters of the Terrigal Formation and the Patonga Claystone.
- Research as presented in **Section 4.3.2** covering an area greater than the Wyong Forest Study Area yet including it, shows that sites are most common (60%) in the Terrigal Formation/Watagan soil landscapes and that sites in these areas may be axe-grinding grooves, artefacts sites or shelters. Sites recorded on Patonga Claystone comprise 23% of the total and only include shelters or axe-grinding grooves. This pattern is thought to reflect the fact that the Patonga Claystone tend to outcrop mid hillslope while the Terrigal Formation comprises ridge caps as well.
- Of previously recorded sites within the Wyong Forest Study Area, 33.3% are located on Patonga Claystone — one sandstone axe-grinding groove site — while 66.6% are situated on the Terrigal Formation, comprising two axe-grinding groove sites. This combination of site type and geological formation is parallel to that of the broader Western Area and similar percentage frequencies relating to site density and surface

geology are to be expected in the Wyong Forest Study Area. If results were extrapolated from the broader Western Area, one may expect to find more sites in the Terrigal Formation than the Patonga Claystone in the Wyong Forest Study Area.

- It must be kept in mind that the results from previous assessment within the Wyong Forest Study Area are not the result of methodological survey but more the result of incidental recordings. Consequently, site distribution within this area can only be interpreted as a snapshot, not as the results of a meaningful test of surface geology in relation to site location.

Using this data, the following conjectures may be made about Aboriginal sites in the hilly Terrigal Formation and Patonga Claystone that characterise the Wyong Forest Study Area:

- Further Indigenous sites are to be expected this Study Area;
- Site types are most likely to be rock shelter sites or axe-grinding grooves. Shelters may have deposits including midden material, but art sites have not been previously recorded in this area, although this does not discount limited potential for their location;
- There is some evidence that sites will be more frequent on ridges between major catchments than on ridges within major catchments, although the distinction of major versus minor is somewhat arbitrary. Nevertheless, within the relation to the Wyong Forest Study Area, all the ridges are within a major catchment and not between and hence if this model were adopted we may expect less sites per km^2 than further afield on major catchment dividing ridges;
- Some artefact sites (open sites or isolated finds) may be located at the foot of slopes where the Patonga Claystones are close to the valley alluvials or on ridge tops of the Terrigal Formation;
- Burial sites and ceremonial sites are considered unlikely as suitable landforms are absent from the Wyong Forest Study Area; and
- Modified (scarred) trees are considered extremely unlikely due to the intense clearing and logging the region has experienced.

<u>Valley floor landforms (flood plains and alluvial terraces) of Quaternary alluvium (Honeysuckle Study Area):</u>

- Quaternary alluvium comprises the valley floors of the Yarramalong, Dooralong and Jilliby Jilliby Valleys (the Honeysuckle Study Area is located on Jilliby Jilliby Creek).
- The waterways of the Wyong River, Jilliby Jilliby and Little Jilliby Jilliby Creeks are fourth order and permanent waterways within this landform.
- The results of previous research over the Western Area recorded only one site in this formation, and that was on the edge of the developed valley floor. None have been previously recorded within the Subsidence Study Area.
- As a result of both hydrological and natural erosion/sedimentation regimes coupled with intensive land-use practices, intact Aboriginal sites are considered extremely unlikely in the valley floor landforms such as the Honeysuckle Study Area.
- There may be small pockets of land remaining less disturbed than others, but the location of these is challenging to predict.

Using this data, the following conjectures may be made about Aboriginal sites in the flat to gently sloping valley floor alluvial landforms within the Subsidence Study Area (Honeysuckle Study Area):

- Virtually no intact Aboriginal sites are to be expected in valley floor alluvial landforms due to natural and anthropomorphic impacts;
- If site material such as Aboriginal stone tools were found in these landforms it is likely they will be one-off, isolated items that are no longer *in situ*;
- There are no predictive tools for the location of such sites as isolated finds and nor is this type of evidence particularly meaningful on a scientific level.

4.5. Survey results

4.5.1. Aboriginal sites recorded

4.5.1.1. Wyong State Forest Survey Study Area

Four Aboriginal axe-grinding groove sites were recorded within Wyong State Forest as part of the heritage assessment of Wyong Forest Study Area. Three are clustered together on the one watercourse in the very north of the Study Area (WSF-AG1–3), while WSF-AG4 is located in the southwest of the Study Area. **Table 5** records the location of these sites, while descriptions of the sites follow. **Figure 8** shows the location of these sites.

Table 5: Aboriginal sites recorded.

Site designation	Site Type	GDA Zone 56 Easting	GDA Zone 56 Northing
Wyong State Forest – Axe groove 1 (WSF-AG1)	Axe-grinding groove site	345580	6325095
WSF-AG2	Axe-grinding groove site	345649	6325056
WSF-AG3	Axe-grinding groove site	345744	6324833
WSF-AG4	Axe-grinding groove site	345784	6318982

WSF-AG1

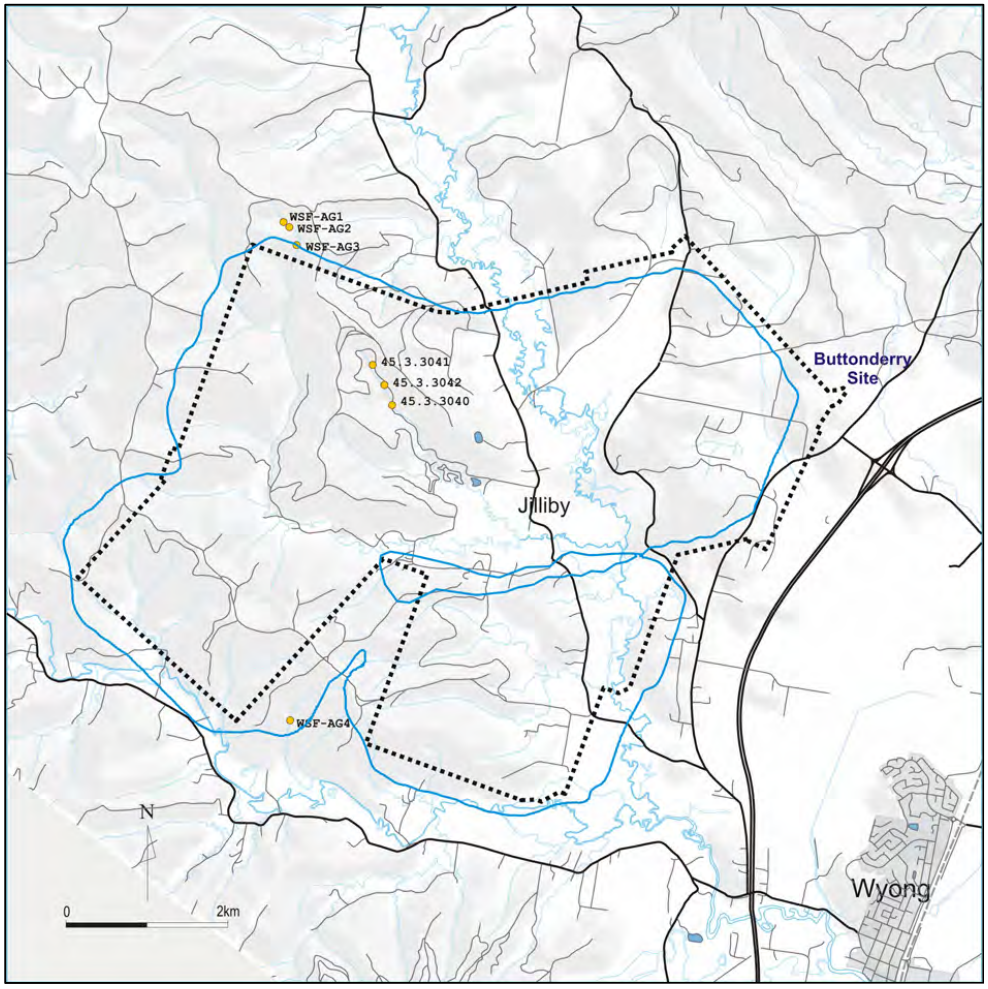
Type of site: Axe-grinding groove site

GPS Coordinates (GDA Zone 56): 345580E, 6325095N

Location: Located on the creek bed of an unnamed tributary to Little Jilliby Jilliby Creek that runs east and parallel to the main branch of the creek near its headwaters. The location of WSF-AG1 is shown in **Figure 10.**

Description: WSF-AG1 is a cluster of 12 axe-grinding grooves of which five are of definite Aboriginal origin. They are located next to a natural rock pool on a slab of bedded sandstone at the confluence of a minor waterway into the larger tributary (**Plate 13**). The axe-grooves range in size between 20–30 cm and are about 7 cm deep on average.

Figure 8: Location of recorded Aboriginal sites (WSF-AG1–4). Previously recorded sites 45-3-3040–3042 are also shown.



WSF-AG2

Type of site: Axe-grinding groove site

GPS Coordinates (GDA Zone 56): 345649E, 6325056N

Location: Located on the creek bed of an unnamed tributary to Little Jilliby Jilliby Creek that runs east and parallel to the main branch of the creek near its headwaters. WSF-AG2 is about 50 m south of WSF-AG1 on the same creek. The location of WSF-AG2 is shown in **Figure 10.**

Description: WSF-AG1 is one axe-groove of definite Aboriginal origin. It is located next to a small natural rock pool on a slab of bedded sandstone (**Plate 14**). The axe-groove is 35 cm long and are about 6 cm deep in a shallow v-shaped groove.

Figure 9: Aerial mosaic showing the location of recorded Aboriginal sites.

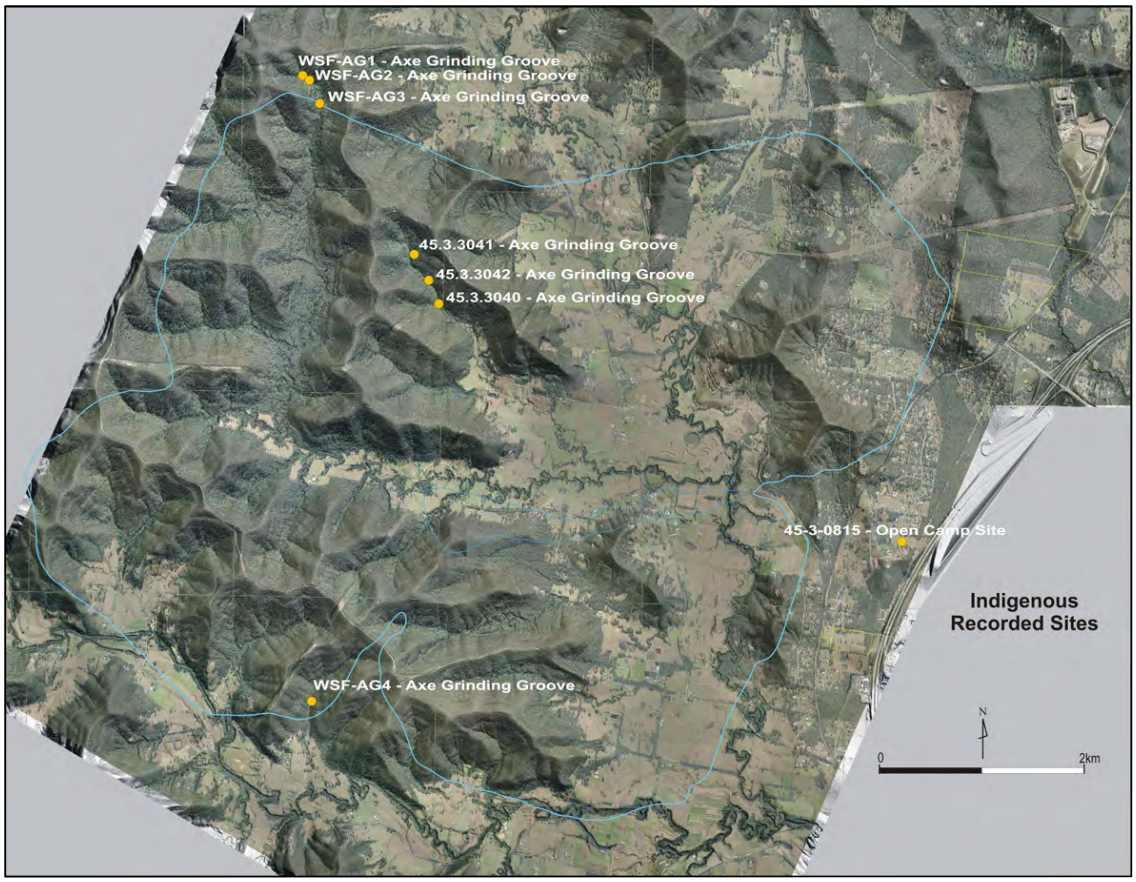
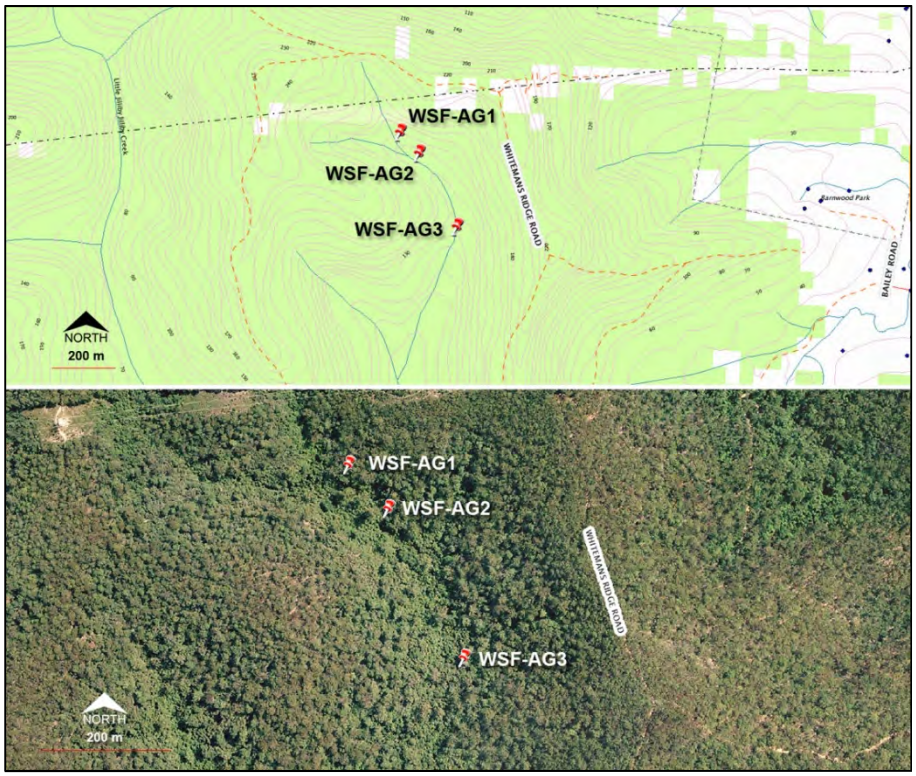


Figure 10: Topographic map and aerial photograph showing the location of WSF-AG1, AG2 and AG3.



WSF-AG3

Type of site: Axe-grinding groove site

GPS Coordinates (GDA Zone 56): 345744E, 6324833N

Location: Located on the creek bed of an unnamed tributary to Little Jilliby Jilliby Creek that runs east and parallel to the main branch of the creek near its headwaters. WSF-AG 1 and WSF-AG2 are located on the same creek as WSF-AG3. The location of WSF-AG3 is shown in **Figure 10**.

Description: WSF-AG3 is two axe-grooves of definite Aboriginal origin along with three shallower grooves of probable Aboriginal origin. They are located next to a natural rock pool on a slab of bedded sandstone in the middle of the creek (**Plate 15**). The axe-grooves range in size between 25–35 cm and are about 7 cm deep on average.

WSF-AG4

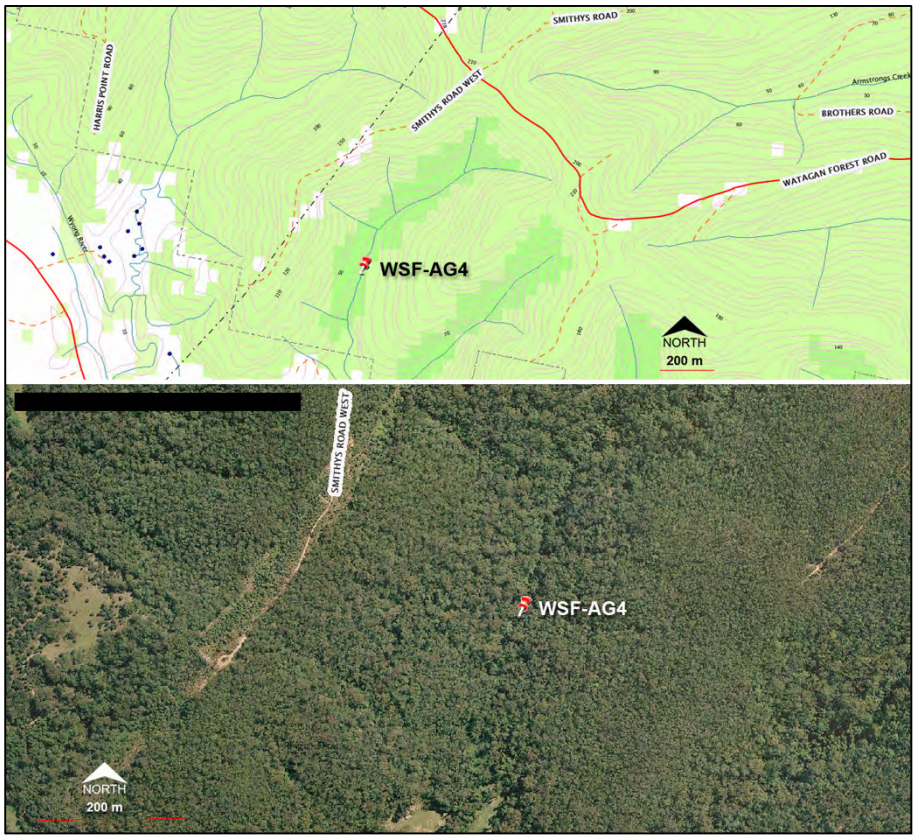
Type of site: Axe-grinding groove site

GPS Coordinates (GDA Zone 56): 345784E, 6318982N

Location: Located on the creek bed of an unnamed tributary to Wyong Creek that runs roughly north–south to the east of Smithys Road West. The location of WSF-AG4 is shown in **Figure 11**.

Description: WSF-AG4 is five axe-grooves of definite Aboriginal origin in an area of rock pools in the middle of the creek. They are located on a slab of bedded sandstone (**Plate 16**). The axe-grooves range in size between 20–38 cm and are about 5 cm deep on average.

Figure 11: Topographic map and aerial photograph showing the location of WSF-AG4.



4.5.1.2. Honeysuckle Park Study Area

No Aboriginal sites were recorded within the Honeysuckle Park Study Area.

4.5.2. Aboriginal sites re-located

Three axe-grinding groove sites had been previously recorded as being located within the area of the Wyong State Forest Survey Study Area. They are:

- **Site # 45-3-3040** is comprised of 14 grooves in three groups within a 15–20 m area. The first group with two grooves, the second with nine grooves and the third with three grooves, all measuring between 16 and 43 cm in length, 5–17 cm wide and 1–4 cm deep. This groove area is located 10 m west of the confluence of a minor tributary with Myrtle Creek;
- **Site # 45-3-3041** is comprised of 30 grooves in two groups on a flat rock surface. The first group with 22 grooves, the second with eight grooves, all measuring between 11 and 47 cm in length, 3–34 cm wide and 0.5-6 cm deep; and
- **Site # 45-3-3042** is comprised of five grooves in one group on a small rock surface c. 250 m southeast of Myrtle Creek/Maculata Rd #1.

All are located within the Wyong State Forest near to or along Myrtle Creek (**Figure 12)**.

As part of the heritage assessment an attempt was made to relocate these sites. As the valley of Myrtle Creek is so narrow and the vegetation so thick, none of the GPS hand-held devices with the survey team could give a position of the previously recorded sites. Therefore the relocation was a visual one only. With thick leaf litter covering the rock platforms within Myrtle Creek it was difficult to relocate all sites. However, one set of grinding grooves was located and, from the site description given above, it would appear that site # 45-3-3041 has been relocated (**Plate 17**).

The other site within Myrtle Creek (site # 45-3-3040) site was not able to be located on the day of the heritage assessment, and no attempt was made to relocate site 45-3-3042 as it would have proved fruitless to search for it without the aid of detailed coordinates from the hand-held GPS devices.

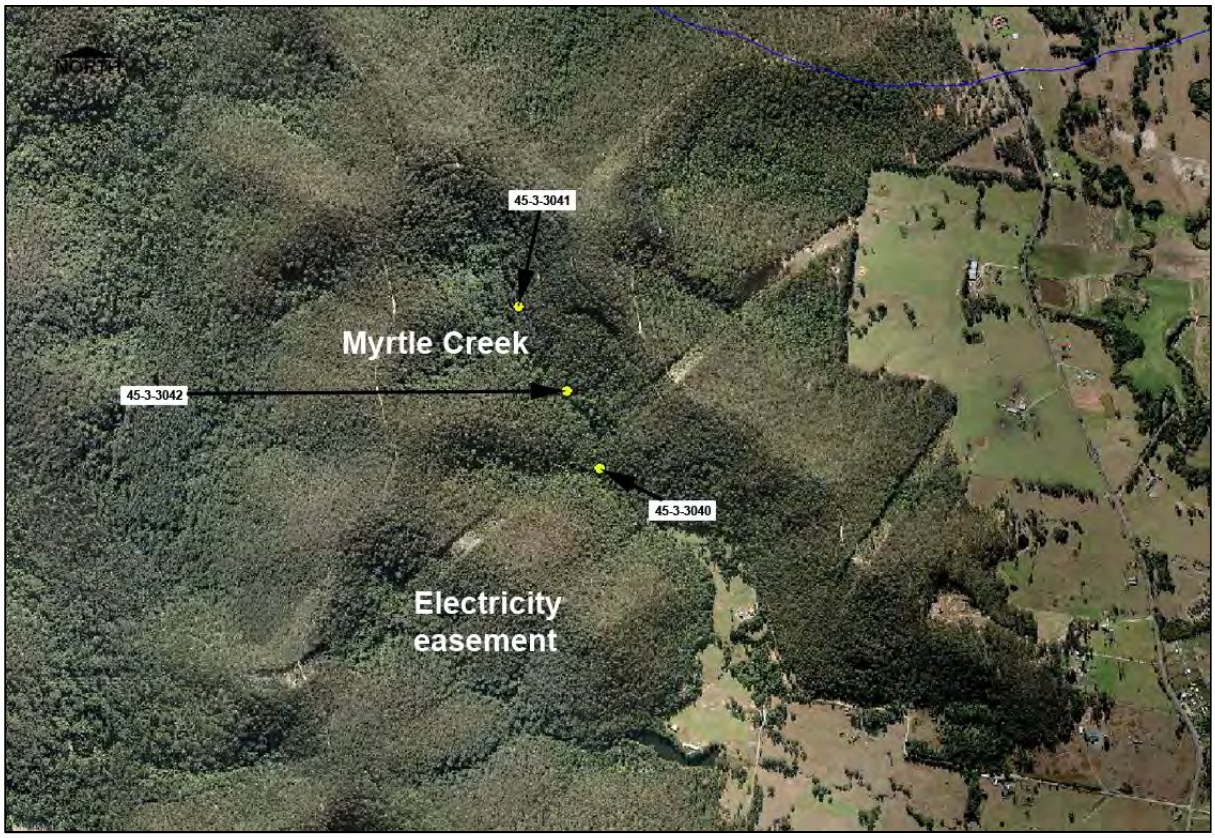
However, given that one of the three previously recorded sites was relocated and that its description matched the site's site card, there is no reason to doubt that the other sites exist as well.

Further, the integrity of site # 45-3-3041 is good with no sign of damage since its recording. Given the rugged nature and inaccessibility of the area in which the sites are located, it is assumed that the other sites also maintain their integrity as people would rarely visit the area.

4.5.3. Aboriginal community input

No places within the Subsidence Study Area, the Wyong State Forest Survey Study Area or the Honeysuckle Park Survey Study Area were identified by the registered stakeholders as holding specific cultural significance.

Figure 12: Aerial photograph showing the recorded locations of sites # 45-3-3040–3042.



4.6. Discussion

The findings of the assessment in both Survey Study Areas (Wyong Forest and Honeysuckle) conform to the predictive model established in **Section 4.4**. All sites recorded were axe-groove sites; a predicted outcome of the predictive model that is based on previous studies in the area.

When the recorded sites are taken into account with the previously recorded sites, axe-grinding groove sites are the only site type to have been recorded within the Wyong Forest Study Area.

Three of the four axe-grinding sites (WSF-AG1–3) are located on Patonga Claystones: a common feature noticed elsewhere in the region.

Although there was a low possibility of shelter sites being located within the Wyong Forest Study Area, it was noted that the Terrigal Formation is not suited to shelter formation and, as such, the incidence of shelters suitable for occupation would be rare. In one area of the Wyong Forest Study Area there were shelters of sufficient size (to the south of where Whitemans Ridge Road becomes impassable: **Plate 5**), but sloping floors or inaccessible locations meant that none were considered to be suitable for occupation. In the main, overhangs of generally small size characterised the Study Area (**Plate 6**). Further, there was ample evidence of the very fragile nature of the Terrigal Formation sandstones (**Plate 7**). While this would not destroy evidence of occupation, roof collapses would destroy art sites and generally make the shelters poor long-term occupation choices.

While not all areas of the Wyong Forest Study Area were directly assessed, the results of this and previous assessments concludes that while there may be further axe-grinding groove sites on other drainage systems (that were unvisited as part of this assessment), and it is likely that this is the site

type that will be recorded more often in the Study Area. Other site types such as open sites would be rare given the nature of the watercourses and the steeply sloping land (**Plate 2**). Modified trees, as predicted, would be very rare given the amount of logging that has taken place (**Plate 8**).

The results from the Honeysuckle Park Study Area also conforms with the predictive model that held a very low probability of locating sites in this area or, if they were located, they would probably be out of *situ*. The floodplains that characterised the Honeysuckle Park Study Area displayed high degrees of disturbance from farming/clearing activities and from periodic flooding (**Plate 10–Plate** 12). The assessment of the landform within the Honeysuckle Park Study Area was that it would hold very low potential for the existence of undisturbed, subsurface deposits.

While the assessment at the Honeysuckle Park Study Area cannot be extrapolated over the remainder of the eastern portion of the Subsidence Study Area, aerial photographs show similar landuse and landforms over the majority of this area. Therefore, the conclusion of the predictive model still has validity in that it holds that undisturbed sites in this area will be very rare if present at all.

4.7. Assessment of Heritage Significance

4.7.1. Introduction

The appropriate management of cultural heritage items is usually determined on the basis of their assessed significance as well as the likely impacts of any proposed developments. Cultural, scientific and public significance are identified as baseline elements of significance assessment and it is through the combination of these elements that the overall cultural heritage values of a site, place or area are resolved.

4.7.1.1. Cultural significance

This area of assessment concerns the importance of a site or features to the relevant cultural group - in this case the Aboriginal community. Aspects of cultural significance include assessment of sites, items and landscapes that are traditionally significant or that have contemporary importance to the Aboriginal community. This importance involves both traditional links with specific areas as well as an overall concern by Aboriginal people for their sites generally and the continued protection of these. This type of significance may not be in accord with interpretations made by the archaeologist - a site may have low scientific significance but high Aboriginal significance, or *vice versa*.

The significance of the archaeological sites located within the study area was addressed during each survey with the Aboriginal community representatives who accompanied the survey team.

4.7.1.2. Scientific significance

Assessing a site in this context involves placing it into a broader regional framework, as well as assessing the site's individual merits in view of current archaeological discourse. This type of significance relates to the ability of a site to answer current research questions and is also based on a site's condition (integrity), content and representativeness.

The overriding aim of cultural heritage management is to preserve a representative sample of the archaeological resource. This will ensure that future research within the discipline can be based on a valid sample of the past. Establishing whether or not a site can contribute to current research also involves defining 'research potential' and 'representativeness'. Questions regularly asked when determining significance are: can this site contribute information that no other site can? Is this site

representative of other sites in the region? In general terms, any Aboriginal object has the ability to either add to our knowledge about an area's Aboriginal history, comment on the technological developments of a people or may act as potential markers for subsurface deposits.

The rationale behind the scientific assessment of the main site types is summarised below.

Axe-grinding grooves

Due to the nature of this site type, there is little that can be gained from an archaeological investigation as there is unlikely to be archaeological deposits associated with the site. Instead the scientific significance of this site type is drawn from the integrity, location and size of the site. Of additional interest is whether the form of the grooves can give information about either tool manufacture or food processing.

Shelter sites

Shelter sites can be both with or without art and with or without artefacts (or other archaeological relics). As noted in **Section 4.2.2**, archaeological investigations in the region were the first to list shelter sites with PADs where the form of the shelter and indications of soil depth gave the researcher confidence that archaeological deposits may exist within the shelter. Shelter sites can have high archaeological significance as they are one of the rare instances in the Australian landscape where undisturbed and possibly stratified archaeological deposits may exist. If a shelter contains art, this is also an archaeologically significant occurrence as a study of the art can give information about past environments, artistic chronologies and the life and rituals of the painters.

Open Sites

The scientific significance of open sites is extremely variable and dependent upon several factors relating to:

- Preservation: Their integrity and potential to be conclusively proven to be Aboriginal in origin;
- Representativeness: Is this the type of site one may expect in this landscape (i.e. does it relate back to the predictive model?); Do many such sites occur nearby?; and
- Are there artefacts or other sites present (material, types or combinations thereof) that are rare in the area or unusual concentrations/or rarity for the area?

Modified Trees

- *Modified trees* are assessed on the basis of the known local context of this site type (i.e. are there many, some or no such features known locally). In general terms, modified trees do not tend to increase our understanding of the area's prehistory, except in situations where past land-use practices have resulted in the total clearance of trees. In these circumstances, modified trees become more significant due to the overall degradation of this resource. Modified trees also increase in scientific significance when they remain extant in stands where a great many exist in the one area or in relationship with other sites.

PADs

- It is always challenging to determine the significance of PADs as there may be no site material (if there are no associated surface artefacts) or soil data to assess.

Consequently, should impact to PADs be unavoidable, test excavation is recommended to investigate the presence, extent, nature and integrity of any possible archaeological deposits such that the PAD's significance can be assessed and appropriate management recommendations devised.

4.7.1.3. Public significance

Sites that have public significance do so because they can educate people about the past. By reducing ignorance about why sites are important to the Aboriginal and scientific community, important sites can be protected from ignorant or inadvertent destruction. Educating the public to understand the need for site preservation should increase the likelihood of maintaining an archaeological resource into the future. For a site to have high public significance it should contain easily identifiable and interpretable elements, and be relatively easily accessed. If an artefact scatter is in some way outstanding (either in terms of spatial size or artefact density) it may be recognisable by the lay person and hence interpretable, but if not, this site type is usually assessed as having low public significance.

Axe-grinding groove sites generally hold a moderate public significance as they are a tangible aspect within the landscape that can be appreciated by the lay-person. However, if the axe-grooves are difficult for the lay-person to access, the site's public significance is diminished.

4.7.2. Assessed significance of the recorded sites

4.7.2.1. Cultural significance

Conversations held with the representatives of the Registered Stakeholders determined that all site types are culturally significant to the Aboriginal community because they provide physical evidence of Aboriginal occupation of the local area.

In the opinion of the Aboriginal representatives who accompanied the survey team, the recorded sites WSF-AG1–4 hold **high cultural significance** as they had manifest attributes that could be identified by present-day Aboriginals with the past presence of their people.

4.7.2.2. Scientific significance

The overall location of sites discovered during the current assessment conforms to the general archaeological settlement pattern that has already been established throughout the broader region.

The axe-grinding groove sites (WSF-AG1–4) are a common feature in the broader region and are representative of other sites previously recorded within the Study Area.

The sites have good integrity and while natural erosion is a threat, there have been no artificial disturbances to the sites.

As axe-grinding groove sites can provide information about past settlement patterns, tool manufacture and food processing, the sites recorded as part of this assessment are held to possess **low-moderate scientific significance**.

4.7.2.3. Public significance

Axe-grinding groove sites are obvious aspects within the landscape whose use can be easily appreciated by the layperson. However, the inaccessible nature of the sites recorded here diminishes the ability of the layperson to visit and appreciate these sites. The recorded sites are therefore assessed as holding **low-moderate public significance**.

Table 6 summarises the assessment of significance given above.

Table 6: Assessment of significance for the recorded sites.

Site Name	Cultural significance	Scientific significance	Public Significance
WSF-AG1	High	Low-Moderate	Low-Moderate
WSF-AG2	High	Low-Moderate	Low-Moderate
WSF-AG3	High	Low-Moderate	Low-Moderate
WSF-AG4	High	Low-Moderate	Low-Moderate

4.8. Likely impacts on Aboriginal heritage from the proposed works

Subsidence associated with longwall mining involves a complex suite of effects on the landform that is influenced by geological factors, landform and topography as well as mining design factors such as depth of mining, height of extraction and panel layout. Among the effects that can have a bearing on the land surface condition, and therefore upon the status of archaeological sites and features, are vertical subsidence (which is overall lowering of the ground surface) and other ground movements including tilt, compressive and tensile strains, and upsidence. Vertical subsidence in itself is not typically a damaging effect where it relates to relatively uniform lowering of the ground across a wide area. However, the strain effects provide for horizontal movements and it is these compressive or tensile forces in the ground which mainly influence the risk level for impacts involving cracking of certain rigid components in the landscape such as rock outcrops, particularly in confined geological settings and where ground stress is concentrated such as steeply-sided, rock-lined streams in the floors of major canyon-like valleys where upsidence damage results from excessive localised compression forces. These types of conditions occur in some parts of the Southern Coalfields but not in the landscape of the W2CP area. Further, strain effects are expected to provide less risk to such rock features if there is already a well developed joint and fracturing system in the smaller scale rock outcrops in unconfined geological settings such as usually found at hillsides and some higher gradient drainage lines along hillside slopes. This is because some level of tolerance to movement may be provided due of the existing weathering and stress-relief jointing already established.

4.8.1. General impacts of longwall mining

The primary surface impact from underground mining, other than construction of the requisite surface infrastructure which has been addressed in another report (OzArk 2009), is the potential surface subsidence resulting from coal seam extraction. Such subsidence often takes the form of a trough or a series of parallel troughs in the ground surface directly above areas where full seam extraction has occurred. Open sites may be impacted causing disruption, i.e. shifting/lowering, of the archaeological deposits or indirect impacts such as altered hydrology may cause erosion patterns to change. The possible collapse of cliffs or cracking in sandstone escarpment country also has the potential to impact rock shelter sites (Byrne *et al* 1997) or axe-grinding groove sites (Kuskie 2006: 12).

The type and extent of subsidence is variable and challenging to predict, although there have been significant advances in computer generated modelling of potential subsidence based on data including the depth of the coal seam from the surface, the thickness of the coal seam, the orientation of the longwalls, the depth and nature of the intervening deposits and the methods of coal extraction. Typically, the largest vertical movements occur in areas of total extraction, while vertical movements diminish outside the edge of the mined area, becoming more likely to be horizontal movements (tilt and strain) along the line of draw. According to Byrne (1997: 2), it is the horizontal movements that are most likely to impact sandstone formations and these are amplified in areas of significant surface slope.

Depending on the site specific circumstances, the effects of longwall mining may be immediate and/or cumulative or delayed. Likewise the potential for slippage or altered hydrology may appear immediately or may not occur for some time depending upon other natural, subsequent environmental conditions. Comprehensive detail on the subsidence predictions and assessment for W2CP are provided in MSEC 2009 and W2CP 2009 which are included as appendices in the W2CP Environmental Assessment report.

In summary, the types of impacts that may be anticipated to affect archaeological sites over the W2CP study area are as follows:

- Subsidence: The vertical movement of the earth as a direct result of certain underground mining activities. These measurements show the amount by which the surface of the landscape will be lowered by after mining has occurred;
- Tilt: The movement of earth on a slope directly related to subsidence. I.e. the portion of land at the edge of an area of subsidence that drops at one end but not the other. An important note about tilt is that it may occur progressively as each long wall panel is mined out. Once the panel has been mined out, the tilt areas along the longitudinal sides of the panels will drop to become areas of flat subsidence;
- Strain: Occurs at the top of the tilted land portion (tensile strain) and the base of the tilted land portion (compressive strain). Overall, these strains will have varied impacts depending upon the surface geology and soil landscapes. Like tilt, strain is also a progressive impact which, particularly along the longitudinal longwall sections, will change with progressive removal of longwall panels;
- Rock fracture: The cracking of outcropping stone. Most likely to occur as a result of subsidence or strain in areas where stone is in massive formation, i.e. escarpments;
- Landslip: The displacement of earth down slope. Obviously this occurs on hill slides that have been impacted by subsidence; and
- Water-related impacts. These include alteration of the flow paths of water courses, flooding, ponding and possible erosion and siltation related to these factors.

4.8.2. Generic impacts of longwall mining on Aboriginal archaeological site types

With respect to potential longwall mining impacts on archaeological sites, there is a reasonable body of literature from which generic information can be gleaned. It must be remembered, however, that the impacts of longwall mining are exceptionally variable, depending upon the depth of the coal seam, the properties of the intervening geological strata, the mine plan design as well as many other less major considerations. Hence although review of other studies is illuminating, they must been accepted as only generically applicable. In contrast, specific and detailed investigations and modelling of subsidence for the W2CP have been undertaken and reported as part of the W2CP Environmental Assessment (MSEC 2009 and WACJV 2008).

Rockshelters

With regards to rockshelter sites in sandstone landforms, the most common impact is rock fall and these are more likely to occur where mining is closer to the surface. Generally these impacts are most likely to occur within days or weeks of the mining impacts occurring although they have been known to be delayed by up to a year or so.

In terms of disturbance, art on the walls of rockshelter sites could potentially be destroyed or rock falls may sterilise potential occupation deposits through the collapse of the shelter roof. Unless major rock falls occur, the effect on a deposit may not be substantial, although it does reduce the visual integrity of a site and hence aspects of its heritage significance. Cracking as a result of subsidence may also impact rockshelter sites through making them unsafe and thus unable to be visited by members of the Aboriginal community or investigated scientifically (Kuskie 2006: 12). An indirect effect of changes in the rock structure is the potential for an increase or change in the flow or seepage of water into the site. Such changes can affect the microclimate of the shelter and may lead to the decay or dilution of the pigment or rock surface of an art site. The stratigraphic integrity of archaeological deposits within rock shelters may also be disturbed by tension cracking or indirectly by changes in water flow resulting in erosion (ERM 2001: 3.3).

Recorded examples of longwall mining impacts have been recorded at Whale Cave (West Dapto), where movement along the joint planes resulted in increased water seepage into the site. Previously well preserved art panels were destroyed and the roof collapsed within four years. On the other hand, other rock shelters that have been monitored demonstrate that changes resulting from subsidence may not necessarily destabilise shelters (Lambert and Sefton in ERM 2001: 3.3).

Axe-grinding grooves

As grinding grooves occur on sandstone outcrops, they have potential to be impacted by subsidence, tilt and strain. Often grooves are located on outcropping or boulderised sandstone near water, i.e. creek beds, and in these areas natural breaks in the rocks may allow them to the shift independently without breaking the rock on which a series of grooves are located. In other cases, the massive nature of a sandstone outcrop on a ridge top may result in the edifice being cracked.

Open sites

Tension cracking, tilt and subsidence may impact open sites/artefact scatters through directly through disruption to the stratigraphic integrity of the deposits. Or indirectly through alteration to the water table or alter water flow, which may precipitate erosion, siltation or soil stripping which could further impact archaeological sites.

Modified trees

Modified trees are unlikely to be directly affected by longwall mining impacts, with the only possible impacts occurring as a result of destabilised soils which may allow trees to fall or be unable to withstand winds/storms prior to soil restabilisation. One possible negative impact to a living scarred tree may be associated with trees that are part of a ground water dependant community that is affected by a subsidence related change in ground water hydrology.

4.8.3. Predicted subsidence, tilt and strain in the Study Area

Section 2.1 details the stages of development for the mine plan, which has been designed to minimise impact to the environment. The proposed underground mining area has been significantly reduced, as has the amount of coal to be extracted, in response to identified geological and environmental constraints and the views of the community. These reductions ensure that subsidence levels readily comply with the levels stipulated by the declared Mine Subsidence District.

Predicted subsidence, tilt and strain impacts are shown in **Figures 13-16** with measurement being provided in metres (m) for subsidence and millimetres per metre (mm/m) for tilt and strain. As can be seen by these predictions, the direct physical effects of these factors are variable over the Study

Area. All factors demonstrate a direct relationship to the layout of the longwall panels underneath, with impacts occurring along linear trajectories. As may be expected, the impacts of all factors, but especially tilt and strain, are greatest at the boundaries of the mined area.

The two areas of highest predicted overall mining impacts (around 2–2.5 m of subsidence, 12 mm/m of tilt and 2.5 mm/m of strain) are those associated with the more elevated terrain in the Wyong State Forest. These include the western portion of the northern mine section (in colluvial landscapes such as Watagan and Mandalong), which will primarily affect from above Little Jilliby Valley to the north, and the west and central portions of the southern mine area, mostly affecting colluvial Watagan landscape and the lower-lying alluvial Yarramalong landscape.

4.8.4. Subsidence related impacts to Aboriginal sites in the Study Area

Subsidence impacts and recorded Aboriginal sitesFigure 13–**Figure** 16 illustrate the location of the seven recorded Aboriginal sites in relation to the four major subsidence related impacts. The previously recorded axe-grinding groove sites (# 45-1-3040–3042) are all likely to be affected by over 2 m in subsidence, around 4 mm/m tilt and c. 0.5 mm/m in strain. Definitive, physical impacts to these sites cannot be accurately predicted, only a risk-based consideration of likely impact levels. However, it is likely the low strain impacts may serve to preserve the sandstone on which the grooves are located from cracking. There is, however, potential for minor increased siltation along beds of Myrtle Creek if significant alteration to run off patterns occurs and if localised soil erosion develops. This possible siltation process may cover the grooves from view. It is noteworthy that this process occurs naturally, for example following bush fire, and is not an impact only generated as a result of longwall mining.

Regarding sites recorded as part of the current assessment, all sites (WSF-AG1–4) are beyond expected extent of compressive (**Figure 16**) and tensile strain (**Figure 15**) as well as tilt (**Figure 14**). Two sites (WSF-AG3 and WSF-AG4 are on the very boundary of the subsidence area and may suffer from subsidence in the order of 0.02 m (**Figure 13**).

The axe-grinding grooves are typically in well-jointed sandstone bedrock units although in geologically confined circumstances. Although some of the axe-grinding groove sites are outside the zone of influence of compressive or tensile strains some may be affected by minor areas of vertical subsidence and tilt from the proposed mining activity. These effects are considered to be at negligible to very low risk of damage to the site's integrity.

Based on their geological and landscape settings and the predicted range of subsidence effects, the individual axe-grinding sites along Myrtle Creek are at a generally low level of risk of damage.

Axe-grinding groove sites featuring scattered instances of individual rock grooves differ in their inherently lower risk of damage to their integrity arising from the proposed works when compared with other rock outcrop-based archaeology sites such as caves, significant shelter sites or rock art sites. There has been no evidence of such sites in the Subsidence Study Area.

In terms of changes to inundation levels, the predicted alteration to overall flooding levels (**Figure 16**) show very minor areas that will be newly impacted, both within the Dooralong and Yarramalong Valleys. No sites have been recorded within the valley floor landforms of the Study Area and predictive modelling of site location (**Section 4.4**) suggests that site material of any integrity is unlikely in the valleys. Possible alteration to the paths of waterways and or erosion modification also has the potential impact Aboriginal sites; however, the ability to predict either these factors or the location of Aboriginal sites in relation to them is low.

Figure 13: Impact from subsidence in relation to Aboriginal recorded sites.

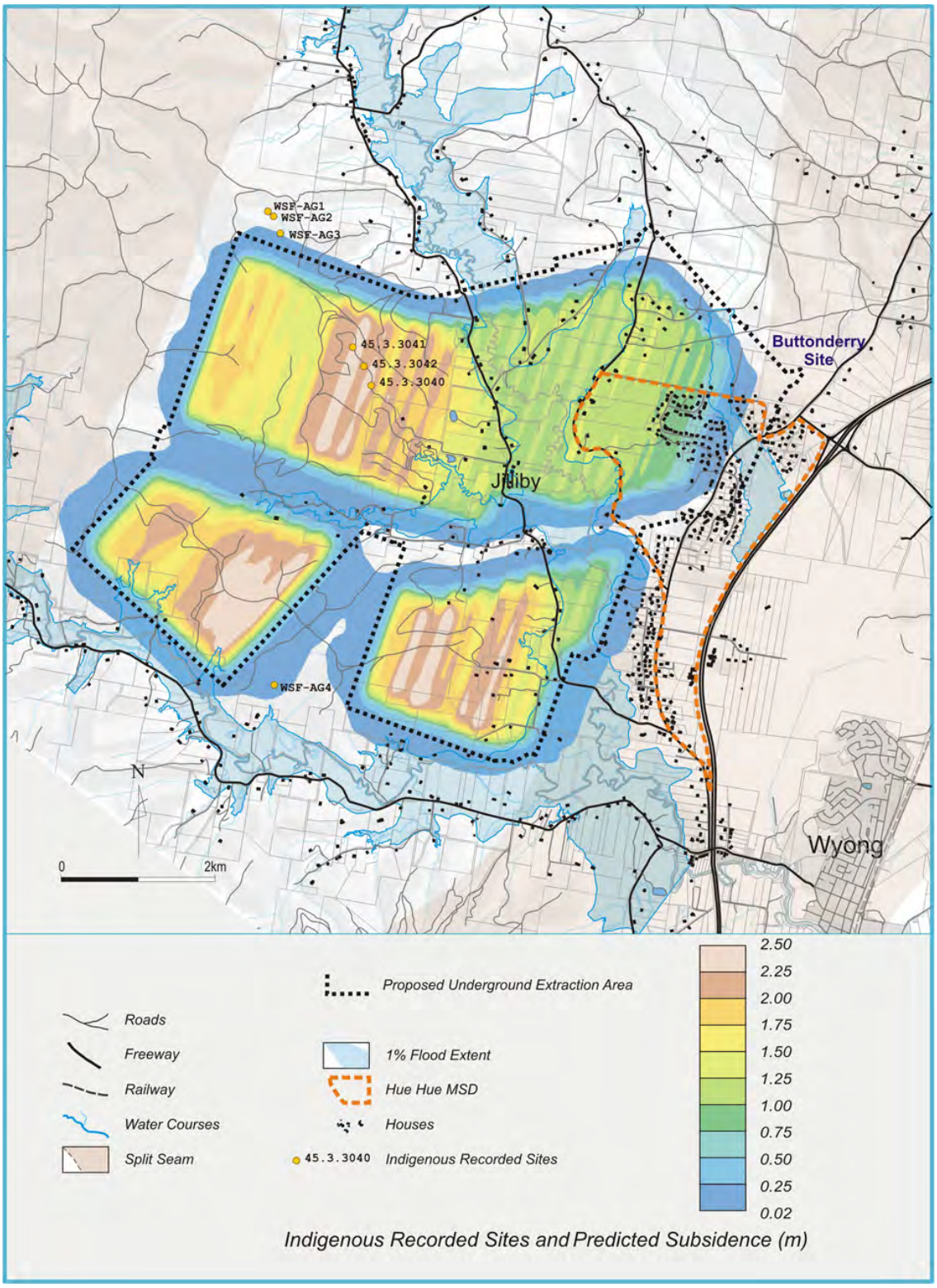


Figure 14: Impact from tilt in relation to Aboriginal recorded sites.

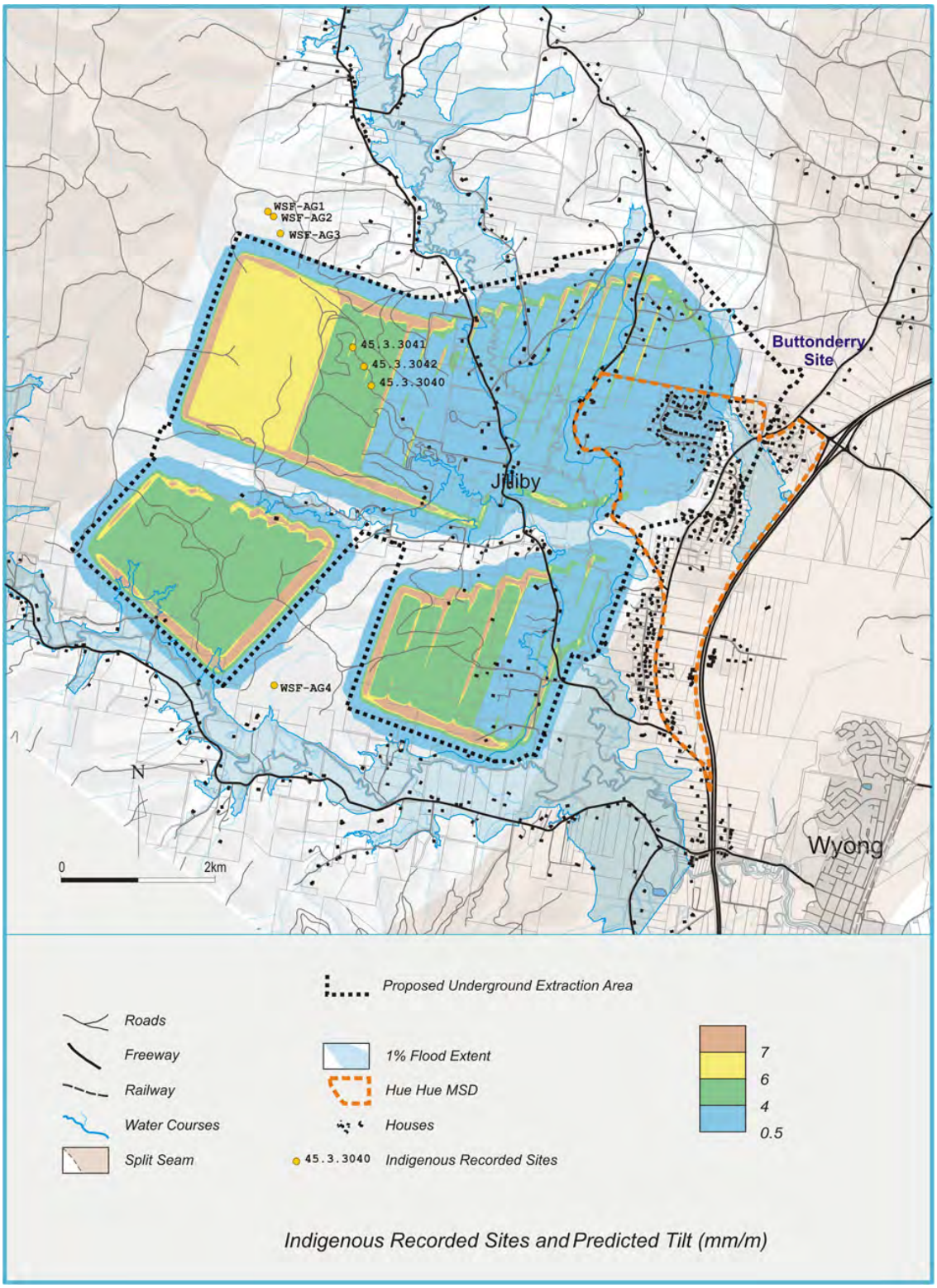


Figure 15: Impact from tensile strain in relation to Aboriginal recorded sites.

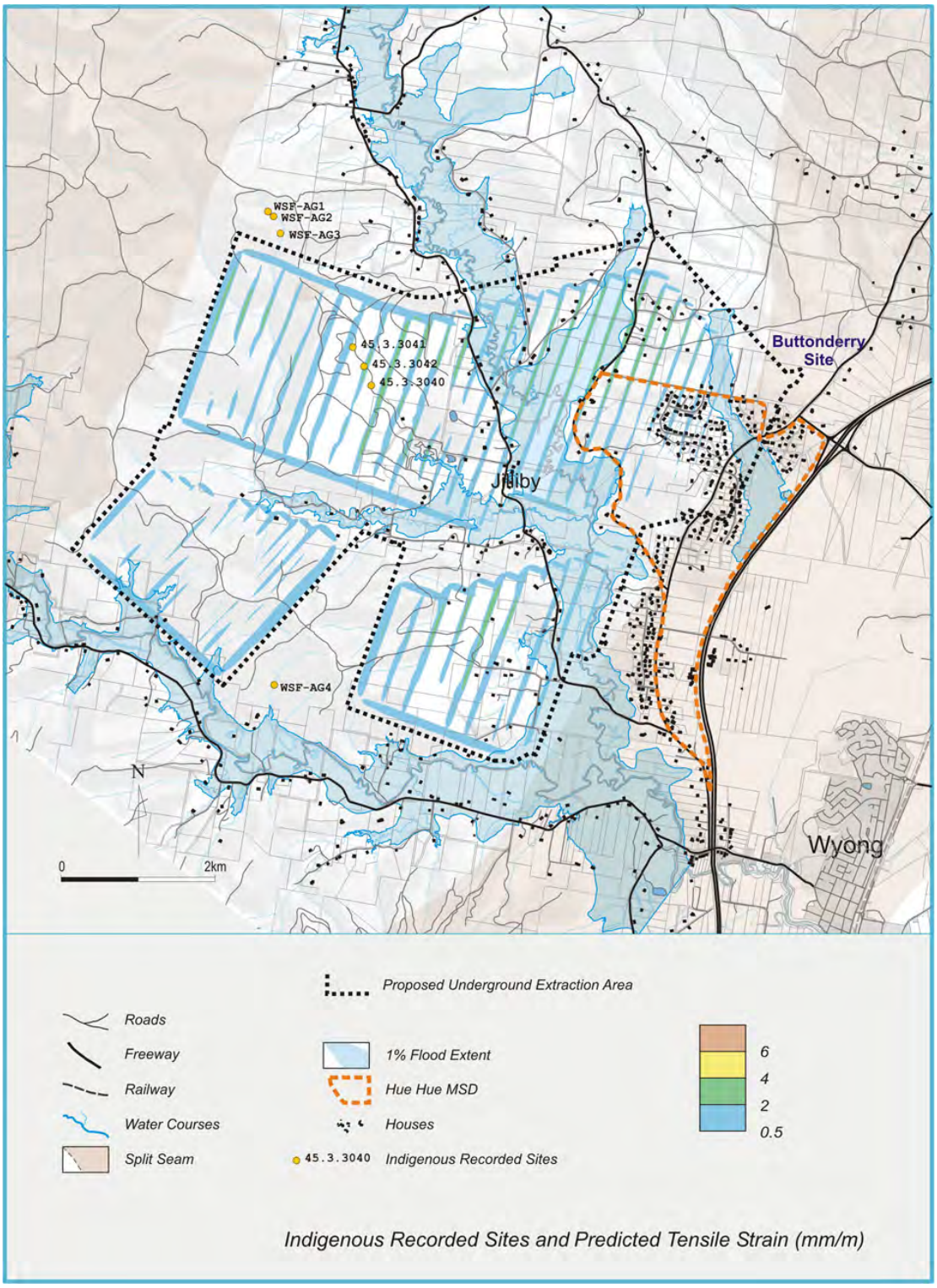
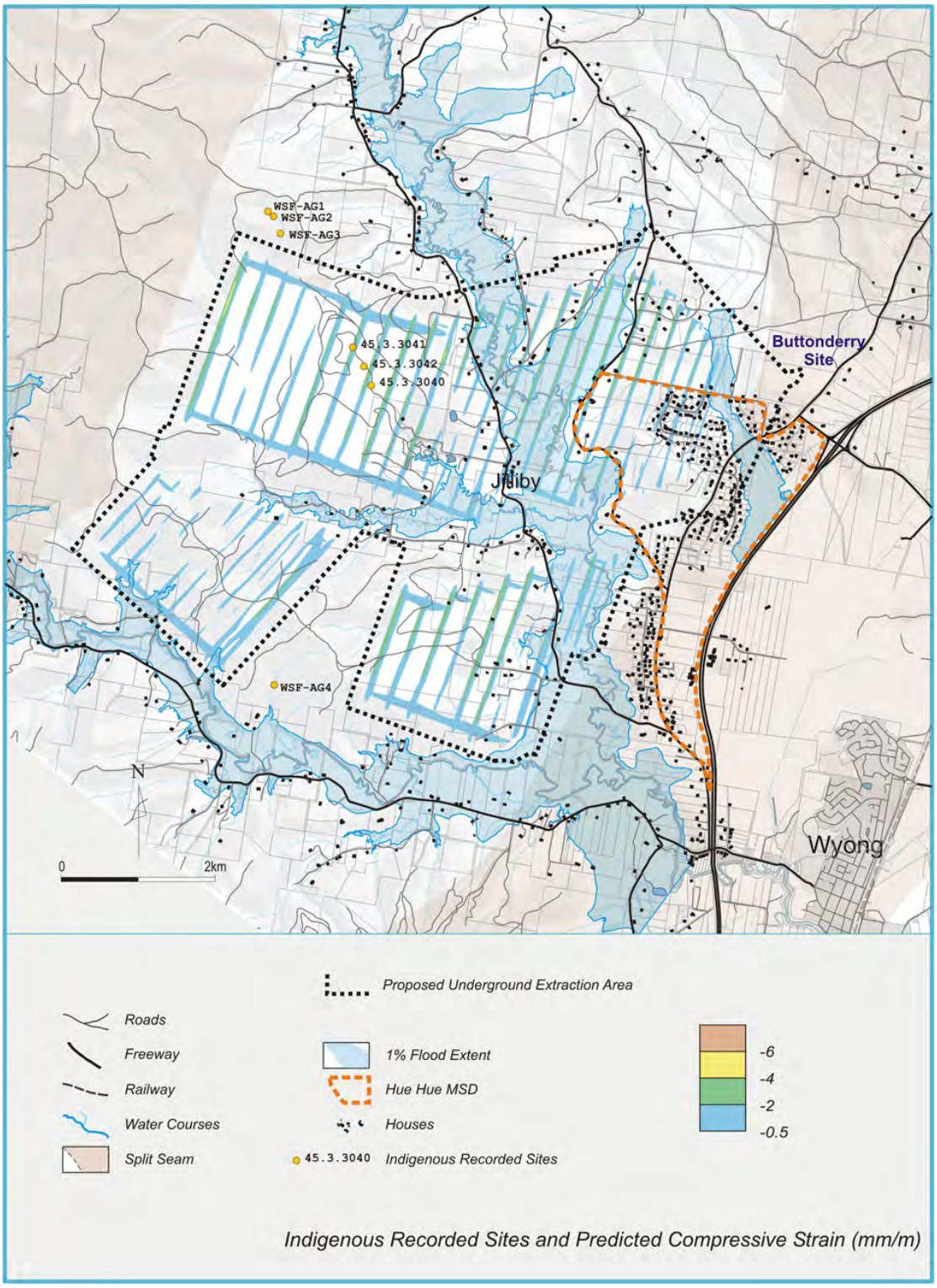


Figure 16: Impact from compressive strain in relation to Aboriginal recorded sites.



Subsidence impacts and potential Indigenous sites

Although there are no other known Aboriginal sites or features within the Subsidence Study Area, this is not because further sites do not exist, but simply reflects practical survey limitations.

From the results of the current assessment, it is concluded that axe-grinding groove sites will form the majority of sites that remain to be recorded in the Wyong Forest Study Area. While other site types are always possible, it is assessed that there will a low possibility of locating open sites and modified trees due to landform and disturbance patterns. It is also assessed that the topography does not allow suitable shelters that can be used for habitation.

Therefore the impact from the proposed works in relation to known sites in the Wyong State Forest Study Area is the same as the potential impact on currently unknown sites: i.e. the effects of subsidence, tilting and strain on axe-grinding groove sites.

As these sites are likely to be located within the Wyong Forest Study Area where the effects from the proposed works will be the greatest, and if the W2CP attains overall planning approvals, further targeted survey work should be undertaken in the Wyong State Forest prior to mining occurring in these locations. The general nature and focus of this subsequent work is documented in **Section 4.9** below and should form the basis for the Indigenous component of the CHMP that will be included as part of the SMP.

4.9. Management options

Appropriate management of cultural heritage items is primarily determined on the basis of their assessed significance, the likely impacts of the proposed development and the application of the relevant legislation.

The following management options are general principles, in terms of best practice and desired outcomes, rather than mitigative measures against individual site disturbance.

4.9.1. Management background

1. All recorded sites are held to hold high cultural significance, low-moderate scientific significance and low-moderate public significance. Therefore the sites should be avoided and preserved. While the sites will not be impacted by the day to day activities of the mine either through the construction or extraction phases, the locations of the sites should be noted and avoided should any future work need to take place within Wyong State Forest.
2. Two of the sites (WSF-AG1 and WSF AG2) are beyond all known impacts from the proposed works. No further management of these sites is required.
3. Two of the sites (WSF-AG3 and WSF-AG4) are within the zero subsidence line and could be affected by subsidence, albeit at a minimal level (0.02 m). While axe-grinding groove sites can be impacted by subsidence, it is the compression and tensile strains that affect the sites more. To this end it is noted that these sites are beyond the affects of strain and tilting.
4. Although targeted surveys have been undertaken to test the predictive modelling assessment over portions of the Subsidence Study Area, further archaeological survey prior to mining impacts is recommended within Wyong State Forest as this area will be most heavily affected by the impacts of the proposed works and has the greater possibility of containing further Aboriginal sites. This may be in the form of further sampling survey to inform an SMP or panel

by panel survey pre mining. Any additional assessments should be undertaken with full involvement of the Aboriginal community.

5. It is noted that the provisions of s.75U of the EP&A Act 1979 obviate the requirement for studies undertaken pursuant to Part 3A approved projects and project application (such as W2CP) to have to obtain s87 and s90 approvals under the NPW Act.

4.9.2. Specific management recommendations

As formalised applications for permits, as previously required under the NP&W Act, are no longer required under the new Part 3A assessment process, this section consolidates the appropriate responsibilities and actions that the Proponent should undertake in terms of potential impacts to the heritage resource within Subsidence Study Area.

A desktop review, reconnaissance inspections and predictive modelling have formed the basis for the week of targeted field survey undertaken to inform this report. This has enabled testing of the predictive model and has allowed for greater certainty in characterising the Aboriginal heritage resource within the zero subsidence area. There remains, nonetheless, the opportunity for gathering detailed information about further potential sites within the valleys of the Wyong Forest Study Area. Accordingly, further field assessment may be considered appropriate to inform SMPs in the post-approval phase, or for site specific management resulting from panel by panel pre-mining surveys.

Overall, the following options for site management are relevant:

1. Avoid impact if necessary, by altering the development proposal, in this case by redesigning the mine plan to avoid potential subsidence impacts to located sites, or to put in place mitigation against site impact. It is accepted that this is a very problematic option with regards to longwall mining, due to the fact that areas of highest human population – the valley floors – which have the least Aboriginal heritage value, are more immediately deserving of mitigation. This leaves the Wyong Forest Study Area as the area where the least private property is to be impacted and hence where more significant impacts may occur to any potential heritage features in those areas, as a result of the greater subsidence predictions.

2. If the potential for impact is unavoidable then further investigation may be required (previously under a Section 87 permit under the NP&W Act) or site destruction from the construction of project infrastructure may occur (previously under a Section 90 permit under the NP&W Act) and will need to be documented in a Statement of Commitments for the project. These then form the basis of the Conditions that the Minister for Planning may place within the Project Approval for the project, which often take the form of a requirement for an Archaeological and Cultural Heritage Management Plan (ACHMP).

The way sites are managed within the Statement of Commitments approval will depend on many factors including the site's assessed significance. Sites of moderate to high significance and/or potential may require either test or salvage excavation, or more detailed recording, as part of approval conditions. Sites of low significance may be impacted with no further archaeological assessment being required, or with an approved monitoring programme. Once granted, the local Aboriginal

communities may wish to collect or relocate artefacts, whether temporarily or permanently, if necessary[8].

4.10. Relevant Legislation

Baseline principles for the conservation of heritage places and relics can be found in the Burra Charter[9], which recognizes that there are places worth keeping because they can enrich our lives on many levels. The significance of such places may be embodied in fabric (physical material), environmental setting, contents, use or its meaning to people, and should be assessed through methodical data collection. Since its adoption in 1979, The Burra Charter has become the standard of best practice in the conservation of heritage places in Australia, and heritage organisations and local government authorities have incorporated the inherent principles and logic into guidelines and other conservation planning documents. The Burra Charter generally advocates a cautious approach to changing places of heritage significance. This conservative notion embodies the basic premise behind legislation designed to protect our heritage, which operates primarily at a State level.

A number of Acts of parliament provide for the protection of Aboriginal heritage at various levels of government[10]. The three most important statutes in New South Wales are the:

- Environmental Planning and Assessment Act 1979 (EP&A Act), amended by the Environmental Planning and Assessment Amendment (Infrastructure and Other Planning Reform) Act 2005 (EP&AA Act).
- National Parks and Wildlife Act 1974 (NPW Act).

While at Commonwealth level, the following statute is relevant:

Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) amended by the *Environment and Heritage Legislation Amendment Act (no. 1) 2003*.

4.10.1. State legislation

The EP&A Act is founded on the *Environmental Planning and Assessment Act 1979* that requires environmental impacts, including cultural heritage, are considered at a land-use planning and decision making level.

Under this Act, Aboriginal heritage is protected in three different ways:

1. Through planning instruments such as State Environmental Planning Policies (SEPP) and Local Environmental Plans (LEPs). Such plans outline permissible land use as well as identifying potential constraints. Section 112 (1) of the EP&A Act delineates that no approval for either prescribed developments or developments likely significantly affect the environment, may be granted without prior appropriate environmental impact assessment.

[8] The fate of all artefacts remains within the statutory control of the NSW DECCW. A care and control permit may be issued to local Aboriginal groups or, with Aboriginal community consent, to other parties, for educational or display purposes.

[9] The Burra Charter defines the basic principles and procedures to be followed in the conservation of all kinds of places such as monuments, buildings, Aboriginal sites, roads, archaeological sites, whole districts or even regions. It was first adopted in 1979, based on the Australian ICOMOS (International Council on Monuments and Sites) review (1977) of the 1966 Venice Charter (Australian ICOMOS Inc. 1998).

[10] NSW Heritage Office 1998: *Living with Aboriginal Culture*, p. 3.

2. Section 90 of the Act (Part 4, Division 5) lists impacts to the environmental resource, including cultural heritage, which must be considered before development approval is granted.

3. All State Government agencies acting as determining authorities on environmental issues must consider a range of community and cultural factors, including Aboriginal heritage, in their decision-making process. The factors to be considered in such assessments are set out in the EP&A Regulations (1980), Part VII.

On 9 June 2005 the NSW Parliament passed the EP&AA Act. This contains key elements of the NSW Government's planning system reforms through major changes to both plan-making and major development assessment. The *Act* was assented to on 16 June 2005.

A key component of the amendments is the insertion of Part 3A (Major Projects) into the EP&A Act. The aim is to facilitate major project and infrastructure delivery and encourage economic development, while strengthening environmental safeguards and community participation. On 1 August 2005 the new Part 3A and related provisions commenced.

The new Part 3A consolidates the assessment and approval regime for all major projects previously addressed under Part 4 (Development Assessment) or Part 5 (Environmental Assessment) of the *Act*.

Part 3A applies to major State government infrastructure projects, development previously classified as State significant, and other projects, plans or programs of works declared by the Minister.

The amendments provide a streamlined assessment and approvals regime for major infrastructure and other projects of State or regional significance. They also improve the mechanisms available under the EP&A Act to enforce compliance with approval conditions or the *Act*.

The *National Parks and Wildlife Act 1974* (NPW Act) (as amended; particularly sections 83-91A) provides statutory protection for all Aboriginal relics and places, regardless of significance, land tenure or whether they have been previously recorded in the DECCW AHIMS. Areas may be gazetted as Aboriginal 'places' when the Minister is satisfied that sufficient evidence exists to demonstrate that the area is or was of special significance to Aboriginal people.

Under Section 90 of this Act it is an offence to knowingly damage, deface or cause or permit the destruction of an Aboriginal relic or place without the prior written consent of the Director-General of the NSW DECCW. Prosecution for such offences may include the imposition of financial penalties and/or imprisonment. Reporting the discovery of previously unknown Aboriginal sites to the Director-General of the DECCW within a reasonable time of discovery is also obligatory under Section 91 of the Act.

The *Heritage Act 1977* (amended 1999) protects the State's natural and cultural heritage and contains measures to protect archaeological remains. Generally, Aboriginal sites are protected by the NPW Act, but if certain sites are deemed as having great significance, they can be further protected by a heritage order, issued by the Minister, on the advice of the Heritage Council.

4.10.2. Commonwealth legislation

The EPBC Act protects the environment, particularly matters of National Environmental Significance. It streamlines national environmental assessment and approvals process, protects Australian biodiversity and integrates management of important natural and cultural places. Under the EPBC Act, definitions of the 'environment' include the following:

- Ecosystems and their constituent parts, including people and their communities;
- Natural and physical resources;
- The qualities and characteristics of locations, places and areas;
- Heritage values of places; and
- The social, economic and cultural aspects of a thing mentioned in the above points.

The EPBC Act provides that any action assessed as likely to have a significant effect on listed matters of national environmental significance is to be known as a *controlled action*, and may only proceed with the Minister of the Environment's approval.

In January 2004 changes to the protection of national heritage came into effect through amendments to the EPBC Act (*Environment and Heritage Legislation Amendment Act (no. 1) 2003*).

4.10.3. Applicability to the Study Area

4.10.3.1. State legislation

The current project is governed by Part 3A of the EP&AA Act.

4.10.3.2. Commonwealth legislation

No places or sites within the Study Area are governed by the EPBC Act.

5. Historic Heritage

5.1. Introduction

Section 3.2 of the report goes into some detail concerning the settlement of the Wyong area and specifically the Yarramalong and Dooralong valleys in relation the nature of land use impact. This provides a broad overview of the historical development of the area.

5.2. Overview of existing data

A Historic heritage survey was carried out by ERM (2001a and others) and the results of these cumulative studies are presented in the BHP Billiton WACJV pre-feasibility study (BHP 2003), Chapter 3.11. As the data provided in this report is of high standard, it was not considered necessary to repeat this previous assessment, but simply to update previous results through undertaking the following:

- Complete new searches of all the relevant registers of Historic heritage data – namely the Wyong LEP, the NSW State Heritage Office register and inventory and the Australian Heritage Database (which now incorporates the Register of the National Estate) to check whether there have been any new listings within the current Subsidence Study Area;
- Reapply the newly configured mine plan and subsidence impact overlays (including subsidence, tilt and tensile strain) to the mapped items of heritage value to determine the nature and degree of likely impact. It is relevant to note here that the newly configured mine plan reduces significantly the varied impacts of subsidence, especially in the Yarramalong and Dooralong Valleys. While this was little help in the conservation of Aboriginal sites, it has operated to reduce considerably the potential impacts to non-Indigenous heritage as this is where these sites are located; and

Through review of existing data and application of the new mining impacts provide an assessment of potential impact and hence formulate management recommendations and mitigative measures. These should form the basis of an Archaeological and Cultural Heritage Management Plan (ACHMP) to prepare in conjunction with the SMP.

5.3. Local context

A search made of the Australian Heritage Database (2/2/10) revealed 11 items of heritage significance within Wyong Shire. None of these items are located within the Subsidence Study Area.

Review of the Wyong Shire LEP 1991 (which includes all listings on the NSW Heritage Office inventory) revealed several items of Historic heritage significance either within or close to the Study Area. **Figure 17** displays the location of these sites in relation to the predicted zero subsidence line, while **Table 7** lists them together with information regarding their location in relation to the W2CP zero subsidence line.

During their field assessment, ERM (2000) identified nineteen additional items of potential heritage significance. This additional survey was undertaken in reference to changes that had been made to the *Heritage Act 1977* regarding the relationship of places to State historical themes. These items are located on **Figure 18** (letter designations) and listed in **Table 8**. Again relation to subsidence and tilt has been manual, hence the approximation of degree of impact. It is noteworthy that the identified

structures are primarily private dwellings, although two bridges, two silos, a picket fence and a cattle/dairy run were also nominated.

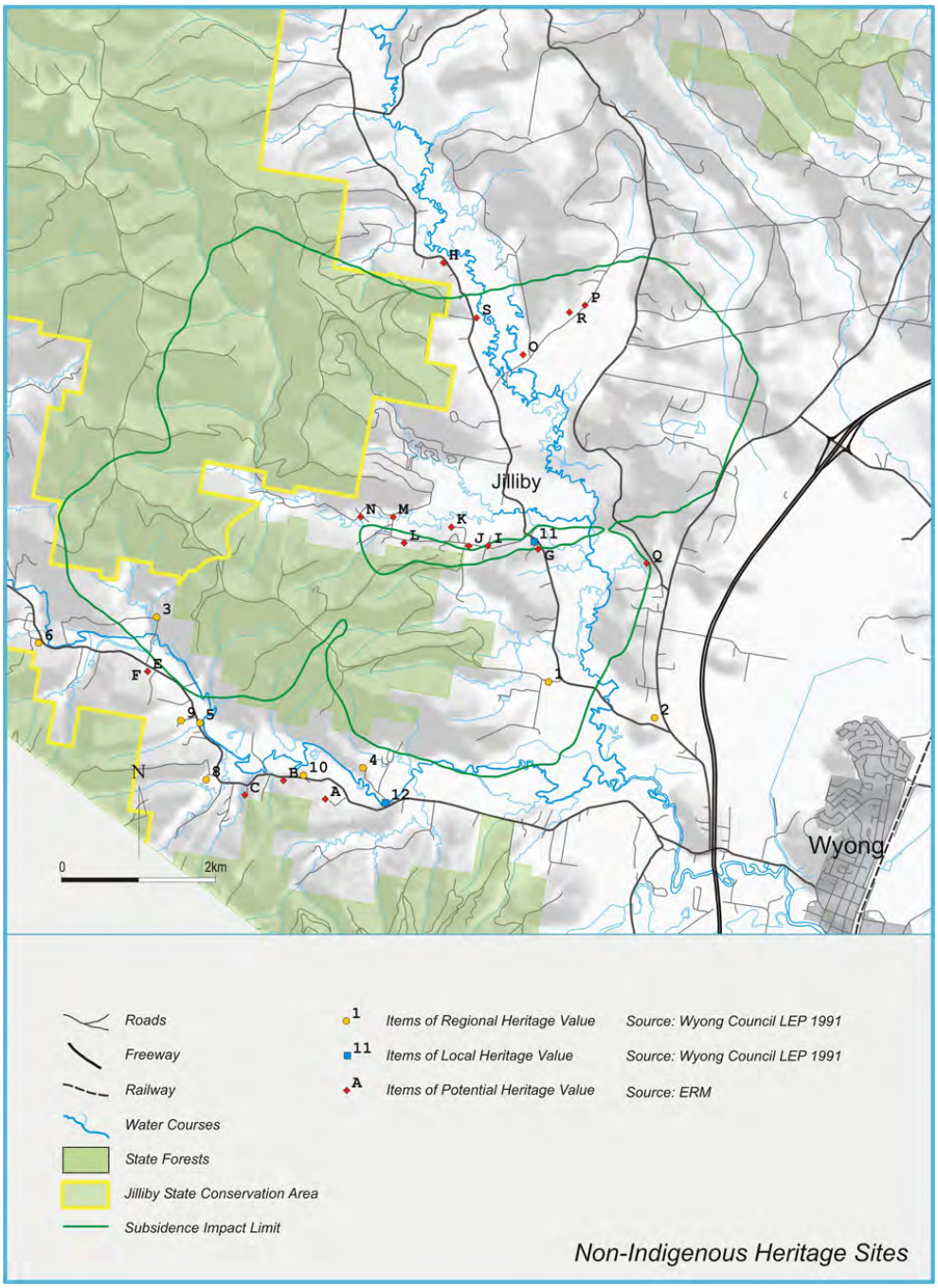
Table 7: Heritage items listed in the Wyong LEP. Location of each item is shown, in numbers, in Figure 17.

Number	Description	Subsidence Zone
Items of Regional Significance		
1	Brick & Iron Silo	√
2	Jilliby Cemetery	X
3	Dwelling "Bangalow"	√
4	Dwelling "Gracemere"	X
5	Wyong Creek Community Hall	X
6	Dwelling (Former "Ebenezer Cottage")	X
7	Dwelling "Hillview"	X
8	Dwelling "Marabilla"	X
9	Silos and Farm Shed	X
10	Wyong Creek Public School	X
Items of Local Significance		
11	Jilliby Public School	X
12	Road Bridge, Kidman's Lane	X

Table 8: Items of potential heritage values identified by ERM (based on BHP Billiton 2003: Table 3.34). Location of each item is shown, in numerals, in Figure 17.

Number	Description	Subsidence Zone
A	Dwelling	X
B	Dwelling	X
C	Dwelling	X
D	Bridge (Yarramalong Rd)	X
E	Dwelling	X
F	Dairy and Cattle run	X
G	Dwelling	√
H	Dwelling	X
I	Dwelling	X
J	Dwelling	√
K	Dwelling	√
L	Dwelling	X
M	Little Jilliby Rd Bridge	√
N	Bunya Pine	√
O	Keegan's Silo	√
P	Picket fence on Durren Rd	√
Q	Silos	√
R	Dwelling	√
S	Dwelling	√

Figure 17: Map showing the location of registered Historic sites in proximity to the Study Area.



5.4. Survey Methodology

The field assessment for Historic heritage items in the Wyong Forest and Honeysuckle Study Areas, took place at the same time as the Aboriginal heritage assessment. Therefore the same methodology was adopted as has been set out in **Section 2.2**. Additionally, the same constraints to the effective survey coverage applied to the Historic assessment as they did to the Aboriginal heritage assessment (**Section 2.3**).

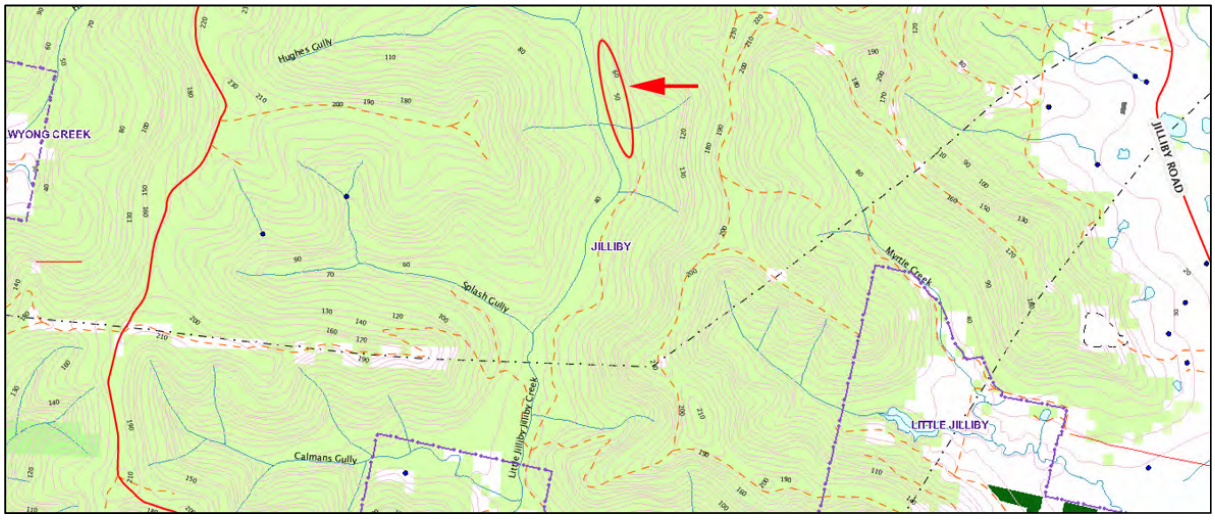
While the survey methodology was devised to identify areas along the easement that had potential to contain Aboriginal heritage items, this survey methodology was augmented in the field to investigate areas with potential Historic heritage items. For example the transect down Little Jilliby Jilliby Creek

was proving difficult in areas where Aboriginal sites might be found and was instead adapted to include inspection of Historic items on an adjacent forestry track (see **Section 5.5**).

5.5. Survey results

The only items of Historic heritage significance were located on the eastern bank along the lower reaches of Little Jilliby Jilliby Creek. These items were a disused forestry road along with infrastructure such as culverts, loading areas and road cuttings (**Figure 18**). The road is washed-out in places but is still a discernable feature in the landscape, particularly due to the frequent road cuts which have been made in the hill slope. The road is used by recreational walkers at present and is in a fragile state in places with trees growing through the earthen road and wash-outs destroying evidence of the engineering efforts. Historic features, spread along about 1–2 km include road cuttings (**Plate 18**), axe-marks in trees used to hold supports for timber-getters in a less-mechanised days (**Plate 19**) and evidence of repairs and upgrades being made to the road in the form of different styles of culverts (**Plate 20**).

Figure 18: Location of Historic heritage items noted during the survey.



5.6. Discussion

Given the location of the two Survey Study Areas (Wyong Forest and Honeysuckle), it was predicted that would be a low incidence of Historic relics had been registered in locations on the river plains and in townships (**Figure 17**), than in areas such as Wyong State Forest. In addition, as a result of Honeysuckle Park being a working property and, because of its size, a subdivision of a larger property, it too was predicted to hold no Historic relics.

In general, the survey results conformed to the predictive model and very few Historic sites were located as a result of the current survey. The remains of the forestry road beside Little Jilliby Jilliby Creek can be expected given the long tradition of logging in the area.

5.7. Likely impacts to Historic sites from the proposed works

Please refer to **Section 4.8.1** and **4.8.2** for information concerning the effects of longwall mining on the landscape. **Figure 19–Figure** 22 display the scale of various impacts on items of registered Historic heritage value.

Figure 19: Map showing the potential impact of subsidence on items of Historic heritage value.

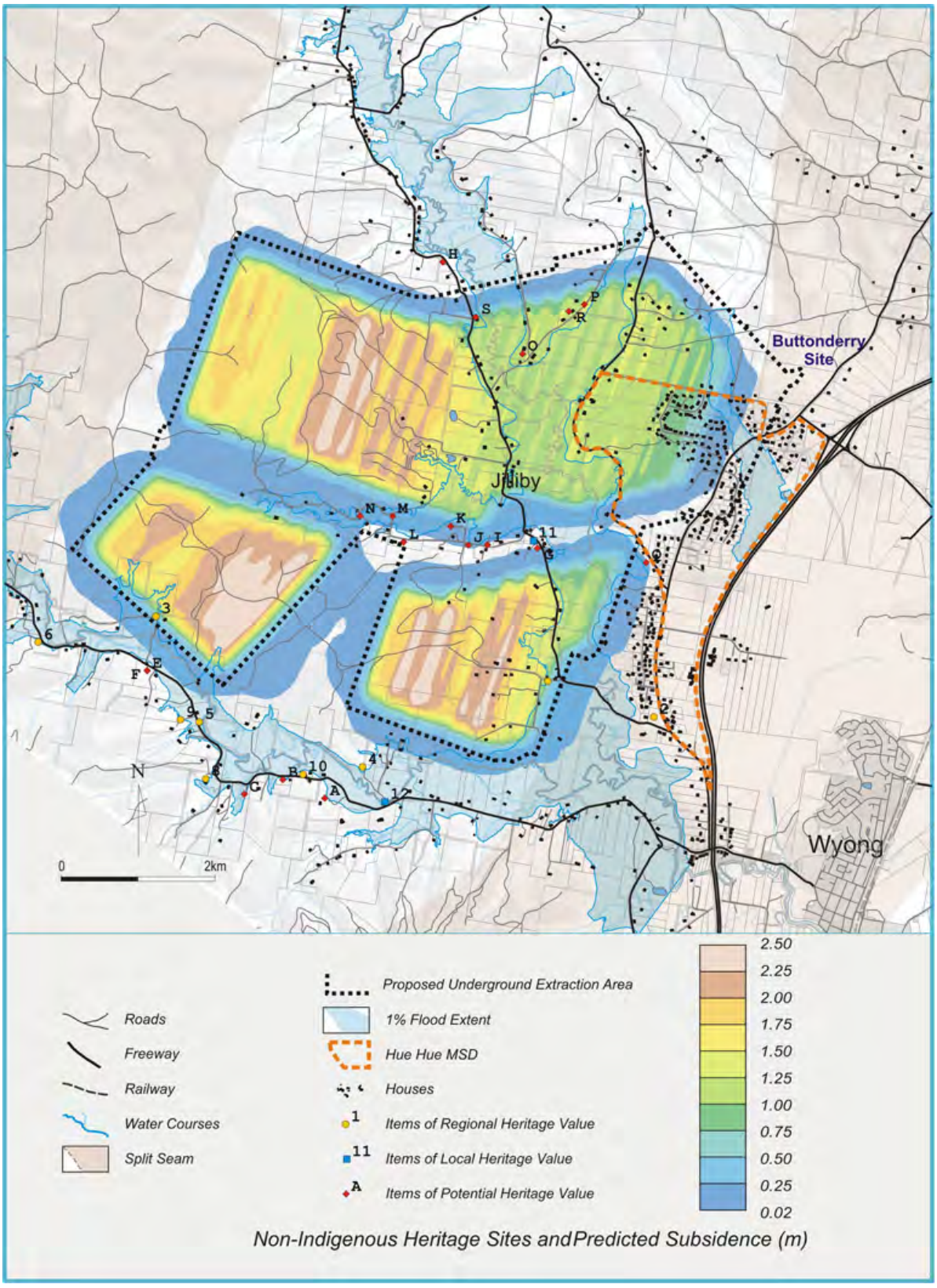


Figure 20: Map showing the potential impact of tilt on items of Historic heritage value.

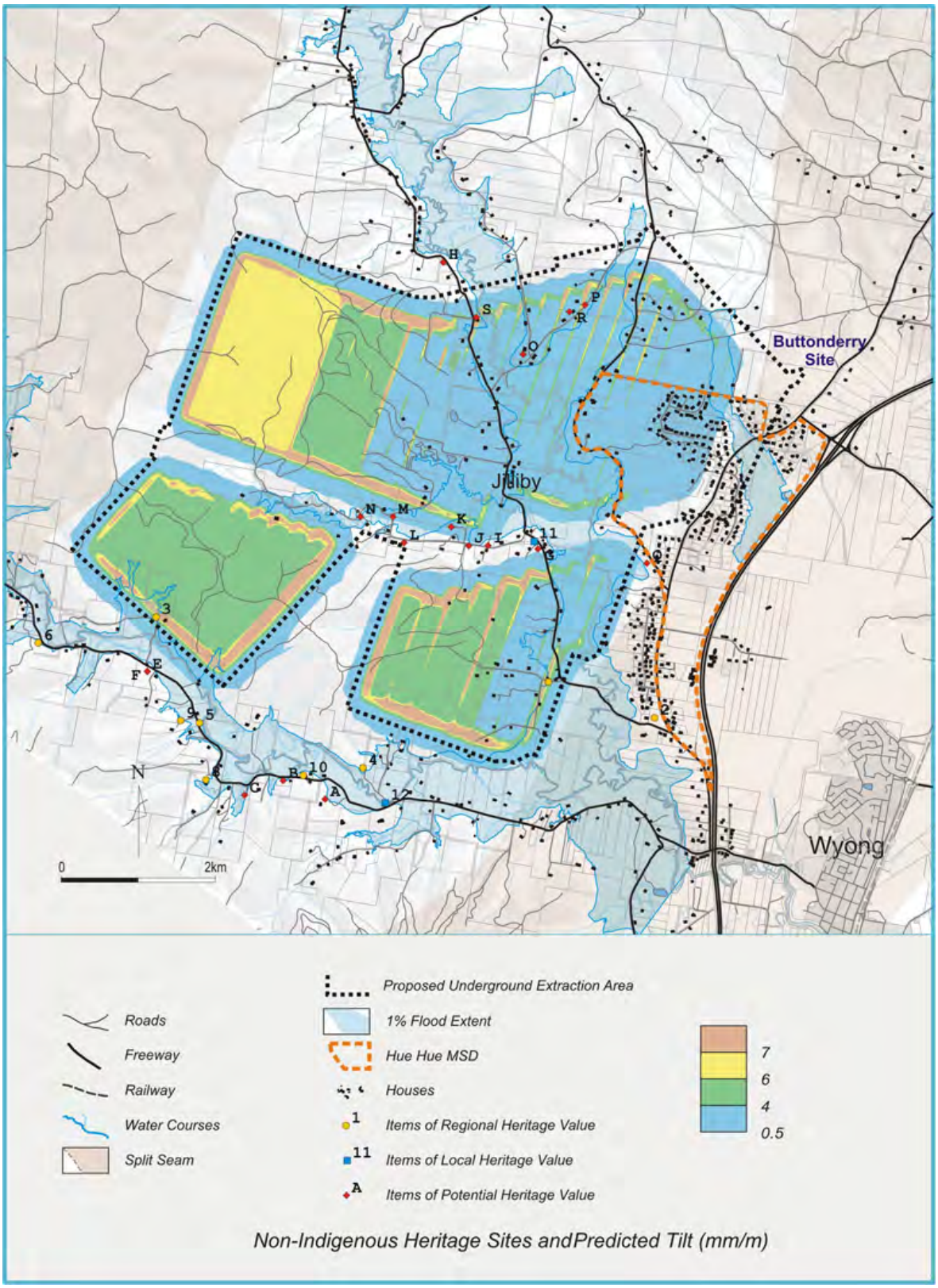


Figure 21: Map showing the potential impact of tensile strain on items of Historic heritage value.

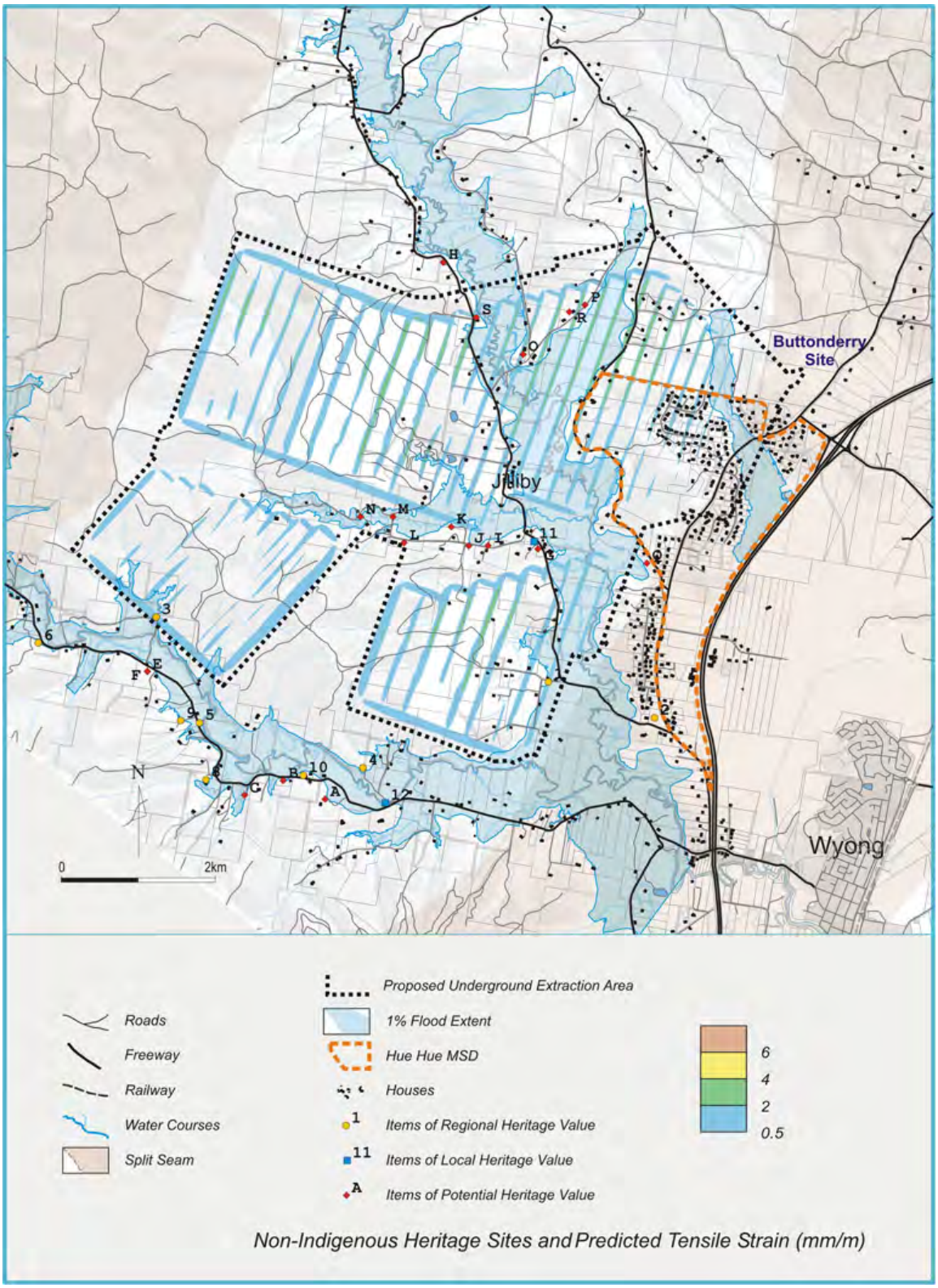
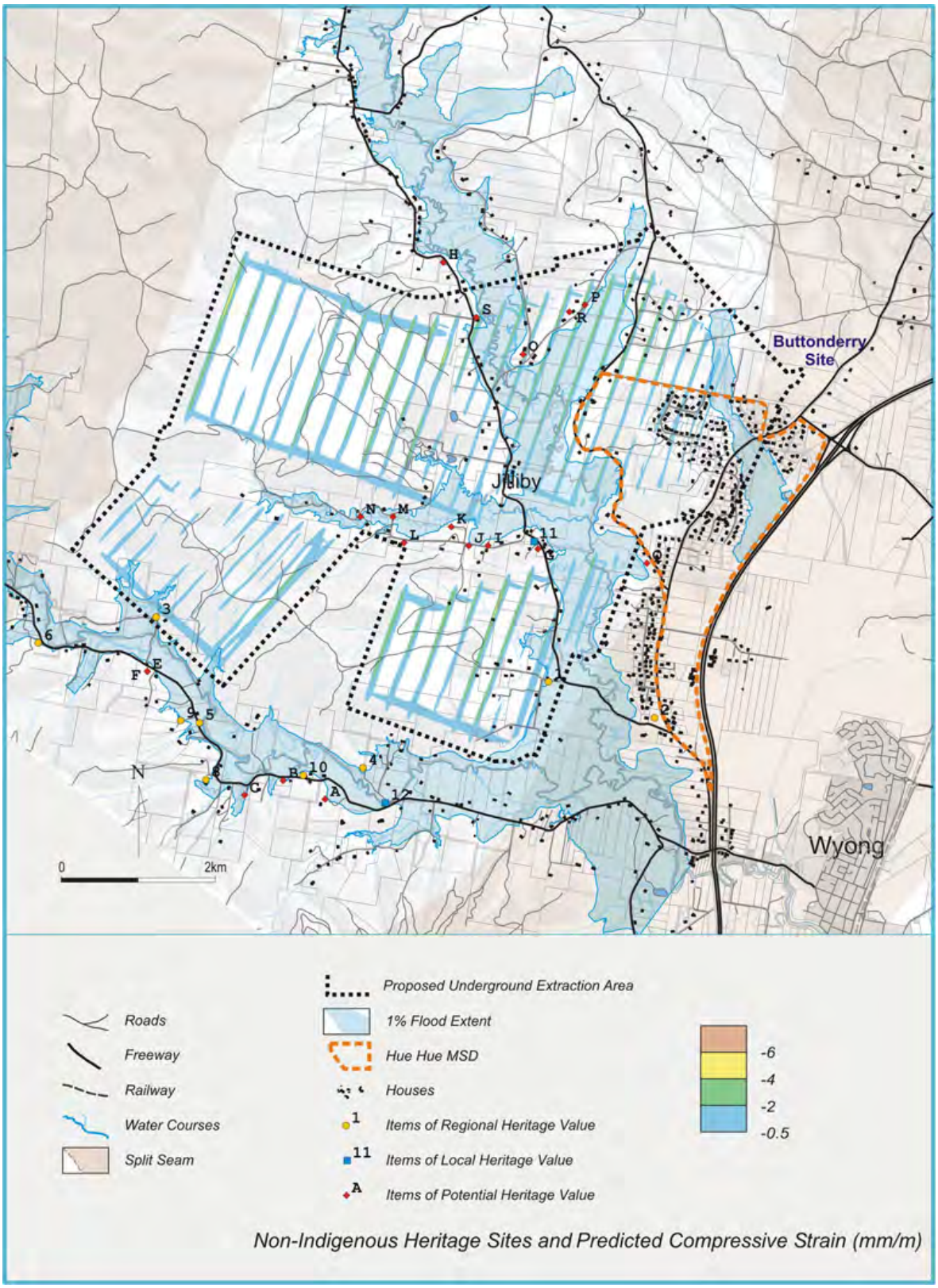


Figure 22: Map showing the potential impact of compression strain on items of Historic heritage value.



Items on the Wyong Shire LEP

Table 7 provides data on whether listed items are within the longwall mining impact zone and an indication as to the degree of likely impact. The exact levels of subsidence, tilt and flooding (1:100 yr) have been predicted through computer modelling.

Of the heritage items from the Wyong LEP listed in **Table 7**, only two are now within the subsidence zone of the mine plan. This has been reduced from five items as a result of the altered mine plan layout. Potential impacts at these locations have also been significantly reduced as a result of the mine redesign. Those that will be potentially impacted comprise one dwelling (Item 3) and a silo (Item 1) shown in **Figure 17** and **Plate 21**.

The silo (Item 1) is predicted to experience a tilt of less than 6.0 mm/m and subsidence of between 0.5 m to 0.75 m. This item will also be impacted by the new extent of the 1:100 year flood zone, possibly registering an additional 0.4 m depth of inundation beyond current inundation levels in the 1:100 year flood (**Figure 23**). Remedial actions will be required to protect this item as it is listed on the Wyong Shire LEP as regionally significant.

Item 3 (Bangalow, a private dwelling) will experience similar potential impacts although less vertical subsidence. Remedial action may be required at this property to ensure that its heritage value, assessed as regional, and condition, is not significantly compromised. As this item is also a domestic dwelling, issues of subsidence impact will be addressed as part of the broader community consultation programme and the Property Subsidence Management Plan (PSMP).

Importantly, Item 11 (Jilliby Public School) is located outside of the subsidence impact zone and therefore will experience nil to very negligible tilt and subsidence and also will not be impacted by the new extent of the 1:100 year flood zone. Nevertheless, the potential impacts and risks to this item (if any) and any appropriate management measures have to be addressed as part of the broader community consultation programme and (if necessary) by a Property Subsidence Management Plan (PSMP) as with the Bangalow residence noted above.

In addition, a component of the ACHMP to be prepared with the SMP will provide for the monitoring of any potentially affected structures over the ensuing years to assess the degree of impact and instigate additional mitigative measures should they be required.

Items recorded during field survey

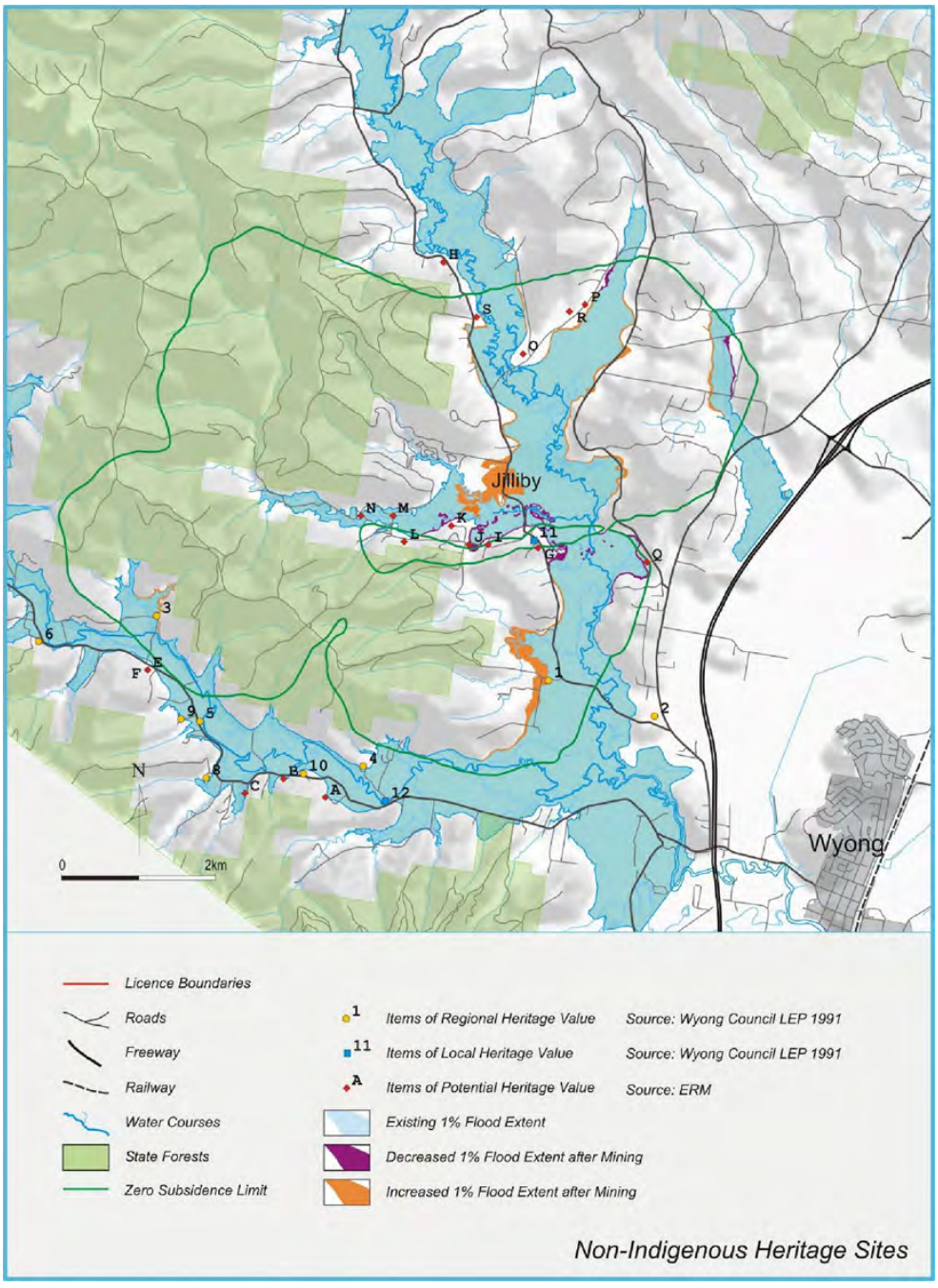
The Historic relics recorded during the current assessment (forestry road and infrastructure) are scattered along an earth-built roadway over an area of almost 2 kilometres. While the area will be subject to subsidence and other effects from the mining activity, it is assessed that there is only a low risk that the overall fabric of the complex would be destroyed by these actions. The road itself is already in a bad state of repair with large washouts frequently along its path while the other Historic items noted are small and unlikely to be impacted by mining-induced earth movement. As noted in **Section 5.7.2**, the heritage significance of these items is considered to be limited only to a local level.

Table 8 provides data on whether items recorded during the ERM 2001 survey are within the longwall mining impact zone and an indication as to the degree of likely impact.

Of these items, ten of nineteen are within the subsidence zone of the current mine plan. The potential for subsidence effects to cause significant impacts at these locations has also been significantly reduced as a result of the mine plan redesign.

As noted in **Section 5.7.2**, the heritage significance of these items is considered to be limited to a local level. More detailed assessment will be done as part of the ACHMP component of the relevant SMP following project approval. This will enable further assessment of the impacts to the heritage significance/values of these items as a result of the actual longwall mining and subsidence experience at the mine and will incorporate specific management measures for each affected item.

Figure 23: Map showing the extent of predicted flooding regimes after mining.



5.7.1. Assessment of significance – general principals

Significance assessment of Historic sites is conducted in accordance with *NSW Heritage Act 1977* requirements and is guided by the Heritage Council of NSW manual *Assessing Heritage Significance* (Heritage Council of NSW 2001).

The significance assessment process is a three-stage process:

- Step 1: Investigate significance;
- Step 2: Assess significance; and
- Step 3: Manage significance.

Significance assessments are carried out on the basis that decisions about the future of heritage items must be informed by an understanding of these items' heritage values. Four categories of heritage value are recognised in the Australia ICOMOS *Burra Charter* (Australia ICOMOS 1999):

- Historic significance;
- Aesthetic significance;
- Scientific significance; and
- Social significance.

Under the Heritage Council of NSW guidelines (2001), these values have been adjusted to conform to seven criteria for assessment:

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

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

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

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

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

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

Criterion (g): An item is important in demonstrating the principal characteristics of a class of NSW's

- cultural or natural places; or
- cultural or natural environments.

Items are categorised as having Local or State level significance. The level of significance is assessed in accordance with the geographical extent of the item's value. An item of State significance is one that is important to the people of NSW whilst an item of Local significance is one that is principally important to the people of a specific Local Government Area (LGA).

In addition to a level of significance, items are assessed as having one of the following grades of significance (Heritage Office of NSW 2001):

- **Exceptional:** an item whose elements are rare or outstanding and contribute directly to its heritage value;
- **High:** an item that retains a high level of original fabric and where the significance is not reduced by alterations;
- **Moderate:** an item whose elements are not themselves of heritage value but which contribute to the overall significance of the item; contains alterations and modifications;
- **Little:** an item that is difficult to interpret and whose altered/modified elements detract from significance; or
- **Intrusive:** an item whose elements damage its heritage value.

Thus, an item may be said to hold **High State significance** if it satisfies one or more of the above criteria, is important to the people of NSW as a whole and retains most of its original fabric.

5.7.2. Assessment of significance of Historic items

Significance assessments have already been applied to the listed items of Historic heritage significance currently registered as being of either local or regional significance on the Wyong LEP (**Table 7**). No further assessment of these items is considered necessary.

The Historic relics recorded during the current survey (old forestry road and related infrastructure) do not satisfy any the criteria as set out in **Section 5.7.1**. Relics of this type are very common across the State due to the widespread incidence of logging and there was nothing remarkable about the relics themselves or of their integrity that would qualify them for a heritage registration. As is often the case, they do, as a collection, have a very local significance that would be of interest to locals and visitors to the site if the features could be properly delineated and explained.

The items of potential Historic heritage significance recorded by ERM in 2001 (**Table 8**) will require limited further assessment to determine their potential significance. What is relevant to note here, however, is that these items were not recorded in heritage studies that led to the generation of the Wyong LEP heritage list. The majority of these potential items are privately owned dwellings or parts thereof (fences[11]/silos) while only two (bridges) are public utilities. Based on this, and on the brief inspection of many if these items by OzArk in 2007, it is considered that none of these locations is likely to possess anything greater than limited local significance, a level not worthy of listing on any statutory registers. Also relevant in this regard is that privately owned dwellings will be managed separately and intensively as part of the Property Subsidence Management Plan (PSMP), which will be prepared only after once overall project assessment has occurred and project approval granted.

It is hence determined as appropriate that determinations of the significance of these items of potential Historic heritage be completed only after overall Project Approval has been granted. At this stage limited consultation with the local historical society and possibly the Heritage office as well as landholders will assist in determining the heritage significance of these locations. This assessment will then form part of the ACHMP.

[11] The fence on the ERM list of heritage items (Item P) is apparently a new fence in heritage style. Robert Byrnes *Pers Comm*.

5.8. Relevant legislation

5.8.1. Introduction

Cultural heritage is managed by a number of State and National Acts. **Sections 5.8.2** and **5.8.3** summarise the legislative requirements in relation to heritage assets and development proposals.

5.8.2. State legislation

NSW Heritage Act 1977

This Act established the Heritage Council of NSW. The Heritage Council's role is to advise the government on the protection of heritage assets, make listing recommendations to the Minister in relation to the State Heritage Register, and assess/approve/decline proposals involving modification to heritage items or places listed on the Register.

Most proposals involving modification are assessed under Section 60 of the *NSW Heritage Act 1979*.

Developments classified as Major Projects or Critical infrastructure are assessed under Part 3A of the *Environmental Planning and Assessment Act 1979*.

Automatic protection is afforded to 'relics', defined as 'any deposit or material evidence relating to the settlement of the area that comprised New South Wales, not being Aboriginal settlement, and which holds State or Local significance' (note: formally the Act protected any 'relic' that was more than 50 years old. Now the age determination has been dropped from the Act and relics are protected according to their heritage significance assessment rather than purely on their age). Excavation of land on which it is known or where there is reasonable cause to suspect that 'relics' will be exposed, moved, destroyed, discovered or damaged is prohibited unless ordered under an excavation permit.

Environmental Planning and Assessment Act 1979 (EP&A Act)

This Act established requirements relating to land use and planning. The four areas controlled by the Act are:

- Part 3: environmental planning instruments, including cultural heritage;
- Part 3A: approvals process for Major Projects;
- Part 4: local government development assessments, including heritage. May include schedules of heritage items; and
- Part 5: environmental impact assessment requirements (for those developments not assessed under Part 3A or requiring consent under Part 4). State owned heritage items listed on LEPs are governed by Part 5.

National Parks and Wildlife Act 1974 (NPW Act)

This Act is administered by NSW Department of Environment, Climate Change and Water (DECCW). DECCW manages NSW parks, natural heritage and cultural heritage. The National Parks and Wildlife Act 1974 contains provisions for the protection of Indigenous archaeological items and sites and register of Indigenous sites is maintained by DECCW.

Unless relating to a Part 3A EP&A Act proposal, Indigenous cultural material is managed under Section 91 (reporting) of the NPW Act, and Section 90 (excavation). Cultural heritage is grounds for a Stop Work order under the provisions of the NPW Act.

5.8.3. Commonwealth legislation

Environmental Protection and Biodiversity Conservation Act 1999.

Amendments in 2003 established the National Heritage List and the Commonwealth Heritage List, both administered by the Commonwealth Department of the Environment, Water, Heritage and the Arts (DEWHA). Ministerial approval is required for proposals involving significant impacts to National/Commonwealth heritage places. Additionally, the Australian Heritage Council maintains the Register of the National Estate (RNE).

Australian Heritage Council Act 2003

This Act established the Australian Heritage Council as an independent advisory body regarding National/Commonwealth heritage places. The Council conducts assessments of listing nominations, advises the Minister for Environment and Heritage, maintains the RNE, and promotes the assessment and conservation of heritage items.

5.8.4. Applicability to the Study Area

State legislation

The current project is governed by Part 3A of the EP&AA Act.

Commonwealth legislation

No places or sites within the Study Area are governed by the EPBC Act.

6. Recommendations

6.1. Aboriginal Heritage

Recommendations for the management of Aboriginal cultural items within the Subsidence Study Area are as follows:

1. Based on review work and the resultant predictive modelling, as well as targeted survey in the Honeysuckle Park Study Area, it has been determined that the valley floors are unlikely to retain intact Aboriginal heritage features. The sample survey of the accessible portion of this landform supported this model. No further Aboriginal archaeological investigation is considered necessary in these areas.
2. The presence of previously recorded axe-grinding groove sites in the Wyong Forest Study Area provides positive evidence for the presence of Aboriginal sites in these wooded ridges and valleys. The current survey of accessible creek lines and overhangs has relocated these axe-grinding groove sites, located further such sites along the creek lines and confirmed the premise that the sandstone formations of the Study Area appear to rarely form rock shelters. It is therefore considered that an overall characterisation of the likely Aboriginal heritage resource over the zero subsidence area has been achieved; however, it is also acknowledged that further sites (axe-grinding grooves, small open sites) may be present. Consequently, panel by panel pre-mining survey within the zero subsidence portions of the Wyong State Forest should be undertaken under the auspices of an Aboriginal Cultural Heritage Management Plan (ACHMP).
3. The ACHMP should be developed to include a system of Aboriginal site monitoring of identified sites to determine their condition pre-mining, immediately post-mining as well as annually for several years after mining has occurred.
4. Post approval surveys should be undertaken in partnership with the Aboriginal community, as per the Department of Planning *Part 3A EP&A Act Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation*. This ensures cultural information relevant to the project is also captured.

6.2. Historic Heritage

5. Further significance assessments should be applied to the list of potential heritage locations recorded by ERM in 2001 (**Table 8**). Such assessments, to be undertaken as part of an ACHMP under the SMP, should be undertaken through applying the NSW Heritage Office criteria, and if necessary, undertaking landholder consultation and as well as investigation through historical societies, Shire Council etc. This will enable further understanding of the heritage values/significance of these locations and allow the development of appropriate mitigative measures closer to the time when future mining and subsidence will occur in those areas. This process for the SMP will be the main detailed assessment process to evaluate potential impacts and provide appropriate and contemporary mitigation measures developed in consultation with the landowner.
6. With regards to the two items on the Wyong LEP that will be impacted by the potential subsidence effects longwall mining in the Subsidence Study Area (a silo and a house: **Table** 7) further assessment and the development of appropriate mitigative measures will be

required. As these items are privately owned, potential impacts to them will also be addressed in the PSMP. Consultation with the Wyong Shire Council and the Heritage Office may also be required.

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Plates

Plate 1: View from Maculata Rd towards Daniels Point across Little Jilliby Jilliby Creek.

Plate 2: Typical view of the slopes below the ridgeline in the Wyong State Forest. Slopes were commonly greater than 30%. Open woodland that had been logged characterised the vegetation.

Plate 3: A typical view of the headwaters of a waterway in the Wyong State Forest Survey Study Area. Drainage features of 1st order waterways are characterised by steep, v-shaped valleys with many sandstone outcrops.

Plate 4: A typical view of 2nd order waterways in the Wyong State Forest Survey Study Area. This view characterises the more-mature phase of drainage features where a gentler gradient allows alluvium to accumulate covering the bedrock in many places.

Plate 5: A large overhang is inspected in the Wyong State Forest Survey Study Area. Overhangs as large as this were very rare.

Plate 6: Overhangs in the Wyong State Forest Survey Study Area were mostly too small to have been used as occupation shelters.

Plate 7: The extremely fragile nature of the rock in the area where the largest overhangs were located on Whitemans Ridge.

Plate 8: An example of the regrowth forest that characterises much of the Wyong State Forest Survey Study Area. In this case on Little Jilliby Jilliby Creek, the regrowth appears to be very consistent and less than 10 years old.

Plate 9: Ground surface visibility: Top: an example of visibility in the ridge environments, Bottom: an example of visibility on valley floors. In both cases, leaf littler reduces visibility to zero.

Plate 10: A view of the Honeysuckle Park Survey Study Area. In this view terracing from floods and the changing location of Jilliby Jilliby Creek can be seen.

Plate 11: Lush grass covers the ground surface in the Honeysuckle Park Survey Study Area reducing ground surface visibility to almost zero in most places.

Plate 12: Vegetation along Jilliby Jilliby Creek (to right) is somewhat intact, although most of the Honeysuckle Park Survey Study Area has been cleared.

Plate 13: WSF-AG1: Top: general view of site; bottom: detail of two of the grooves.

Plate 14: WSF-AG2: Top: general view of site; bottom: detail of one groove.

Plate 15: WSF-AG3: Top: general view of site; bottom: detail of two of the grooves.

Plate 16: WSF-AG4: Top: general view of site; bottom: detail of two of the grooves.

Plate 17: A view of the relocated DECCW site # 45-3-3041 in Myrtle Creek (Wyong State Forest Survey Study Area).

Plate 18: A view of a road cutting for the forestry road running along Little Jilliby Jilliby Creek.

Plate 19: Axe marks in a tree stump beside the forestry road along Little Jilliby Jilliby Creek.

Plate 20: Different phases of culverts beneath the forestry road along Little Jilliby Jilliby Creek. On the left is the older form of drain made from tin, while a concrete drain to right suggests the road was re-engineered at some point and new drainage features installed. There is no clue as to when these jobs were done.

Plate 21: Brick and iron silo that comprises Item 1 of the Wyong LEP listed items in **Table 7**. This site, assessed as being regionally significant, will be affected by subsidence related impacts.

Appendix 1: Aboriginal Community Communication Log

WALLARAH 2 COAL PROJECT, WYONG IEC						
STAGE 1 – NOTIFICATION & REGISTRATION – ADVERT	**DATE AD WRITTEN**	**DATE AD APPEARS**	**EOI CLOSE**	**COMMENTS**	**STAGE 1 – NOTIFICATION & REGISTRATION – ADVERT**	**DATE AD WRITTEN**
Advertisement		23.08.06				Closes 8.9.06 placed by IEC, submissions to be in writing to OzArk
STAGE 1 LETTERS	DATE SENT				Contacted by /Organisation	Comment
Darkinjung LALC	28.8.06			Expressed interest in participating in project		
Native Title service - Steve Ryan	5.9.06			KAS called native title service to find out where to forward letter for Wallarah No. Coal Project	Phone Steve Ryan	
Natalie Rotahah, Native Title Service Coffs Harbour.	5.9.06			Forward to Natalie Rotahah Com. Facilitator in Coffs Harbour requesting knowledge of existing or pending NT claims. Response requested by 18.9.06	letter	
Local Government - Wyong Shire Council	5.9.06			Mr K Yates, GM letter seeking details of indigenous groups know to council	letter	
DECC - Syd office	5.9.06			Letter seeking details of indigenous groups know to DECC in Wyong area	letter	
DECC - North East - Brendan Diacono	15.9.06			Letter from DECC re indigenous groups in Wyong district. Guringai Tribal Link Aboriginal Corp, Mur-Roo-Ma Inc.	letter reply	
Wyong Shire Council	19.9.06			Called to reply to letter with name of Gudaga who he understands is a traditional owners group in the Wyong area and knew the surname 'Smith' believed to be associated with group but no further contact details available.	Phone call from Jonathan Luke	
DECC	20.10.06			Seeking phones/faxes for groups provided	Brendan Diacono	

WALLARAH 2 COAL PROJECT, WYONG IEC						
STAGE 1 – NOTIFICATION & REGISTRATION – ADVERT	**DATE AD WRITTEN**	**DATE AD APPEARS**	**EOI CLOSE**	**COMMENTS**	**STAGE 1 – NOTIFICATION & REGISTRATION – ADVERT**	**DATE AD WRITTEN**
						Fieldwork 12th – 14th October 2006. Sites officers from Darkinjung LALC and Guringai Tribal Link Aboriginal Corp participated.

Date	Person Contacted	Organisation	method	Address	Oz rep	comment
18.12.09	Chairperson	Darkinjung LALC	Mail	Darkinjung LALC c/- Chairperson PO Box 401 Shop 3 / 61 Howarth Street Wyong NSW 2259		Sent letter with draft report inviting comment by 15.01.10 and advising that fieldwork to assess the subsidence area will also be scheduled in the new year.
18.12.09	Chairperson	Guringai Tribal Link Ab.Corp	Mail	Members: Guringai Tribal Link Ab.Corp c/- Chairperson 19 Coolabah Road Wyongah NSW 2259		Sent letter with draft report inviting comment by 15.01.10 and advising that fieldwork to assess the subsidence area will also be scheduled in the new year.
07.01.10	Chairperson	Darkinjung LALC	Email / mail	Email: 'darkinjung@dlalc.org.au'		Sent email with copy of letter advising that fieldwork is scheduled for January 25-29 inclusive and inviting two representatives from DLALC. Noted dates also for test excavation and usual information re: fee offer and information on area(s) to be surveyed. DLALC should contact OzArk prior to Monday 18th January, and provide copies of insurances, if they wish to participate.
07.01.10	Chairperson	Guringai Tribal Link Ab.Corp	mail	Members: Guringai Tribal Link Ab.Corp c/- Chairperson 19 Coolabah Road Wyongah NSW 2259		Sent letter advising that fieldwork is scheduled for January 25-29 inclusive and inviting two representatives from GTLAC. Noted dates also for test excavation and usual information re: fee offer and information on area(s) to be surveyed. GTLAC should contact OzArk prior to Monday 18th January, and provide copies of insurances, if they wish to participate
12.01.10	Kara	Darkinjung LALC	PH: 4351 2930			Spoke to Kara who advised that they received the correspondence yesterday and that the manager will be looking over the documents. Left contact number for return call.
12.01.10	Tracey-lee Howie	Guringai Tribal Link Ab.Corp	PH: 4392 8743 Ph: 4397 4175 Ph: 0404 182 049 New #:	GTLAC PO Box 4061 Wyongah NSW 2259		Both landline numbers have been disconnected. Phoned mobile and spoke to Tracey-lee who advised they have moved office (2 years ago) thus she has not received the draft reports or the recent letter advising dates for field work. Obtained email address and forwarded letter advising hard copies of the report will be reprinted and sent to PO

Date	Person Contacted	Organisation	method	Address	Oz rep	comment
			4396 8743 E: 'guringai@kooee.com.au'			box given, email also.
13.01.10	Suzanne Naden	Darkinjung LALC		E: SNaden@dlalc.org.au'	CB	Hi Cheryl I am responding to your request for our feedback regarding the above project for Thursday this week. However, as we only returned to work on Monday 11 Jan 2010 and only just received your report we will not be able to respond by your due date. However we express our Interest in this project now. As Darkinjung LALC are a significant land owner in the Bushells Ridge area, because of the significance of our land holding we require more time to evaluate the report and to formulate a respond. A formal written respond will be sent from Darkinjung by Friday 22nd Jan 2010. Regarding a site officer for the week beginning 25th Jan 2010 to 29th Jan 2010 (inc public holiday) I will try to arrange someone however you must realise that most people will not work on the public holiday also students return back to school this week also. Darkinjung Schedule of Rates are $165.00 per hour per person, however due to the significance of this project we may be able to reduce the fee to $125.00 per hour per person. Should you have any further enquires please do not hesitate to contact on my numbers below. cheers Suzanne Naden Operations Manager Darkinjung Local Aboriginal Land Council 168 Pacific Highway, Watanobbi NSW 2259 PO Box 401 Wyong NSW 2259 Ph |02 4351 2930 Fx |02 4351

Date	Person Contacted	Organisation	method	Address	Oz rep	comment
						2946 www.darkinjung.com.au *fee approved by Robert Byrnes / IEC
15.01.10	Tracey-lee Howie	Guringai Tribal Link Ab.Corp			CB	Received, via fax, certificate of Currency from Tracey-lee GTLAC exp. 24/03/10 Tracey-lee also confirmed that their sites officer was able to work on the Public Holiday, I advised I would be in touch via phone as her internet is currently down and she is not receiving emails
20.01.10	Suzanne Naden	Darkinjung LALC		E: SNaden@dlalc.org.au'		Received DLALC Certificate of Currency and schedule of rates, approved & signed by IEC & emailed to DLALC with information re: meeting place for survey on Monday.
21.01.10	Tracey-lee Howie	Guringai Tribal Link Ab.Corp		Ph: 0404 182 049		Spoke to Tracey-lee and confirmed meeting time and rates billable. Tracey-lee is one of the sites officers and GTLAC will have two sites officer per day for five days for the survey.
22.01.10	Sean Gordon	DLALC		s.gordon@dlalc.org.au	CB - via email	Hi Cheryl, on reviewing the Archaeological Report provide by Ozark, Darkinjung would like hold back from responding until after next week to see if there are any further artefacts found and a more recent survey has been carried out by one of our Officers. Should you need to discuss our position please contact me on the mobile number below. Regards Sean Gordon Chief Executive Officer Darkinjung Local Aboriginal Land Council 168 Pacific Highway, Watanobbi NSW 2259 PO Box 401 Wyong NSW 2259 Ph |02 4351 2930 Fx |02 4351 2946
						Fieldwork 25th – 29th January 2010. Sites officers from Darkinjung LALC and Guringai Tribal Link Aboriginal Corp participated Kyle Howie / Warren Howie / Tracey Howie / David Pross

Date	Person Contacted	Organisation	method	Address	Oz rep	comment
						(GTLAC) Darren Carney / Sharon Hodgetts (DLALC) Ben Churcher (OzArk) Pauline Hams (OzArk)
03.02.10	Sharon Hodgetts	DLALC	Email	scholajh@tpg.com.au	BC	Ben Churcher emailed plotted results / maps of area surveyed
03.02.10	Darren Carney	DLALC	Email	d.carney@dlalc.org.au	BC	Ben Churcher emailed plotted results / maps of area surveyed)
13.02.10	Tracey-lee Howie	GTLAC	Email	tracey@guringai.com.au	CB	Received copy of GTLAC report relating to the recent survey.
26.02.10	Suzanne Naden	DLALC	Email	E: SNaden@dlalc.org.au’	CB	Suzanne indicated DLALC would submit their report on Monday 1/3/10
01.03.10	Suzanne Naden	DLALC		E: SNaden@dlalc.org.au’ 0404479569	CB	Suzanne unable to send report will have it first thing tomorrow (02.03.10).
01.03.10	Suzanne Naden	DLALC		E: SNaden@dlalc.org.au’ 0404479569	CB	Emailed copy of OzArk entire revised report (minus DLALC response letter)
01.03.10	Tracey-lee Howie	GTLAC	Email	tracey@guringai.com.au	CB	Emailed copy of OzArk entire revised report (minus DLALC response letter)

Appendix 2: Aboriginal Community Correspondence

Guringai Tribal Link
Aboriginal Corporation
ABN 18 351 198 069. ICN 4270
(Traditional Owners of the NSW Central Coast)

PO Box 4061,
Wyongah NSW 2259

Phone:(02) 4396 8743
Fax:(02) 4396 9525
Mobile: 0404 182 049
Email: tracey@guringai.com.au

4th Feburary, 2010

Ben Churcher
Archaeologist
OzArk. Environmental
& Heritage Management. Pty.Ltd.
145 Wingewarra Street,
Dubbo, NSW, 2830

Emailed to: cheryl@ozarkehm.com.au

Dear Ben,
Please find following;
* GTLAC report for Wallarah 2 Coal Project, mine subsidence assessment.

Thank you for including the Guringai Mob in this project.
We look forward to working with you in the future.

Tracey-lee Howie
Chairperson
Female Cultural
Heritage Officer
(contacts above)

ABORIGINAL CULTURAL HERITAGE IMPACT ASSESSMENT REPORT FOR WALLARAH 2, COAL PROJECT WYONG NSW.

Prepared by Guringai Tribal Link Aboriginal Corporation.

INTRODUCTION;

Guringai Tribal Link Aboriginal Corporation(GTLAC) was contacted by OzArk, Environmental & Heritage Management Pty.Ltd. (OzArkEHM) for our participation in an Aboriginal Cultural Heritage Impact Assessment for the Wallarah 2 Coal Project, Wyong, NSW.

This assessment was to establish the presence or absence of Aboriginal materials/artefacts, scar trees, rock engravings, camping/hunting areas and assess potential impacts to them due to mine subsidence.

STUDY AREA;

The study area is within the Wyong Local Government Area and includes the Wyong and Jilliby State Forest/ Conservation areas, Calman's Gully, Myrtle Creek, other creeklines within the study area, Whitemans Ridge and Honeysuckle Farm, Jilliby Road, Jilliby.

METHODOLOGY;

The survey was conducted on foot. The main focus for this survey was centred around creeklines and ridgetops, as these being the likely areas for rock shelters/overhangs (occupational areas) and grinding groove/engraving sites, which have the potential of being effected by mine subsidence.

Representatives for GTLAC were, Tracey Howie (Mon-Fri), Kyle Howie (Mon), Warren Howie (Tues) and David Pross (Wed, Thur, Fri).

HISTORICAL INFORMATION;

The study area for the proposed mine subsidence, has been and still is, home to the Guringai speaking Mob (Wanangani), for generations and seasonally occupied in various locations by the Darginyung and Awaba peoples. Pre and post European settlement.

Well known and documented members of the Guringai mob were; Boongaree, Matora, Mosquito, Jewfish, Cora(Gooseberry), Flathead, Long Dick, Sophy (Booratora), Kitty and Charlotte Ashby.(nee.Webb).

Thier presence in this area was initially recorded pre 1790. References to these Guringai speaking people are located on Government Blanket list and Court Bench records taken in the Gosford/Wyong areas and Colonial Secretary minutes, which are held at Gosford City Library and early recordings from surveyors John Fraser,Chappell, Felton & Sarah Matthews, journals written by Rev.L.E.Threlkeld, Rev. Glennie, Matthew Flinders, Augustus Earl, R.H Mathews, and current AIATSIS maps.

The traditional areas occupied by the Guringai speaking comprises of; All of Port Jackson catchment, including the tributaries of Middle Harbour and Lane Cove River, the Broken Bay catchment, including tributaries of Brisbane Water, Cowan Creek and Pitt Water,the water shed along Peats Ridge, following along the range through to Kulnura, as well as the Lakes of the Central Coast to lower Lake Macquarie.

Guringai - People of the Coast.

Darginyung - People of the Ranges

Darug - People of the Plains. (as described by J.Fraser 1892)

Charlotte Webb was the very first recorded Aboriginal birth on the Central Coast. She was born in 1823 in Gosford. Charlotte was the daughter of Sophy (Booratora), daughter of Boongaree (Bungaree) and Matora. Sophy was sexually assulted by Ship-building merchant, James Webb. Charlotte was the result of this rape.

Well known and documented Aboriginal man of Brisbane Waters, was Billy Faulkner. His presence was initially recorded on the Central Coast in the 1860's. Billy Faulkner was found drowned in Tuggerah Lake in 1875.

Well known and documented Darginyung (Wollomi) woman, was Sophie Newman. Her presence was first recorded on the Central Coast in the 1860's. Descendants of Sophie settled here and some descendants are still living within the Wyong Shire today.

Well known and documented Awaba couple were, Ned and Margaret. They were known as King Ned and Queen Margaret of the Awaba. Descendants of Ned and Margaret are still living in parts of the Central Coast and Lake Macquarie today.

FINDINGS;

An abundance of native fauna species, particualy wombats and lizards are currently utilising a large portion of Calmans Gully, the south-western corner of the study area. (See attachment 1, Pic #1.)

A series of water holes and grooves were identified approximately 200mtrs down stream of the previously recorded Aboriginal grinding groove site on Myrtle creek. They consist of 3 water holes in a line heading down stream (See attachment 1, Pic #2.). Approx. 3mts up stream are 2 large grooves running north-south and approx. 1300mm long x 600mm wide. (See attachment 1, Pic #3.) and approx. 4mts further up stream is 2 water holes. (See attachment 1, Pic #4) GPS reading, GMA: 0346925E/6323017N.

WSF/AG1, consists of a minimum of 12 axe grinding grooves ranging from 80mm - 250mm in length and 40mm - 80mm in width and 6 water bowls ranging from 90mm round - 150mm round. WSF/AG1 is located in a fork, on a tributary of Little Jilliby Creek, within the Jilliby State Conservation Area, approximately 100mtrs south-west of Whitemans Ridge Road. GPS reading, GDA:56345580E/6325095N (See attachment 1, Pic #5).

WSF/AG2, consists of minimum of 2 axe grinding grooves approx. 330mm x 80mm and is situated approximately 50mtrs down stream of WSF/AG1. (See attachment 1, Pic #6.)

WSF/AG3, consists of 2 axe grinding grooves. 1 x 130mm long and 80mm wide. 2 x 400mm long and 80mm. and is approx. 95mtrs down stream of WSF/AG2. (GPS reading, GDA: 034581E/6324777N) (See attachment 1, Pic #7.)

Relocated previously recorded axe grinding groove site in tributary of Myrtle creek. (GPS reading, GMA:0346925E/6323017N)

Large sandstone rock shelters and overhangs were identified along the ridge top at the end of Whitemans Ridge Road. Closer inspection revealed no visible art, deposits or engravings at the time of this survey. (See attachment 2, Pic #8.)

WSF/AG4, consists of 5 axe grinding grooves, all running east - west, ranging from 250mm - 400mm long and 80mm - 150mm wide and are located in the creekbed of a tributary of Wyong Creek, approximately 1km south of Smithys South Road, Jilliby. (Zone 56) (GPS reading, GDA:345784E/6318982N)

Potential stone artefact deposit, isolated find, semi in-situ, on exposed surface in cattle paddock of Honeysuckle Farm, Jilliby Road, Jilliby and consists of quartzite material. Due to this stone material being inconclusive of all artefact qualities and characteristics, it's location was recorded for the purposes of this report and for future reference but it will not be recorded on the AHIMS Database with Department of Environment, Climate Change & Water (DECCW). (GPS reading, GDA:349543E/6321342N). (See attachment 2, Pic #9 & #10.)

RECOMMENDATIONS:

GTLAC recommend that an Aboriginal Cultural Heritage Management Plan be prepared in conjunction with GTLAC and DLALC for future monitoring and/or inspections of the recorded Aboriginal sites and other known and recorded Aboriginal sites within the wider study area.

Attachment 1.

Pic #1
Wombat habitat in Calmans Gully.

Pic #2
Series of 3 water holes, Myrtle creek.

Pic #3
2 large grooves, Myrtle creek.
Approx. 3mtrs up stream of Pic #2.

Pic #4
2 water holes, Myrtle creek.
Approx. 4mtrs up stream of Pic #3.

Pic #5
WSF/AG1.
Apprx. 12 axe grinding grooves in tributary of Little jilliby Creek.

Pic #6.
WSF/AG2
2 axe grinding grooves.
Approx. 50mtrs down stream of WSF/AG1

Attachment 2.

Pic #7
WSF/AG3
2 grinding grooves in tributary of
Little Jilliby creek.
Approx. 95mtrs down stream of WSF/AG2.

Pic #8
One of a series of sandstone rock shelters,
Ridgetop at end of Whitemans Ridge Road, Jilliby.

Pic #9
Inconclusive quartzite stone artefact.
Honeysuckle Farm, Jilliby.

Pic #10
Exposure in pastural paddock
were inconclusive artefact, Pic #9 was identified.

This report was written by Tracey Howie, Senior Female Cultural Heritage Officer, Guringai Tribal Link Aboriginal Corporation. PO Box 4061, Wyongah, NSW, 2259.

Should you have any queries about this report and the information contained in it, please don't hesitate to contact me on 0404 182 049 or 4396 8743. email: tracey@guringai.com.au.